

Monetary Policy, the Lower Bound, and Inequality: Evidence from a Panel VAR

Master's Thesis

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Abstract

To cope with persistently low inflation and slacking economic growth in the wake of the Great Recession, many central banks around the world have introduced a range of unconventional monetary policy measures as traditional interest rate policy had already been exhausted. Their critics often argue that those policies only benefit a very few and thus increase economic inequality. To address this question, I discuss different channels through which monetary policy might transmit to and change the income distribution. A vector autoregressive model on panel data of 22 countries is used to study the question empirically. I thereby use a monetary policy indicator that includes the implementation of quantitative easing and alike to identify monetary policy shocks. There is a significant negative effect of expansionary monetary policy on the Gini coefficient of market income inequality in the medium run. The fact that monetary policy tries to stabilise the labour market seems to be the important channel. However, other indices show that inequality due to top incomes does not fall quite as much, especially when including the most recent available data. Concerns that unconventional monetary policies increase income inequality, especially due to the highest percentiles, should not be ruled out prematurely.

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1 Introduction

After the Great Recession, many central banks have started implementing new tools. While interest rates had been the main instrument before, the crisis and succeeding hysteresis were so severe they believed lowering the stance of monetary policy to zero was not sufficient to counter the risks of depression and deflation. Because it was believed that policy rates cannot fall substantially below zero (referred to as the zero lower bound), other expansionary measures became necessary. Their implementation was to a large extent unknown territory, and they became known as unconventional monetary policy. However, unconventional policies can have unconventional consequences; and with several years' experience of a sluggish economy and booming share prices since 2009, voices about increasing inequality induced by monetary policy are more and more heard.

Critics of central banks in general, and of unconventional interventions in particular, often alert to the danger of financial instability, the distortion of markets, and economic inequality. Liquidity that is offered via large asset-purchasing programmes, they argue, only reaches a very few: It is mainly absorbed by stock, bond and real estate markets; and "ordinary folks on main street" are neither able to invest in securities nor can they sell their homes. Therefore, they would not be able to reap the profits of unconventional policies.

The debate on income inequality is a vivid one, both in society and in academia. Many people, politicians and public intellectuals fear that society is drifting apart.

It is no secret that the past few decades of widening inequality can be summed up as significant income and wealth gains for those at the very top and stagnant living standards for the majority. I think it is appropriate to ask whether this trend is compatible with values rooted in our nation's history. *Janet Yellen, 17 October 2014*

The fact that the Chairwoman of the Federal Open Market Committee (FOMC), the most looked at monetary policy body, is concerned about inequality is remarkable but not new. Not new, because monetary policy decisions always have and will have distributional effects. As a matter of fact, monetary policy-makers influence the value of money, assets, and credit. In the past two decades, however, many central banks have successfully managed to keep prices stable and anchor inflation expectations. Distributional effects of monetary policy were not part of the debate on inequality, which was dominated by financial deregulation, technology, and globalisation.

Many people have concerns about the rising gap between rich and poor, which most prominently manifests itself by the popularity of contributions from Piketty (2014) and Deaton (2015). Chairwoman Yellen's statement comes at a time where central banks' unconventional monetary policies have been in place for more than five years. The success such as rising asset prices is widely accepted, the broader results in terms of fighting hysteresis and stabilising prices are arguably accomplished. But voices critical of the effects on the allocation of resources and increasing inequality have increased. The statement indicates that monetary policy-makers have again become part of the inequality debate, even though their role is not entirely clear.

Because the use of new instruments can have different consequences than conventional monetary policy, in particular with respect to the distribution of wealth and the allocation of resources, it has become more important that those consequences are identified, weighed and where necessary mitigated. *Mario Draghi, 14 May 2015*

This thesis dedicates itself to finding channels through which monetary policy, whether conventional or unconventional, affects the distribution of income in an economy. Specifically, it tries to put some flesh on the bones of the ongoing debate by empirically testing whether increasing inequality is a consequence of the ballooning central banks' balance sheets seen in recent years.

To do so, I use a dynamic vector autoregressive model, a popular tool in Empirical Macroeconomics, to study the impact of expansionary monetary policy shocks on inequality measures. While the public debate has triggered a few similar country-specific studies on the topic (such as Coibion, Gorodnichenko, Kueng, and Silvia (2012) or Saiki and Frost (2014)), I contribute to the literature in two ways. First, I use a new monetary policy indicator proposed by Lombardi and Zhu (2014) to proxy short-term interest rates and balance sheet tools in one variable and to identify monetary policy shocks – as this indicator is able to “translate” unconventional measures back to a fictional short-term interest rate to cope with the empirical problem of policy rates being restricted to the non-negative domain. Secondly, I use a set of panel data for 22 economies. This allows to exploit the cross-section of history, because countries have applied a wide set of unconventional policies from asset-purchasing programmes to direct exchange rate interventions or the more subtle tool of communication. The panel dimension also helps to cope with data issues; reliable data for many countries is only available in annual frequency, and most measures are quite persistent; which makes it almost impossible to find a meaningful effect from the relatively short history of unconventional monetary policy in a single country.

The results suggest that after an expansionary monetary policy shock, inequality indices increase at first but then fall substantially. This is attributed to the stabilising effect on the labour market in the medium term. Over the course of about ten years, the effect evaporates. These findings are quite robust. Furthermore, there is little evidence that increasing income inequality measured by broad indices such as the Gini has to be expected from quantitative easing and alike. However, the inverted Pareto-Lorenz coefficient, which puts more weight on rich households, falls less in the medium run and then rises faster, especially when the most recent available data is included. This suggests that top incomes play an important role and have an inequality augmenting effect in times of a binding lower bound.

The remainder of the paper is organised as follows: Section 2 provides an overview of the main concepts needed to assess the research question. It introduces the transmission channels of monetary policy, both conventional and unconventional, and briefly summarises trends and findings in inequality research. This might shed some light on how the two interact and motivates the different channels to be considered in the empirical assessment. A selection of six countries – namely the United States, Japan, the United Kingdom, Switzerland, Sweden, and New Zealand – is used throughout the paper in order to illustrate facts and mechanisms. Section 3 describes the model to study how the income distribution responds to monetary policy shocks as well as the data and the Bayesian methods used to estimate it. Section 4 covers the analysis of results of different model specifications and draws conclusions for monetary policy in general and unconventional tools in particular. A closer look on top incomes and periods of a binding lower bound with unconventional monetary policies rounds off the analysis. Section 5 concludes.

2 Background and literature review

2.1 Monetary policy instruments

Monetary authorities all around the world control the supply of money. They are instructed to insure monetary stability in general, by maintaining price stability or securing full employment. In the past 25 years, most central banks have become inflation targeters to a smaller or greater extent.

2.1.1 Inflation targeting and the transmission mechanism of short-term interest rates

The post-Bretton Woods era of the 1970s and 1980s saw high and volatile inflation rates in many countries. In 1990, New Zealand was the first country whose central bank adopted the strategy that is nowadays considered the reason many countries have managed to keep inflation low and stable. It has become the dominant paradigm in monetary policy with 25 central banks of industrialised and emerging markets operating in its framework: inflation targeting (Svensson, 2010). In most cases, it consists of a publicly announced medium-term target by which an index of consumer prices (CPI) may or should grow a year. The Reserve Bank of New Zealand targets a range of CPI growth of 1 to 3 percent. Canada uses a point target of 2 percent but also communicates a 1 percentage tolerance above and below. Sweden and the Bank of England have implemented a point target of 2 percent without a specific range, Norway aims at an annual 2.5 percent CPI growth. The Swiss National Bank wants price growth to be “less than 2 percent” but positive (Jordan, Peytrignet, & Rossi, 2010). And the European Central Bank (ECB), that manages money supply in the Euro area, communicates a target of “below but close to 2 percent”. The ECB shall also contribute to “full employment” and “balanced economic growth”. In general, central banks differ in their explicit and implicit obligation to support economic growth. The United States Federal Reserve (Fed) is mandated to do so even stronger: It has the dual mandate to “maintain long-run growth” and “maximum employment, stable prices and moderate long-term interest rates”. In practice, however, the FOMC judges that a 2 percent growth of the price index for personal consumption expenditures (PCE) is most consistent with the mandate.¹

The central bank does not control the money supply as such, but steers short-term interest rates through open market operations with banks. An increase in the policy rate leads to a medium-term decrease in deposits and, more persistently and with a several months' lag, in loans (Bernanke & Blinder, 1992). Monetary aggregates are reduced by positive innovations of the short-term interest rates, and consumption and investment are discouraged. As Bernanke and Blinder (1992) also show, the unemployment rate reacts to tightening monetary policy shocks after several months, but very persistently. The other way around, if a central bank fears depression or deflation, it can loosen monetary policy and thereby encourage consumption and investment, whereas the additional demand will ultimately increase prices (European Central Bank, 2015). Additionally, monetary policy decisions affect the real economy via the exchange rate channel (if exchange rate changes are passed through) – accommodating policies usually weaken the currency and thus make domestic goods cheaper on export markets and imports more expensive (Peersman & Smets, 2001), which

¹Given the range of mandates and policies, specifications on national policies and detailed tools cannot be covered in full detail here. For a detailed picture, I refer to national sources, which are listed in the appendix.

increases the external component of GDP.

Inflation targeting is usually accompanied by transparency, accountability, and constant communication of targets and tools (Svensson, 2010). If they are credible, market participants have no reason to expect inflation in the future which they have to anticipate by increasing their own prices and thus triggering the very inflation they fear. As figure 1 shows, the last decade of the old and the first decade of the new millennium are characterised by relatively low and stable inflation rates in many countries, whether this is due to inflation targeting or other reasons.

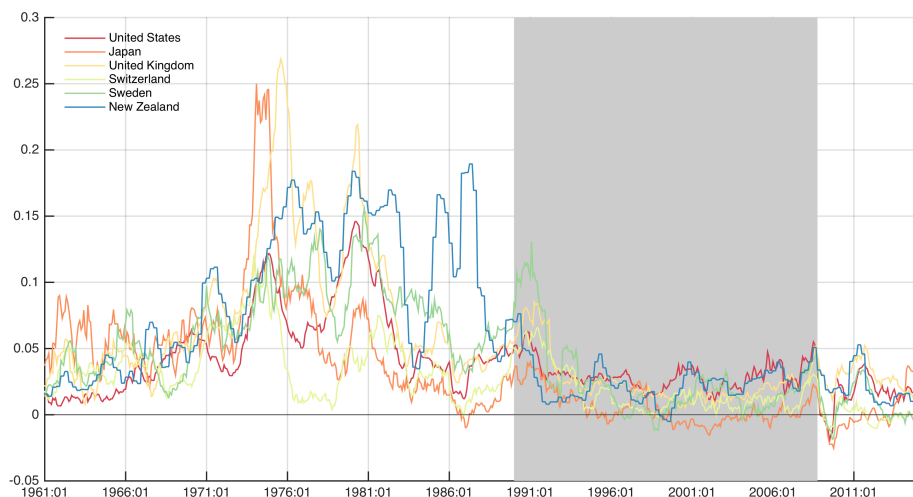


Figure 1: **Global inflation 1960-2014** Monthly year/year growth rates of national consumer price indices of a selection of industrialised economies. *Source: National sources.*

Nevertheless, the interest rate tool faces a few constraints. In the paradigm of the credit-money economy with fractional reserve banking, only a small share of the money supply is actually managed by the central bank. The vast amount is determined by commercial banks granting credits to firms and households. Even though a central bank can change incentives for expanding or reducing money liquidity, it cannot directly control it (Baeriswyl, 2014).

The most prominent constriction, however, is that short-term interest rates cannot be lowered infinitely. Even when they face deflation, central banks are highly concerned about lowering policy rates close to or below zero. Not only does this limit discretion in case of an unforeseen negative shock in the economy, but at some point it will become very costly for banks and eventually bank clients to deposit short-term liquidity at the bank; they will transfer their holdings to other currencies or hold them in cash, which means the central bank loses the control over money supply whatsoever and risks financial instability. This constraint has become known as the zero lower bound or, since the central banks of Denmark and Switzerland, the Swedish Riksbank and the European Central Bank have lowered some of their interest rates slightly into negative territory and the “zero” became obsolete, the *effective* lower bound.² At this point, conventional interest rate policy is believed to have pushed the envelope, and balance sheets of central banks as well as management of expectations have become vital monetary policy tools.

²For thorough and timely updates, please consult the Bank of International Settlements’ quarterly reviews, e.g. Bank of International Settlements (2015).

2.1.2 Unconventional monetary policy tools at the (zero) lower bound

At the lower bound, traditional monetary policy becomes ineffective and is kept in a liquidity trap as discussed by Keynes (1936). With nominal interest rates close to zero, currency and interest-bearing assets become substitutes so additional liquidity is all absorbed, without any impact on real rates. While fiscal stimulus would be one effective tool, it is usually not within the scope of a central bank's discretion. Scholars and central bankers have worked out a set of unconventional monetary policy tools which are briefly discussed in the following in order to understand the setup of the empirical model. Figure 2 shows the effects of conventional and unconventional monetary policy decisions on interest rates and balance sheets of a selection of central banks. fadfsdf

- *Quantitative easing (QE)*: The purchases of assets financed by the issuance of central bank reserves became known as quantitative easing (Borio & Disyatat, 2009). The bank issues base money, by which it buys government bonds or other assets on financial markets, which is supposed to prevent the economy from sliding into deflation through several channels. The one effect which empirical studies (such as Joyce, Lasaoa, Stevens, and Tong (2011)) have found to be the most important one is the portfolio balance effect. Even though non-existent in conventional New Keynesian models (with perfect asset substitutability), the purchase programmes, which cover a specific asset class such as government bonds, increase the price and reduce the return on the assets bought, and market participants rebalance their portfolios towards investments with higher marginal returns. The artificial demand for a broad variety of assets weighs on long-term interest rates, making consumption and investment more attractive (Bernanke, Reinhart, & Sack, 2004).

Christensen and Krogstrup (2015) argue that a portfolio-balance effect is independent of the assets purchased if they are “financed” by central bank reserves. The reason is that reserves can only be held by banks, who have to invest the assets in the market.

However, when central bank purchases increase nominal prices of assets which also serve as collateral for mortgages and consumption credit, the programmes also ease credit constraints and thereby transmit to real economic activity (Stiglitz, 2015), mostly to households and businesses whose credit constraints have been binding before (Jensen, Ravn, & Santoro, 2015). Overall, quantitative easing increases liquidity on financial markets and boosts nominal expenditure.

Additionally, some argue for a signalling channel, that ensures markets' interest rates will be low for a longer period of time, because the enlarged asset portfolios of central banks make them reluctant to losses from raising interest rates (and decreasing asset prices) (Eggertsson & Woodford, 2003; Krishnamurthy & Vissing-Jorgensen, 2011).

The inflation channel is an effect of market participants' expectations, too. If they know that monetary expansion will ultimately lead to higher inflation in the long run, their inflation expectations will rise; and D'Acunto, Hoang, and Weber (2015) have convincingly shown that higher inflation expectations stimulate consumption.

There is a widespread consensus that the programmes had the intended effects on asset prices, even worldwide (Fratzscher, Duca, & Straub, 2013), thereby mitigating some of the overly negative extremes of the financial crisis. However, effects on the real economy are less clear-cut, because it is hard to think of a counterfactual scenario (Fawley & Neely, 2013). Gambacorta, Hofmann, and Peersman (2014) have also used a panel VAR approach to study

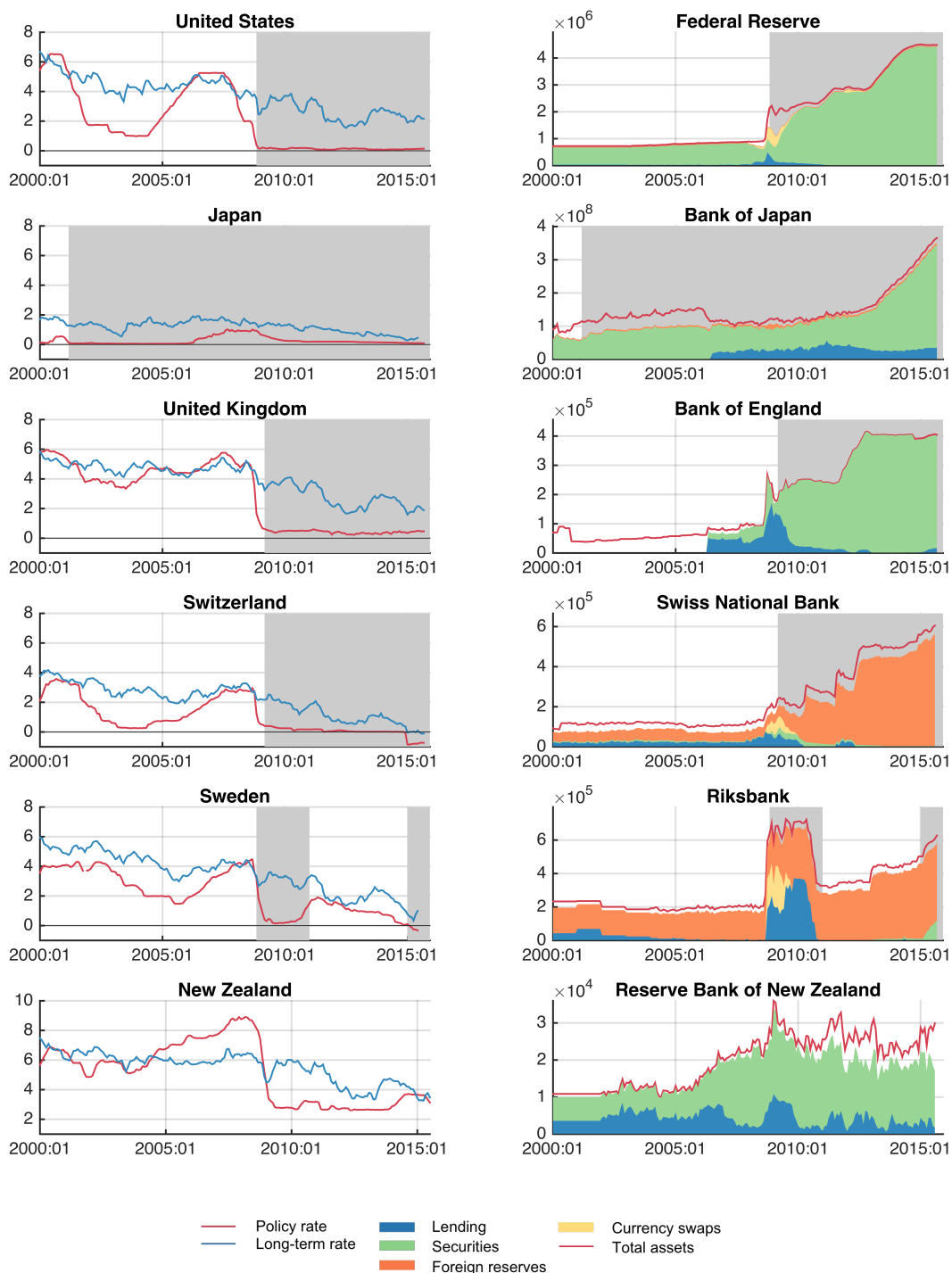


Figure 2: **Unconventional monetary policies** Left panels: Monthly series of central banks' policy rates (in blue), typically with a maturity of 3 months, compared to the interest rate of a 10-year government bond (in red). At times unconventional measures have been in place and/or the lower bound was binding, the timeline is marked grey. Right panels: Central bank assets and their main components in millions of national currency. Please note that balance sheet reporting policies differ (e.g. with respect to distinguishing assets according to their purpose (lending vs. holding) or denomination (foreign reserves vs. national assets)) and are subject to change (e.g. Bank of England in 2006 and 2014); for details, please refer to the national sources. *Source: National sources.*

the empirical effects of different unconventional monetary policies. The main findings are, first, that there is a positive effect on output and prices (comparable in size and persistence to a conventional expansion), but second, especially the effect on inflation is small and short. Ultimately, despite the heterogeneity of countries and measures, responses are similar across regions.

Japan has already been engaged in asset purchases to provide excess liquidity since March 2001 in order to fight an extended period of low nominal and real growth. The programme starting in January 2009 did gradually increase the Bank of Japan's (BoJ) balance sheet (Fawley & Neely, 2013), but the more significant increase came with a political shift in favour of expansionary measures and currency devaluation, which is referred to as Abenomics.

When the Fed bought mortgage-backed securities and treasuries worth more than 2 trillion dollars during its QE1 programme as a direct reaction to financial market turmoil (2008-2010), it focused on mortgage-backed securities. In contrast, the 600 billion dollar volume of QE2 (2010-2011) concentrated on Treasury purchases. Krishnamurthy and Vissing-Jorgensen (2011) argue that QE1 was particularly influential due to the portfolio balance effect that had a broad effect on private sector bonds, while QE2 was less effective. A third round (QE3, 2012-2014) again targeted commercial housing market debt risk and amounted to 85 billion dollars a month, with decreasing amount over time.

In the United Kingdom, the programme was 200 billion pounds of government securities (gilts) and low-risk private sector assets over the course of 2009 and was gradually expanded to the amount of 375 billion later on. A study on the first step of the programme made by the Bank of England's (BoE) economists found that long-term interest rates were depressed by about 100 basis points, mainly due to the portfolio balance channel (Joyce et al., 2011). The ECB's record of buying 100 billion euros of private sector assets in 2009 and 2011 was comparatively modest in size. Additionally, the bank purchased around 200 billion euros of government bonds, even though they were to a large extent driven by political considerations on the peak of the sovereign debt crisis rather than core monetary policy decisions (Fawley & Neely, 2013).

Switzerland did a form of QE, too. A lesser-known fact is that the Swiss National Bank (SNB) also bought assets on the market, but only mortgage-backed covered bonds ("Pfandbriefe") in order to ease credit conditions. Kettemann and Krogstrup (2014) find significant effects on spreads in the days after the announcement in March 2009. However, when the bonds were sold in 2010 without any communication, markets show no affection.

The Swedish Riksbank took a slightly different approach and implemented what is referred to as credit easing. Large-scale lending to banks against specific collateral allows to channel funds to specific markets instead of purchasing assets (Elmer, Guibourg, Kjellberg, & Nessen, 2012). This also reflects the fact that the European financial system is organised around large national banks, whereas the implementation of US monetary policy is easier through its unified and liquid capital market. The BoE's Funding for Lending Scheme (FLS, Bank of England (2012b)) can also be included in this class, and they conclude that it has had broadly positive effects in terms of increasing real GDP (0.5 to 0.8 percent) and inflation (0.6 percent) comparable to quantitative easing. Sweden's programme was of relatively short time, and by 2011 all loans had expired. The Riksbank even started increasing short-term rates, but since output and inflation did not evolve as forecasted, it started gradually easing again shortly after, and announced another small round of quantitative easing in 2015.

- *Forward guidance:* Macroeconomists agree that expectations about the future path of macro-variables are pivotal for present behaviour (Muth, 1961); and thus the anticipation of short-term interest rates and the management of expectations plays a crucial role in monetary policy. In times where the lower bound is binding, a credible commitment to a non-negative interest rate for an extended period of time can mitigate the distortion of the lower bound. On the other hand, open market operations that do not influence public expectations are not very effective (Eggertsson & Woodford, 2003).

While it has been shown for many countries that financial markets react relatively quickly to central bank communication, the sign and magnitude of the effects are often puzzling (Campbell, Evans, Fisher, & Justiniano, 2012). Del Negro, Giannoni, and Patterson (2012) argue that this has a twofold effect: On the one hand, it signals an extended period of easing – according to New Keynesian models, a credible commitment should have a much bigger impact on financial markets. On the other hand, it signals bad news and not much hope.

As the most known example, the Fed communicated its commitment to keep interest rates low “for an extended period of time” in December 2008, and then gradually reinforced the statement to say in 2011 that it would not increase the rate until 2013. Since central banks always use communication as a tool to reinforce or complement their policies (Svensson, 2010) and because it is difficult in any empirical framework to identify exogenous shocks to expectations (Del Negro et al., 2012), it is beyond the scope of this application to incorporate the real effects of forward guidance. Nevertheless, expectations of market participants should become manifest in the yield curve, of which the shorter and the longer end are included in the analysis. As figure 2 (left-hand panels, blue curve) shows, assets with a longer maturity did fall throughout the period of unconventional monetary policies, but relatively slowly and not to the extent a fully credible forward guidance would imply.

- *Foreign exchange intervention:* To some extent, exchange rate interventions as they have been conducted in the aftermath of the financial crisis in countries such as Denmark, Switzerland, or the Czech Republic, are a form of balance sheet policy targeted at the foreign exchange market, not the capital market (directly). In the case of monetary expansion via the exchange rate, base money is issued and sold against foreign currency. The domestic currency thereby depreciates (Borio & Disyatat, 2009). The currency bought can either be exchanged to neutralise the effect on other exchange rates or invested in foreign securities, which will be part of the foreign reserves on the asset side of the bank’s balance sheet.

Many small open economies, especially those with safe-haven characteristics such as a robust economy and monetary independence, are used to invest some of their assets abroad (compare Switzerland and Sweden in 2, New Zealand equivalently). When Switzerland started buying euros as a response to a significant strengthening of the franc, this became visible in a ballooning balance sheet. In September 2011, the SNB governing board introduced a policy that maintained the minimum exchange rate of 1.20 francs per euro. The floor was enforced through verbal articulations to deter speculation against it and, when needed, actual interventions on the foreign exchange market, which led to a step-wise increase of the foreign reserves to an amount almost equivalent to the Swiss gross domestic product. The procedure when looking at the effects on inequality is different from quantitative easing in the sense that assets are typically invested abroad, thereby not directly increasing domestic asset prices. However, as the case of Switzerland (compare figure 2) shows, long-term interest rates

are already very low because of the capital inflows that led to the intervention eventually. Even though the Swiss National Bank discontinued the commitment to the currency floor in January 2015, it is still active on the market of currencies (Jordan, 2015).

- *Negative interest rates:* Additionally, Switzerland further decreased the target for its policy rate, to -1.25 to -0.25 percent and charges a “negative” interest rate of 0.75 percent on base money above a certain threshold held at the central bank. Banks are supposed to hand over the burden of the interest to their (preferably international) clients, thereby making investments in the franc less attractive and weaken the currency. Additionally, negative interest rates discourage holding money reserves and hence encourage spending for consumption and investment (Buiter & Panigirtzoglou, 2003). It is unlikely, though, that decreasing the policy rate into negative territory is the negative equivalent of conventional interest rate policy, since accommodating into negative territory also pours money out of the system (in the form of interest rates) at the same time. (World Bank, 2015).

Other institutions are trying to do the same: The Danish National Bank has several months experience with negative rates of -0.1 and -0.05, but lowered to -0.75 in 2015; the Riksbank went to -0.25 in 2015, too. The ECB pushed some of its policy rates down to -0.2 in 2014. However, central banks hesitate to go lower into negative territory, because they fear financial instability as participants might switch to holding cash instead of money. However, there are ideas to overcome the liquidity trap in this situation. The lower bound could be overcome by cutting or limiting the possibility to go into cash – for example by introducing an exchange rate between cash and fiat money or, more extremely, by abolishing cash at all and only allow digital money as legal method of payment.

2.2 Inequality

In the past few decades, a tradeoff between efficiency and economic equality was believed to be a given rule among economists. Arthur Okun famously said “that pursuit of efficiency necessarily creates inequalities”. 40 years ago he wrote that a capitalist system is designed in order to encourage effort for households and to allocate resources efficiently. These incentives would inevitably lead to a tradeoff between efficiency and equality. In his book, he is concerned about the degree of economic inequality, especially inequality of opportunity and that market institutions are at odds with a distributional equilibrium. However, he argues, after a shift toward a more equal society in the wake of World War II and Roosevelt’s New Deal, there is no systematic evidence of the income distribution drifting apart (Okun, 1975).

In the years after, there has always been a rather ideological debate, but Macroeconomics in the classical tradition did not say much about the distribution of resources and output. “Crucial progress in microfounding behavioural relationships in terms of optimal choices and expectations accompanied heavy reliance on ‘representative-agent’ modeling strategies” (Bertola, Foellmi, & Zweimueller, 2006, p.10), and most scholars ignored the heterogeneity of economic agents in macroeconomic models. In the past few months and years, the literature on inequality of income, wealth, and opportunity has been surging, especially in terms of policy-oriented and empirical work (e.g. Dabla-Norris, Kochhar, Suphaphiphat, Ricka, and Tsounta (2015) or OECD (2015)). The following paragraphs are meant to be guiding towards the macroeconomic analysis and to explain the framework for the measurement of inequality.

2.2.1 Trends and measurement

The debate about the gap between the rich and the poor in many countries is seething in public academia and among political activists, representatives, and commentators, and even in multinational companies. It reached a new peak with the publication of Piketty’s “Capital in the 21st century” that neatly describes the historic development of inequality. The prevalence of capital, he argues, approaches values unseen after the two World Wars, and the gap is widening. The book ultimately tries to build up a theory of capital that “naturally” accumulates in the pockets of a very few if the return rate to capital exceeds growth of aggregate economic activity (Piketty, 2014). Critics counter that data from before and during the Industrial Revolution still suggests that wealth inequality used to be much higher than today. Additionally, the fact that Piketty uses high returns on capital for his case in times where real interest rates are in fact historically low is paradoxical, and the demographic shift tends to increase the importance of labour and rather dampen capital returns (Paque, 2014).

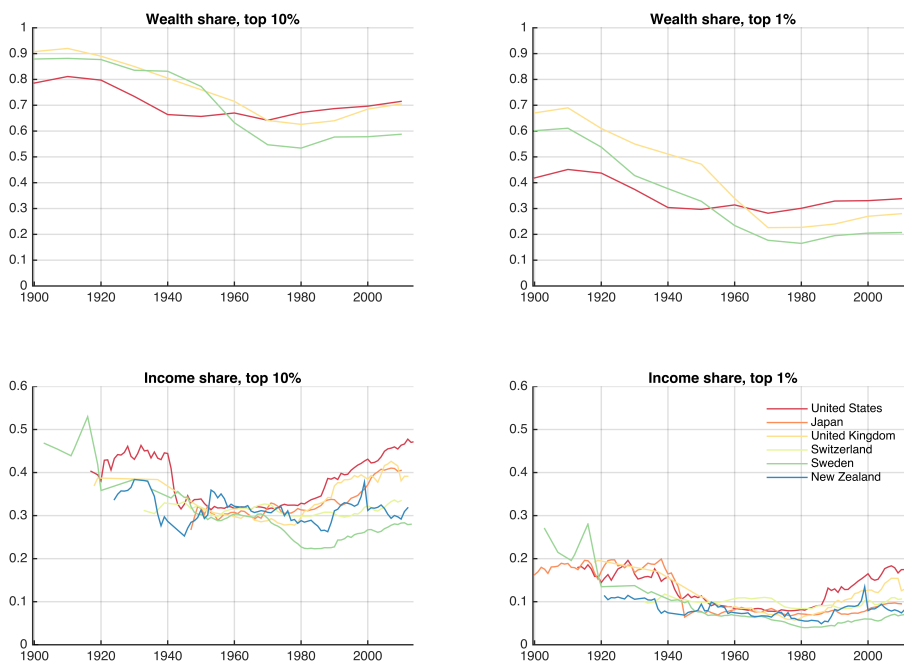


Figure 3: **Wealth and income inequality 1900-2014** Concentration of wealth (upper panels) and income (lower panels) among to highest decile (left panels) and percentile (right panels) of the distribution. Missing data points are linearly interpolated. *Source: Alvaredo et al. (2015); Piketty (2014)*

The available data on wealth (Piketty, 2014) and high incomes (Alvaredo et al., 2015) which is summarised in figure 3 shows that the concentration of wealth among the top 10 or 1 percent has been increasing in the past ten years, even in relatively equal societies such as Sweden. However, the share of wealth among the rich is still lower than during the pre-war period. Globally, research conducted at a multinational bank finds that the riches one percent own 48.2 percent of the world’s wealth, and the top 10 percent own 87 percent of global assets. The bulk of the increase in inequality

seen in the last decades, however, comes from developing countries (Credit Suisse, 2014). Because the macro distribution of wealth is a very persistent phenomenon with low data frequency and to a large extent determined by the population structure of a society and the way wealth is inherited, I will as of now concentrate on income inequality. While there is some cross-country evidence for a correlation between wealth and income inequality, there are numerous exceptions (Credit Suisse, 2014). Switzerland, for example, shows a distribution of wealth that is among the most unequal in the world, but income inequality is rather low.

One needs to distinguish between income inequality among economies, among people within an economy, and global inequality among all people on earth. The development of the latter during the last three decades can be briefly summarised in two stylised facts: First, developing and populous countries like China, India, Indonesia, and Brazil have grown new middle classes. People within the 2nd and 6th decile of the global income distribution have seen an increase of more than 50 percent between 1988 and 2008. The bottom 5 percent as well as those between the 7th and 9th decile have seen none or moderate increases of their real incomes. The highest 5 percent, or the top 1 percent even more so – and this is the second stylised fact – have seen an exceptional increase of their real earnings by 30, respectively 60 percent, of their income. (Milanovic, 2013). Because the first phenomenon dominates global inequality measures by far, concentrating on the type of income inequality within a country makes more sense, especially when examining the influence of national monetary policy.

The respective figures on the national distribution of income (two lower panels of figure 3) show a somewhat different picture than the distribution of wealth: The concentration of income, which does not include capital gains, among the top decile and percentile has shown a significant upward trend since the 1980s. It is historically high in the US, the UK, and Japan. This is in line with the hypothesis of Milanovic (2013) that the extraordinary growth of top incomes dominates rising inequality in industrialised countries. Nevertheless, income inequality should be measured in terms of the overall distribution and in an abstract, scale and size independent way. Those are the measures that are used most frequently by researchers and throughout this thesis.

- The *Gini coefficient* is used most commonly and therefore the baseline measure used in this paper. It is equivalent to one half of the average value of absolute differences between all pairs of incomes divided by the mean income to normalise the scale (Kendall & Stuart, 1977).

$$G = \frac{\frac{1}{n^2} \sum_{i=1}^n \sum_{j=1}^n |y_i - y_j|}{2\mu} = \frac{1}{2n} \sum_{i=1}^n \sum_{j=1}^n |y_i - y_j| \quad (1)$$

where y_i denotes the income of households $i \in (1, 2, \dots, n)$ ordered such that $y_1 \leq y_2 \leq \dots \leq y_n$ and j equivalently so. μ is the average income, i.e. $\frac{1}{n} \sum_{i=1}^n y_i = \frac{1}{n}$ since the share of the sum of all incomes must equal to one. Therefore, one can simplify as done on the right-hand side of equation 1. The Gini index would equal to one if all the income was concentrated at one household and zero in case of a uniform income distribution.

- An often used alternative that is more intuitive and reduces the statistical effects of outliers is to compare properties of different *shares and ratios of population groups*, for example the share of total income that is earned by the first or fifth quintile, or the average income among those groups. These measures are typically scale dependent, i.e. high-income countries will automatically have higher inequality coefficients.

- The *Atkinson measure* of inequality is more normative; it allows to determine which part of the distribution contributes the most and thus shows whether inequality is driven by the higher or lower tails of the distribution. The figure is an average of a function of individual household incomes dependent on an inequality aversion parameter ε .

$$A_\varepsilon = 1 - \frac{1}{\mu} \left(\frac{1}{n} \sum_{i=1}^n y_i^{1-\varepsilon} \right)^{\frac{1}{1-\varepsilon}} \quad (2)$$

If $\varepsilon = 0$, social welfare is determined by mean income and with increasing ε , higher incomes are given less weight. The intuition is the amount of social utility achieved by complete redistribution. Equivalently, equal societies have a lower index and the closer to 1, the more they could gain in aggregate utility by redistributing, given ε . The Luxembourg Income Studies (LIS), which has become the international standard on inequality measurement, uses indices with $\varepsilon = 0.5$ and 1.

- A more objective way to measure the significance of tails is estimating the coefficient of an empirical income distribution modelled by the Pareto distribution. Its density and cumulative distribution functions look as follows:

$$f(z) = \frac{\alpha}{z^{\alpha+1}} \quad F(z) = 1 - \frac{1}{z^\alpha}, \quad \alpha \in (0, \infty). \quad (3)$$

The α is also called the *Pareto-Lorenz coefficient*. It is low when the distribution is characterised by a heavy upper-tail. To make the scale easier to interpret, applied researchers use the *inverted Pareto-Lorenz coefficient*.

$$\beta = \frac{\alpha}{\alpha - 1} \quad (4)$$

A high β indicates that the distribution of income is heavily skewed to high-income households.

Figure 4 shows Gini coefficients of the six selected countries since 1960. We distinguish between a market measure, which is calculated on national micro datasets that contain all earned incomes from labour and capital. The series are drawn from the Standardised World Income Inequality Database (Solt, 2014). As opposed to this, the net Gini coefficient which is usually reported by governments and the Luxembourg Income Studies is based on data of disposable income, i.e. after tax and transfers. For the purpose of studying the transmission effects of monetary policy on the market, the former will be of more interest.

In all countries, the market-based Gini measure is higher than it was in 1980. While the United States have seen a steady increase in income inequality since the 1970s, the United Kingdom shows a clear trend of widening income disparities between the end of 1970s and the 90s, which corresponds to the years Thatcherism dominated the UK's economic policies. Switzerland has seen some increase in the Gini coefficient around the change of the millennium, but the last few years have pointed in the opposite direction so that an overall trend is difficult to find. The same holds for Sweden, even though the average after 1990, the time the Scandinavian economy suffered low growth and currency devaluation, is clearly higher than the pre-crisis period. Sweden, typically considered one of the most equal countries, has a market Gini comparable to other capitalist economies – what is striking is the large gap to the inequality of disposable income, i.e. the large

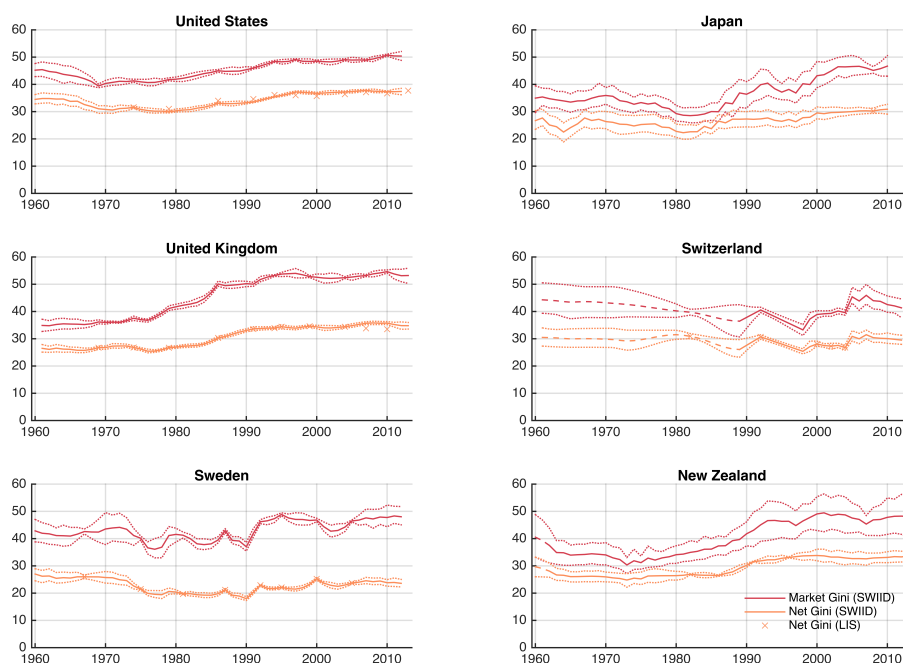


Figure 4: **Inequality measures 1960-2014** Inequality has been increasing in many countries since the 1980s or 90s. Annual SWIID/LIS-based Gini coefficients over time. Dotted lines are 95% confidence intervals; dashed lines are interpolations of missing years. *Source: Solt (2014)*

redistribution of incomes. This difference has also grown in Japan, which has seen a significant upward trend since the mid-1980s. One could argue that Japan with its long history of monetary accommodation, including balance sheet policy, to fight hysteresis, is an alarming example for other economies who have recently expanded their balance sheets (Saiki & Frost, 2014). However, New Zealand has not expanded money supply to a similar extent and has still seen a steady rise of inequality in terms of a market-based Gini coefficient. To appropriately reflect the rise of top incomes as a driver of increasing inequality over the past 30 years, several indicators for income inequality with a closer eye on the distribution's upper tail are summarised in figure 5.

As Atkinson, Piketty, and Saez (2011) discuss, top incomes have increased substantially over the past three decades in English-speaking countries, and rose only slightly disproportionately in continental Europe. In Switzerland, the share of income of the top 0.01 percent doubled to a level comparable to the US, whereas the top 1 percent group earns now about 11 percent of national income, compared to 8 percent 30 years ago. Moreover, a shift among top earners from capital to labour income is found (Foellmi & Martinez, 2014). In many countries, the share of labour income of the top is now much higher than it used to be in the post-war decades, for example 10 percent of US households earn half of national income, as opposed to a third up to the 1970s. Top earners earn more than they used to, and they often receive a higher share of their income as salaries or bonuses.

Most studies on top incomes evaluate tax data on gross incomes before tax. As opposed to this, key figures published by the Luxembourg Income Studies are calculated from disposable income collected in household surveys.

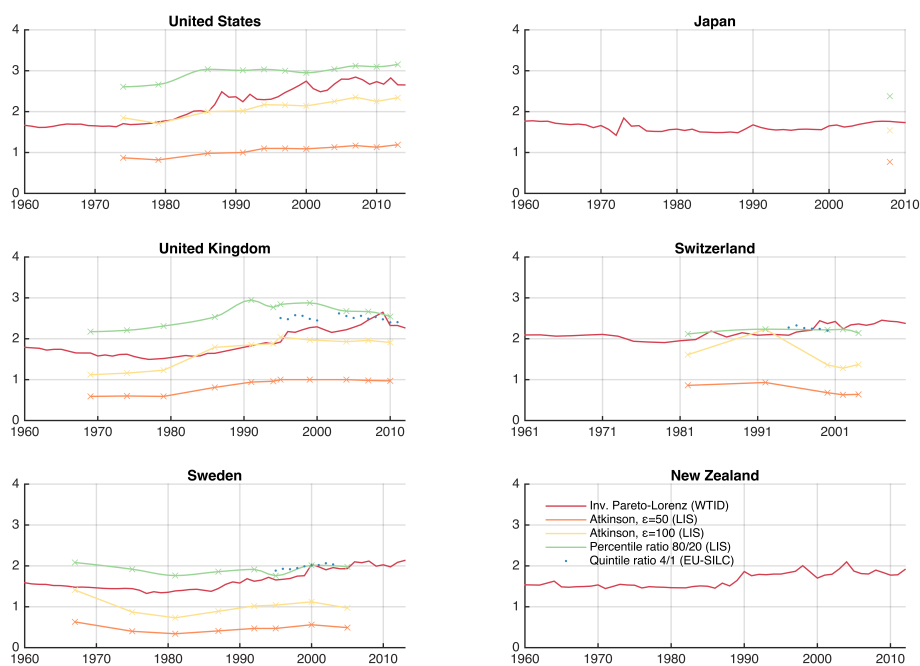


Figure 5: **Inequality measures 1960-2014** Measures on inequality which stress the development on the upper tail of the distribution. Missing data is linearly interpolated. *Sources: Alvaredo et al. (2015), LIS, EU statistics on income and living conditions*

2.2.2 Causes and consequences

It is often argued that differences in income are necessary to provide incentives for people to innovate and compete – two factors that are inevitable for sustained economic growth. This reasoning is related to the belief that there is some sort of “natural” path of inequality that first rises and then decreases with the economic development of a country, known as the Kuznets curve (Kuznets, 1955). Barro (2000), however, studied a panel of developing and industrialised countries and finds that the effect of inequality on growth is negative for low per capita GDP countries and the opposite for more developed economies.

More recent research by the International Monetary Fund points to the fact that an increasing income share of the richest group of the population decelerates growth in the medium term, while the opposite holds for the poor people’s income (Ostry, Berg, & Tsangarides, 2014). A report of the Organisation for Economic Co-operation and Development highlights that the human capital channel is the main responsible: If inequality becomes too high, low-income households are less likely to invest in education (OECD, 2015).

Furthermore, high inequality could fuel financial crises (Rajan, 2010) or, a somewhat weaker claim, result from financial liberalisation and deregulation, as does the financial crisis of 2008 (Acemoglu, 2011). This argument is of particular interest within the scope of this thesis since it adds a financial and business cycle dimension to the discussion, which is usually more prominent in monetary policy considerations than questions of long-term growth.

Overall, many of the recently published reports confirm that the economic gains from efficiency

do not trickle down and there is a static tradeoff between equality and efficiency. Dynamically, however, mainstream macroeconomists more and more challenge Okun's tradeoff view and warn that economic inequality leads to part of the growth potential lying idle. Therefore, economic inequality is not only relevant from a social standpoint, but for macroeconomic reasons, too. Given that equality measures started to rise in many countries throughout the 80s, suspecting that globalisation of markets for goods, capital, and top executives plays a crucial role, is not far to seek. A rising skill premium – through labour-saving technologies or offshoring – is named as a significant reason for widening income gaps in industrial countries; high external trade (indicating high efficiency) and corresponding financial flows between countries are commonly cited to be driving forces of income inequality (Feenstra & Hanson, 1996; Dabla-Norris et al., 2015). The story about financial globalisation is a double-edged sword: On the one hand, financial inclusion and deepening allow middle-class households to have access to credit and investment (??), but on the other, the rich might have more access to financial instruments, knowledge, which will eventually increase their return to capital, and thus inequality (Claessens & Perotti, 2007), and growing, risk-taking financial sector increases the likelihood of negative spillovers to the real economy (Korinek & Kreamer, 2014). Therefore, one of the major challenges is to distinguish short-run, policy-driven innovations of the Gini coefficient or other indicators of inequality from a long-term trend. Changes in labour market institutions or redistributive fiscal policies (such as reducing the progressivity of tax codes, or fiscal consolidation (Agnello & Sousa, 2014)), or the costs of education are suspected to be other important drivers (OECD, 2011; Dabla-Norris et al., 2015). Including the labour market, whose indicators play an important role in monetary policy considerations and their consequences. A labour market channel through which monetary policy changes inequality is one but not the only plausible channel.

2.2.3 The role of monetary policy: old and new claims and channels

Monetary policy influences prices in the economy: of goods, labour, and assets of different classes. And since economic agents are far from homogeneous in terms of endowments and activity on these markets, monetary policy, whether implemented in conventional or unconventional ways, will ultimately have distributional effects.

This is not only important because it adds to the public's increasing concern about high income disparity. Additionally, if inequality is a side effect the monetary authority does not consider in its decision-making (and most models used in central banks are based on representative agents), it might create unforeseen negative welfare effects.

One could argue that the point income inequality reached new highs in many countries roughly coincides with the time central banks started to become more conservative in terms of disciplining inflation. Figure 6 plots the average growth of the pre-redistribution Gini coefficient according to the Standardised World Income Database (compare chapter 2.2.1) against the growth rates of monetary variables and real GDP in a set of economies for which sufficient data on income inequality is available (see chapter 3.2). Countries that have seen high growth of the money supply happen to have a more equal income distribution, and vice versa. In other words, the new paradigm of inflation targeting which limited central banks' discretion to expand the money supply could indeed be a trigger for increasing inequality.

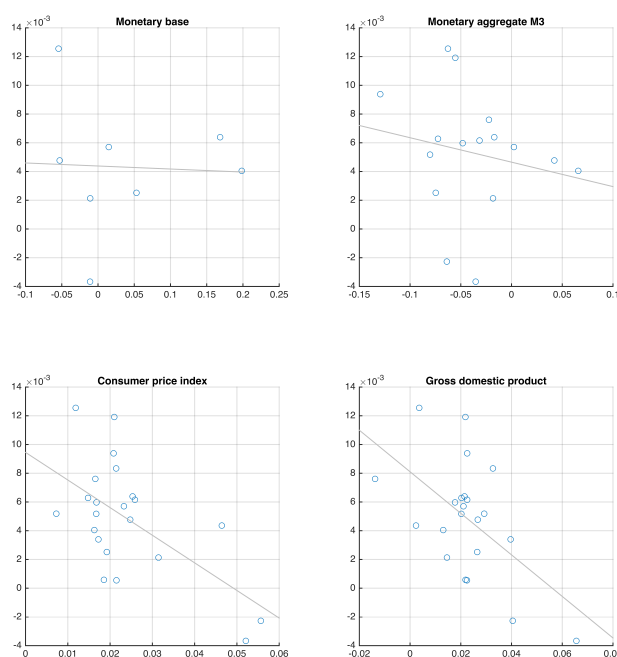


Figure 6: **Long-term correlations** Stylized cross-country correlations of changes in the Gini coefficient (y-axes) and macroeconomic growth variables (x-axes). *Sources: Solt (2014), national sources*

However, this fits into the “old” critique that hard-nosed central banks do not stabilise the labour market (Akerlof, Dickens, & Perry, 2000) and thus do not act in favour of middle class workers. The “new” critique is that expansionary measures, especially those of non-interest rate nature, increase inequality (Spitznagel, 2012) or is captured by partisan groups such as the financial sector (Acemoglu & Johnson, 2012).

While the correlations plotted above provide some evidence that monetary expansion as such is not a good explanation for a long-term increase in inequality (nor is it for its level, for which the correlation is virtually zero), this does not imply causality. For this, going back to the transmission mechanism may shed some light on how monetary policy decisions could have heterogeneous effects and eventually change the distribution of income. Coibion et al. (2012) have discussed five channels through which monetary policy could affect inequality.

- *Income composition channel:* Households differ with respect to their sources of income, as figure 7 shows. Middle class households typically rely primarily on labour earnings while the poor receive a larger fraction of their income through transfers and the rich through business and financial earnings. In the United States, all quintiles except the highest have labour earnings that amount for more than 80 percent of their market income. For the highest quintile, the share was still 66 percent in 2011, but it’s only 38 percent for the top percentile, where business earnings and capital gains are the major sources (41 percent). In Switzerland, the four upper quintiles all have a share of labour between 80 and 88 percent, whereas the lowest quintile almost exclusively relies on government benefits.

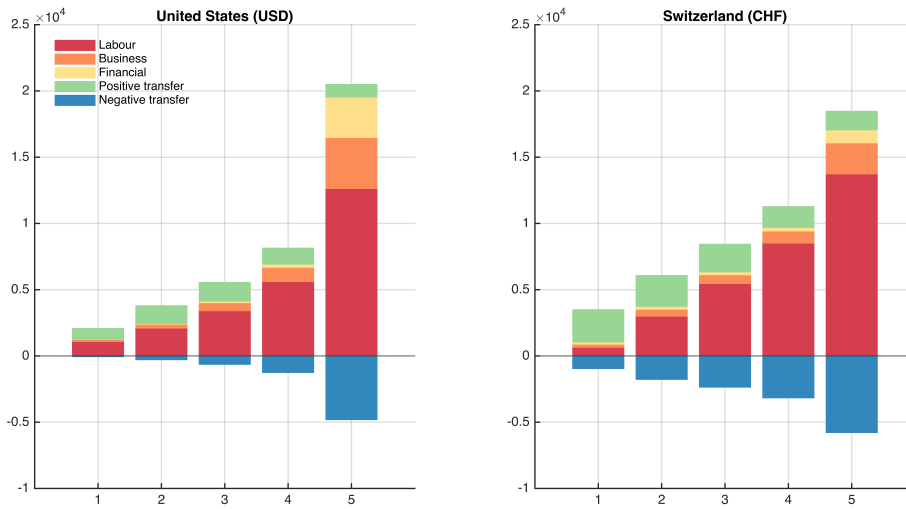


Figure 7: **Heterogeneous income sources** Sources of disposable monthly income of US and Swiss households in 2011, by quintile of gross income. According to the Swiss tax code, capital gains are not considered as income. Sources: Congressional Budget Office (2014); Swiss Federal Statistics Office (2015)

However, if monetary policy affects financial income more than real wages, the rich are to benefit disproportionately, especially in countries like the United States where the top earners have different sources of income.

- *Financial segmentation channel:* Some households are more closely connected to financial markets than others. Because monetary policy is always implemented via financial markets, those who have more leeway (e.g. access to more financial instruments, or knowledge on how specialised markets work) can easier benefit thereof. For example, a middle class household will not be able to benefit from rising house prices because it cannot simply sell the home. This effect might be particularly strong when looking at quantitative easing policies, which are meant to increase asset prices: Gains from financial assets³ stay within those who actually have any voluntary financial investments. This is a very limited group, as examples show: In Switzerland, only 17 percent of the population have any investments in equity at all (apart from mandatory life-cycle savings) (Birchler, Volkart, Ettl, & Hegglin, 2011) and in the United States, 1 percent of all households owned 38 percent of the stocks in 2013 (Wolff, 2014).
- *Portfolio channel:* On the other hand, low-income households typically hold a higher fraction of their assets in cash and consume a higher fraction of their income. If the central bank undertakes measures that are meant to increase prices, lower-income households carry a burden that is relatively higher than those with high earnings. At the same time, when looking at quantitative easing more specifically, rich households which hold a relatively high share of stock capital are less prone to the devaluation of money.

³Capital gains are not necessarily classified as income. Therefore, the effect might be correct for the distribution of wealth, but doesn't trickle down to income inequality.

- *Savings redistribution channel*: Lowering interest rates, all else equal, benefits borrowers and hurts lenders. Those who have a positive net worth will thus rather lose from lower interest rates. Inflationary policies further reduce the real value of debt in the long term, thus making net debtors, especially younger people from the lower 90 percent of the distribution better off in terms of wealth.
- *Earnings heterogeneity channel*: Not only do people's incomes differ in their reaction to monetary policy decisions because they have different income compositions (compare income composition channel), but also because one single class of income can behave differently for different groups. It is commonly known that labour-market indicators of low-skilled (and low-income) workers are more volatile (Solon, Basky, & Parker, 1994) and it has been shown that the employment status of young professionals and racial minorities is more sensitive to disinflationary monetary policy (Carpenter & Rodgers III, 2004). A central bank's expansionary policy therefore meets the needs of those on the lower end of the distribution more immediately.

The former three channels discussed tend to increase inequality, the latter two act in the opposite direction, which makes the overall effect ambiguous. However, there are a few more thoughts and opinions scholars and policy-makers alike have added to the complex matter, especially with respect to the specific case of unconventional monetary policy implementation:

- Draghi (2015) stresses the fact that there are both distributional consequences from monetary policy action as well as from monetary policy inaction. If the central bank had not met its mandate, net borrowers and those in precarious job situations would lose the most. Additionally, he argues that since those people have higher marginal propensities to consume, they are particularly helpful for economic recovery after a crisis. It is an interesting thought that monetary policy effectiveness could indeed be higher if society is more equal, or the implementation particularly targets poor and middle class households.
- Many acknowledge that monetary policy has distributional effects but defend unconventional policy actions by saying that they have to be evaluated against a counterfactual (Bernanke, 2015; Bivens, 2015; Doepke, Schneider, & Selezneva, 2015). Bernanke (2015) also mentions that accommodative policies are designed to stabilise the economy and avoid mass unemployment. With the vast majority of the population relying on labour income, stable wages and/or low unemployment would certainly not increase economic inequality.
- Bivens (2015) suggests comparing the effects on income and its distribution of a fiscal stimulus of the size that has the same effect on aggregate output as is attributed to quantitative easing⁴. Even though fiscal policy implications on inequality depend very much on the way they are implemented (progressive tax cuts vs. increased government spending, or extended unemployment benefits), Bivens (2015) makes the point that all three asset-purchasing programmes by the Fed (QE1 through QE3) together increased GDP by about 2 percent and lowered unemployment by about 1 percent, about the same effects that are found for the 2010 fiscal stimulus package of tax cuts and unemployment benefit extensions, whose first-round effects are relatively easy to track in tax data. From the capped payroll tax cut, the

⁴Note that fiscal policy is likely to become more effective at the lower bound. Conventional measures of the fiscal multiplier might be misleading.

bottom 95 percent benefit disproportionately; and from unemployment benefit extensions, the four lower quintiles are said to benefit more than their pre-stimulus share of overall income. He acknowledges that asset purchases have increased the concentration of corporate equities and bond securities through their nominal value, but the increase of house prices would mainly go to the lower 90 percent. Since quantitative easing will eventually run out with the termination of the assets bought, the inequality-increasing effects would not be permanent. This is somewhat unconvincing since increasing stock prices can be turned into income while real estate prices do not directly help the income or consumption situation of middle class households unless they are able to increase their mortgage or sell the property. One gap that remains unresolved is how inflating asset prices translate to the income and consumption situation of households, for example via pension funds and real estate prices linked to mortgages.

Even if the effects of fiscal and monetary policy (quantitative easing) on employment in the event study are similar at a rough estimate, it is hard to compare the two stimuli, first and foremost because the empirical evidence on complex monetary policy transmission is missing.

- Another argument that is brought forward by Bernanke (2015) is that large-scale asset-purchasing programmes applied all around the world have indeed increased asset prices, but after an episode they have fallen rapidly in the wake of the financial crisis. Therefore, the artificial demand that is initiated by central banks and transmitted through the portfolio effect brings asset prices “back to trend”.
- A more fundamental conjecture is that the monetary system as such is built in a way that allows inequality to increase. Huelsmann (2014) argues that if monetary policy is limited to, for example, a commodity, its distributive effects are limited, too. However, this neglects any positive, and possibly equalising effects, from a monetary policy that stabilises output and employment. After all, historical evidence for any relation of monetary regimes like the gold standard or the Bretton Woods system and inequality is weak.
- Most scholars would agree on the two facts that monetary policy is neutral in the long run and inequality is a slow phenomenon for which long-term trends play a large role. Together, this would mean that by the time unconventional balance sheet expansion reached its full power on inequality, the effect of monetary policy has evaporated; the bonds purchased have expired and balance sheet sizes have returned to “normal”.

Most arguments of people involved in the matter point to the conjecture that expansionary policies tend to decrease inequality, but the net effects are not straightforward, given the multiple channels and heterogeneity. This has triggered a range of research papers and work in progress. They apply very different methods and techniques, the explanation of which go beyond this thesis. I will therefore concentrate on briefly describing the mechanisms at work and summarise the main findings of the previous literature related to inequality.

2.3 Literature review

Within the representative-agent framework, the welfare effect of inflation has been the dominant research question: a low-inflation steady state is associated with a significantly higher welfare than

high inflation (Lucas, 2000). But since many nominal prices (including wages, rents, pensions, debt, and interest on debt) are sticky or even fixed, inflation has real effects, and this to various extent for different subgroups of society, like lenders and borrowers, the young or the retired, those relying on labour vs. capital income. The overlapping-generations model of (Doepke & Schneider, 2006b) is calibrated to match the fraction of different household groups in the US population and it also contains the business sector, the government as well as lender and borrowers from abroad. The impact of an unanticipated inflation shock is measured as a percent deviation of lifetime consumption from its balanced growth pass. The effect on the old is therefore limited given the shorter time frame the effect can have. The beneficiary of inflation are the middle-class cohorts in their middle working age and the poor in their 50's and pre-retirement cohorts. Those cohorts have relatively high amounts of nominal debt which is devalued in periods of inflation. The old rich, who are net lenders, lose because the value of their assets declines, and the young rich because they inherit less. Retirees are affected negatively as their nominal savings loose in value on the one hand, and on the other because they cannot smooth consumption as easily as their offspring. Doepke and Schneider (2006b) find a substantially negative effect on labour supply because the working people who benefit substitute some of their welfare gains for leisure. The aggregate effect is somewhat surprising: households benefit because foreign lenders loose most and the burden of government debt on future generations is reduced. Since the losing rich have lower marginal utility than poorer people, the partial redistribution also increases aggregate welfare. They confirm their results in a more data-driven approach using US data Doepke and Schneider (2006a) and in a recent contribution including the real estate market more explicitly (Doepke et al., 2015).

This evidence is not indisputable, however. The poor are more prone to changes in the purchasing power since they need a larger share of their cash earnings for consumption, whereas the rich typically have a large percentage of their wealth in capital (Erosa & Ventura, 2002). In a calibrated model of money (in the spirit of Lagos and Wright (2005)) applied to different OECD countries, Boel (2013) finds that inflation widens the wealth gap between the rich and the poor with a varying magnitude across countries. This finding only holds if there is an alternative asset class that is not prone to the inflation tax, like equities.

There is some empirical evidence that monetary policy affects the regional distribution of wealth and income. Micro data for the United States shows that mortgage activity and real spending declined most where collateral lost most of its value (Beraja, Fuster, Hurst, & Vavra, 2015), confirming that the role of credit is important when studying inequality.

To understand monetary policy effects on top incomes, the stock market is one important channel to look at: A data-rich panel VAR (with data on 18 OECD countries and 90 years of stock market history) model has shown that accommodative monetary policy contributes to asset price booms, especially real estate (Bordo & Landon-Lane, 2013), even though at the same time, Gali and Gambetti (2015) have found that stock markets respond positively to monetary tightening in the medium run. The other way around, Ravn (2014) estimated a Dynamic Stochastic General Equilibrium model (DSGE) to show that central banks behave somewhat asymmetrically: they act fast in times of stock market crashes but hesitate to contract monetary policy in times of asset price booms or bubbles.

On the lower end of the distribution, it has been shown empirically that expansionary monetary policy is helpful for the poor in the short run (via stabilisation of output) but over the long run, a conservative monetary policy with focus on low inflation has proved to reduce poverty most successfully (Romer & Romer, 1999). Using panel regressions on data including the non-inflation

targeting era, they also conclude that while the partial (positive) effect of a change in the unemployment rate on the well-being of the poor is small, they find that both, anticipated and unanticipated inflation, narrow the income distribution significantly. The fact that the lowest quintile's share of total income increases in cases of surprising inflationary episodes is robust, too.

A first bulk of the new literature motivated by the recent history of expansionary monetary policy sets up theoretical models with heterogeneous players to study the effect of policies and shocks on the distribution of wealth and income.

One idea is to look at the economy as a network: heterogeneous businesses and agents are connected and trade with each other, but some have closer ties than others. When the central bank intends to be expansionary, money must enter the network somewhere. One can show that entities holding the same goods as the ones that are purchased by the central bank in return for money liquidity benefit the most because those goods will increase in value first, due to the artificial demand. The effect will percolate through the network, but the further away from the injection point, the weaker the effect will be (Ledoit, 2011). The distortion of relative prices originating at the point where money enters the economy is confirmed in a lab experiment (Baeriswyl & Cornand, 2015). However, since the effect highly depends on the endowment of agents, it impacts the distribution of wealth more than of income.

Stiglitz (2015) sets up a very stylised model of risk-averse life-cycle savers who rely on labour income and invest their savings in government bonds on the one hand, and capitalists who hold all the equity. There is no movement between the two even if relative prices and returns change. Therefore, the price of the bond is to a large extent determined by the amount of workers' savings and fluctuates with their disposable income. If the interest rates on government bonds are financed via taxes on labour, workers like to have low interest rates as disposable income's fluctuation is minimised. When lowering the interest rates the value of equities (via lower discounting of future earnings) increases and the return on capital is left unchanged (because interest rates are only financed by labour taxes), capitalists' income increases. As a result, expansionary monetary policy would be a redistribution from the bottom up in the short run. In the long run, Stiglitz (2015) concludes that the overall effect on inequality is per se unclear and depends on the elasticity of substitution, i.e. on whether and how the capital stock increase translates to higher wages.

The very recent contributions in the field tie in with the growing literature on DSGE models, particularly the New-Keynesian sticky price models. Modelling heterogeneous agents with respect to saving endowments, labour productivity, and employment allows to analyse the distribution of income. Gornemann, Kuester, and Nakajima (2014) build a DSGE with nominal frictions that are frequently used to study the dynamic effects of monetary policy (Christiano, Eichenbaum, & Evans, 2005) and add two distinct features. First, they introduce asset market incompleteness, i.e. credit constraints are binding for some but not for others. Second, they characterise the labour market with matching frictions in the style of (Mortensen & Pissarides, 1994).

The authors find that expansionary monetary policy shocks lead to a significant and persistent homogenisation of wealth, earnings, and consumption. While technology shocks tend to act quite uniformly, monetary policy transmission is found to have different welfare implications for different groups of the population. Rich households who rely heavily on returns of financial assets, which usually decrease with the policy rate, see their volatile incomes shrink with the accommodation of policy rates. At the same time, households on the lower end and the middle of the income distribution typically rely almost solely on labour income, which is meant to be stabilised by expansionary monetary policy. When simulating a recession the depth of the Great Recession in 2008 and 2009,

the bottom 80 percent benefit when monetary policy responds aggressively. The bottom 5 percent gain 1.5 percent of permanent consumption via higher-than-otherwise employment, and the top 5 percent lose an equivalent of 1 percent as returns on business investment decreases. However, in the long run, i.e. over many booms and busts, countercyclical monetary policy that intends to stabilise the labour market also reduces the incentive for people to accumulate precautionary savings by themselves, which reduces the capital stock and welfare (Gornemann et al., 2014).

There is already an empirical literature on which this thesis is built on and with which results will be compared.

It has been estimated that 40 percent of the wealth increases due to asset purchasing programmes in the UK benefited the wealthiest 5 percent of British households (Bank of England, 2012a).

The European Central Bank conducts the Household Finance and Consumption Survey. Its data on Germany shows that lowering interest rates have distributional effects insofar as they lower the debt burden for households with mortgages – even though they receive interest rates on savings, it became easier to finance mortgages. Furthermore, it is argued that the returns on fixed assets on the one hand, and real estate and equity on the other, which are drifting apart since 2008, lead to higher wealth inequality (Demary & Niehues, 2015).

Coibion et al. (2012) find that contractionary monetary policy shocks lead to greater inequality, i.e. expansionary monetary policy usually eases economic heterogeneity. They use household data from the United States' Consumer Expenditures Survey on income and consumption because they are available on quarterly frequency from 1980 to 2008. However, the survey does not include the highest percentile because inference on the very upper tail from such surveys is low. To identify monetary policy shocks, they use a measure proposed by Romer and Romer (2004) that is a deviation of the Federal Funds rate to forecasts published by the FOMC. The labour earnings and total incomes of different groups and subgroups are regressed on monetary policy shocks. The results show the following pattern: Contractionary shocks are followed by labour income fluctuating more heavily among the rich than the low-income households during the first two years. After that, labour income on the top stabilises at a level that is significantly higher than the pre-shock level, and lower incomes are persistently and significantly lower. Therefore, labour market dispersion increases. The same holds for consumption. The response of overall incomes is similar for the upper end of the distribution, but higher for the lower 10 or 25 percent. That reflects the redistributive effect of social security and transfers which offset labour income.

The same main conclusions have recently been drawn using data from the United Kingdom (Mumtaz & Theophilopoulou, 2015).

Even though broadly consistent and plausible, the empirical analysis has several shortcomings: First and foremost, data from or after the Great Recession is not included, thereby making it difficult to draw any conclusions on unconventional monetary policy, especially since the rate shocks are calculated based on interest rates. Additionally, the behaviour of income of the top 1 percent would be crucial to include since the channels that potentially increase inequality (income composition and the financial segmentation channel as discussed in chapter 2.2.3) involve top incomes. Saiki and Frost (2014) criticise further that wealth data is not included, so the effect of the portfolio channel is mitigated.

As a response, they conduct an empirical analysis on the country that has the longest history on quantitative easing: Japan, from the first quarter of 2002 to the latest available (2013-Q3). A vector-autoregressive model that uses income and savings micro data from a Japanese household survey. The series included are GDP, inflation, the monetary base, stock prices and the Gini coef-

ficient. Shocks to the monetary base are identified using a Cholesky decomposition (whereas the variables are ordered as listed above). Point estimates indicate a positive effect of unconventional monetary policy on inequality, even though the confidence intervals do not completely rule out the opposite effect. They show that after monetary shocks income inequality increases to an economically significant level during the first quarters because the Nikkei increases.

While Saiki and Frost (2014) provide a neat evaluation of the data, they give a lot of weight to the stock market but ignore channels that run through the labour market. Japan – even though it is an ideal candidate for a case study because it has the longest history of unconventional monetary policy – is a special case just with respect to the distribution of wealth and income in society. Furthermore, the country has experienced events such as the earthquake, tsunami and nuclear catastrophe in 2011 that have definitely affected the distribution of wealth - however, it is not directly related to monetary policy but likely affects results with time series of just 40 data points. Therefore, the following section describes a model that does not rely on micro data from one country's history, but describes a purely empirical approach that adds a cross-sectional dimension of 22 countries. This should allow to extract information from data on 5 years of unconventional monetary policy, which would hardly be possible when looking at one country only. The second contribution to the literature is that monetary policy shocks are neither derived from interest rates nor from central bank balance sheets alone but from a monetary policy indicator that is constructed on both.

3 Model

3.1 Methodology

3.1.1 Vector autoregressive model with panel data

Vector autoregressive (VAR) models are a powerful tool to analyse the dynamic behaviour of endogenous and interdependent macroeconomic variables. Early applications such as Sims (1992) or Bernanke and Blinder (1992) were augmented by various features. More recently, the richer and internationally standardised datasets and the gradual increase of global economic interdependencies have led to the use of a panel dimension that is added to the VARs (Canova & Ciccarelli, 2013). They allow to exploit the cross-sectional dimension and to analyse the dynamics between entities, for example countries. In this case, the use of a panel VAR (PVAR) is not only a “can” but a “must” since official, internationally comparable inequality data is available only in annual frequency and only for a limited time frame (compare chapter ??), especially if considered for the period unconventional policies have been in place. For most countries, a Gini coefficient is available up to 2012 or 2013 as of now, and two or three data points of unconventional monetary policy won't bare enough evidence of a significant increase or decrease in inequality, especially since it is a relatively persistent variable. Estimating the equation system for a set of 22 countries⁵ that implemented different policies at different points in time will allow this if those different policies can be condensed to one indicator on which one can derive exogenous innovations.

The panel VAR model can be written in the following representations:

$$Y_{it} = A_{i,1}Y_{i,t-1} + A_{i,2}Y_{i,t-2} + \dots + A_{i,p}Y_{i,t-p} + \mu_i + \nu_{it} \quad (5)$$

$$A_i(L)Y_{it} = \mu_i + \nu_{it} \quad (6)$$

where Y_{it} is a vector of k endogenous variables for every country i . Besides the two variables of interest – an indicator for monetary policy (MPI , compare chapter 3.2.1) and one for inequality ($GINI$) – the model includes stock returns, consumer prices, and unemployment in the benchmark specification to capture the channels through which income distribution is affected (compare chapter 2.2.3).

$$Y_{it} = [MPI_{it}, STOCKS_{it}, CPI_{it}, UNEMP_{it}, GINI_{it}] \quad (7)$$

Therefore, $k = 5$. Data is stationary and normalised (demeaned and standardised), therefore no constant term or trend components are necessary in the estimation. $A_i(L)$ is a matrix polynomial in the lag operator L such that $A_i(L) = I - A_{i,1}L^1 - A_{i,2}L^2 - \dots - A_{i,p}L^p$, whereas A matrices have a $k \times k$ dimension. The residuals consist of a country-specific component μ_i , which is assumed to be time-invariant. Pooled estimation with fixed effects is the standard approach to estimate the parameters of the model if one can assume that the dynamics is homogeneous (Canova & Ciccarelli, 2013). Since we are not interested in the international spillovers of monetary policy, this is unproblematic. Other approaches estimate the system for each entity separately and then mean the results. The matrix $\nu_{it} \sim N(0, \Sigma_i)$ is used to identify monetary policy shocks.

⁵The countries are selected based on their monetary policy history and the availability of complete and reliable data. They are listed in the appendix.

3.1.2 Identification strategy

In order to get meaningful results that allow causal inference, one tries to identify exogenous innovations of the monetary indicator. Can residuals, i.e. unexpected and unexplained changes of the monetary indicator, explain part of all the variables' future behaviour? In other words, what is the impulse response function (IRF) to a shock?

$$\frac{\partial Y_{i,t+j}}{\partial \nu_{it}} \quad \forall j = 0, 1, 2, \dots$$

The baseline specification of the model applies a Cholesky decomposition to identify orthogonal innovations of the monetary indicator. The idea of the decomposition is that the variables are ordered in a way that some interdependencies are ruled out, which reduces the amount of coefficients to be estimated and makes the model solvable. Variables listed earlier in the Cholesky order can impact later ones contemporaneously, whereas those listed later only influence earlier ones with a lag. The variables that are believed to be exogenous thus come first.

The baseline model assumes that monetary policy is the most exogenous variable, and that the first reaction of stock markets are quite immediate. Prices indices react to monetary policy in the medium term. At the same time, prices could be excluded at all because their role in the transmission to the distribution is highly unclear; or placed first because price indices have a significant exogenous part that has a contemporaneous effect on monetary policy. The unemployment rate is included because it's considered an important channel, and it's ordered directly before the inequality measure because it is somewhat more persistent. Alternative Cholesky orders will be tested as well to compare the results to Saiki and Frost (2014) who choose the ordering such that monetary policy is contemporaneously responding to prices and economic activity and the transmission to inequality happens through the stock market exclusively.

3.1.3 Bayesian estimation

Given the limited length of standard macroeconomic datasets, Bayesian methods have become an increasingly popular way of dealing with the problem of over-parameterization – the fact that VARs become very large and hard to estimate (Koop & Korobilis, 2010). Bayesian estimation can help solve that risk in two ways: First, one can consider prior information on partial relations as a conjecture in the estimation. Second, and more importantly, the estimation coefficients are treated as random variables with a probability distribution.

The Monte Carlo algorithm without dynamic interdependencies follows Canova and Ciccarelli (2013): OLS estimates on the coefficients of $\hat{A}_i(L)_{OLS}$ and $\hat{\Sigma}_{OLS}$ are used as priors. Random draws from the (inverted) Wishart distribution are drawn to get a distribution of estimates on Σ that are consistent with the residuals ν_{it} . A new estimate of $\hat{A}(L)$ is drawn from a Normal distribution based on the variance of the data and the estimated covariances. If a draw's estimates fulfil stability conditions, i.e. the roots of the VARs companion form lie within the unit circle, it is kept to calculate impulse responses, which are then averaged over all accepted draws.

3.2 Data

3.2.1 Monetary policy stance

If short-term interest rate are restricted by a lower bound around zero, identifying monetary policy shocks on the series will lead to biased results. Regressions with the observed path of a money market rate as an explanatory variable would overestimate any effect because an artificially small variation in the rate would explain a relatively large share of the regressors.

There are different ways to cope with this problem. One is to estimate a factor-augmented form of the VAR (FAVAR). When estimating the model, a common factor of a set of series is estimated and included in the VAR equation (Bernanke, Boivin, & Elias, 2005). Unfortunately, the model becomes less tractable and the impulse response to a shock in the underlying factor is more difficult to interpret.

Therefore, I will follow Lombardi and Zhu (2014) who essentially do the same in a two-step procedure: First, I take a set of standard monthly series of monetary variables that could help to assess the stance of monetary policy:

- *Short-term interest rate:* As introduced in chapter ??, monetary policy is usually implemented with short-term money market operations; and the policy interest rate is either a 3-month money market rate or closely correlated with it. For the purpose of this exercise, I exclude all data points of 0.5 percent or less from the series, since they are possibly affected by a lower bound. Results are quite robust to the chosen threshold.
- *Long-term interest rate:* Asset purchase programmes were designed to flatten the yield curve, and so is the concept of forward guidance and many other tools that try to manage expectations. Longer-term interest rates such as the 10-year bond yield therefore have to be included in the panel to describe monetary conditions.
- *Monetary aggregates:* Many central bank's expanded their balance sheets in order to be even more expansive at the lower bound. Different monetary aggregate such as the money base, M1 or M3 are thus added to the panel in seasonally adjusted quarter-on-quarter growth rates.
- *International reserves:* Since a currency can be quite strong a determinant of monetary conditions, exchange rate interventions are a powerful tool central banking. Since the mirror of those interventions are foreign currency reserves, the series (ideally excluding gold and mandatory contributions to international organisations) are used as another monetary policy indicator (as q-o-q growth rates, sa). The exchange rate itself proved not to be helpful.

Based on this panel X_t of n time series, I try to find unobserved factors that drive its dynamics, i.e. the “overall stance” of monetary policy considering a range of tools.

$$X_t = \Lambda F_t + \epsilon_t \tag{8}$$

$$F_t = \sum_{h=1}^q B_h F_{t-h} + \varepsilon_t \tag{9}$$

The factors are denoted F_t ⁶. Λ is called the factor loadings and describes the historical correlations between factors and multiple time series. At the same time, the common factors follow a VAR process of order q . The appropriate method to estimate an unobserved component of the panel data was proposed by Watson and Engle (1983), and the version of Banbura and Modugno (2014) is able to draw the factor with an arbitrary set of missing data points⁷, which makes it feasible for this application with omitted interest rate data close to zero.

Secondly, based on the unobserved factor and its correlations with observed series, the missing data points can be reconstructed. They will be based on the observed, non-restricted part of the interest rate and on the dynamic factor created by the set of variables that determines monetary conditions. However, it will not be restricted by any lower bound, be it at zero or below.

The respective rates for a selection of countries can be found in figure 8.

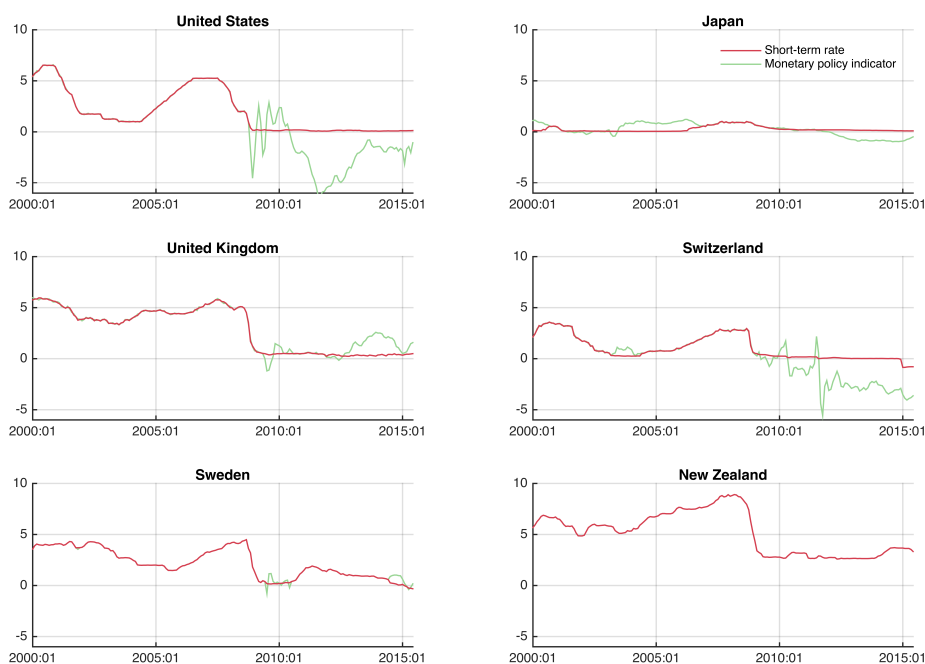


Figure 8: **Monetary policy indicator 2000-2015** Based on interest rate and central bank balance sheet data, a “shadow rate” for periods close to zero is constructed using a dynamic factor model with an EM algorithm for arbitrary missing data. The policy indicator (green) can be both lower or higher than the observed interest rate (red) path. *Sources: Databanks from Federal Reserve Bank of St. Louis, Bank for International Settlements, Organization for Economic Co-operation and Development, Eurostat, national central banks and statistical offices*

In fact, the monetary policy indicator for the US, which is supposed to track a Federal Funds Rate that includes the effects of large-scale asset-purchasing programmes in times of a binding lower bound, falls lower than -5 percent during QE2 (which is similar in magnitude to results from Lombardi and Zhu (2014) who use a larger set of monetary variables but only for one country.)

⁶Their number r varies among countries because the amount of input variables available is different. Generally, it is chosen as small as possible in order to reach convergence and optimise the fit of the indicator series with past interest rate behaviour and the monetary policy history. r is typically chosen to be 5, the lag length h is 4.

⁷I thank Marta Banbura and Michele Modugno for kindly sharing their codes for the EM algorithm, as well as Marco Lombardi and Thomas Nitschka for bringing it to my attention.

In Switzerland, the calculated policy indicator plummets in September 2011. The policy of an enforced minimum exchange rate seems to have acted quite expansionary. In Sweden and Japan, the two do not deviate much, but the Japanese case shows that post-crisis quantitative easing can be considered more expansionary than the policies in the first half of the decade. In the United Kingdom, historical correlations even suggest that the way macro variables behave in the last three years indicates a more restrictive policy than the official bank rate implies.

Overall, the procedure allows to create a monetary policy indicator (MPI) that allows to incorporate different unconventional measures from QE to forward guidance in the VAR.

3.2.2 Macro variables

All other macro series are downloaded from public websites such as the Federal Reserve Bank of St. Louis. GDP series are retrieved exclusively from the IMF World Economic Outlook database, and for the asset price or stock market indicator, the largest stock index for every country is taken. In general, I obtain monthly series and aggregate them to annual frequency. In the end, we need annual data. If the raw series are not covariance stationary (e.g. consumer price indices), annual growth rates from the last observations of all the years are calculated to capture developments that took place over the course of the year. If the originals are stationary (in their demeaned form, e.g. many unemployment series), the annual average is used for the model. For real GDP and stock prices, annual series are easier to find for a large scale of countries and sufficiently far back in time. Both are non-stationary, which is why growth rates have to be calculated. I also calculated a potential GDP and its difference to the original series, the output gap, using an Hodrick-Prescott filter.

3.2.3 Inequality

Empirical approaches on inequality always face the major problem of rather short and thin base of reliable data. The main source for the empirical part of this paper is the Standardized World Income Inequality Database, also referred to as SWIID (Solt, 2014). It contains data from the United Nations World Income Inequality Database, the OECD Income Distribution Database, national statistical offices around the world and employs standards of the Luxembourg Income Study (LIS). Since its coverage and comparability exceed those of publications with a similar aim, it is best suited for the purpose of this paper (Solt, 2009). The reasons for preferring the SWIID over others are as follows:

- *International comparability:* Tax administration data as used by Atkinson et al. (2011) or Foellmi and Martinez (2014) would provide longer and typically more comprehensive time series to assess the effects on various groups and subgroups than surveys. However, this paper conducts a cross-national analysis - and at this level, for the lack of comparability, tax accounts are no suitable data source. The very idea of this paper is to include many countries to exploit the fact that monetary policy changed at different times and to various extents across monetary areas.
- *Distinction of labour and capital income:* The source on which income is based should account for the fact that monetary policy affects different sources of income differently. Social security

datasets usually only include wage income, and so do surveys that are in line with the standards by the International Labour Organisation (ILO), such as the Swiss Labour Force Survey (SLFS, or SAKE). The SWIID does not explicitly differentiate between sources of income, unfortunately, but it has the favourable feature of reporting two Gini coefficients for pre- and post-redistribution.

- *Preferability of micro data:* The SWIID database unfortunately only publishes the Gini index as a measure of income inequality. Therefore, having a dataset that is consistent over time and across countries comes at the cost of losing information about the heterogeneity of households. For example, we are not able to identify different effects of monetary policy on people in the highest quartile of the income distribution, compared to those on the lower end. Therefore, I repeat the exercise with time series on inverted Pareto-Lorenz coefficients, which are available on the World Top Incomes Database (WTID) of Alvaredo et al. (2015)⁸.
- *Available frequency and time span:* The SWIID incorporates international databases from the United Nations and OECD and considers national sources as well. The published figures are standardised and merged in a consistent way in order to extract more information than can be provided by the single studies and surveys on their own. For example, the Swiss Household Budget Survey (HBS, or HABA) interviews about 3000 households a year and publishes annual aggregate figures which are compatible with Luxembourg Income Studies (LIS) standards. However, time series can be constructed back to the year 2000 only, and two more surveys are available for 1998 and 1990. The SWIID tries to make earlier studies and findings compatible with the prevailing standards and is able to publish reliable figures (including the estimation uncertainty around them) back to the 1960s for most countries (compare figure 4). This is not the case for other international databases such as the LIS or the EU Survey of Income and Living Conditions. All countries under consideration include annual data up until 2010, some of them up to 2013.

Cumulative number of countries...		
available up to	SWIID (Gini)	WTID (Par.-Lor.)
2013	8	2
2012	19	7
2011	21	8
2010	22	14

The data base, as many, is far from perfect of course. A rich set of high-frequency micro data over time would be a much appreciated upgrade to make a cogent case. Nevertheless, the fact that the data used is internationally comparable, includes incomes from different sources and is available for many countries over quite a long time frame, makes it a good source to examine inequality.

⁸Data that enters is retrieved from national tax offices and thus includes capital income at least to some extent. As the initiators of the database warn, there might be definitional breaks in both the time and cross-sectional dimension that cannot be corrected, for example to what extent capital gains are taxable. Additionally, they stress the fact that especially the top percentiles of the income distribution have a strong incentive to understate taxable incomes in their tax declarations (Atkinson et al., 2011).

4 Results

This section presents results of the model explained in section 3 and relates them to the discussion in section 2. Whereas it is difficult to draw conclusions on unconventional monetary policy from the baseline version, a few robustness checks and alternative specifications follow to shed some light on redistributive effects of the policies used since the financial crisis.

4.1 Baseline impulse responses

The baseline model includes all 22 countries for which all requested time series are available from 1990 to 2010. Figure 9 shows the impulse responses to an expansionary monetary policy shock of one standard deviation⁹ on the other variables for the 10 consecutive years.

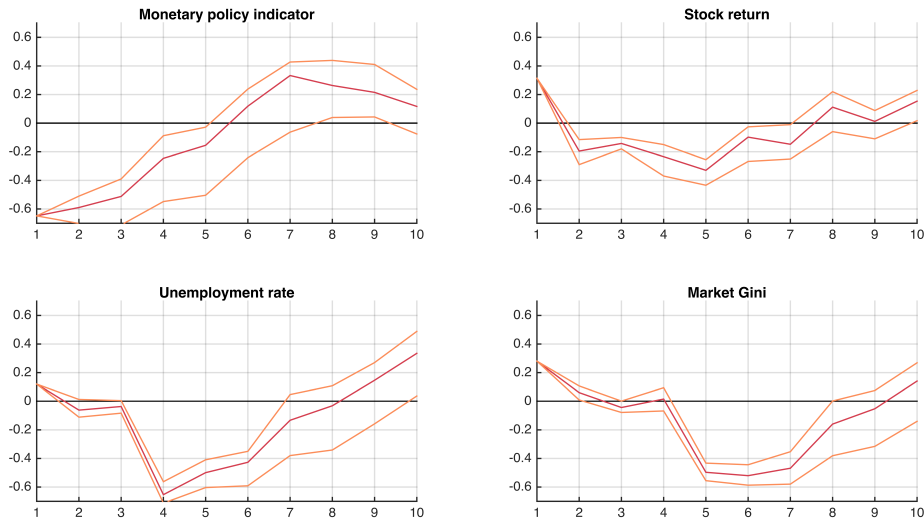


Figure 9: **Baseline results** Impulse responses (in standard deviations) to a monetary policy shock, including confidence bands of one standard error.

$Y_{it} = [MPI_{it}, STOCKS_{it}, UNEMP_{it}, GINI_{it}]$. 22 countries, 1990-2010, 4 lags.

The negative (i.e. expansionary) monetary policy shock (upper left-hand side panel) leads to an immediate gain of the stock market (upper right-hand side panel), which turns significantly negative from the second to seventh year. This is very much in line with Gali and Gambetti (2015), and also weakly with Saiki and Frost (2014), who find less significant results. What the latter do not include is a labour market indicator such as unemployment and plausibly, this turns out to be very significant for explaining the transmission of monetary policy. Expansionary shocks are followed by a large and significant drop in unemployment in the medium run (lower left-hand side panel), comparable in size to Christiano, Eichenbaum, and Evans (1996).

The VAR finds that an accommodative shock of the monetary policy indicator is followed by a short increase in inequality, probably driven by returns on stock market investments which flow to the rich. Afterwards, the estimated coefficients point to falling inequality after several years.

⁹In the case of the Fed and the Swiss National Bank, this is equivalent to about -150, resp. -140 basis points.

This is in line with country-specific empirical findings from Coibion et al. (2012) and Mumtaz and Theophilopoulou (2015). However, the effect fades out over time (lower right-hand side panel). Because the model is linear, it indicates that contractionary monetary policy increases inequality in the medium run and is neutral in the long run. The peak effect is reached at half a standard deviation, thus we can deduct that a rate hike of 1 percentage point increases inequality by about 0.4 to 1.2 points on the Gini scale.

What the impulse response functions of the baseline version imply is that a conventional inequality measure such as the Gini index strongly correlates with unemployment, even though somewhat lagged and slightly more persistent. The correlation with returns on stocks is much weaker. This is plausible for two reasons: First, the vast majority of household income is earned on the labour market, which is why this channel is expected to be very important. Even though wages, employment and the natural rate of unemployment are important, too, the unemployment rate provides a good approximation of the state of the labour market. Second, stock returns, even though typically earned by households on the higher end of the distribution, do not directly translate to income since they consist of both dividends and capital gains.

4.2 Robustness checks

4.2.1 Sample selection

The baseline includes all the countries for which the SWIID database has data that are reliable and go back sufficiently far in time, and for which monetary and financial data is available for the respective time period. Additionally, countries that experienced a collapse of their currency and/or hyperinflation (e.g. Russia or Argentina) were excluded as well.

A first attempt to check whether the above results are robust is to run the model on different samples. Figures and facts that test the above results for robustness typically deviate from the baseline with respect to the mentioned characteristics and are not changed otherwise.

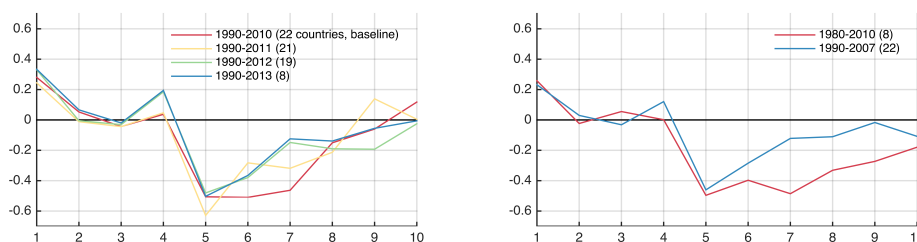


Figure 10: **Time and sample selection** Impulse responses to a monetary policy shock, with variation at the start and current margin.

Since unconventional monetary policy started in 2008 and will probably unfold the years after, choosing the right time frame for the analysis is of particular importance. The left-hand side graph of figure 10 shows that choosing the end year does not change much of the Gini coefficient's reaction to monetary policy – if at all, evidence for lowering inequality becomes a little weaker when including the current margin¹⁰.

¹⁰Beware, however, that there might be a composition effect. Cutting the dataset by one year allows to include more countries. For a detailed discussion on the effects of unconventional monetary policy, refer to chapter 4.4

The country selection is important, too and should be cross-checked, for example because half the dataset consists of European countries with little variation in labour market institutions and monetary policy. However, figure 11 shows that inequality in European countries does not react significantly differently from others. Also, the reaction of countries that already have a relatively unequal distribution of market incomes is a bit more volatile, but the difference is not statistically significant.

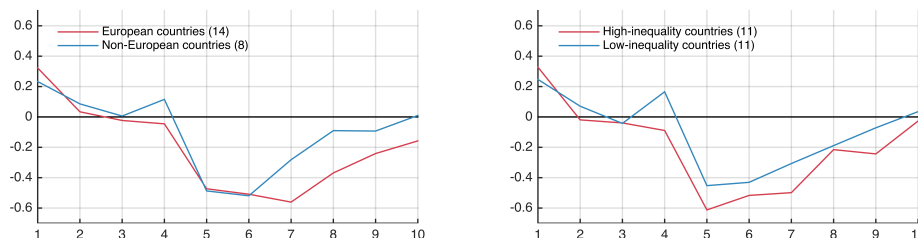


Figure 11: **Country selection** Impulse responses of a monetary policy shock for different groups of countries.

4.2.2 Variables and Cholesky ordering

Unemployment and stock returns capture two main channels through which monetary policy could affect cyclical inequality. However, we have to compare them to alternatives.

Measuring the effect of inflation on inequality in a VAR is very difficult, because when using a Cholesky decomposition, IRFs show almost always what is referred to as the price puzzle – the fact that prices increase as a response to a contractionary shock, which is exactly the opposite of what is usually intended (Giordani, 2004). It proves to be very difficult to study inflation within a small-scale VAR.

Instead, I try to find whether other real and financial channels work, too. Unemployment is replaced by the amount of slack in the economy, defined as the deviation from potential growth or output gap. Stock market returns are replaced by bond yields.¹¹ The medium-run effect of this version still accounts for about 80 percent of the baseline, and is more persistent, such that an expansionary shock does not have an augmenting effect even after 10 years.

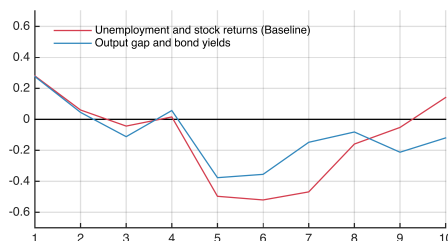


Figure 12: **Alternative channels** Impulse responses to a monetary policy shock via different real and financial channels: $Y_{it} = [MPI_{it}, BONDS_{it}, OUTPUTGAP_{it}, GINI_{it}]$.

¹¹Chile, Korea, and Portugal have to be excluded for the lack of data.

The model is not very sensitive to the use of the monetary policy indicator, either. Figure 13 compares the model on the 8 countries up to 2013 (to get the longest possible episode of a binding zero lower bound). In the short run, the reaction of the short-term interest rate is a bit higher, accounting for the fact that an artificially small variation of the policy rate explains the change in inequality. If we assume that the monetary policy indicator adequately describes the real stance of monetary policy, the increasing effect on inequality in the very short term diminishes somewhat. One should be careful about making policy conclusions on the long-term deviations of the two IRFs because there is simply no data on an unconventional monetary policy shock after 10 years, not even for Japan.

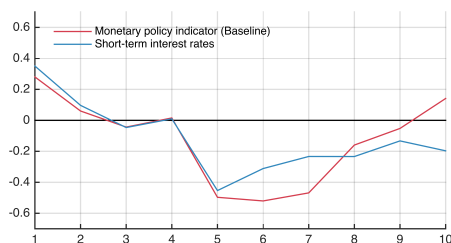


Figure 13: **Monetary policy instruments** Impulse responses to different monetary policy shocks. $Y_{it} = [I3M_{it}, STOCKS_{it}, UNEMP_{it}, GINI_{it}]$. 8 countries, 1990-2013.

Any VAR solved with a Cholesky decomposition is dependent on the ordering of the variables. Therefore, I order the variables once as they are in Saiki and Frost (2014): Unemployment is observed by the central bank which reacts with policy that is transmitted via the stock market (which loses with contractionary policy and wins with expansionary policy) to the distribution of income.

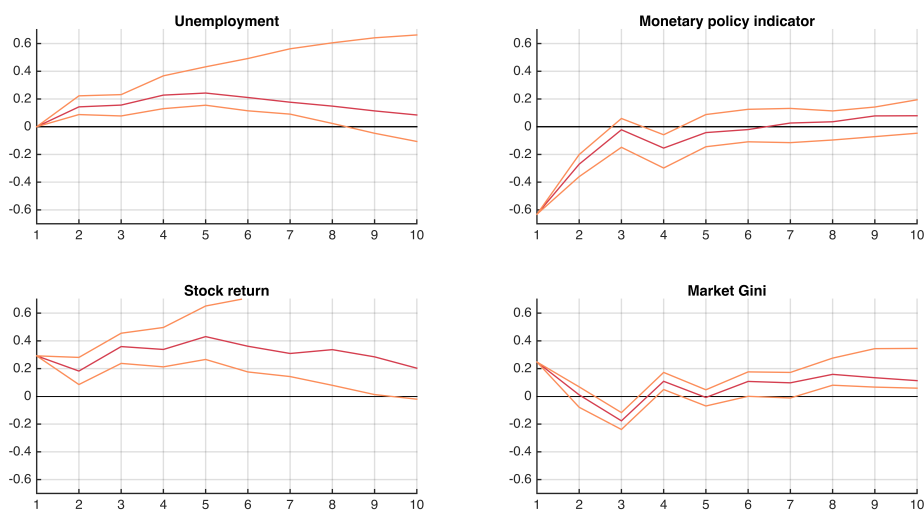


Figure 14: **Cholesky ordering** Impulse responses to a monetary policy shock, including confidence bands of one standard error. $Y_{it} = [UNEMP_{it}, MPI_{it}, STOCKS_{it}, GINI_{it}]$

The results are similar to those of the Cholesky decomposed VAR on survey data from Japan: After an expansionary shock and some time of noise, the Gini stabilises at a significantly higher level. This is a very biased picture, however. First of all, it makes the stock market the dominant channel for the transmission of income inequality, which is one element of a complex process but not more. Secondly, this version of the model makes unemployment a countercyclical variable: When monetary policy is loosened, all else equal, unemployment surges. It is very hard to find theoretical and empirical justification for this behaviour.

When including unemployment, the Gini measure increases to contractionary shocks and decreases with expansionary policy in almost all cases. Therefore, we can conclude that expansionary monetary policy rather reduces than increases income inequality, and that the labour market is the primary transmission channel in doing so.

4.3 The role of top incomes

Increasing (labour) incomes on the high end of the income distribution have been identified as an important driver of inequality in recent years. Therefore, it is interesting to see how their incomes react to monetary policy shocks.

Given that there is no internationally consistent measure that captures top incomes exclusively at an annual frequency, I use the inverted Pareto-Lorenz coefficient retrieved from the WTID. When the index is high, the distribution of income is characterised by a heavy upper tail, i.e. a small share of the population earns a significant share of total income. Its estimated response to monetary policy seems similar to the Gini coefficient, which captures the overall dispersion, but there are a few crucial insights.

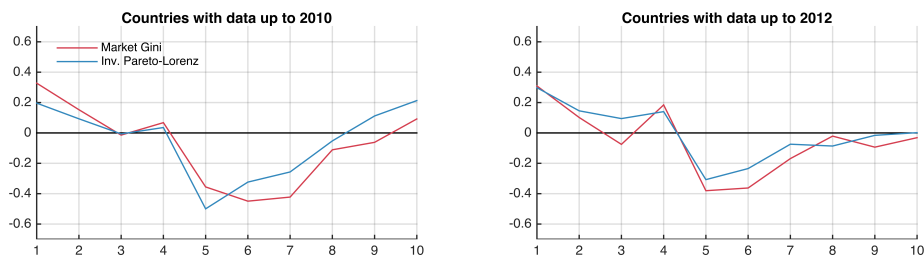


Figure 15: **Top incomes** Impulse responses to a monetary policy shock on the inverted Pareto-Lorenz coefficient. $Y_{it} = [MPI_{it}, STOCKS_{it}, UNEMP_{it}, PARLOR_{it}]$ Left: 14 countries, 1990-2010. Right: 7 countries, 1990-2013.

When all the countries are modelled for which both measures are available until 2010, the inverted Pareto-Lorenz coefficient obtains a less sharp increase in the first place. Additionally, after reaching the peak around -0.5 standard deviations after 5 years, it moves somewhat faster back to normal than the Gini for the same set of countries (compare figure 15, left-hand side). After monetary expansion, both inequality measures fall within the first handful of years, but the one with a heavier weight on top incomes rises again fast. In short, the re-boost of inequality in the medium run is driven by top incomes.

The right-hand panel looks at those countries for which both series are available until 2012 (including some data on unconventional measures), and the results are striking. The immediate reaction to an expansionary shock is more positive for the inverted Pareto-Lorenz coefficient than for the

Gini coefficient, and less negative in the medium term. This indicates that some rich households benefit disproportionately from balance sheet expansion, indeed. A broad stabilisation of middle class incomes limits the impact on overall distribution measures such as the Gini, but when putting a heavier weight on top incomes, the measure does not fall as much. For the course of almost the entire response period, the path of the Pareto-Lorenz curve is higher than the Gini. Inequality due to the rich falls less than the overall measure. The conclusion is that top incomes do not only drive the long-term trend of increasing inequality, but are also part of the cyclicity of the income distribution.

4.4 Hints on effects of unconventional monetary policy

The critique expressed in political debates and the media is that unconventional monetary policy tools are to be made causally responsible for inequality. With the substantial publication lag of income inequality data, it is impossible to fully answer this question empirically. Even though the data on the Japanese experience since 2002 would be sufficient, the magnitude of the Japanese pre-crisis quantitative easing is not comparable to the programmes seen by the Fed, the BoE, or the BoJ since 2009. Nevertheless, the model can be used to shed some light on whether the allegations are justified.

First, I repeat the exercise for different end dates of the data sample and look how the IRF behaves, particularly on the short-term horizon. To get meaningful results, the sample needs to be fixed to avoid a composition effect. There are 15 countries (including European countries with centralised monetary policy) for which data are available up to 2012, and the model is estimated for all end years back to 2008. As figure 16 shows, the short-term end, which one would expect to be most sensitive to the sample end, is very robust. For the medium term, IRFs change somewhat, but the basic story of increasing inequality in cases of contractionary shocks holds up. In the longer run, IRFs based on data that include more recent years tend to be more persistently negative, therefore implying that expansionary policies have a long-lasting cushioning effect on inequality. The same procedure on the five countries at the zero-lower bound for which the database includes 2013 does not change the fundamental picture. Certainly, the IRFs do not imply that higher-than-before income inequality increases can be expected because of unconventional monetary policy.

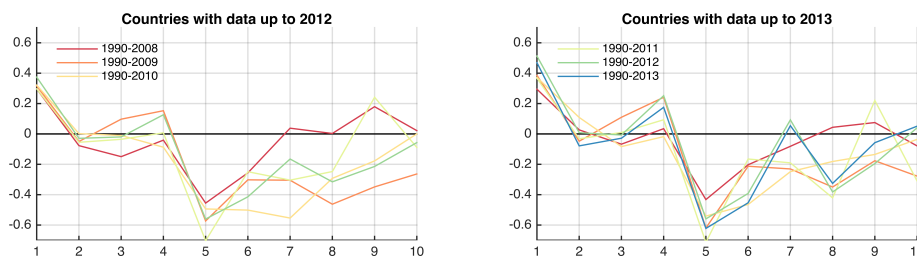


Figure 16: **Information from recent data releases** Impulse responses to a monetary policy shock on time series with different end dates. Left: 15 countries, 1990-2012. Right: 6 countries, 1990-2013.

Interestingly enough, the short end of the stock market’s impulse response is rather sensitive to choosing the end data of the estimation (not shown in the figure). The closer to the present, the deeper is the contemporaneous increase of stock markets to expansionary shocks. That reflects very well anecdotal evidence of the past years, when market participants often reacted positively to bad news from the real economy, because this would imply a tightening of monetary policy to recede further into the distance.

Japan has the longest history of a binding lower bound, and of quantitative easing – even though the programme used to be somewhat hesitant before the crisis. Nevertheless, if quantitative easing did have an augmenting effect on income inequality, the monetary policy shock IRF of the model including Japan would be less negative than the baseline.

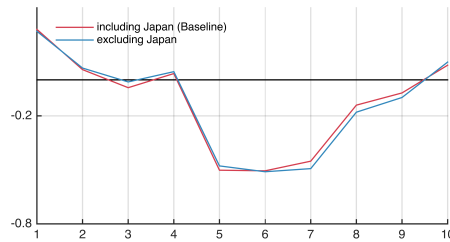


Figure 17: **Information from Japanese data** Impulse responses to a monetary policy shock with and without Japan

As a matter of fact, the two are almost identical. If any, the difference would be such that the IRF including Japan is somewhat higher from years 7 to 9 after the shock. Including Japan pulls the blue curve upwards. Therefore, the Japanese case could indeed indicate that inequality increases (or decreases less than with conventional interest rate accommodation), even years after the policy implementation.

5 Concluding thoughts

This thesis studied whether monetary policy influences the distribution of labour and financial income in an economy, especially in the light of the unconventional measures such as asset-purchasing programmes, credit easing or exchange rate interventions which were implemented in recent years. Different channels through which monetary policy affects household heterogeneously were discussed. The empirical part of the article used a vector-autoregressive model to identify whether the behaviour of inequality measures such as the Gini or Pareto-Lorenz coefficients can be explained by monetary policy shocks.

This relates to a vivid debate on inequality in general and the role of (unconventional) monetary policy in particular, and it enhances the existing literature mainly in two ways: First of all, a panel dataset on 22 countries from 1990 to 2013 is used for the estimation instead of looking at just one country. Secondly, I account for the fact that the conventional monetary policy tool of short-term interest rates was stretched to its limits in many countries in the wake of the Great Recession because it cannot be cut (substantially) below zero – a phenomenon which is referred to as the lower bound. Therefore, I calculate a monetary policy indicator that replaces the restricted policy rate by a series that also captures the unconventional measures taken, and use it to derive monetary policy shocks in the VAR using a Cholesky decomposition.

The results suggest that after an expansionary monetary policy shock, inequality indices increase at first but then fall substantially. This is attributed to the stabilising effect on the labour market in the medium term. Over the course of about ten years, the effect evaporates.

A few further findings are worth noting, too: The sensitivity of results to the sample end is rather low, i.e. the use of quantitative easing and alike have not changed the transmission mechanism such that increasing inequality has to be expected because of unconventional measures. Nevertheless, the marginal effect of Japan – the country with the longest history of a binding lower bound – could indicate exactly that. Additionally, a measure of income inequality that puts more weight on top incomes still falls in the wake of loosening monetary policy, but less than the Gini coefficient. This implies that while top incomes have played an important role of long-term inequality trends in many countries in recent decades, they might also do so in the transmission of monetary policy. Therefore, concerns that unconventional monetary policy transmits to higher inequality, especially due to the highest percentiles, should not be ruled out prematurely.

Most models used at central banks rely on homogeneous agents, and policy-makers do not (explicitly) account for inequality among households when taking policy decisions, even though their actions always have distributional effects. Their mandate is to ensure monetary stability in terms of steady inflation and, to some degree, promote that economic growth is close to its potential. For the lack of experience, it stays guessing what would have happened to inequality if central banks did not try to maintain price stability when facing the zero lower bound. After all, expansionary measures which stabilise the labour market when depression is threatening will likely flatten the income distribution compared to the counterfactual of no intervention. On the other hand, there might be alternatives such as fiscal policy or monetary policy approaches which promise stimulus with less distributional effects. Blyth and Lonergan (2014), for example, suggest that monetary injections via lump-sum transfers to households transmit more evenly than via the credit market. Hopefully, the question studied in this thesis will be considered when evaluating whether the current monetary system is able to cope with hysteresis and deflationary pressure or whether it should be developed further.

References

- Acemoglu, D. (2011, January). *Thoughts on inequality and the financial crisis*. (Presentation at the American Economic Association Annual Meeting on 7 January 2011)
- Acemoglu, D., & Johnson, S. (2012, March). *Who captured the Fed?* (New York Times)
- Agnello, L., & Sousa, R. M. (2014). How does fiscal consolidation impact on income inequality? *Review of Income and Wealth*, 60(4), 702-726.
- Akerlof, G. A., Dickens, W. T., & Perry, G. L. (2000). Near-rational wage and price setting and the long-run Philipps curve. *Brookings Papers on Economic Activity*, 31(1), 1-60.
- Alvaredo, F., Atkinson, A. B., Piketty, T., & Saez, E. (2015). *The world top incomes database*. Retrieved from <http://topincomes.g-mond.parisschoolofeconomics.eu> (12 August 2015)
- Atkinson, A. B., Piketty, T., & Saez, E. (2011). Top incomes in the long run of history. *Journal of Economic Literature*, 49(1), 3-71.
- Baeriswyl, R. (2014, December). Intertemporal discoordination in the 100 percent reserve banking system. *Study Center Gerzensee Working Papers*, 06.
- Baeriswyl, R., & Cornand, C. (2015, June). The distortionary effect of monetary policy: Credit expansion vs. lump-sum transfers in the lab. *Groupe d'Analyse et de Theorie Economique (GATE) Working Papers*, 1516.
- Banbura, M., & Modugno, M. (2014). Maximum likelihood estimation of factor models on datasets with arbitrary pattern of missing data. *Journal of Applied Econometrics*, 29, 133-160.
- Bank of England. (2012a). The distributional effects of asset purchases. *Quarterly Bulletin*, Q4, 254-266.
- Bank of England. (2012b). The funding for lending scheme. *Quarterly Bulletin*, Q4, 306-320.
- Bank of International Settlements. (2015). *Quarterly review, September 2015*. Bank of International Settlements. Retrieved from http://www.bis.org/publ/qtrpdf/r_qt1509.htm
- Barro, R. J. (2000). Inequality and growth in a panel of countries. *Journal of Economic Growth*, 5(1), 5-32.
- Beraja, M., Fuster, A., Hurst, E., & Vavra, J. (2015, June). Regional heterogeneity and monetary policy. *Federal Reserve Bank of New York Staff Report*, 731.
- Bernanke, B. S. (2015). Monetary policy and inequality. Retrieved from www.brookings.edu/blogs/ben-bernanke/posts/2015/06/01-monetary-policy-and-inequality
- Bernanke, B. S., & Blinder, A. S. (1992). The federal funds rate and the channels of monetary transmission. *American Economic Review*, 82(4), 901-921.
- Bernanke, B. S., Boivin, J., & Eliasch, P. S. (2005). Measuring the effects of monetary policy: A factor-augmented vector autoregressive (FAVAR) approach. *The Quarterly Journal of Economics*, 120(1), 387-422.
- Bernanke, B. S., Reinhart, V. R., & Sack, B. P. (2004). Monetary policy alternatives at the zero bound: An empirical assessment. *Brookings Papers on Economic Activity*, 35(2), 1-100.
- Bertola, G., Foellmi, R., & Zweimueller, J. (2006). *Income distribution in macroeconomic models*. Princeton University Press.
- Birchler, U., Volkart, R., Ettl, D., & Hegglin, R. (2011). *Aktienbesitz in der Schweiz 2010*. University of Zurich Institute for Banking and Finance.
- Bivens, J. (2015, June). Gauging the impact of the Fed on inequality during the Great Recession. *Hutchins Center Working Papers*, 12.
- Blyth, M., & Lonergan, E. (2014). Print less but transfer more. *Foreign Affairs*, 93(5).

- Boel, P. (2013, November). On the redistributive effects of inflation: An international perspective. *Sveriges Riksbank Working Paper Series*, 274.
- Bordo, M. D., & Landon-Lane, J. (2013). Does expansionary monetary policy cause asset price booms? Some historical and empirical evidence. *The Chilean Economy, Central Bank of Chile*, 16(2), 4-52.
- Borio, C., & Disyatat, P. (2009, November). Unconventional monetary policies: An appraisal. *BIS Working Papers*, 292.
- Buiter, W. H., & Panigirtzoglou, N. (2003). Overcoming the zero bound on nominal interest rate with negative interest on currency: Gesell's solution. *The Economic Journal*, 113.490, 723-746.
- Campbell, J. R., Evans, C. L., Fisher, J. D. M., & Justiniano, A. (2012). Macroeconomic effects of FOMC forward guidance. *Brookings Papers on Economic Activity*, 44(1), 1-80.
- Canova, F., & Ciccarelli, M. (2013, January). Panel vector autoregressive models: A survey. *European Central Bank Working Paper Series*, 1507.
- Carpenter, S. B., & Rodgers III, W. M. (2004). The disparate labor market impact of monetary policy. *Journal of Policy Analysis and Management*, 23(4), 813-830.
- Christensen, J. H. E., & Krogstrup, S. (2015, April). Transmission of quantitative easing: The role of central bank reserves. *Federal Reserve Bank of San Francisco Working Paper Series*, 18.
- Christiano, L. J., Eichenbaum, M., & Evans, C. L. (1996). The effects of monetary policy shocks: Evidence from the flow of funds. *The Review of Economic and Statistics*, 78(1), 16-34.
- Christiano, L. J., Eichenbaum, M., & Evans, C. L. (2005). Nominal rigidities and the dynamic effects of a shock to monetary policy. *Journal of Political Economy*, 113(1), 1-45.
- Claessens, S., & Perotti, E. (2007). Finance and inequality: Channels and evidence. *Journal of Comparative Economics*, 35(4), 748-773.
- Coibion, O., Gorodnichenko, Y., Kueng, L., & Silvia, J. (2012, June). Innocent bystanders? Monetary policy and inequality in the U.S. *NBER Working Papers*, 18170.
- Congressional Budget Office. (2014, November). *The distribution of household income and federal taxes, 2011*. Retrieved from <https://www.cbo.gov/publication/49440>
- Credit Suisse. (2014). *Global wealth report 2014*. Credit Suisse Research Institute.
- Dabla-Norris, E., Kochhar, K., Suphaphiphat, N., Ricka, F., & Tsounta, E. (2015, June). Causes and consequences of income inequality: A global perspective. *IMF Staff Discussion Note*, 15(13).
- D'Acunto, F., Hoang, D., & Weber, M. (2015, May). Inflation expectations and consumption expenditure. *Social Science Research Network Scholarly Paper*.
- Deaton, A. (2015). *The great escape: Health, wealth, and the origins of inequality*. Princeton University Press.
- Del Negro, M., Giannoni, M., & Patterson, C. (2012, October). The forward guidance puzzle. *Federal Reserve Bank of New York Staff Report*, 574.
- Demary, M., & Niehues, J. (2015, June). Auswirkungen von Niedrigzinsen und unkonventionellen geldpolitischen Massnahmen auf die Vermoegensverteilung. *IW Policy Papers*, 15.
- Doepke, M., & Schneider, M. (2006a). Inflation and the redistribution of nominal wealth. *Journal of Political Economy*, 114(6), 1069-1097.
- Doepke, M., & Schneider, M. (2006b, June). Inflation as a redistribution shock: Effects on aggregates and welfare. *NBER Working Paper*, 12319.

- Doepke, M., Schneider, M., & Selezneva, V. (2015, June). Distributional effects of monetary policy. *Hutchins Center Working Paper*, 14.
- Draghi, M. (2015). *The ECB's recent monetary policy measures: Effectiveness and challenges*. Retrieved from <https://www.ecb.europa.eu/press/key/date/2015/html/sp150514.en.html> (Camdessus lecture at the International Monetary Fund, Washington DC on 14 May 2015)
- Eggertsson, G. B., & Woodford, M. (2003). The zero bound on interest rates and optimal monetary policy. *Brookings Papers on Economic Activity*, 34(1), 139-235.
- Elmer, H., Guibourg, G., Kjellberg, D., & Nessen, M. (2012). The Riksbank's monetary policy measures during the financial crisis: Evaluation and lessons learnt. *Sveriges Riksbank Economic Review*, 3, 8-31.
- Erosa, A., & Ventura, G. (2002). On inflation as a regressive consumption tax. *Journal of Monetary Economics*, 49(4), 761-795.
- European Central Bank. (2015). *Transmission mechanism of monetary policy*. Retrieved from <https://www.ecb.europa.eu/mopo/intro/transmission/html/index.en.html>
- Fawley, B. W., & Neely, C. J. (2013). Four stories of quantitative easing. *Federal Reserve Bank of St. Louis Review*, 95(1), 51-88.
- Feenstra, R., & Hanson, G. H. (1996). Globalization, outsourcing, and wage inequality. *American Economic Review*, 86(2), 240-245.
- Foellmi, R., & Martinez, I. Z. (2014, June). Volatile top income shares in Switzerland? Reassessing the evolution between 1981 and 2009. *Centre for Economic Policy Research Discussion Paper*, 10006.
- Fratzscher, M., Duca, M. L., & Straub, R. (2013, June). On the international spillovers of US quantitative easing. *European Central Bank Working Paper Series*, 1557.
- Gali, J., & Gambetti, L. (2015). The effects of monetary policy on stock market bubbles: Some evidence. *American Economic Journal: Macroeconomics*, 7(1), 233-257.
- Gambacorta, L., Hofmann, B., & Peersman, G. (2014). The effectiveness of unconventional monetary policy at the zero lower bound: A cross-country analysis. *Journal of Money, Credit and Banking*, 46(4), 615-642.
- Giordani, P. (2004). An alternative explanation of the price puzzle. *Journal of Monetary Economics*, 51(6), 1271-1296.
- Gornemann, N., Kuester, K., & Nakajima, M. (2014). *Doves for the rich, hawks for the poor? Distributional consequences of monetary policy*. (Unpublished manuscript)
- Huelsmann, J. G. (2014). Fiat money and the distribution of incomes and wealth. In *Howden, D. & Salerno J. T. The Fed at One Hundred. A Critical View on the Federal Reserve System*. Springer International Publishing.
- Jensen, H., Ravn, S. H., & Santoro, E. (2015, March). Changing credit limits, changing business cycles. *Centre for Economic Policy Research Discussion Paper*, 10462.
- Jordan, T. J. (2015). *The impact of international spillovers on inflation dynamics and independent monetary policy: the Swiss experience*. (Speech at the 39th Economic Symposium in Jackson Hole on 28 August 2015)
- Jordan, T. J., Peytrignet, M., & Rossi, E. (2010). Ten years' experience with the Swiss National Bank's monetary policy strategy. *Swiss Journal of Economics and Statistics*, 146(1), 9-90.
- Joyce, M. A. S., Lasoosa, A., Stevens, I., & Tong, M. (2011). The financial market impact of quantitative easing in the United Kingdom. *International Journal of Central Banking*, 7(3),

113-161.

- Kendall, M., & Stuart, A. (1977). *The advance theory of statistics. Vol. 1. 4th edition*. Macmillan, New York.
- Kettemann, A., & Krogstrup, S. (2014). Portfolio balance-effects of the Swiss National Bank's bond purchase program. *Journal of Macroeconomics*, 40(C), 132-149.
- Keynes, J. M. (1936). *The general theory of employment, interest and money*. Macmillan, London.
- Koop, G., & Korobilis, D. (2010). Bayesian multivariate time series methods for Empirical Macroeconomics. *Foundations and Trends in Econometrics*, 3(4), 267-358.
- Korinek, A., & Kreamer, J. (2014, October). The redistributive effects of financial deregulation: Wall Street versus Main Street. *BIS Working Papers*, 468.
- Krishnamurthy, A., & Vissing-Jorgensen, A. (2011). The effects of quantitative easing on interest rates: Channels and implications for policy. *Brookings Papers on Economic Activity*, 43(2), 215-287.
- Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review*, 45(1), 1-28.
- Lagos, R., & Wright, R. (2005). A unified framework for monetary theory and policy analysis. *Journal of Political Economy*, 113(3), 463-484.
- Ledito, O. (2011). The redistributive effects of monetary policy. *University of Zurich Department of Economics Working Paper Series*, 44.
- Lombardi, M., & Zhu, F. (2014, June). A shadow policy rate to calibrate US monetary policy at the zero lower bound. *BIS Working Papers*, 452.
- Lucas, R. E. (2000). Inflation and welfare. *Econometrica*, 68(2), 247-74.
- Milanovic, B. (2013). Global income inequality in numbers: in history and now. *Global Policy*, 4(2), 198-208.
- Mortensen, D. T., & Pissarides, C. A. (1994). Job creation and job destruction in the theory of unemployment. *Review of Economic Studies*, 61(3), 397-415.
- Mumtaz, H., & Theophilopoulou, A. (2015, February). Monetary policy and inequality in the UK. *Queen Mary University of London Working Paper*, 738.
- Muth, J. F. (1961). Rational expectations and the theory of price movements. *Econometrica*, 29(3), 315-335.
- OECD. (2011). *Divided we stand: Why inequality keeps rising*. OECD Publishing.
- OECD. (2015). *In it together: Why less inequality benefits all*. OECD Publishing.
- Okun, A. (1975). *Equality and efficiency: The big tradeoff*. Brookings Institution.
- Ostry, J. D., Berg, A., & Tsangarides, C. G. (2014, February). Redistribution, inequality, and growth. *IMF Staff Discussion Note*, 14(02).
- Paque, K.-H. (2014). Der Historizismus des Jakobiners. *Perspektiven der Wirtschaftspolitik*, 15(3), 271-287.
- Peersman, G., & Smets, F. (2001, December). The monetary transmission mechanism in the euro area: More evidence from VAR analysis. *European Central Bank Working Paper Series*, 91.
- Piketty, T. (2014). *Capital in the twenty-first century*. The Balknap Press of Harvard University Press.
- Rajan, R. (2010). *Fault lines*. Princeton University Press.
- Ravn, S. H. (2014). Asymmetric monetary policy toward the stock market: A DSGE approach. *Journal of Macroeconomics*, 39, 24-41.

- Romer, C. D., & Romer, D. H. (1999). Monetary policy and the well-being of the poor. *Economic Review*(Q I), 21-49.
- Romer, C. D., & Romer, D. H. (2004). A new measure of monetary shocks: Derivation and implications. *American Economic Review*, 94(4), 1055-1084.
- Saiki, A., & Frost, J. (2014, May). How does unconventional monetary policy affect inequality? Evidence from Japan. *DNB Working Paper*, 423.
- Sims, C. (1992). Interpreting the macroeconomic time series facts: The effects of monetary policy. *European Economic Review*, 36(5), 975-1000.
- Solon, G., Basky, R., & Parker, J. A. (1994). Measuring the cyclicalty of real wages: How important is composition bias. *Quarterly Journal of Economics*, 109(1), 1-25.
- Solt, F. (2009). Standardizing the World Income Inequality Database. *Social Science Quarterly*, 90(2), 231-242.
- Solt, F. (2014). *The Standardized World Income Inequality Database*. Retrieved from <http://myweb.uiowa.edu/fsolt/swiid/swiid.html> (SWIID Version 5.0, October 2014.)
- Spitznagel, M. (2012, April). *How the Fed favors the one percent*. (Wall Street Journal)
- Stiglitz, J. E. (2015, May). New theoretical perspectives on the distribution of income and wealth among individuals. Part IV: Land and credit. *NBER Working Paper*, 21192.
- Svensson, L. E. (2010). Inflation targeting. In B. M. Friedman & M. Woodford (Eds.), *Handbook of monetary economics* (Vol. 3, p. 1237-1302). Elsevier.
- Swiss Federal Statistics Office. (2015, October). *Haushaltseinkommen und -ausgaben nach Einkommensklasse (je-d-20.02.01.12)*. Retrieved from <http://www.bfs.admin.ch/bfs/portal/de/index/themen/20/02/blank/key/einkommen0/niveau.html>
- Watson, M. W., & Engle, R. F. (1983). Alternative algorithms for the estimation of dynamic factor, mimic and varying coefficient regression models. *Journal of Economics*, 23(3), 385-400.
- Wolff, E. N. (2014, December). Household wealth trends in the United States, 1961-2013: What happened over the Great Recession? *NBER Working Paper*, 20733.
- World Bank. (2015, June). Negative interest rates in Europe: A glance at their causes and implications. *Global Economic Prospects*.
- Yellen, J. L. (2014). *Perspectives on inequality and opportunity from the Survey of Consumer Finances*. Retrieved from <http://www.federalreserve.gov/newsevents/speech/yellen20141017a.htm> (Speech at the Conference on Economic Opportunity and Inequality at the Federal Reserve Bank of Boston MA on 17 October 2014)

Appendix

Panel VAR country details			
Country	Inequality databases		Monetary policy sources
	SWIID	WTID	
Australia	2012	2010	rba.gov.au
Austria	2013		ecb.eu, oenb.at
Belgium	2012		ecb.eu, nbb.be
Canada	2011	2010	bankofcanada.ca
Chile	2011		bcentral.cl
Denmark	2013	2010	nationalbanken.dk
Finland	2013		ecb.eu, suomenpankki.fi
France	2012	2012	ecb.eu, banque-france.fr
Germany	2012	2010	ecb.eu, bundesbank.de
Ireland	2012		ecb.eu, centralbank.ie
Italy	2013		ecb.eu, bancaditalia.it
Japan	2010	2010	boj.or.jp
Korea	2013	2012	bok.or.kr
Netherlands	2012		ecb.eu, dnb.nl
New Zealand	2013	2012	rbnz.govt.nz
Norway	2012	2011	norgesbank.no
Portugal	2012		ecb.eu, bportugal.pt
Spain	2012	2012	ecb.eu, bde.es
Sweden	2012	2013	riksbank.se
Switzerland	2012	2010	snb.ch
United Kingdom	2013	2012	bankofengland.co.uk
United States	2012	2013	federalreserve.gov

Declaration of Authorship

I hereby declare that

- I have written this thesis without any help from others and without the use of documents and aids other than those stated above,
- I have mentioned all the sources used and that I have cited them correctly according to established academic citation rules,
- the topic or parts of it are not already the object of any work or examination of another course unless this has been explicitly agreed on with the faculty member in advance,
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