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ABSTRACT

Die Verteilungseffekte von Quantitative Easing haben sich zu einem bedeutenden wirtschaftlichen und ökonomischen Interesse entwickelt. Daher hat sich eine Reihe von Wirtschaftswissenschaftlern diesem Thema in Theorie und Empirie gewidmet. Diese Arbeit gibt einen Überblick über diese sehr aktuelle Literatur und approximiert die Verteilungseffekte von QE. Diese sind heterogen und unterliegen sowohl der Zusammensetzung von QE Programmen als auch Länder- / Haushalt-Spezifika, aber vor allem der Haushalt-Heterogenität, sprich der Ungleichheit selbst. Die Literatur identifiziert drei Hauptübertragungskanäle von QE auf die Haushaltseinkommen, den Asset Price, den Employment und den Mortgage Refinancing Kanal. Der Erste ist tendentiell regressiv, beide letzteren Kanäle sind progressiv. Die Literatur deutet darauf hin, dass QE in den USA, besonders wegen der hohen Ungleichheit, leicht regressiv war. Dieser Effekt könnte sich insbesondere in EWU-Ländern mit geringer Ungleichheit und hoher Umverteilung umkehren.

ABSTRACT

The distributional effects of Quantitative Easing have become a major economical and political concern. Thus, a raising number of economists has addressed this matter in theory and in empirics. This thesis reviews on this very recent literature approximating on the distributional effects of QE. These are heterogenous and subject to both, the composition of QE measures and country / household specifics, but foremost household heterogeneity, speaking inequality. The literature identifies three main transmission channels of QE to incomes across households, namely the Asset Price, the Employment and the Mortgage Refinancing channel. The former is regressive, both latter channels are progressive in nature. The literature suggests that QE was modestly regressive in the US, especially for its high inequality. This effect may alter, especially within EMU economies with low inequality and large redistributive policies.

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List of Abbreviations	
ABSPP	Asset Backed Securities Purchase Programme
APF	Asset Purchase Facility
APP	Asset Purchase Program
BoE	Bank of England
BoJ	Bank of Japan
CBPP	Corporate Bond Purchase Programme
CSPP	Covered Bond Purchase Programme
ECB	European Central Bank
EMU	European Monetary Union
Fed	Federal Reserve
GDP	Gross Domestic Product
HANK	Heterogenous Agent New Keynesian
IMF	International Monetary Fund
LSAPs	Large Scale Asset Purchases
LTROs	Long-Term-Refinancing Operations
MBS	Mortgage-Backed Securities
PSPP	Private Sector Security Purchase Programme
QE	Quantitative Easing
RIF	Recentered Influence Function
UMP	Unconventional Monetary Policy
VAR	Vector Auto Regression

1 INTRODUCTION

Today, the Bank of Japan (BoJ), the Bank of England (BoE), the Federal Reserve (Fed) and the European Central Bank (ECB) issued Quantitative Easing (QE) programs to achieve their inflation targets and stimulate the economy, especially after the great recession from 2007/08. The consensus is that QE was mostly successful in achieving these goals [30].

But, persistent criticism is held against one potential side-effect of QE - increasing inequality. There is an ongoing debate on whether and if so, to what extent, Quantitative Easing exacerbated inequality. To this point, the evidence is controversial and, due to the currency of QE, the literature on this matter is still in its infancy [13]. Yet, most studies conducted indicate a regressive effect of QE on inequality at least in the short- to medium term [5, 20, 52, 45, 10, 41, 47].

Debates on the distributional impacts of monetary policy reach back far and today there seems to be a broad consensus that monetary policy has a distributional dimension. Anyhow, the distributional impacts of monetary policy were long neglected and are still mostly considered small or even neutral over the economic cycle, benefiting one subgroup in the upswing and the other during downturn [13]. In addition, the argument prevails that incorporating inequality cannot be part of an independent central bank's mandate. Distributional measures are commonly assigned to fiscal policymakers for several reasons, predominantly due to their democratic legitimization. This is a major argument since a redistributive mandate that is not legitimated and checked democratically may well be prone to its abuse [13, 7]. Otherwise, democratically legitimized but short-sighted governments might be corrupted given the ability of unrestricted money printing. Thus, the separation of monetary and fiscal policymaking has become the state of the art of modern central banking, as pioneered by Barro and Gordon [4].

Keeping this in mind, in the aftermath of the crisis the interdependence between inequality and monetary policy has caught the attention of economists, fiscal and monetary policymakers as well as the public in general. There is evidence that inequality does affect economic growth, the stability of financial markets and, thus, the effectiveness of monetary policy making itself. In recent years, several studies that foster this relationship were published including Ostry et al. [4], Ko

[37], Motta and Tirelli [46]. Challenging the predominant view that distributional impacts of monetary policymaking are small, Doepke et al. [21] constructed a complex live cycle model with US household data concluding that these effects may indeed be large.

Further, renowned economists, including Krugman [39], Summers [62], Stiglitz [61] and Turner [63], argue that rising inequality may be a core issue of post-crisis economic stagnation. Note, today these economists also have a political background. In line, in 2017 the International Monetary Fund (IMF) Blog [23] published an article exhorting that rising inequality can "... undermine the sustainability of growth itself". Given these findings, it is more than reasonable that this controversy has risen to the executive floors of central banks around the world [33].

The contribution of this thesis to this debate is twofold: first, I give an overview of studies estimating the distributional impacts of QE, wholly or in part. Doing this, I cover most relevant and frequently cited studies until the end of 2017. For an overview of these studies see page 27. Second, based on these studies I give an approximation of the distributional impacts of QE on income inequality. In addition, I line out driving factors in the transmission of QE to incomes across quantiles including the composition of QE measures and relevant country / household characteristics.

In aggregate, the underlying literature suggests that Quantitative Easing has increased income inequality in the United States at least in the short- to medium-term. This effect may differ for the other, especially European Monetary Union (EMU) economies due to differences in QE measures and country / household specifics, most importantly inequality itself.

Literature and Structure

This thesis is structured as follows: first I give an introduction to Quantitative Easing. In this, I define QE and give an overview of QE programs, respective central bank targets and whether they were achieved. Then, I lead over to the issue of inequality and how it is affected by Quantitative Easing. In assessing this question I divide my thesis in two parts.

The first part, theory, provides the theoretical framework on the transmission of monetary policy in general and Quantitative Easing specifically to incomes across households and, thus, inequality. I close by identifying a range of key country characteristics relevant to the transmission of QE through these channels.

The second part, empirics, then emphasizes on the empirical literature and respective findings. I start by introducing the applied method. Next, I give an overview of the underlying studies assessing the distributional effects of QE and their challenges and limitations. After, I look at each of the distributional channels specifically assigned to QE by the literature, namely the Asset Price, Employment and Mortgage Refinancing Channel. Then, I perform a cross-country comparison for the US, UK, Japan and the five biggest Euro area economies looking at the key country characteristics identified. Finally, I conclude my findings.

In more detail, in the introductory section on QE, I define QE emphasizing on Fawley [30] and the Bank of England [5]. Then, I look at the size and composition of QE measures of the Federal Reserve, the Bank of England, the European Central Bank and the Bank of Japan. This is based on Fawley [30] and central bank data [55, 3, 27, 56].

In the theory part, I focus on Coibion et al. [19] when assessing the distributional channels of monetary policy in general. After, following Bivens [10], Montecino and Epstein [45] I elaborate on the distributional channels specifically assigned to QE. I close by illustrating the key country characteristics relevant to the transmission of QE to inequality. I hereby refer to Coibion [19], Bivens [10], Montecino and Epstein [45], Deutsche Bundesbank [13] and Guerello [33].

I open the empirics part introducing my applied method. Following Montecino and Epstein [45], I focus on net income including asset and employment income as well as mortgage debt payments. I apply a three-step approach: first, I look at the distribution of each variable, namely asset income, employment income and mortgage debt. Next, I provide implications on how respective variables affected net income throughout QE. Lastly, I elaborate on counterfactual estimates, speaking how much of this change is due to QE?

The forthcoming section gives an overview of the underlying studies assessing the distributional effects of QE and points out respective challenges and limitations.

Studies comprise the Bank of England [5], Dobbs et al. [20], Saiki and Forst [52], Bivens [10], Montecino and Epstein [45], Bernoth [9], Lazar [41], Deutsche Bundesbank [13], Mumtaz and Theophilopoulou [47], Guerello [33] and Bunn et al. [49]. This sums to eleven studies.

Subsequently, I evaluate the Asset Price, the Employment and the Mortgage Refinancing channel in this order. Applying the three-step approach, in the first section I look at empirical data from Bivens [10], the US Tax Policy Center [15], Statista [60] and the US Census Bureau [14]. Next, I provide estimates from Montecino and Epstein [45] on how each variable affected inequality throughout QE. Finally, in the third section I discuss counterfactual scenarios following Montecino and Epstein [45], Bivens [10], Engen et al. [26], Kiley [36], Chung et al. [16]. Lastly, I perform a cross-country comparison, where I compare countries investigated by key country characteristics identified in the last theory section. This comparison is based on OECD data [48], an IMF policy paper [57], Statista [58, 59] and Trading Economics data [25, 24], Lea [42], and the World Bank [43]. I close by concluding for my findings.

2 INTRODUCTION TO QE

In this section, I define Quantitative Easing, give an overview of QE programs, their key features, respective central bank targets and whether they were achieved. Until now, the Bank of Japan, the Federal Reserve, the Bank of England and the European Central Bank issued QE programs to stimulate the economy and achieve their respective inflation targets [30]. The literature broadly agrees that QE was effective in achieving these goals [5, 33, 10, 9, 49].

2.1 Defining Quantitative Easing

Following Fawley [30] and in line with many of the empirical studies [52, 41, 47, 33, 49], I define Quantitative Easing generally as central bank balance sheet enlargements, on both, the asset and liability side. QE measures can primarily affect either the asset or the liability side of a central bank's balance sheet. An example of liability side measures would be an extension of credits by the central bank, while an example of asset side operations would be outright asset purchases [30]. The effect of such measures on the real economy is multi-faceted and complex. The idea behind QE, however, is quite simple: at the point when lowering the interest rate, the price of money, becomes infeasible, increasing the amount of money is another option to cause inflation and, thus, stimulate the economy [30].

The transmission of these measures to the real economy is dependent on both, the composition of QE measures and country specifics. For example, Bernanke [7] argues that extensive loan supply (a liability side measure) reduces risk premia and illiquidity in all assets that are eligible collateral, while bond purchases (an asset side measure) solely affect the risk-free component of interest rates. In turn, economic characteristics, e.g. the composition of household balance sheets, affects this transmission on the country side [33, 13, 49].

The predominant form of QE is outright asset purchases. There are three main transmission channels of asset purchases on the real economy identified by the Bank of England [5]:

First, boosting asset prices through direct purchases and indirect portfolio effects. As the returns to assets bought by the central bank diminish, markets will turn to better substitutes. These receive price gains too, this is also known as arbitrage. For example, the central bank buys government bonds, returns fall, markets sell government bonds and buy e.g. stocks or equity. This boosts stock prices and equity alike. In addition, asset purchases have a signaling function, which improves market confidence and alleviates speculations.

Second, boosting investment and, thus, employment. The effect of QE on employment is twofold: on the supply side, stimulated investment increases employment; on the demand side, rising employment stimulates consumption that in turn increases employment. For instance, corporate bond purchases enhance corporate spending and, thus, increase employment.

Third, lowering long-term interest rates, e.g. mortgage rates. Buying long-term assets like government bonds declines long-term interest rates through both, price and substitution effects. If a central bank buys a 10-year government bond, other long-term interest rates are affected by the same portfolio effects as for the asset price channel. This also has a signalling component, as a central bank with extended asset portfolio has an incentive to keep long-term rates low.

Additionally, Quantitative Easing has further effects on the economy. These include wider impacts on expectations like boosting consumer confidence and economic outlook, but also falling risk premiums. In aggregate, these impacts reduce real interest rates, stimulate demand, enhance employment and, thus, boost the economy [5]. In the next section, I give an overview of the most important QE programs issued.

2.2 Overview of QE Programs

As alluded, to this day the BoE, the BoJ, the Fed and the ECB engaged in QE. QE measures started at different points in time and varied in size and composition. Some measures primarily expanded the liability side of the central bank balance sheet but most measures constituted outright asset purchases. Figure 1 depicts the evolution of balance sheet to Gross Domestic Product (GDP) ratios for all four central bank between 2006 and 2014 [30].

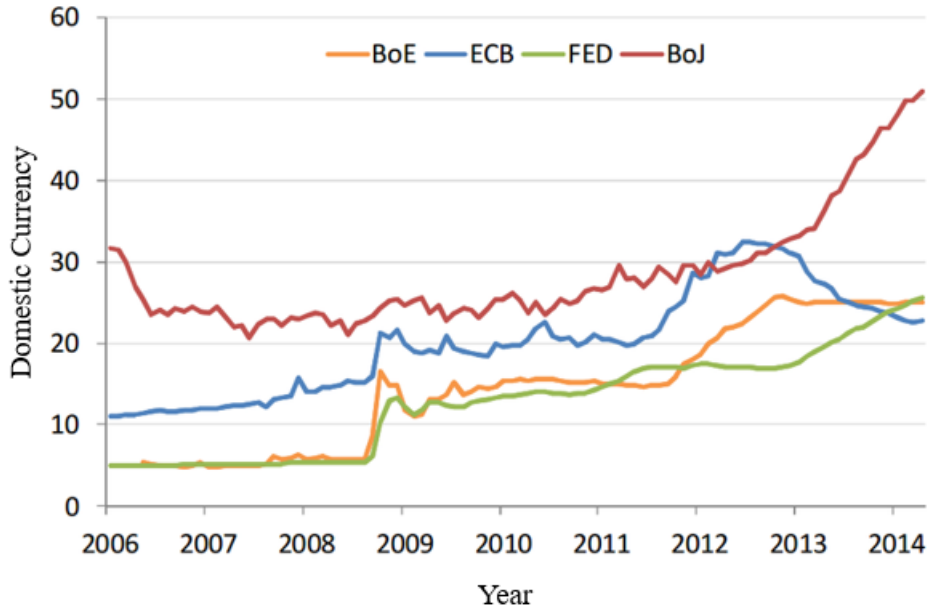


Figure 1: Central Bank Balance Sheets in Percent of GDP¹⁸

In terms of balance sheet enlargements, all four central banks engaged in QE after the outset of the crisis. Both, the BoE's and the Fed's balance sheets show a steep increase in late 2008. The ECB's balance sheet hikes at this point too, while the BoJ, starting from a high level in terms of GDP, performs only minimal enhancements.

The ECB and BoE conducted another large expansion in 2011/12 and the Fed

¹⁸**Source:** Claeys p. 10 [17]; **Note:** Fed and ECB, both in Millions of Dollars and Euros, BoJ in 100 Million Yen, BoE in 100 Thousand Pound.

followed in 2013/14. At this point, the ECB was already consolidating its balance sheet again. Again, the BoJ's balance sheet exhibits only incremental increases but accelerates from 2013 onwards.

In addition, the ECB, BoJ and BoE fostered excessive balance sheet expansions after 2014 [3, 27, 56]. Unfortunately, none of the studies available covers this aggressive QE period. Oncoming research on this recent period would be of great value to this discussion. In the following, I summarize on the most relevant QE measures undertaken by the Federal Reserve, Bank of England, European Central Bank and Bank of Japan respectively.

2.2.1 Quantitative Easing by the Federal Reserve

In the aftermath of 2007/08, the Federal Reserve engaged in various measures to fight recession and alleviate financial market distress. In its balance sheet expansion, the Fed issued three programs also termed QE1, QE2 and QE3 also known as Large Scale Asset Purchases (LSAPs). The goal of these programs was to meet the Fed's policy target of close to 2 % inflation and to boost employment [30].

QE1 started on November 25, 2008. It sized \$ 1750 billion, whereby the central bank bought \$ 200 billion in government-sponsored enterprise debt, \$ 1250 billion in mortgage-backed securities and \$ 300 billion in long-term Treasury securities. The program aimed to stimulate the entire economy but prioritized the plagued US mortgage market [30].

The second round, QE2, followed in September 2010. The Fed increased its balance sheet by another 600 billion longer-term Treasury Securities until mid-2011. This program explicitly headed to dwarf long-term real interest rates [30].

The last round of purchases, QE3, started in September 2012. In contrast to QE1 and QE2, the Fed committed to a monthly pace of 40 billion instead of fixing a size of total purchases. These mainly targeted mortgage-backed securities. In December 2012, the Fed expanded its purchases by another 45 billion long-term Treasury securities. Purchases ended in October 2014 [55, 30].

In sum, the Fed's QE programs almost quadrupled its balance sheet with all programs summing up to about 3 trillion. In 2014, this amounts to a share of roughly 17 % of GDP. In this, the Fed decided to focus on asset side measures. The con-

sensus is, that the Federal Reserve was successful in achieving its primary goals, to boost the US economy, bring down employment and alleviate financial- and especially mortgage market distress. The Fed ended all QE operations in late 2014 [55, 30].

2.2.2 Quantitative Easing by the Bank of England

The Bank of England embarked on asset purchases soon after the Federal Reserve. Its self-defined goals were boosting the money supply, aggregate demand and, therefore, achieve its inflation rate target. It implemented the Asset Purchase Facility (APF), a separate entity, in March 2009 to conduct these purchases [30]. Until September 2012, the APF purchased a total of £375 million. The program predominantly targeted medium and long-maturity government bonds, so-called gilts in the UK, but also private sector assets [30].

The BoE further raised these purchases from 2016 onwards. Continuously, government gilts constituted the favored asset. In January 2018, gilts amounted to a total of £435 million and an additional £10 million in corporate bonds [30].

In addition, the BoE established the Term Funding Scheme in September 2016 to provide funding to UK banks at close to bank rate interest. The main goal was to incentivize banks to encourage lending and lower interest for households and business. The program ended in early 2018 accounting for a total of £126.6 million [30].

In sum, the BoE quintupled its balance sheet within ten years between 2008 and 2018. In this period, total purchases accounted for about 23 % of UK GDP in 2017. Again, the consensus is that QE was successful in achieving BoE targets: boost inflation, spending, employment and overall economic performance [20]. Like the Fed, the BoE mainly engaged in outright asset purchases. The purchases ended in early 2018 [30, 27].

2.2.3 Quantitative Easing by the European Central Bank

Unlike the Fed and the BoE, the European Central Bank at first focused on liability side measures, its large-scale asset purchases started comparatively late. Its primary goals were to alleviate financial market distress and improve bank lending

to achieve its inflation target, later these goals were expanded to support heavily indebted EMU countries and, thus, sustain the Euro [30].

The ECB started in late 2008 with its Long-Term-Refinancing-Operations (LTROs) providing excessive liquidity to banks solely limited by available collateral. These were accompanied by the Corporate Bond Purchase Programme (CBPP1) accounting for €60 billion in Euro denominated covered bonds, which started in mid-2009. Bond purchases constituted a minor share compared to the LTROs [30].

It expanded both programs in October 2011, again with a focus on LTROs. CBPP2 accounted for another €40 billion. On both occasions, enlargements from LTROs soon diminished from 2013 onwards, as loans expired unsubstituted by the central bank. With their 3-month maturity, the ECB's LTRO had a much shorter duration than outright asset purchases, given that assets are held to maturity [30].

Finally, the ECB decided to embark on large-scale asset purchases in Fed and BoE manner from 2015 onwards. In line with the Fed's QE3, purchases were conducted monthly from March 2015 onwards. The ECB announced to end these purchases in December 2018. Programs targeted public sector securities (Public Sector Purchase Programme, PSPP), covered bonds (Covered Bond Purchase Programme, CSPP), corporate bonds (Corporate Bond Purchase Programme, CBPP) and asset backed securities (Asset Backed Securities Purchase Programme, ABSPP) [30, 3].

In May 2018, the lion share of assets bought by the ECB constituted public sector securities valuing about €1992 million. The CBPPs sum to assets worth €254 million, the CSPP to €156 million, and the ABSPP accounts for a total of €27 million. From 2008 to 2018, the ECB's balance sheet doubled [30, 3].

In sum, purchases valued €2.431 billion, accounting roughly 21 % of Euro area GDP in May 2018. For the effectiveness of the ECB's asset purchases there is mixed evidence. Its measures appear to have boosted output and lowered the Euro Dollar exchange rate and long-term interest rates, but these effects seem to have diminished in the medium-term. Purchases continue expectably until the end of 2018 [30, 3].

2.2.4 Quantitative Easing by the Bank of Japan

Much like the ECB, the Bank of Japan focused on lending operations early after the crisis, but shifted to outright asset purchases later. Its main policy goal was to boost the Japanese economy, which was already struggling with sluggish growth when the crisis hit, achieve its inflation target and support the distressed Japanese banking sector [52, 30].

The Bank of Japan pioneered QE in March 2001. Until 2006, the BoJ enhanced its reserves by 35 trillion Yen. Throughout the course of this program, the BoJ purchased public and private debt, mostly government bonds and asset-backed securities. The program was minor relative to the other programs discussed in this thesis and shut down in March 2006. The literature deems this program failed.[30, 54]

After 2007/8 the BoJ slowly but steadily expanded its balance sheet further. In ECB manner, its special-funds-supplying operations provided extensive lending to banks conditioned solely on available collateral. In December 2008 the BoJ also enhanced its Japanese government bond purchases from 1.2 trillion Yen to 1.4 trillion. The BoJ fostered its balance sheet expansion further buying an additional 3 trillion Yen in commercial paper and 1 trillion in corporate bonds in 2009. In addition, it increased government bond purchases to 21.6 trillion Yen yearly. This expansion accelerated after 2010 with the Asset Purchase Program (APP). The program targeted treasury discount bills, commercial paper, corporate bonds, ETFs, and Japanese Real Estate Investment Trusts, but favored Japanese government bonds. In December 2012 APP purchases totaled 61 trillion Yen [30].

As for the BoE and the ECB, QE became far more aggressive after 2012 when the BoJ engaged in excessive bond purchases. In fact, the BoJ's balance sheet shot up from about 1400 trillion Yen in early 2012 to over 5200 trillion Yen at the end of 2017, compared to about 1000 trillion Yen in mid-2007. In terms of GDP, this size is unique, accounting for a share of over 90 % of Japanese GDP. Purchases, however, slowed down in 2017 though the BoJ did not announce an end of its balance sheet expansions yet. Unfortunately, for Japan QE was not a story of success. Compared to the size of the program the Japanese economy is still falling short [30, 53].

2.2.5 Summary of QE Measures

All four central banks engaged in excessive balance sheet expansions to achieve their mandates and stimulate their economies. Further goals diverge. Both, the Federal Reserve and the Bank of England engaged early in outright asset purchases, while the ECB and the BoJ focused on lending operations and shifted to asset purchases later.

The Fed used QE predominantly to lower long-term interest rates and aid the plagued US mortgage market, buying large shares of Mortgage-Backed Securities (MBS) and treasuries. The BoE focused its operations on boosting the UK economy and achieve its inflation target. Its purchases focused on government bonds. Both, the ECB and the BoJ largely relied on lending operations to improve situations for their respective banking sectors. Clearly, both economies rely much more on banking than the US and the UK [43]. Facing ongoing sluggish growth, both central banks embarked on large-scale asset purchases eventually. The ECB enlarged its balance largely with public sector securities, covered and corporate bonds. The BoJ emphasized on government bonds and treasury bills.

In terms of GDP the BoJ issued the largest QE measures accounting for an over 90 % enlargement in 2017. The size of the other central bank's programs lie comparatively close with 23 % in the UK, 21 % in the Euro area and 17 % in the US. Evidence on the progressive effects of QE on the economies is mixed. The literature suggests that central banks were mostly successful with their operations in the short- to medium term. But, these effects seem to diminish in the long-run. This may indicate that QE can only be used to mask economic issues, not cure them.

Moreover, QE is controversial not only for its uncharted nature but also for its potential side effects, one of which is exacerbating inequality. In fact, this questions seems to dominate the public debate about QE. Further, not only for its rising political brisance, this question has risen the attention of fiscal and monetary policymakers alike. Rising inequality in many developed economies is suspect to be not only threatening political stability and social cohesion but economic growth and the effectiveness of monetary policy making itself [39, 62, 61, 63]. In the following, I address this question in theory and empirics.

3 THEORY

In this part, I provide the theoretical framework to assess the question how Quantitative Easing affects incomes across quantiles and, thus, inequality. In this, I give an overview of the distributional channels of monetary policy to inequality as proposed by Coibion et al. [19] and cited by many of underlying studies estimating the distributional impacts of QE [33, 45, 13]. After, I illustrate the distributional channels assigned to QE explicitly as argued by Bivens [10], Montecino and Epstein [45]. Finally, I identify key country characteristics relevant to the transmission of QE to inequality on behalf of these channels.

3.1 Monetary Policy and Inequality

The transmission channels of monetary policy on income inequality are diverse and there are several papers aiming to identify them. One frequently cited paper providing an overview over respective channels is Coibion et al. [19], following Deutsche Bank [13] I summarize their findings in Table 1.

1. The income composition channel (i) works through the composition of household income regarding business, financial, labor and transfer incomes. Montecino and Epstein [45] also subtract debt payments to grasp the overall impact of policy changes. All these incomes are affected differently by a shift in monetary policy. Assuming a monetary expansion, falling interest rates lead to a decline in interest income while business income (equity) tends to rise. Also, falling interest rates benefit debtors. By boosting the economy, a monetary expansion is also expected to raise employment and wages. Finally, by providing better refinancing conditions for governments, transfers potentially increase. In sum, the distributional impact of this channel is highly dependent on the ex-ante distribution of wealth and income. In the literature, falling mortgage refinancing rates are considered equalizing, contrastingly rising returns on stocks and equity are generally regressive. Labor income and transfers are lagging, and are both considered equalizing. The overall impact of this channel is ambiguous.

Transmission Channel	Transmission Mechanism
(i) Income composition	Business, financial and labor income as well as transfers respond differently to changes in the monetary regime.
(ii) Financial segmentation	Richer households tend to be better-informed and participate more actively in the financial market. Therefore, they have an advantage in case of a change in the monetary policy rate.
(iii) Portfolio	Broadly diversified portfolios are less prone to inflationary losses. Households with large positions unprotected against inflation suffer disproportionately from inflationary pressure after a monetary expansion.
(iv) Savings redistribution	A fall in real interest rates generally benefits borrowers while hurting savers. As savers tend to be wealthier than borrowers, a monetary expansion benefits the poor.
(v) Earnings heterogeneity	Wage elasticities to changes in the monetary regime differ across quantiles. Bottom households are more vulnerable to unemployment. In boosting employment a monetary expansion is equalizing.

Table 1: Transmission Channels of Monetary Policy¹⁹

2. The financial segmentation (ii) channel argues that better-informed households that participate frequently in the financial market tend to benefit disproportionately from changes in the monetary regime. In this respect, the relative closeness of households to the financial market determines the size of this channel. In both cases, if all households, and, if no households participate in the financial market with (more or less) the same information, the expected size is small. Otherwise, if some households exhibit a systemic advantage, its size inclines. In reality, as Deutsche Bundesbank p. 21 [13] points out, “the early bird catches the worm” or as Bernanke [7] argues, rich households tend to be more active on the

¹⁹**Source:** Ciobion et al. p. 2 [19]

financial market. Thus, this channel is arguably regressive.

3. The portfolio channel (iii) refers to the heterogeneous distribution of assets across the population. A monetary expansion affects this channel mainly through rising inflation. While better-informed households which usually also participate more actively in the financial market (see (ii)) exhibit broadly diversified portfolios protected against inflation, less fortunate households may hold large shares of their wealth in assets affected by inflation. Hence, this channel is generally regressive.

4. The savings redistribution channel (iv) suggests that a monetary expansion is shrinking interest rates and boosting inflation, thus benefiting borrowers and hurting savers. The extent of this channel depends on the ex-ante composition of financial contracts and refinancing opportunities. For example, Claeys et al. [17] points out, that for several Eurozone countries including Austria, Belgium, France, Italy, Germany and the Netherlands fixed mortgages might hinder refinancing. Also, households at the bottom of the income and wealth distribution may be unable to take advantage of improving refinancing conditions due to low or even negative equity as argued by Montecino and Epstein [45]. Irrespectively of these limitations, this channel is tendentially equalizing.

5. The earnings heterogeneity channel (v) captures the distributional effects of the relative returns on labor income across the population. While the wealthy exhibit large shares of capital income relative to labor income, those at the bottom of the income distribution depend mainly on labor income. By boosting employment and, thus, wages a monetary expansion is progressive. Anyhow, wage rigidities and skewed elasticities benefiting those at the top induced e.g. by unlike competitive pressure, mobility and/or bargaining-power might diminish equalizing impacts [45, 37]. Still, this channel is progressive in nature.

Summarizing, the overall impact of the income composition channel is ambiguous. While both, the financial segmentation and the portfolio channel tend to

exacerbate inequality in case of a monetary expansion, the savings distribution and the earnings heterogeneity channel are both arguably equalizing. All these channels are dependent on country or household specifics, e.g. the distribution of assets or debt. In the following, I will refer to these channels when illustrating the distributional channels assigned to QE specifically, namely the asset price, employment and mortgage refinancing channel.

3.2 Quantitative Easing and Inequality

Regarding Quantitative Easing the literature points to three main transmission channels, the asset price channel, the employment channel and the mortgage refinancing channel, whereby the asset price and the employment channel are considered the most relevant. The asset price channel is regressive in nature, while the employment and the mortgage refinancing channel are generally speaking progressive [10, 45]. Table 2 summarizes on these channels, in the following three subsections I detail on each.

3.2.1 The Asset Price Channel

The most direct impact QE has on the economy is inflating asset prices, e.g. stocks, either through direct purchases or as assets are utilized as collateral. This is the most predominant argument of QE critics: as the rich own more assets than the poor, they profit disproportionately. Hence, by boosting asset prices, QE exacerbates inequality. This primarily refers to the (i) income composition channel, as capital income clusters at the top of the distribution, while the bottom percentiles rely mainly on labor income [7, 13, 45].

Even more, the wealthy tend to be better-informed, exhibit better diversified portfolios, see (ii) portfolio channel, and longer-term investment strategies than the poor, see (iii) financial segmentation. Thereby, they are less affected by falling (short-term) interest rates and rising inflation in the cause of Quantitative Easing. This also implies considerations from the (iv) savings redistribution channel. In particular, households with large shares of deposits unprotected against inflation

tend to lose out in the cause of QE [19, 13].

Transmission Channel	Transmission Mechanism
Asset Prices	Quantitative Easing boosts asset prices, either through direct purchases or through indirect substitution effects. As assets are mainly held by the rich, this channel is arguably regressive.
Employment	Quantitative Easing boosts demand and, thus, enhances employment. As poor households rely largely on employment income and are more prone to unemployment, this channel is rather progressive.
Mortgage Refinancing	Quantitative Easing lowers long-term interest rates and, therefore, improves mortgage conditions. As mortgage debt is relatively skewed to the bottom, this channel is progressive. Anyhow, this is dependent on mortgage refinancing conditions across households.

Table 2: Transmission Channels of Quantitative Easing²⁰

Maggio et al. [44], Krishnamurthy and Vissing-Jorgensen [38] find that portfolio rebalancing plays a subordinate role in this transmission. This means, that assets are not perfect substitutes and it does matter which assets are targeted by the central bank. For example, mortgage-backed security purchases affect the mortgage market, including mortgage rates, disproportionately. This also holds for other assets and may relate to the signaling effect of QE. Further, this effect diminishes in the long-run with QE measures reaching their maturity as argued by Bivens [10].

Clearly, the size of this channel is dependent on both, the composition of QE measures and the distribution of assets across households. While stocks, bonds and equity tend to be held by the most wealthy, especially housing is usually distributed rather egalitarian. Meanwhile, large shares of assets unprotected against inflation are often held by the middle class. In this, the relative closeness of households to

²⁰**Source:** Bivens p. 6-7 [10], and Montecino and Epstein p. 4 [45]

the financial market is important. Finally, asset income is also dependent on fiscal transfers, e.g. capital taxes may redistribute asset incomes and, thus, smooth this regressive effect [7, 33, 10].

Most of the underlying studies elaborate on this channel. In this, there is a broad consensus that asset prices appreciations exacerbated inequality [5, 20, 52, 45, 10, 41, 47]. Anyhow, estimates diverge in size and quality. E.g., Saiki and Forst [52] miss to construct a counterfactual scenario in their analysis, while Mumtaz and Theophilopoulou [47] base their regression solely on bond prices. For such shortcomings, Bivens [10], Bernanke [7] and Deutsche Bundesbank [13] criticize several studies covered.

3.2.2 The Employment Channel

Monetary easing promotes job creation, this is the core argument of QE's defenders. As the argument goes, higher employment mainly benefits those at the bottom of the income distribution for two reasons: first, as working income is the most important source of income for poor and middle-class households, the employment channel is largely equalizing. Second, high skilled workers are usually less threatened by unemployment, whereby low-skilled workers profit disproportionately by improving labor market conditions. This refers to both, the (i) income composition and the (v) earnings heterogeneity channel [19].

This argument has prominent advocates. Bivens [10] for example argues that this is the dominant transmission channel of QE on income inequality. Bernanke [7] and Deutsche Bundesbank [13] also emphasize the strong beneficial effects on equality through improving labor market conditions. Additionally, the beneficial effects of employment gains are unlikely to fade with QE measures reaching maturity [10]. Anyhow, there are potential limitations to this progressive impact of employment. For instance, asymmetries and frictions across skilled and unskilled workers could skew these effects. Ko [37] and Dolado et al [22], both construct Heterogenous Agent New Keynesian (HANK) models assessing the distributional consequences of a monetary policy expansion. Ko argues that as low-skilled workers face stickier wages, boosts in labor income mainly benefit those at the top of the income distribution. Dolado et al. [22] conclude that a combination of search and matching

asymmetries and capital-skill complementarity across skilled and unskilled workers induce equally regressive results.

In addition, Bivens [10] points out that a monetary expansion depreciates the domestic currency, thus increasing exports. As tradable goods tend to pay higher wages than others, this could boost top wages disproportionately and, thus, increase inequality. These arguments emphasize changes in the return to employment.

In this thesis, however, I focus on changes in inequality due to changes in the employment rate, as there is no conclusive evidence on how Quantitative Easing affects the return to employment, the wages, across households [45]. As for these limitations, the progressive effect of employment is likely overestimated, meaning that I derive a rather conservative estimate on whether QE increased inequality through employment. Future studies could provide further insights into this dimension.

As for the asset price channel, the employment channel is dependent on both, QE measures and country / household specifics. Programs specifically designed to boost labor market conditions enhance employment disproportionately. In turn, ex-ante employment and the economic environment affect outcomes.

In the underlying literature, the employment channel is explicitly addressed by Bivens [10], Montecino and Epstein [45], Dobbs et al. [20] and Deutsche Bundesbank [13]. The consensus is that QE had a progressive impact on inequality through boosting employment.

Note, as economic theory suggests, boosts in employment should also increase wages for the given changes in labor supply and demand. Yet, none of the underlying studies specifies this effect. This has two reasons. First, it seems almost impossible to measure this effect due to the uncharted nature of QE. Secondly, income inequality is on the rise in most developed countries. Drivers of this evolution are agreeably automation, digitalization and globalization. Compared to these forces the distributional effect of QE on wage inequality are arguably small [45, 22].

3.2.3 The Mortgage Refinancing Channel

Easy monetary policy dampens real interest rates, in the wake of QE specifically long-term interest rates, through both, lowering nominal interest and boosting inflation. This benefits debtors and hurts borrowers. As debtors tend to be less wealthy than borrowers this channel is potentially progressive on inequality as argued by my co-authors [7, 10, 45, 13].

For QE, mortgage refinancing is proposed by the literature as a proxy for the (iv) savings redistribution channel. The main implication is that mortgage refinancing is considered the primary contributor to the (iv) savings distribution channel as mortgage debt usually constitutes a large share of long-term debt. This is mostly held by middle and bottom quantile households. Taking it as a proxy is therefore a matter of simplicity and data availability.

Moreover, as inflation in all countries observed remained comparatively low, the effect of QE on inflation is unclear. Hence, the distributional consequences of inflation due to QE were potentially small. In line with the underlying studies, I focus on the effect of long-term interest and neglect potential effects of inflation. As for the asset price channel, long-term interest is expected to return to its previous levels with the end of QE measures [10, 45].

Studies point out some limitations to the mortgage refinancing channel. The most critical issue is asymmetries in refinancing conditions across quantiles. Specifically, top quantile households close to the market, see (ii) financial segmentation, tend to have a systemic advantage in accessing new credit and exploiting improvements in refinancing conditions. Bottom quantile households may be excluded from this process, especially under tightening banking regulation in the aftermath of the crisis. This may skew the benefits of falling interest to the top. Besides, other forms of debt, i.e. corporate debt, are largely held by top quantile households, which in turn profit from falling corporate debt payments. In part, this effect is incorporated in changes in equity prices [36, 45, 33].

From this, the progressive effect of mortgage refinancing is largely dependent on total mortgage debt in the economy and the availability of new credits and refinancing capabilities across households. Economies with a large share of fixed mortgages tend to exhibit less beneficial effects on inequality than economies with

variable-rate mortgage contracts [17].

Compared to the employment channel, empirical evidence is scarce. From the underlying studies, Dobbs et al [20], Bivens [10], Montecino and Epstein [45], Bernoth [9], and Guerello [33] provide implications on the mortgage refinancing channel. All these studies agree on its progressive impact. Anyhow, in the US its size was largely limited by restricted access to refinancing for bottom quantile households [45].

Note, the losses for medium and bottom quantile households through falling returns to savings due to QE are arguably small. For QE mainly affects long-term interest rates and inflationary pressure remained low. For instance, in the UK in 2011 around 55 % of deposits were held in relatively short-term accounts, while solely around 10 % had fixed-rates beyond 2 years maturity [5, 45].

3.2.4 Summary

In aggregate, the distributional impact of Quantitative Easing is heterogeneous and unclear a priori. While the asset price channel is arguably regressive in size, the employment and the mortgage refinancing channel are both progressive in nature. The most prevalent channels are the asset price and the employment channel. Anyhow, size and direction of all channels are dependent on a range of variables. Specifically, the composition of Quantitative Easing measures, for example, the type of assets targeted by the central bank, and country or household specifics, e.g. the distribution of assets [10, 45, 44, 38].

For the empirical assessment of the distributional transmission of QE to inequality, this rises diverse challenges. It is necessary to disentangle between different QE measures and country specifics. Also, the timeframe is important as the asset price and the mortgage refinancing channel are both fading in the long-run while employment gains are likely to sustain [10]. In the oncoming section, I elaborate on several country characteristics relevant for the transmission of QE across economies.

3.3 Key Country Characteristics

The literature identifies several country specifics relevant to the transmission of QE to incomes across households. I summarize on the most relevant key characteristics in table 3.

Country Characteristic	Transmission Mechanism
Income Inequality	The ex-ante distribution of different types of incomes across quantiles is determining the distributional changes in the cause of QE.
Fiscal Redistribution	The distributional effects of QE are shaped by redistributive fiscal policies, for example capital taxes.
Distribution of Assets	The distribution of assets across households drives the distribution of asset price appreciations in the cause of QE.
Distribution of Housing	The distribution of housing across households drives the distribution of returns to house price appreciations in the cause of QE.
Mortgage Debt to GDP	The size of mortgage debt to GDP is relevant to the potential size of the mortgage refinancing channel.
variable-rate Mortgages	The share of variable-rate mortgages determines the refinancing capabilities across households in the short- to medium term.

Table 3: Key Country Characteristics²¹

1. The most important feature is household heterogeneity, speaking how equal are different types of income distributed across households. In other words, inequality is a main driver of the transmission of QE to inequality. For example, if capital income clusters at the top, a boost in capital income in the cause of QE mainly benefits the rich, thus, exacerbating inequality. Otherwise, if asset

²¹**Based on:** Coibion [19], Bivens [10], Montecino and Epstein [45], Deutsche Bundesbank [13] and Guerello [33]

incomes are evenly distributed, rising asset prices benefit the whole population [10, 13, 49]. Further, high inequality indicates asymmetries in market power favoring top quantile households, this somewhat refers to financial segmentation across the population. Rich households tend to be better informed and, therefore, profit disproportionately from changes in the monetary stance. Hence, if income is distributed egalitarian at the onset of QE, its effects are likely neutral or even progressive accounting for employment gains at the bottom of the distribution. Contrastingly, high inequality is tendentially exacerbated due to QE.

2. Fiscal redistribution is a key determinant of inequality across households. Therefore it is strongly tied to the previous argument. Fiscal redistribution naturally benefits the poor and hurts the rich. For instance, capital taxes smooth the potentially regressive effect of asset price appreciations. The same accounts for interest income. Fiscal transfers also boost market power for workers through implementing explicit or implicit minimum wages through social security. This links to potential employment gains. Ergo, redistributive policies work progressive in the event of QE [33].

3. The distribution of assets across households is highly relevant to the distributional effect of the asset price channel. If assets are largely held by top quantile households, rising returns to assets due to QE are exacerbating inequality. If assets are distributed uniformly, this effect diminishes. For example, if stocks are mainly held by top households stock price appreciations worsen inequality [7, 10, 45]. Additionally, if large shares of short-term assets unprotected against inflation are held by the middle class, inflationary pressure of QE hurts these households, potentially increasing inequality relative to the rich. This can broadly be captured by dividing economies in bank vs. market based economies. In bank-based economies the middle class largely relies on bank deposits, while assets are distinctly held by top households. In market-based economies, assets are comparatively egalitarian distributed [19, 7, 13].

4. The distribution of housing is usually accounted separately from other

assets for it is rather evenly distributed implying a neutral or even progressive effect of QE through house price appreciations. Otherwise, for countries with many households living for rent, house price appreciations arguably increase inequality as a result of rising rents. As for the other assets, an egalitarian distribution is therefore considered neutral or even progressive as top quantile households commonly hold minor shares of their total wealth in housing [10, 45].

5. Mortgage debt to GDP is a key ratio to the potential size of the mortgage refinancing channel. *Ceteris paribus*, large shares of mortgages relative to GDP enhance the size of the mortgage refinancing channel. Diversely, a low ratio suggests a diminishing effect of mortgage refinancing to incomes across quantiles. This holds independent of the direction of the mortgage refinancing channel. As mortgage refinancing is tendentially progressive, a high share of mortgage debt to GDP is considered equalizing [20, 45].

6. Finally, the mortgage refinancing channel is largely dependent on refinancing options across households. In turn, these rely on the share of variable- and fixed-rate mortgages in the economy, whereby variable-rate mortgages adapt to decreasing long-term interest automatically, while households with fixed-rate mortgages are excluded from this benefit. Hence, large shares of variable-rate mortgages enhance the size of the mortgage refinancing channel, regardless of its direction. Again, as mortgage refinancing is arguably progressive, large shares of variable-rate mortgages are tendentially progressive [20, 9, 33].

Summarizing, inequality, redistributive policies, and the distribution of assets, including housing, are important determinants for the distributional transmission of Quantitative Easing through asset price appreciations. Employment income and transfers are related to redistributive policies and inequality. Lastly, mortgage debt to GDP and the share of variable-rate mortgages in the economy are key features of the transmission through mortgage refinancing. This demonstrates the heterogenous effects of Quantitative Easing to the economy, and to different forms of income across households. In the following, I dive into the empirical literature.

4 EMPIRICS

A growing number of studies addresses the distributional consequences of QE. Anyhow, the evidence is controversial and further studies must provide more evidence on this matter. For the underlying studies, the collective suggests a modest increase in inequality due to QE in the US at least in the short- to medium term [5, 52, 45, 41, 47, 9]. This may diverge for the other QE economies [33, 49]. In this part, I summarize on and compare these findings. I elaborate on the asset price, the employment and the mortgage refinancing channel, approximating on the overall distributional effect of QE.

4.1 Method

In the following analysis, I give an overview of the underlying studies my argumentation is focused on, and illustrate respective distinctions, challenges and limitations. After, I address the three channels specifically assigned to QE, namely the asset price, employment and mortgage refinancing channel. I compare findings from the outlined studies and add a range of further results underpinning my argumentation. I focus on findings for the US but include estimates for the other QE economies.

Following Montecino and Epstein [45], I look at changes in net income incorporating asset income, employment income and mortgage payments, defined as:

$$NetIncome = w_q E_q + r A_q + m r_q M_q \quad (1)$$

where w_q depicts the return to employment, E_q the employment rate, r the return to assets, A_q the amount of assets held, i_q the mortgage rate and M_q the respective mortgage debt. The index q characterizes the distribution across quantiles. In line with Montecino and Epstein [45], the return to different types of assets r is assumed to be constant.

As for the transmission of QE, I look at changes in income induced by shifts in

the employment rate across quantiles E_q , the return to assets, r , and the mortgage rate across households mr_q . As argued in 3.2, it is unclear whether, and if so, how QE affects the returns to employment across quantiles w_q , the distribution of assets across quantiles A_q and the distribution of mortgage debt M_q . Thus, for the effect of QE these can be assumed to be constant in this analysis.

As alluded, in the oncoming analysis I focus on tail ratios, namely the 99/10 and 90/10 ratio as the distributional effects of QE arguably affect the tails of the income distribution rather than the middle class, for which effects tend to cancel out. I include estimates for the Gini coefficient for its prominence throughout studies. Note, as inequality is a relative measure QE may have been regressive on inequality despite its overall progressive effects on household income. Bottom household income would have been smaller in the absence of QE [45, 10, 13].

Looking at each distributional channel I apply a three-step approach:

1. I look at the evolution of asset prices, employment, mortgage debt and payments in the cause of QE by looking at empirical data. I ask, how was this variable affected since the start of QE?
2. I look at the distribution of incomes across quantiles and how they affected inequality since the onset of QE by comparing empirical findings with a focus on the results of Montecino and Epstein. I ask, how did this variable affect inequality since the onset of QE?
3. I look at the counterfactual, what would have happened in the absence of QE by comparing respective estimates. I ask, how much of this change can be attributed to QE?

After, I perform a comparison of the key country characteristics illustrated in section 3.3 for the US, UK, Japan and the biggest five Euro area economies, namely Germany, France, Italy, Spain and the Netherlands. From this, I provide implications on the distributional effects of QE across economies.

4.2 Overview of Studies

From 2012 onwards, a range of empirical and literature based studies addressed the distributional consequences of Quantitative Easing. Countries and intervals investigated differ. The same accounts for the distributional channels analyzed. Moreover, the authors employ varying measures for inequality, data sets and methods reaching contrary conclusions. This section summarizes these distinctions.

Note, I include further studies heading to estimate the distributional effects of monetary policy in general. These are not included in this list, though I cite many of these studies in my line of argumentation.

My archive comprises studies undertaken by the Bank of England in 2012 [5], Dobbs et al. in 2013 [20], Saiki and Forst in 2014 [52], Bivens and Montecino and Epstein in 2015 [10, 45], Bernoth, Lazar and Deutsche Bundesbank in 2016 [9, 41, 13], Mumtaz and Theophilopoulou in 2017 [47]. The most recent papers I include are Guerello and Bunn et al. both published in 2018 [33, 49]. This sums to eleven studies.

To the best of my knowledge, most relevant studies investigating the distributional dimension of QE up to April 2018 are included. This comprises only studies available in English. I summarize these studies, their main characteristics and findings in table 4 on page 29.

Looking at the institutional background: the studies were published at/by the Bank of England, McKinsey Global Institute, De Nederlandsche Bank, Hutchins Center, Institute for New Economic Thinking, DIW Berlin, University Prague, Deutsche Bundesbank, International Journal of Money and Finance, Queen Mary University and, again, the Bank of England, in this order. Note, Lazar's [41] survey is a Master's thesis. Guerello [33] wrote the paper during a trainee program at the ECB. The paper does not necessarily represent the ECB's views.

Dobbs et al. [20] include findings for all central banks that issued QE programs between 2007 - 2012. Bivens [10], Lazar [41], Montecino and Epstein [45] examine the distributional impact of the Fed's LSAPs between 2007 – 2014. The Bank of England [5], Mumtaz and Theophilopoulou [47] employ data until 2012 and Bunn et al. [49] until 2014, all these studies focus on the UK.

Author; Background	Environment analyzed	Measure of Inequality	Method	Main Findings	Note
Bank of England (2012) [5]	Quantitative Easing by the BoE from 2009 - 2012.	Wealth and income of UK savers, pension funds and pensioners.	Partial Equilibrium Analysis using mainly Bank of England data.	QE benefited the economy but disproportionately the richest 5 % of households.	The study does not incorporate broader effects of QE including employment.
Dobbs et al. (2013) [20]; Mckinsey Global Institute	Unconventional Monetary Policy (UMP) by the BoJ, Fed, BoE and ECB from 2007 - 2012.	Cross-sector impacts on interest income, expenses and wealth effects of asset price purchases.	Cross-sector Analysis employing mainly McKinsey Data.	Non-financial corporations profited while the effect on banks is dependent on country specifics. Life-insurance companies lost out. Net borrowers benefited from loose monetary policy while net savers lost. The impact on bond prices is ambiguous, and positive on housing prices.	The study does not disentangle between the impacts of ultra-low interest rates and QE.
Saiki and Forst (2014) [52]; De Nederlandsche Bank	UMP by the BoJ from 2002 - 2013.	Income inequality in Japan, focus on the Gini coefficient and Theil index.	VAR Analysis with household data from the Japanese Cabinet Office.	QE exacerbated inequality in Japan, especially after 2008 when it became more aggressive. Transmission mainly incurs through portfolio effects.	The study does not incorporate broader effects of QE, it lacks a counterfactual scenario.
Bivens (2015) [10]; Hutchins Center	Monetary Policy by the Fed from 2007 - 2014.	Income inequality in the US, focus on the Top 1, 10, Middle 3 and Bottom 90 quantiles.	Literature based, plus two scenario comparisons: QE vs. fiscal stimulus and QE vs. no stimulus.	QE's impacts were equalizing as it pushed the economy closer to full employment. Compared to an equally large fiscal stimulus, QE falls short in mitigating inequality. Compared to no stimulus at all its impact is progressive. The latter is the correct counterfactual for comparison.	The study does not disentangle between the impacts of ultra-low interest rates and QE.
Montecino and Epstein (2015) [45]; Institute for New Economic Thinking	Quantitative Easing by the Fed from 2008 - 2013.	Income inequality in the US with focus on the 99/10, 90/10 ratio and the Gini coefficient.	RIF Regression in conjunction with the Oaxaca-Blinder decomposition on Survey of Consumer Finance data.	The distributional impacts of QE are heterogenous. Employment and mortgage refinancing were progressive over the observed period, but were swamped by the regressive impacts of asset price appreciations. This finding is significant for a range of counterfactuals.	Findings do not imply that QE itself is disequalizing. The framework is an accounting not a causal one. External counterfactuals are applied.
Bernoth et al. (2016) [9]; DIW Berlin	Quantitative Easing by the ECB from 2015 - 2016.	Wealth gains from asset price appreciations across quantiles.	Literature based analysis incorporating selected data for Euro countries.	Asset price appreciations likely increased inequality in the short-run. The long-run impacts of asset purchases are uncertain.	Study does not provide a detailed analysis on the broader effects of QE.
Lazar (2016) [41]; University Prague (Master's thesis)	Quantitative Easing by the Fed from 2008 - 2014.	Gini index on wealth inequality in the US.	Formulation of a theoretical model based on the evolution of money supply and the Gini index.	QE led to a significant 10 % increase in the US Gini index. Indirect impacts of QE are neglected which would most likely mitigate results.	Based on loose and unstructured data with limited potential. Lack of counterfactual scenario and macroeconomic adjustment effects.
Deutsche Bundesbank (2016) [13]	Conventional and Unconventional Monetary Policy by the ECB.	Gini coefficients on income and wealth inequality within EMU.	Literature based, including many of the studies above.	Monetary policy does exhibit a distributional dimension. Anyhow, non-standard monetary policy did not exacerbate inequality. If anything, unconventional monetary policy was progressive on inequality.	Previous studies finding a regressive relation between QE and equality are criticized for picking wrong counterfactual scenarios.
Guerello (2017) [33]; Journal of Intern. Money and Finance	Conventional and Unconventional Monetary Policy by the ECB from 2001 - 2015.	Theil and Gini coefficients on income inequality within EMU.	VAR Analysis on European Commission Consumer Survey data.	The distributional impacts of UMPs are dependent on country specifics such as the closeness of households to the financial market and fiscal transfers.	A special focus is set on the interdependence between monetary policy and inequality by comparing between country characteristics.
Mumtaz and Theop. (2017) [47]; Queen Mary Univ.	Monetary Policy shocks by the BoE from 1969 to 2012.	Gini coefficient on income inequality in the UK.	VAR Analysis with micro data from the Family Expenditure Survey.	Monetary policy shocks explain a significant share of fluctuations in inequality. QE may have increased income inequality.	Study neglects broader impacts of Quantitative Easing.
Bunn et al, (2018) [49]; Bank of England	Monetary Policy by the BoE between 2008 - 2014.	Gini index and 90/10 Ratio on income and wealth inequality.	Multistage Analysis with Microdata from the ONS Wealth and Assets Survey.	Changes in wealth and incomes are not trivial, but cancel out in relative terms across quantiles. Net effects depend on individual household characteristics.	A special focus is set on household characteristics determining the transmission of QE to incomes and wealth.

Table 4: Studies estimating the distributional effects of QE

For the European Monetary Union studies are provided by Deutsche Bundesbank [13], analysing data from 2009 - 2012, Guerello [33] from 2009 - 2015 and Bernoth [9] from 2015 - 2016. Saiki and Forst [52] specify findings for Japan between 2002 - 2013.

Measures of inequality diverge. Studies addressing QE's impacts on income inequality prevail, including Saiki and Forst [52], Bivens [10], Montecino and Epstein [45], Guerello [33] and Mumtaz and Theophilopoulou [47]. The Bank of England [5], Dobbs et al [20], Deutsche Bundesbank [13] and Bunn et al. [49] include considerations on both, wealth and income inequality. Lastly, Bernoth [9] and Lazar [41] solely elaborate on wealth inequality. In line with these studies, I focus on income inequality.

This approach, however, will most likely yield more modest estimates than an analysis on wealth inequality. In fact, Deutsche Bundesbank [13] and Lazar [41] argue that QE's is rather exacerbating wealth than income inequality.

Another obstacle is that measures of inequality diverge, making studies hard to compare even with a focus on income inequality. Prevalent measures applied comprise the Gini and Theil coefficient as well as different income ratios. As evidence suggests, tail ratios are better fit to estimate the distributional impacts of QE, as its impacts rather affect the edges of the distribution, speaking the uppest and lowest quantiles. Effects tend to cancel out for the middle class. Following Montecino and Epstein [45] I will mainly rely on the 99/10 and 90/10 ratio but also include estimates on the Gini coefficient for comparison.

As alluded, applied methods diverge across surveys. For the empirical methods, vector-auto-regression models dominate the picture. Saiki and Forst [52], Guerello [33] and Mumtaz and Theophilopoulou [47] all apply Vector Auto Regression (VAR) models. Montecino and Epstein [45] use a Recentered Influence Function (RIF) regression in conjunction with the Oaxaca-Blinder decomposition. Finally, Bunn et al. [49] perform a multistage analysis using microdata. All of these studies provide empirical estimates contributing to the question addressed in this thesis: How does Quantitative Easing affect Income Inequality?

Moreover, Lazar [41] constructs an individual model to estimate the distributional impacts of QE on wealth inequality. The Bank of England [5] performs an analysis

on the distributional impacts of QE through asset price appreciations for savers, pension funds and pensioners. Dobbs et al. [20] consider the distributional impacts across sectors in the economy. These studies do not add empirical findings concerning income inequality, they do give important insights that contribute to this thesis nevertheless.

Literature based studies are executed by Bivens [10], Deutsche Bundesbank [13] and Bernoth [9]. These studies summarize for a large count of empirical literature, adding critical thoughts. Especially Deutsche Bundesbank [13] criticizes some of the empirical papers included in my analysis.

Having a look at the main findings: clearly, most studies conclude for a regressive impact of QE on inequality. This includes the Bank of England [5], Saiki and Forst [52], Montecino and Epstein [45], Lazar [41], Mumtaz and Theophilopoulou [47]. Bernoth [9] concludes for a regressive effect in the short-run, while the long-run impact is uncertain. In turn, Bivens [10] and Deutsche Bundesbank [13] promote a progressive impact of QE. Guerello [33] and Bunn et al. [13] argue that country and household specifics, such as ex-ante inequality, fiscal redistribution and the closeness of households to the financial markets are determining the distributional direction of QE. Bunn et al. [49] find, that young households benefited on average, while older households reliant on savings lost. Dobbs et al. [20] judge that non-financial corporations profited, life insurances lost, net borrowers profited and savers lost. I detail on these findings in sections 4.4 – 4.6.

4.3 Challenges and Limitations

There are several obstacles to estimating the distributional effect of QE to inequality. The authors repeatedly dispute three key problems: first, disentangling between monetary policies in general and Quantitative Easing specifically. Second, incorporating the broader macroeconomic effects of QE, most important employment gains and improving mortgage market conditions. Many studies solely elaborate on QE’s impacts through asset prices. Third, choosing the right reference scenario. Especially Deutsche Bundesbank [13] criticizes unfit reference scenarios in some of the underlying studies. [10, 45, 13]

In more detail, to disentangle between Quantitative Easing and other conventional and unconventional monetary policies is the first challenge faced by my co-authors. In my thesis, I follow Montecino and Epstein [45] who focus on the three channels mainly linked to QE. This provides a quite detailed picture. Studies employing a VAR analysis account for changes in the monetary base, and / or long-term treasury rates. Lazar [41] also employs the monetary base. The Bank of England [5] looks at the impacts of asset price purchases for different groups. Dobbs et al. [20] and Bivens [10] both do not differentiate between other monetary policy measures and QE in their analysis. Bivens [10] does, however, provide important findings for all three QE channels.

The second challenge is including all relevant distributional dimensions of QE. Quantitative Easing affects variant asset prices directly but also inflation, interest rates and employment. Studies pay attention to this challenge to different extents. In line with Bivens [10], Guerello [33], Montecino and Epstein [45] I elaborate on all three channels assigned to QE specifically. Other studies focus solely on the asset price channel, such as the Bank of England [5], Saiki and Forst [52], Lazar [41], Mumtaz and Theophilopoulou [47]. Note, there are further channels that could be addressed, e.g. QE's effect through lowering interest on corporate debt, or its effect through boosting inflation. Anyhow, these channels seem to play a subordinate role and are therefore mostly neglected by the literature.

The third and possibly most challenging issue is defining the counterfactual: What would have happened in the absence of QE? Indeed, this issue is addressed by almost all the studies covered in my analysis, even though handled in various ways. For example, Bivens [10] is comparing the effects of Quantitative Easing to two scenarios: first, an equally sized fiscal stimulus and second, to a situation of no stimulus. He concludes the latter is the right reference scenario. Other studies provide estimates for the evolution of inequality in the absence of QE. Saiki and Forst [52], Montecino and Epstein [45], and Lazar [41] do not construct a counterfactual situation. Anyhow, Montecino and Epstein [45] provide an entire section on counterfactuals using estimates from other studies. I address this problem by looking at a range of counterfactual estimates on the evolution of asset prices, employment and mortgage refinancing.

I need to emphasize that these counterfactuals cannot account for singularities that might have occurred in the absence of QE, e.g. a break-up of the Euro area or another break down of the financial sector. Both events would likely have hurt all economies across the globalized market decreasing incomes across quantiles while aggravating unemployment which usually hurts bottom quantile households most. Also, deflationary pressure in the absence of QE could have induced a downward spiral of lowering demand and rising unemployment. For the uncharted nature of QE and the instable situation of QE economies both economic growth as well as inequality might have been far worse in the absence of QE. As always, the counterfactual remains up for grabs.

4.4 The Asset Price Channel

The asset price channel is the most prominent distributional channel of QE. Thus, all of the underlying studies address this channel [5, 20, 52, 10, 45, 9, 41, 13, 33, 47, 49]. The consensus is that QE largely exacerbates inequality by raising asset prices. In the following, I give an overview of the distribution of assets across households, then I look at the evolution of asset prices and how this evolution affected inequality throughout QE. Finally, I consider counterfactual situations, speaking how much of the distributional impact can be assigned to QE.

4.4.1 The Distribution of Assets

Table 5, gives an overview of the composition and distribution of assets by wealth class for the US in 2013, the data is retrieved from Bivens [10]. Panel A illustrates the composition of household wealth by wealth class including stocks and securities, business equity, housing, liquid assets and debt per income. Panel B shows the percent of total assets held including stocks and mutual funds, business equity, housing, liquid assets and debt.

Note, break-downs diverge between Panels. Panel A differs between the Top 1 percent, the Next 19, and the Middle 3, the 40th to 60th, whereas Panel B, replaces the Next 19 with the Next 9, the 90th to 99th, and then sums for the bottom 90

percent.

Panel A shows the total share of wealth held in various assets for the overall population. For example, from the third row in Panel A, Housing, we see that 28.5 % of total wealth consists in housing, which is highly concentrated at the middle class with a share of 62,5 %, while the Top 1 percent of households hold a comparatively small share of 8.7 %. Contrastingly, stocks and securities make up over a quarter of Top 1 percent wealth holdings, while constituting solely 3.4 % of middle class wealth. An even larger gap accounts for equities contributing 46,9 %, of wealth held by the top 1 percent and only 8,6 % for the middle class.

Panel A: Composition of Household Wealth by Wealth Class, 2013				
	All	Top 1	Next 19	Middle 3
Stocks & Securities	17.4	27.3	16.3	3.4
Business Equity	28.5	46.9	24.2	8.6
Housing	28.5	8.7	28	62.5
Liquid Assets	7.6	6.1	8.4	8.1
Debt/Income	107.1	38.2	96.6	125
Panel B: Percent of Total Assets Held by Wealth Class				
	Total	Top 1	Next 9	Bottom 90
Stocks & Mutual Funds	12.7	49.8	41.2	9.1
Business Equity	18.3	62.8	31	6.2
Housing	28.5	9.8	31.1	59.2
Securities (bonds)	1.5	54.7	39.6	5.7
Liquid Assets	7.6	24.8	42.4	32.8
Debt	15.2	5.4	21.1	73.5

Table 5: Distribution of Assets by Wealth Class, 2013²²

Panel B depicts the relative shares of total assets held across quantiles. In particular, the Top 1 percent holds 9.8 % of total housing wealth compared to an

²²**Source:** Bivens p. 15 [10]

overwhelming 59.2 % held by the Bottom 90. Contrariwise, stocks and mutual funds, securities and business equity are strongly skewed to the top with total shares of 49.8 %, 54.7 %, 62.8 % respectively, held by the Top 1 % relative to 9.1 %, 5.7 % and a dwarfing 6.2 % of equity held by the Bottom 90 %.

In addition, the total size of respective asset classes illustrated in the second column, All, indicates the potential size of the transmission of each asset class to inequality. In the US, housing and business equity comprise more than 50 % of total wealth, stocks and securities value about 17.4 %. Liquid assets seem to play a subordinate role in the US, for adding a minor share of 7.6 %. Also, the distributional effects of QE are attributed to long-term rather than short-term interest. This provides two important implications for the transmission of QE through asset prices. First, the distribution of assets is heterogeneous and is, in most cases, strongly skewed to the top. But, appreciations in housing prices may have equalizing impacts as for the mostly democratic distribution of housing across the population. Second, housing, equity and stocks arguably play the most important role in the transmission of QE to inequality as they constitute about 70 % of total wealth.

For the lowest quantiles, that do not own property, Bivens [10] argues that improving refinancing conditions and the employment channel are more relevant in boosting income. This is plausible, but does not necessarily contradict an exacerbation of inequality if the regressive effects of asset price appreciations are sufficiently large. As argued in section 4.1, inequality is a relative measure and even if QE was beneficial for all, its benefits may be distributed unevenly. In other words, even if employment and improving refinancing conditions had a narrowing impact on income inequality, their impacts may have been swamped by the adverse effects of asset price appreciations other than housing.

Similar findings on the distribution of assets are provided by the Household Finance and Consumption Survey for Europe, even though dispersions in Europe are far more moderate and exhibit large differences across countries. Guerello [33] summarizes on this data: the top 10 percent hold about 75 % of total financial assets in the Euro Area, while the Median covers about 12 %, while the bottom 20 percent of households do not receive any notable income from assets. This dis-

tribution is even steeper for Cyprus, Germany and France, while other countries including Greece, the Netherlands, Slovakia, Austria and Italy exhibit a relative moderate distribution of total assets across quantiles.

Looking at the composition of financial assets within the EMU, Guerello [33] finds that deposits account for about 2/5th of financial assets. Pensions and insurance account for about 1/4th but also shares, bonds and mutual funds make up 1/4th of total assets. This indicates a significant impact of these asset classes on the distribution of income. Also, as for the US deposits are relatively modestly distributed across quantiles, while stocks and bonds are held exclusively by the wealthy.

Both distributional statistics, for the US and the Eurozone suggest a strong impact of the earnings heterogeneity and the financial segmentation channel. While housing has a possibly progressive or neutral impact on income dispersion, stocks, equity and bonds are clearly regressive. The dominant asset classes in the transmission of QE are housing, stocks and equity. For the US bonds can be omitted, contributing a minor share of 1.5 % to total assets. For the Eurozone bonds play a more important role.

4.4.2 The Impact of Asset Prices on Inequality

Since the outset of QE asset prices have risen broadly in the United States. They fell sharply after the crisis but recovered far beyond pre-crisis levels today. Figure 2 depicts the evolution of the S&P 500 Index between 2008 and 2018.

The graph illustrates a steep incline in asset prices within the last 10 years. In fact, the index more than tripled from its lowest point in late 2008. In terms of asset price appreciations, this evolution was clearly regressive on inequality. But, it is unclear how much of this change is due to QE and how much of this change can be attributed to other factors, e.g. a return to pre-crisis trend. Figure 3 illustrates their findings for these channels.

In their analysis, Montecino and Epstein [45] include four types of asset classes, namely stocks, directly held bonds, mutual funds invested in bonds and short-term financial assets. With this, Montecino and Epstein [45] provide a broad insight in the distributional impacts of asset price fluctuations on the distribution of income between 2008 and 2013 in the US.



Figure 2: S&P 500²³

Figure 3 depicts the influence of each variable on each quantile of net income as defined by Montecino and Epstein [45] and introduced in section 4.2. The Y-Axis shows the share of net income contributed by respective assets per quantile. An upward sloping curve indicates that a variable is regressive in the sense, that e.g. an increase in stock prices is affecting net income of households in the upper quantiles disproportionately and, therefore, exacerbates inequality.

For instance, looking at short-term financial assets the 50th quantile, speaking the median household, increases its income by about 55 % through returns to short-term asset holdings. In other words, a household at the 50th quantile without short-term financial assets retrieves 55 % less net income than the average household with short-term assets. Moving to the right, the relative impact on net income of richer households' declines indicating that for most of the net income distribution a boost in short-term asset prices is equalizing. Contrastingly, stocks, directly held bonds, and mutual funds invested in bonds are strongly regressive. All contribute excessively to top quantile net incomes.

²³**Source:** Fred data[29]

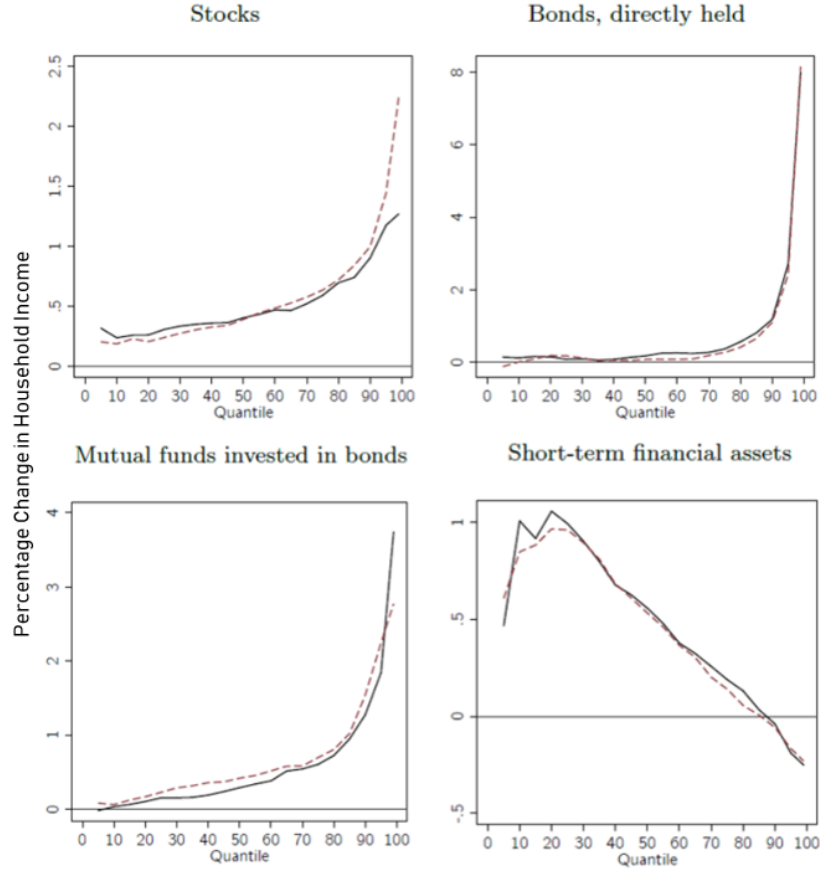


Figure 3: The Distributional Effects of Asset Classes²⁴

This is in line with the illustrated distribution of assets in 4.4.1. While households in the middle of the distribution hold large shares of their income as short-term financial assets, mainly bank deposits, households at the top of the distribution hold increasing shares in long-term assets, like stocks, and bonds. Conversely, households at the bottom of the income distribution hold negative short-term assets. As alluded, QE mainly boosts long-term asset prices. Short-term assets are likely hurt by rising inflation in the cause of QE. Anyhow, empirical evidence on this matter is lacking for sustaining low inflation in all economies investigated. [10, 45, 7]

²⁴**Source:** Montecino and Epstein p. 14 [45]

Moreover, the black line indicates the period before QE, the red line the period after. From the graphs, only stocks seem to have exacerbated inequality by boosting incomes at the top significantly. Even though other studies find that QE increased equities, there is no significant difference between the distributional impact of directly held bonds before and after QE from Montecino and Epstein’s [45] analysis. One argument provided is, that bond ownership impacts household income through interest returns, not capital gains, which are not included in their analysis. There is also no significant change in short-term financial assets. Anyhow, as developments in short-term financial assets are primarily linked to conventional monetary policy measures, this is not too surprising. Contrastingly, returns on net income from mutual funds increased for all but the highest quantiles.

Following Bivens [10], Montecino and Epstein [45], in the oncoming analysis I exclude the distributional impacts through short-term assets for two reasons. First, the impact of QE on the returns to short-term assets is considered limited and rather tied to conventional monetary policies. Second, in the US the distribution of short-term assets is quite even across the population, despite their relative size to total assets. Hence, its distributional impact can be assumed to be small.

To disentangle the distributional impacts of QE and expansive interest rate policies Montecino and Epstein [45] decompose their estimates for each variable into an explained and unexplained component. The former measures changes in endowments (stocks, employment ...), the latter changes in the returns to respective endowments (stock prices, wages ...). As there is no reason to believe that QE affects asset endowments (the composition of household wealth) across quantiles, Table 6 reports solely Montecino and Epstein’s [45] findings on the change in the returns to assets between the pre- (2008 - 2010) and post (2011 - 2013) QE period. Indeed, the returns to stocks seem to be highly regressive contributing over 15 % to changes in the 99/10 ratio. This impact is greater than the total change in the 99/10 ratio of 8.3 % estimated by Montecino and Epstein [45] for the entire period indicating that other channels, like employment and mortgage refinancing, had a counteracting progressive effect on the distribution of income. The impact on more modest measures of inequality diminishes. For the 90/10 ratio, Montecino and Epstein [45] find a 2 % change, and the Gini coefficient exhibits a modest

but significant decrease. Both latter measures place more weight on the middle of the distribution. The strongly skewed distribution of stock income towards the topmost 1 % explains these large distinctions across measures applied.

	99/10 ratio	90/10 ratio	Gini
Financial returns	0.2851	0.1621	0.0144
Stocks	0.1541	0.0217	-0.0011
Bonds, directly held	0.0042	0.0005	0.0007
Bond, mutual funds	-0.0396	0.0094	0.0007
Short-term / liquid assets	0.1665	0.1304	0.0142

Table 6: Regression Results on Financial Returns²⁵

The effects of the other assets are mixed. The effect of short-term assets was regressive as for its negative impact on the lowest quantiles (especially the 10th) and its almost neutral impact on higher quantiles. For directly held bonds and mutual funds, most of the results are not significant at standard confidence levels, even though their coefficients are regressive. This contrasts with other studies that find significant relationships between QE and business equity. The authors argue that this discrepancy may reason in the fact, that returns to equity are rather related to the explained variable, namely the price of bonds than the returns. Anyhow, for the investigated period the fall in the stock of financial assets and for the relative drop in returns especially for wealthier households in the aftermath of the crisis, the explained component of stocks, bonds and bonds from mutual funds was negative, and equalizing as top quantile households are affected disproportionately in Montecino and Epstein’s [45] analysis. Clearly, this must not reason in QE but post-crisis recession. In fact, in the absence of QE this could have plausibly been worse with more defaults and, thus, even lower asset stocks.

The regressive effects of asset price appreciations are also emphasized by the Bank of England [5], Saiki and Forst [52], Bivens [10], Bernoth [9], Lazar [41], Guerello [33], Mumtaz and Theophilopoulou [47] and Bunn et al. [49]. In this, there is a broad consensus in the underlying literature.

For housing, several studies including Bivens [10], Bernoth [9], Deutsche Bundes-

²⁵**Source:** Montecino and Epstein p. 16 [45]

bank [13] and Bunn et al. [49] argue in favor of a progressive effect on inequality, especially in the US where housing is relatively evenly distributed. Unfortunately Montecino and Epstein [45] do not incorporate estimates on housing. But, housing could very well offset the disequalizing effects of stocks and bonds at least partly as housing constitutes a massive 28.5 % share of total wealth in the US [10].

What must be determined in the following is the counterfactual, speaking how much of the distributional impact of the asset price channel is due to QE. For example, in the case of the asset price channel Bivens [10] and Bernanke [7] argue that much of the appreciation is rather a return to trend after the crisis, but a result of QE. To disentangle these effects is a task of the oncoming section.

4.4.3 The Counterfactual Evolution of Asset Prices

A range of studies elaborate on the counterfactual evolution of asset prices. What is wanted is: How much did QE contribute to the observed asset price appreciations? Think of the causal effect, $\check{\Delta}_A$, of QE on inequality through the asset price channel:

$$\check{\Delta}_A = \Delta_A - \Delta_A^C \quad (2)$$

Where Δ_A expresses the change in asset prices observed and Δ_A^C denotes the change in asset prices in the absence of QE. Simplifying, the impact of QE on e.g. stock prices can be narrowed down to a parameter θ representing the percentage change in stock prices due to QE. The impact of stock prices on inequality can then be written as:

$$\check{\Delta}_A = \theta \check{\gamma}_{0,S} \bar{X}_{0,S} \quad (3)$$

Where $\check{\gamma}_{0,S}$ is the return to stocks before QE, $\bar{X}_{0,S}$ is the endowment in stocks across quantiles and θ is the percentage change in stock prices due to QE. $1 - \theta$ then represents the counterfactual evolution of asset prices, e.g. rising asset prices as a return to trend. If QE had no impact on asset prices, $\theta = 0$. Studies estimating the impact of stock prices including Rosa [51], Rogers et al. [50], Kiley [36] and Engen et al. [26] conclude for values of θ ranging from 3 – 9 %.

Further, Bivens [10] summarizes the most relevant estimates of the impact of Fed's LSAPs on further asset classes. The increase in bond prices ranges between an

estimate of 9 – 14 %. Bivens [10] assumes a 1 - 1.5 % fall in 10-year treasury rates. Equity was boosted by about 3 % – 8.5 % as found by Dobbs et al. [20], Engen 2014 [26] and Kiley [36]. Dobbs et al. [20] and Bivens [10] suggest that home prices rose by about 7 %.

From the underlying data and estimates, it is possible to extrapolate an approximation for the individual and overall impact of QE on inequality through the asset price channel. Consider the transmission of QE through stock prices assuming a conservative $\theta = 5$. For Montecino and Epstein’s [45] estimates, this translates into a 0.77 % change in the 99/10 ratio and a 0.1085 % change in the 90/10 ratio. The impact on directly held bonds is small and possibly neglectable for the diminishing share of bonds to total assets. Employing a rather conservative $\theta = 10$, bonds contribute a modest 0.021 % to the 99/10 ratio and 0.0025 % to the 90/10 ratio.

The estimate for mutual funds on the 99/10 ratio is indeed negative. This relates to the decline in bond mutual fund income for the top 1 %. Anyhow, the effect is positive for the 90/10 ratio and the Gini coefficient. For the 99/10 ratio an estimate of -0.198 % on the 99/10 ratio, but 0.047 to the 90/10 ratio.

Montecino and Epstein [45] point out that due to the SCFs characteristics, it is impossible to disentangle bond maturities and, thus, separate the impact of QE and other monetary policies. For this ambiguity, I will omit the distributional impact of bonds and bonds from mutual funds. Providing a thorough estimate on the transmission of bonds is a task for future research.

A similar issue arises concerning the transmission of equity price appreciations. Even though, concise estimates on the transmission of QE to equity prices are available, the underlying literature does not provide an estimate on the distributional impact of equity price appreciations on income dispersion. Looking at the distribution of equity, the impact of equity price appreciations on income dispersion is likewise significant. Equity makes up a massive 28.5 % of total assets [10]. Further, equity is even stronger skewed to the top than stocks. Both indicate an even larger contribution of equity price appreciations to income inequality than stocks. If QE contributed a 3 % change to equity price appreciations, the transmission of QE through equity prices on inequality might even outrange the given

estimate of QE has through stocks.

Finally, housing is specified as the most progressive asset class, for its mostly democratic distribution [10, 13]. The middle class owns an astonishing share of 62.5 % of total housing. Recall, housing accounts for a share of 28.5 % of total assets. In fact, given this data, the distribution of housing is likely to counterbalance the adverse impacts of equity appreciations. Even more, given a 7 % boost in housing prices, the impact of QE through housing may swamp the adverse effects of equity price appreciations. This statistic, however, ignores that the bottom quantiles own a minuscule share of housing [10, 45]. This observation provokes some doubt, that housing price appreciations were progressive for the rather extreme ratios 99/10, 90/10 examined in this thesis. Sadly, as for equity prices, none of the underlying studies provides a concise estimate on the transmission of housing prices to the distribution of income that could be applied.

In addition, Guerello [33] employs an EMU stock market index retrieved from the ECB to estimate the asset price channel. In line with the surveys quoted above, a crucial role in the transmission of QE is emphasized. Anyhow, Guerello [33] finds high cross-country heterogeneity, dependent on country specifics. While countries with low shares of deposits relative to assets, like Belgium, Cyprus, Greece and Spain exhibited negative correlations between QE and income dispersion, countries with low deposits to asset shares but high redistributive fiscal policies such as the Netherlands, Italy and Germany show a progressive correlation. In fact, her findings conclude for a strong connection between the share of deposits to assets and a regressive impact of unconventional monetary policies. This resembles both, the relevance of the financial segmentation (ii) and the portfolio channel (iii).

The Bank of England [5] points out that boosts in asset prices are a result of various factors, foremost an oversupply in savings, especially from China. Anyhow, it asserts the broadly disequalizing impact of asset price appreciations as the distribution of assets is strongly skewed to the top-most quantiles.

Taking a step back, there are various assets that may be affected by Quantitative Easing including stocks, bonds, equity and housing. All contribute to the dispersion of income as for their varying distribution across quantiles. While stocks, bonds and equity exhibit a negative contribution to inequality, the impact of hous-

ing is ambiguous and rather progressive. The given parameters account for a 0.593 % increase in the 99/10 ratio and a 0.158 % increase in the 90/10 ratio. While the estimates on bonds must be treated with caution due to data issues, estimates on the distributional impact of housing and equity price appreciations are object to future research.

Note, comparing conventional with unconventional monetary policies, Guerello [33] concludes, that indeed the asset price appreciations can uniquely be attributed to unconventional monetary policy measures, foremost QE. She points out that “The assets price index clearly falls after a conventional monetary policy shock in the very short-run and this reaction is small and short-lived. On the opposite, the response of this variable to an UMP shock is positive, persistent and significant, even in the medium-long-run” [33] p. 198.

4.5 The Employment Channel

Employment is potentially the most progressive distributional channel of QE to inequality. In the underlying literature, the employment channel is explicitly addressed by Bivens [10], Montecino and Epstein [45], Dobbs et al. [20] and Deutsche Bundesbank [13]. The consensus is that QE had a progressive impact on inequality through employment. Wage rigidities at the bottom of the income distribution dwarfed this effect. In the oncoming subsections, I look at the distribution of employment income, then I go into the distributional effects of employment throughout QE and finally, I elaborate on the counterfactual evolution of employment.

4.5.1 The Distribution of Employment Income

Table 7 illustrates the evolution of employment income across households for the US in 3-year intervals. 2006 pictures the distribution of income before the great recession, 2009 immediately after and the start of QE, 2012 3 years and 2015 6 years after QE’s start. As the literature argues, QE’s impacts on employment and income are lagging, therefore, the last column shows the percent change in income across quantiles between 2009 and 2015 [10, 13].

Quantiles	2006	2009	2012	2015	Percent Change*
Lowest	\$11.352	\$11.552	\$11.490	\$12.457	$\approx 7,8 \%$
Second	\$28.777	\$29.257	\$29.696	\$32.631	$\approx 11,5 \%$
Third	\$48.223	\$49.534	\$51.179	\$56.832	$\approx 14,7 \%$
Fourth	\$76.329	\$78.694	\$82.098	\$92.031	$\approx 16,9 \%$
Top Fifth	\$168.170	\$170.844	\$181.905	\$202.366	$\approx 18,5 \%$
Top 5 %	\$297.405	\$295.388	\$318.052	\$350.870	$\approx 18,8 \%$

Table 7: The Distribution of Employment Income²⁶

In general, all quantiles enhanced their labor income between 2006 and 2015. Surprisingly, small income setbacks after 2007/08 are solely displayed for the lowest quantile and the Top 5 %. After, income growth shows a clear trend: while the bottom of the income distribution gained roughly 7.8 % between 2009 and 2015, the highest fifth enjoyed an astonishing 18.5 % increase. Even more, the Top 5 % not only recovered from the post-crisis setback but surpassed the highest fifth quantile with an astonishing 18.8 % boost. This suggests that overall employment income was regressive throughout the observed period. Drivers of this evolution are arguably automation and digitalization but QE [12, 45, 22].

Unfortunately, it is not possible to disentangle between changes in returns to employment (wages) and employment gains due to QE from this data. As argued, there is no certainty how QE affects the distribution of labor income while there is a broad consensus that QE boosted employment [10, 45, 20, 13].

The statistic shows an improvement of income conditions for all quantiles nevertheless. Of course, this could just be a return to trend but the cause of QE. Also, the UK and many European countries exhibit similar evolutions in employment and employment income [13].

4.5.2 The Impact of Employment on Inequality

Figure 4 shows the evolution of employment for the US. The graph depicts a prompt spike in unemployment with the economic downturn in 2007/08. At the

²⁶**Source:** Tax Policy Center [15]

end of 2009, employment stabilizes and then declines steadily until the end of 2016. The Fed engaged in QE from 2009 onwards. At the announcement of QE 3 in September 2012 unemployment stood at 7.8 % after falling an entire percentage point. Engen et al. [26] find that LSAP’s employment effects reached their pike in 2015 long after its implementation. Purchases ended in October 2014. In sum, the graph depicts a huge fall in employment throughout the QE period of about 5 % from its highest point in early 2010.

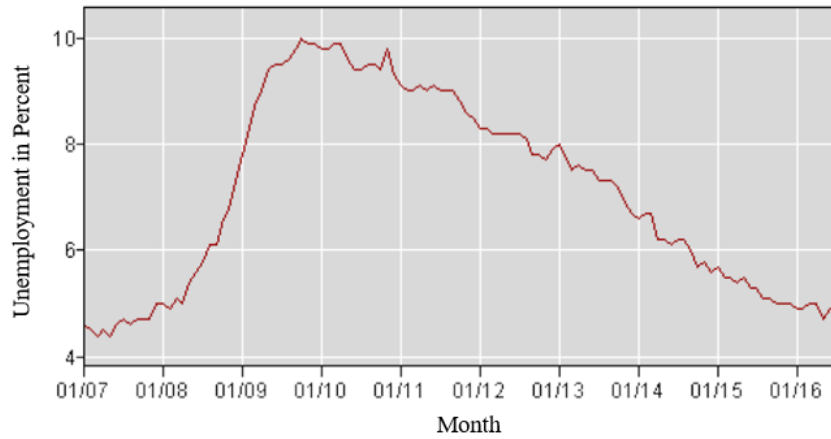


Figure 4: Employment in the US²⁷

As for the asset price channel, Montecino and Epstein [45] provide a detailed analysis on the impact of labor income on inequality between 2008 and 2013. Figure 5 depicts their findings on the change in the relative importance of employment to household income across quantiles. The black line illustrates the “pre QE” period from 2008 – 2010 and the dotted red curve the “post QE” period from 2010 - 2013.

Apparently, employment has a strong equalizing impact, making up a maximum effect of almost 1 for the poorest households. This means that employment boosts income by about 100 % if the primary earner is employed. For the median household employment contributes about 40 % and top households gain a minor share of 20 % through employment. The drop in employment income represents a fall in real wages relative to total income. This is in line with observed stagnant wages

²⁷**Source:** Bureau of Labor Statistics [40]

for bottom quantile households and strongly rising asset income for the rich.

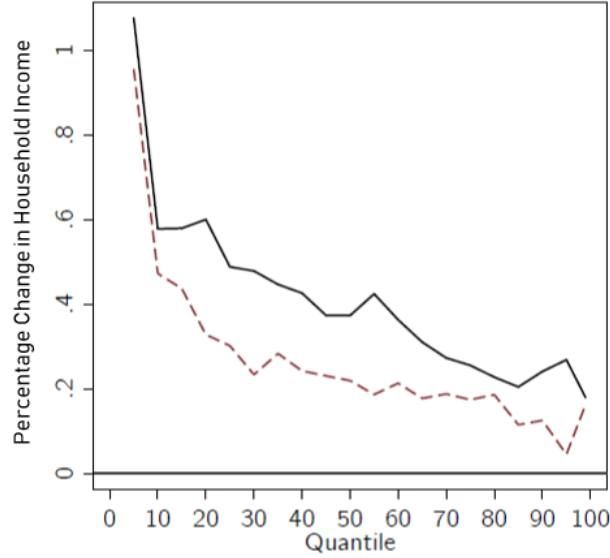


Figure 5: The Distributional Effect of Employment²⁸

Montecino and Epstein [45] continue to split employment into an explained and an unexplained component, whereby the explained component measures the change in employment income due to employment gains, while the unexplained component measures changes in the returns to employment, wages. Table 8 depicts their results for the 99/10 Ratio, the 90/10 Ratio and the Gini coefficient.

	99/10 ratio	90/10 ratio	Gini
Employment	0.0745	-0.0166	0.0012
Explained	-0.0086	-0.0073	-0.0010
Unexplained	0.0831	-0.0093	0.0022

Table 8: Regression Results on Employment Income²⁹

Throughout the surveyed period, employment decreased by about 2.5 %. This change in employment, the explained component, was progressive for all measures

²⁸**Source:** Montecino and Epstein p. 14 [45]

²⁹**Source:** Montecino and Epstein p. 16 [45]

of inequality. It contributes to a reduction of 0.86 % to the 99/10 ratio, a 0.73 % to the 90/10 ratio and 0.1 % to the Gini coefficient. These results are significant at standard levels. Further, Montecino and Epstein [45] find, that the employment gains contributed 2.5 % to income gains for the lowest 5 %, 1.3 % for the lowest 10 %, whereby the top 90 % profited solely by 0.5 %.

For the other studies, Bivens [10] points out that historically, employment gains largely benefit the poorest households. He resumes on studies fortifying this relationship including Katz and Krueger [35], Gregg and Machin [32], and Baker and Bernstein [2]. Katz and Krueger [35]. All these studies find a regressive relationship between labor income and unemployment which is specifically sensitive for low and medium income households. Similar results are found by Baker and Bernstein [2] and Gregg and Machin [32]. Bivens and Mishel [11] emphasize these results concluding for a large impact of employment on wage growth. In the next section, I look at estimates on how much of this change is due to QE.

4.5.3 The Counterfactual Evolution of Employment

As for the asset prices channel, several studies gauge QE's effect on employment. The estimated change in employment across quantiles due to QE, $\Delta \check{X}_E^{QE}$, can be written as $(\Delta \bar{X}_E - \Delta \bar{X}_E^C)$, where $\Delta \bar{X}_E$ is the change in employment observed and $\Delta \bar{X}_E^C$ is the hypothetical change in employment in the absence of QE. The change in income across quantiles due to the explained employment component is written as $\check{\Delta}_E$. Then, the employment effect can be described as:

$$\check{\Delta}_E = \Delta \check{X}_E^{QE} \check{\gamma}_{0,E} \quad (4)$$

where $\check{\gamma}_{0,E}$ is the return to employment, the wages, across the income distribution in the before QE period. As alluded, there is no evidence how this variable is affected by QE, thus I can not quantify on its effect, leaving $\check{\gamma}_{0,E}$ unchanged in this section. In other words, I do not elaborate on the counterfactual change in wages across quantiles due to QE, but only on income gains due to changes in employment [45].

Bivens [10] reviews on a range of studies set to estimate the change in employment

triggered by QE, $\Delta \tilde{X}_E^{QE}$. Concretely, Chung et al. [16] employ estimates on the term-premium and simulations based on the Feds' FRB-US model. They conclude for a 1.5 % increase in employment. Engen et al. [26] use a similar approach concluding for a lower bound estimate of 0.8 % and an upper bound of 1.5 %. Their baseline estimate accounts for 1.2 %. Bivens [10] continues to employ a 1 % change in employment due to QE. Deutsche Bundesbank [13] also argues in favor of these findings.

Applying these numbers to Montecino and Epstein's [45] estimates on the impact of employment gains, the explained component, of QE on income: for Engen's [26] upper bound of 1.5 % this corresponds to a 0.51 % decrease to the 99/10 Ratio, for the baseline scenario of 1.2 % this suggests a 0.41 % change and a lower bound change of 0.27 %. The baseline scenario decreased the 90/10 Ratio by roughly 0.35 % and the Gini coefficient by 0.05 %.

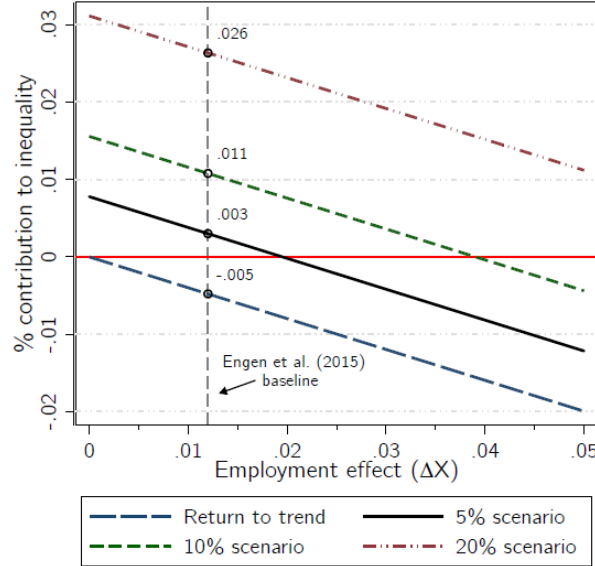


Figure 6: Employment in the US

Montecino and Epstein [45] introduce a framework comparing a range of estimates on the counterfactual evolution of stock prices and employment on inequality. For most counterfactuals, the regressive effect of stock price appreciations surpasses the positive effect of employment. Figure 6 illustrates this approach.

The X-axis accounts for the employment effects of QE, the vertical line outlines Engen’s 1.2 % baseline scenario. The Y-axis illustrates the net contribution to the 99/10 Ratio for the effect of stock prices and employment. The black line depicts this relationship for a 5 % change in stock prices. The bottom blue line represents a 0 % change, which equals the marginal return to trend scenario proposed by Bivens [10]. The upper lines show the effect for the 10 % and the 20 % scenario. For example, for a 5 % change in stock prices and a 1.2 % increase in employment, QE mildly increased the 99/10 Ratio by roughly 0.3 %. Further, to cancel out the 10 % asset price scenario it requires almost a 4 % increase in employment. In turn, the employment channel decreased QE by 0.51 % in the return to trend case ($\theta = 0$).

Note, Bivens [10] points out one major argument to these considerations: even if stock price appreciations surpassed beneficial employment effects, the stock price effect will diminish in the long-run (once QE measures reach maturity). Contrawisely, it is unclear why employment gains should fade in the long-run. For the limited QE period observed, this could suggest that QE is regressive in the short-to medium-term while progressive in the long-run.

4.6 The Mortgage Refinancing Channel

QE is potentially beneficial on inequality through improving mortgage refinancing conditions. Anyhow, this is not clear a priori as this effect is largely dependent on the distribution of mortgage debt and access to improving refinancing across households. Compared to the asset and employment channel, empirical evidence is thin. From the underlying studies Dobbs et al [20], Bivens [10], Montecino and Epstein [45], Bernoth [9], and Guerello [33] provide implications on the mortgage refinancing channel. All these studies agree on its progressive impact. In the following I look at the distribution of mortgage payments, the distributional effects of mortgage refinancing throughout QE and detail on respective counterfactuals.

4.6.1 The Distribution of Mortgage Debt and Payments

Figure 7 depicts the value of total mortgage debt in the US between 2001 and 2017 in trillion US dollar. The graph shows a significant incline before the Great Recession. Outstanding mortgage debt fell slightly after but rebounded soon. This recovery was sure boosted by QE programs. The black line indicates the start of QE 1 in 2009 which explicitly engaged in mortgage purchases. Between 2008 and 2009 outstanding mortgage debt accounted for more than a 100 % of US GDP. Since then this ratio is steadily declining accounting for 76.86 % in 2017. In other words, the mortgage market strongly deleveraged since the crisis.

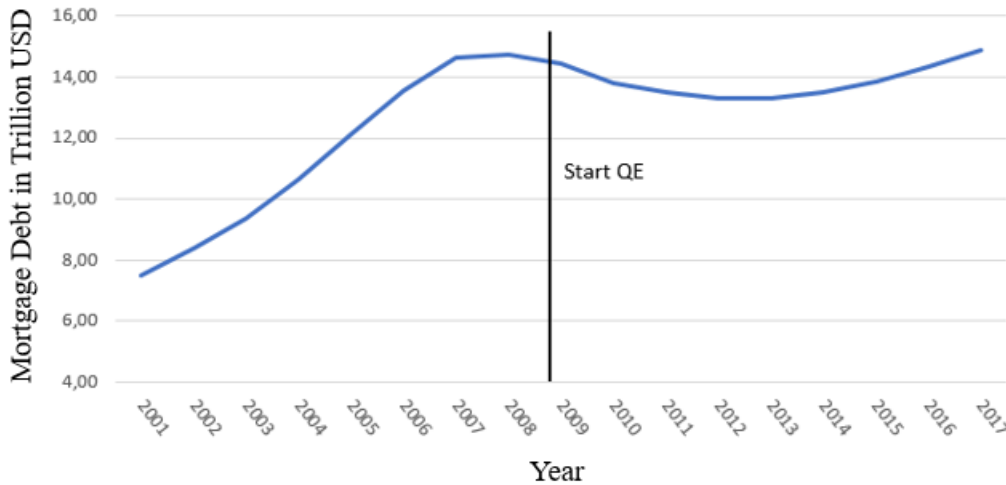


Figure 7: Total Mortgage Debt in Trillion US Dollar³⁰

Table 9 illustrates stylized facts on the distribution of mortgage debt and payments across incomes. Average mortgage payments and outstanding debt increase with income. But, relative to household income mortgage debt makes up a falling share. The second lowest income gap with a median income of \$15.000 per year devotes approximately 4 % of yearly income to monthly mortgage payments. The income gap averaging \$45.000 spends only 1.7 % and the second highest income gap with \$110.000 median income exhibits a 1.1 % expense.

³⁰**Source:** Statista [60]: Value of mortgage debt outstanding in the United States from 2001 to 2017

Income	Median Monthly Income	Median Interest Rate	Median Outstanding Debt
Less than \$10.000	\$635	4 %	\$60000
\$10.000 - \$19.999	\$607	5 %	\$62000
\$20.000 - \$29.999	\$631	5 %	\$63000
\$30.000 - \$39.999	\$700	5 %	\$78000
\$40.000 - \$49.999	\$769	4 %	\$87000
\$50.000 - \$59.999	\$850	4 %	\$90010
\$50.000 - \$59.999	\$850	4 %	\$90010
\$60.000 - \$79.999	\$927	4 %	\$102000
\$80.000 - \$99.999	\$1.024	4 %	\$125000
\$100.000 - \$119.999	\$1.200	4 %	\$140000
\$120.000 or more	\$1.600	4 %	\$200000

Table 9: The Distribution of Mortgage Debt and Payments³¹

From this data, it is possible to give a first implication on how mortgage refinancing affects different net income ratios (income minus yearly mortgage payments). For example, a symmetric 1 % decrease in average mortgage payments for the \$15.000 and the \$110.000 gaps leads to a modest decline in the respective net income ratio of 0.78 %³².

As the data and the literature imply, however, this progressive impact might be muted due to refinancing asymmetries across households [45, 8]. Unsurprisingly, high income households with larger mortgage credits show lower median interest rates (4 %) than lower income households (5 %). This suggests that top income households can negotiate better conditions. In addition, tightening banking regulation restricted mortgage refinancing especially for less creditworthy households. And, steep declines in housing prices set many mortgage creditors underwater with loan to value ratios above 100 %, restricting their refinancing options. Again, this mainly affected bottom income households. Bair [1] argues that improving refi-

³¹**Source:** Census Bureau American Housing Survey [14]

³²Percentage change in net income is equal to: $\Delta NI_{1\%} = \left[\frac{110000 - 12 \cdot (0.99 \cdot 1200)}{15000 - 12 \cdot (0.99 \cdot 607)} - \frac{11000 - 12 \cdot 1200}{15000 - 12 \cdot 607} \right] / \frac{110000 - 12 \cdot 1200}{15000 - 12 \cdot 607}$

nancing conditions for underwater households was not a priority of the Fed, nor was any program implemented supporting these households.

Due to these and further issues, the Board of Governors of the Federal Reserve System stated that solely 50 % of households were capable of profitably refinancing their credits in 2012 [8]. Since then, surely further households benefited from improving refinancing conditions. But, as I point out in the next sections, these limitations broadly muted the progressive effects of mortgage refinancing and possibly even reversed its effect on inequality in the United States. In the next section I look at the empirical evidence on the impact of mortgage refinancing throughout the QE period [45, 6].

4.6.2 The Impact of Mortgage Refinancing on Inequality

Mortgage refinancing rates remained quite constant between 2001 and 2007/08 with 30- and 15-year rates roughly ranging between 7 % and 5 %. After, they dropped sharply with 15-year rates falling below 3 % and 30-year rates to a minimum of 3.5 % as illustrated in Figure 8. Recently both rates started rising slowly. The black bar indicates the start of QE1 in November 2008. As suggested by theory and argued by the literature, the graph suggests that mortgage rates fell in the cause of QE. In fact, all studies elaborating on this relationship agree that QE significantly contributed to this fall. The aggressive deterioration in early 2008 can likely be attributed to other monetary policy measures.

Dobbs et al. [20] point out that in the US in 2012 mortgage payments made up roughly \$491 billion, while total household debt payments merited \$822 billion. Mortgage payments approximate for 60 % of overall household debt payments. They emphasize that most of these are fixed-rate mortgages accounting for roughly \$393 billion, whereby a minor share of \$98 billion is variable-rate mortgages. This suggests a diminishing effect through mortgage refinancing in the United States.

Montecino and Epstein [45] provide detailed estimates on the distributional impact of mortgage refinancing throughout QE. Figure 9 from their analysis illustrates the impact of mortgage refinancing across quantiles in the pre- and post QE period.

³³**Source:** Fred [28] 15- and 30-Year fixed-rate Mortgage Average in the United States



Figure 8: Mortgage Rates in the US³³

As in section 4.4.2 and 4.5.2, the graph shows the relationship between household income across quantiles and income gains through mortgage refinancing. The black line refers to the pre- QE period between 2008 and 2010, while the red line indicates the post QE period between 2011 and 2013 as proposed by Montecino and Epstein [45].

Clearly, mortgage refinancing is enhancing income for all quantiles. But, the graph suggests an overall regressive impact on inequality, with income gains through refinancing skewed to the top. Montecino and Epstein [45] point out, that this finding possibly indicates asymmetries in refinancing conditions between rich and poor households. Anyhow, to this point a microanalysis on these limitations to the mortgage refinancing channel is outstanding.

Moreover, income gains through refinancing hike in the post QE period, suggesting that QE was successful in lowering mortgage rates. This finding is also in line with Dobbs et al. [20], who point out that US household interest income fell sharply with the Fed engaging in post-crisis policies, translating into falling mortgage debt payments. Surprisingly, this effect seems not to hold for the 99th

³⁴**Source:** Montecino and Epstein p.14 [45]

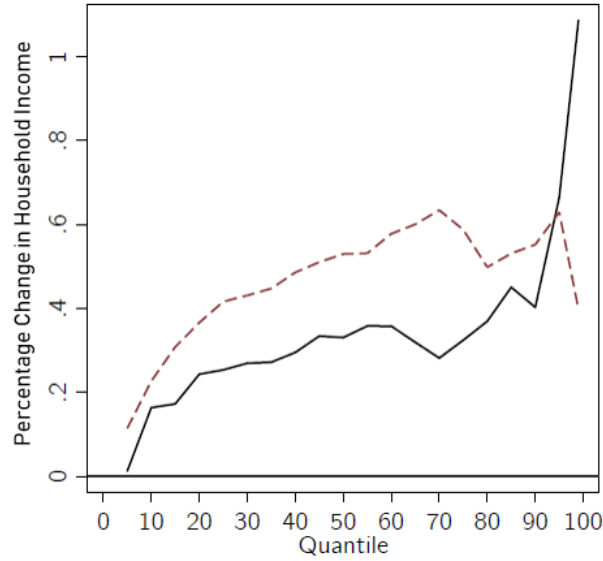


Figure 9: The Distributional Effect of Mortgage Refinancing³⁴

quantile and it is not clear why. Montecino and Epstein [45] suggest that returns to refinancing for the 99th quantile were possibly exceptionally high in the pre QE period. Possibly this is just a data issue.

	99/10 ratio	90/10 ratio	Gini
Mortgage Refinancing	-0.0016	0.0257	0.0004
Explained	0.0682	0.0177	0.0009
Unexplained	-0.0698	0.0080	-0.0005

Table 10: Regression Results on Financial Returns ³⁵

Table 10 reports the regression results of Montecino and Epstein [45] on the distributional effects of mortgage refinancing on different measures of inequality. The explained component indicates the effect of inequality through changes in the mortgage volume refinanced. The unexplained component refers to the effect of changes in returns to refinancing. The former increased inequality for all measures applied, this possibly suggests that asymmetries in access to refinancing worsened inequal-

³⁵**Source:** Montecino and Epstein p. 16 [45]

ity as many bottom quantile household mortgages were underwater. This was also noted by a Federal Reserve White Paper in 2012 [8]. The latter is progressive for the 99/10 Ratio and the Gini coefficient, while it was slightly regressive for the 90/10 Ratio. This implies that falling interest rates predominantly benefited bottom quantile households. Especially the effect on the 99/10 Ratio is for both components very strong contributing almost 7 %.

In aggregate mortgage refinancing was regressive for all but the 99/10 Ratio which shows a minor progressive effect. Note, while the diminishing effect of QE on mortgage rates is emphasized by a range of studies, it is not clear how QE could affect mortgage volumes refinanced. In part, the regressive effect of the explained component can surely be explained by tightening access to credit and the closeness of better-situated households to the market. Hence, for the unexplained component QE was likely progressive on inequality. [45, 10, 9]

Note, Montecino and Epstein [45] emphasize that both components broadly increased incomes across all quantiles, as could be seen from Figure 9. In fact, mortgage refinancing contributed the major share of 4.3 % to income gains in Montecino and Epstein’s [45] analysis. In sum, financial returns, rising employment and mortgage refinancing contributed 4 % to median income. Put differently, in the absence of QE median income would have been 4 % smaller.

Clearly, these estimates are solely based on Montecino and Epstein’s analysis and further studies must fortify or reject these findings. To the best of my knowledge, there are no further studies estimating the distributional impact of mortgage refinancing throughout this period. But, several studies emphasize a progressive impact of falling interest on inequality such as Coibion [19], Bivens [10], Deutsche Bundesbank [13] and Bernoth [9].

4.6.3 The Counterfactual Evolution of Mortgage Rates

Though the counterfactual evolution of mortgage refinancing in the absence of QE is not quantified by any of the underlying studies, all studies agree that QE was effective in bringing down long-term refinancing rates including mortgage interest. In addition, there are several papers explicitly looking at the relationship between Quantitative Easing and mortgage rates including Hancock and Passmore [34],

Krishnamurthy and Vissing-Jorgensen [38], Gabriel and Lutz [31] and Maggio et al. [44]. In line with the underlying literature, these studies fortify the regressive impact of QE on mortgage rates.

In detail, Hancock and Passmore [34] find that mortgage rates are tightly linked to MBS yields. They find a 0.82 % drop in mortgage rates at the announcement of QE1 and a 0.64 % drop at the end of QE1. Krishnamurthy and Vissing-Jorgensen [38] find that especially QE1 affected MBS rates beyond a signaling effect, while this does not hold for QE2. They conclude that MBS purchases play a significant role in the impact of QE on mortgage rates, while portfolio rebalancing plays a subordinate role. They conclude for a 1.07 % decrease in 30-year MBS rates due to QE 1 and a minor 0.09 % decrease due to QE2. Both findings hold at 10 % significance levels.

Further, Gabriel and Lutz [31] find that throughout the Fed's QE1 to QE3 an unconventional monetary policy shock that reduces Treasury yields by 0.25 %, reduces 30-year MBS rates by 0.36 % on average. For an estimated reduction in Treasuries of 1 % as argued by Bivens [10], this leads to a total reduction of 1.44 %. In line, Maggio et al. [44] find a mortgage rate increase greater than 1 % due to QE1, while QE2 and QE3 led to minor reductions of 0.35 % and 0.18 %.

Although comparing these findings is difficult due to different methods and rates examined, it is possible to extract a corridor on QE's effect on mortgage rates. Conservatively, these findings suggest that LSAPs reduced mortgage rates by between 1 - 1.5 %.

As alluded in 4.6.2 mortgage rates fell by about 2 % between 2008 and 2013, the period covered by Montecino and Epstein's [45] analysis. In a linear framework QE then contributed half to three-fourths of improvements in refinancing conditions, the explained component of mortgage refinancing. For this basic computation, QE contributed a decline in the 99/10 Ratio between 3.5 % and 5.25 %. These are strong effects and these findings suggest a largely progressive impact of QE through improving refinancing conditions.

Anyhow, authors point out that these reductions were not eligible to all households. Especially top quantile households benefited in full of this effect, while these benefits deteriorate for bottom quantile households. Maggio et al [44] emphasize

that especially households with high loan to value ratios struggle with refinancing which was tightly restricted for so-called underwater mortgages. For this, I conclude that though improving refinancing conditions were strongly progressive, this channel of QE was largely muted by asymmetries in access to refinancing in the United States. In the oncoming section I elaborate on the key country characteristics identified in 3.3 comparing the US, UK, Japan and the five biggest EMU economies.

4.7 Cross-Country Comparison

As argued throughout this thesis there are several factors affecting the size and direction of the distributional impacts of QE. I provide an empirical overview of the key country characteristics identified in 3.3. Concretely, I refer to inequality and redistributive policies across countries, the distribution of housing, the size of mortgage debt to GDP, whether countries exhibit rather fixed or flexible mortgage rates and the relative closeness of households to the financial market. Countries with high inequality, fixed mortgages and intensely segmented financial markets exhibit potentially larger regressive effects of QE on inequality. Generous redistributive policies, large shares of mortgage debt to GDP and evenly distributed housing are considered progressive. Table 11 gives an overview of these key country characteristics for the US, UK, Japan, Germany, France, Italy, Spain and the Netherlands.

Income Equality: Looking at countries observed, the US show relatively high levels of inequality while many European countries exhibit traditionally low levels including Germany, France and the Netherlands. In comparison, the Gini coefficient in 2013 for the UK indicates comparatively high inequality, though it is far more equal than the US. Italy and Spain both exhibit medium values. This also accounts for Japan for which data is only available in 2012. Saiki and Forst [52] imply that since then, this evolution aggravated further. Figure X depicts the evolution of Gini coefficients since 2008 as far as data is available. Note, for Japan and Germany missing data points between available values were added in

a liner framework. These findings suggest that the US and UK are potentially more prone to a regressive effect of QE on inequality through QE than the other countries observed. Based on OECD data [48].

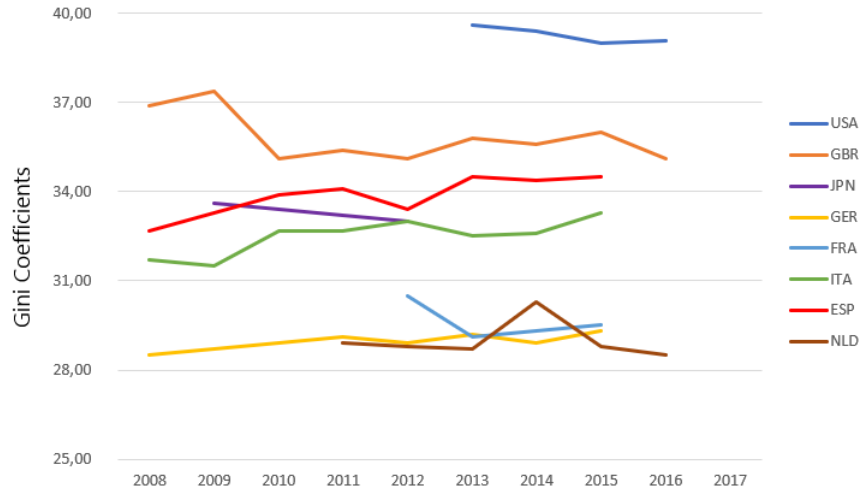


Figure 10: QE Economies' Gini Coefficients between 2008 and 2017³⁶

Redistributive Policies: High redistributive policies are considered equalizing. For example, capital taxes smooth capital gains in the cause of QE which usually benefit wealthier households. Redistributive policies are high in Germany, France and the UK. Guerello [33] points out, that these are tightly related to low levels of inequality within EMU countries. They are medium sized in the Netherlands and low in the US, Italy and Spain. As for inequality, low indicates a rather regressive effect. Based on the IMF Policy Paper on Fiscal Policy and Income Inequality [18].

Homeownership: As argued in 4.4 and emphasized by Bivens [10], housing is relatively evenly distributed in the US. Thus, households broadly benefited from housing price appreciations which likely decreased inequality. But, homeownership fell sharply after the crisis indicating the critical effect of the mortgage bubble burst on house prices which set many homeowners underwater. In fact,

³⁶**Source:** OECD [48] Income distribution and poverty

homeownership fell from 69 % in 2006 to a minimum of 63.8 %. Since then, homeownership seems to have stabilized [59]. A similar evolution is found for the United Kingdom [25]. Homeownership fell by an astonishing 9.1 % from 72.5 % in 2008 to 63.4 %, today both countries exhibit a medium profile. Note, in the absence of QE, this fall could have been worse. Homeownership in Japan did not show such intense shifts, but roughly stagnated around 61 %, which takes also a medium position [24]. Homeownership is high in Spain, Italy and France all show rates above 65 % in 2016. This does not hold for Austria and Germany with homeownership rates of 55 % and 51.7 % respectively [58]. Based on Statista [58, 59] and Trading Economics [25, 24] data.

Mortgage Debt to GDP: Outstanding mortgage debt is specifically high in the US, UK, and the Netherlands with GDP ratios ranging between 75 % and 100 % in 2008. Spain, Germany and Italy all display relatively low levels of Debt to GDP. For example, in 2008 outstanding mortgage debt in Germany amounts roughly 50 %, for Spain this ratio is slightly above 60 % while Italy ranges below the 20 % mark. Data for France is lacking. Based on Lea [42].

Variable-Rate Mortgages: The lion-share of US mortgages are long-term fixed-rate mortgages, largely limiting refinancing options for US households. For the UK, Japan and the five biggest Euro Area countries, only mortgages in France show similarly high ratios of long-term fixed-rates. In Germany and the Netherlands, most mortgages have short- to medium-term fixed-rates. Contrastingly, variable-rate mortgages are prevalent in Spain and the UK. This also holds for Japan. Lea [42] does not include this data for Italy. Claeys et al. [17] point out that the Italian mortgage market is split between fixed and flexible rates. Based on Lea [42].

Country Characteristics	Income Equality ³⁷	Redistributive Policies ³⁸	Home-ownership ³⁹	Mortgage Debt to GDP ⁴⁰	Variable-Rate Mortgages ⁴¹	Marked- vs. Bank-based ⁴²
United States	Low	Low	Medium	High	Low	Market-Based
United Kingdom	Low	High	Medium	High	High	Market-Based
Japan	Medium	n/a	Medium	Low	High	Bank-Based
Germany	High	High	Low	Low	Medium	Bank-Based
France	High	High	Medium	n/a	Low	Bank-Based
Italy	Medium	Low	High	Low	n/a	Bank-Based
Spain	Medium	Low	High	Medium	High	Bank-Based
Netherlands	High	Medium	High	High	Medium	Market-Based

Table 11: Key Country Characteristics

³⁷**Source:** OECD data [48]; Gini coefficients on income inequality in 2013 (for Japan in 2012); High resembles to coefficients below 30, Medium to coefficients between 30 and 35 and Low to coefficients above 35.

³⁸**Source:** IMF Policy Paper p.16 [57]; Effect of redistributive policies on the Gini coefficient; High resembles to values reducing the Gini coefficient by more than 0.15, Medium to values between 0.15 and 0.12, and Low values below 0.12.

³⁹**Source:** Statista [58, 59] and Trading Economics data [25, 24]; Homeownership by countries in 2016 (in 2015 for Italy and in 2013 for Japan, data for the Netherlands is provisional); High indicates homeownership rates above 65 %, Medium rates between 60 and 65 and Low values below 60 %.

⁴⁰**Source:** Lea p. 12 [42]; Relative size of outstanding mortgage debt to GDP in 2008 (for Japan in 2006, data for France is missing); High resembles to values above 75 %, Medium to values between 75 % and Low to values below 50 %.

⁴¹**Source:** Lea p. 18 [42]; Relative share of variable-rate mortgages in the economy in 2010 (data for Italy is missing); High resembles to variable-rate, Medium to mixed and Low to fixed-rate dominated mortgage markets.

⁴²**Source:** World Bank Appendix Table 12 [43]; Market- vs. Bank-based economies.

Marked vs. Bank-based: Market-based economies show a high participation of households in the asset market, while bank-based economies are dominated by intermediating banks. Arguably, market-based economies with low inequality will exhibit less regressive effects through asset price appreciations as assets tend to be more equally distributed across households. Bank-based economies with high inequality, on the other hand, are prone to increasingly regressive effects as assets are typically skewed to the top and median households show high shares of bank savings which are hurt by falling interest. Both, market-based economies with high inequality and bank-based economies with low inequality take a median position. From the countries observed, the US and UK are both defined as market-based economies. Japan is defined as bank-based, like the biggest European Economies including Germany, France, Italy and Spain, but also Austria, Portugal and Belgium. The Netherlands are defined as market-based. Based on the widely cited World Bank paper from 1999 [43].

In sum, the US shows an overall regressive profile when it comes to the distributional effects of QE. It has high inequality, which is limiting a possible mitigation of its market-based financial system. The excessive share of fixed mortgage rates, and tightening credit standards, restricted potential benefits of mortgage refinancing despite the large amount of mortgage debt to GDP. Even though housing is relatively evenly distributed, the fall in homeownership especially for bottom quantile households largely muted the beneficial effects of housing. Last but not least, redistributive policies are low.

The UK economy is in many ways similar to the United States. It is relatively unequal despite its high redistributive policies. It is a market-based economy with assets held by the middle class, it shows a huge amount of outstanding mortgage debt and, different to the US, mostly variable-rate mortgages. This suggests a largely progressive effect of mortgage refinancing. Again, homeownership is very evenly distributed but fell after the crisis. These factors display a mixed picture for the UK.

Though inequality in Japan was historically low, Japan exhibits a rather mediocre value of inequality. Its economy is bank-based, boosting the regressive effect of

the asset price channel. Mortgage debt is low which limits the benefits of mortgage refinancing, but most mortgages are variable, thus, mortgage payments fall directly with long-term interest rates. Housing is quite evenly distributed. This suggests an overall average profile of the Japanese economy.

Contrastingly many European countries exhibit better circumstances for bottom income households. All display low levels of inequality compared to the US, especially Germany, France and the Netherlands and high redistributive policies. Bank-based economies are prevalent amongst EMU countries including Germany, France, Italy and Spain. From the five biggest EMU economies, only the Netherlands is market-based. Also, mortgage debt is low across EMU countries limiting possible benefits of mortgage refinancing. The only exception is, again, the Netherlands. The picture for mortgage rates is heterogeneous, France sticks out with large shares of fixed mortgages. Germany, Italy and the Netherlands exhibit a relatively mixed mortgage market while variable-rate mortgages dominate in Spain. Finally, housing is less evenly distributed in Germany and Austria, where many people rent. France, Spain and Italy all show more uniform ownership rates. Hence, housing price appreciations arguably hurt middle European tenants by raising their rents. This development has become a crucial political issue in Germany as many people struggle with exploding rents but is also an issue in the US.

I conclude the US are likely prone to a regressive effect of QE on inequality. The UK and Japan take a medium position. EMU countries provide the most beneficial circumstances for a progressive effect of QE on inequality with relatively low inequality and high redistributive policies. This holds especially for the Netherlands with its markets based economy, low inequality, high mortgage debt and a mixed mortgage market.

5 CONCLUSION

So does Quantitative Easing increase income inequality? My answer is it might, but it must not. Its distributional consequences are diverse and dependent on both, the composition of QE measures and country characteristics. It has, however, like monetary policy in general, significant effects on different income sources across quantiles and, thus, income inequality. Disentangling these effects from other variables and constructing valid counterfactual scenarios are key challenges for providing concrete estimates on this question.

Studies concur that QE broadly benefited the economies to spur growth and lower unemployment. Even if QE increased inequality, bottom quantile households would have been worse off in the absence of QE for higher unemployment and mortgage rates. Still, even though QE boosted incomes across all quantiles not all households benefited automatically. Additionally, unique events that could have occurred in the absence of Quantitative Easing, for example another break down of the financial system, a break-up of the euro system or continuous deflationary pressure might have hurt economies, lowered incomes and enhanced inequality far further.

As empirical evidence suggests, Quantitative Easing in the United States was modestly regressive at least in the short- to medium-term. For the other QE economies evidence is controversial and insufficient to draw a conclusion on whether QE measures worsened inequality. The cross-country comparison implies that QE was potentially less regressive for the other economies. Especially within EMU economies with low inequality and large redistributive policies, QE might have even been progressive. This means that fiscal policy largely shapes the distributional effects of monetary policy.

Beyond, I found that the asset price, employment and mortgage refinancing channel dominate the transmission of QE to inequality, whereby the former is rather regressive, while both latter channels tend to be progressive on inequality. Size and direction of these effects are dependent on the composition of QE programs and country / household characteristics.

From the central bank perspective, QE measures that engage in large-scale asset purchases predominantly drive respective asset incomes, e.g. MBS purchases lift

housing prices and abate mortgage refinancing rates. Portfolio rebalancing effects play a subordinate role. This advocates that central banks can choose to shape QE programs in a manner that is rather progressive on inequality. Whether such considerations can be part of an independent central banks mandate is up for more sophisticated discussions.

On the country / household side, the distributional effects of QE are dependent on a range of characteristics. For example, households that got employed (or did not lose employment) due to improving labor market conditions in the cause of QE clearly benefited. This also accounts for mortgage creditors that took advantage of improving refinancing conditions. Further, especially top quantile households gained from rising asset income. Contrastingly, creditors lost due to falling interest, especially medium- to long-term interest rates fell in the cause of QE. Also, tenants (mostly bottom quantile households) lost due to rising rents, while homeownership boosted wealth.

Moreover, as McAfee and Brynjolfsson [12] argue convincingly, main drivers of rising inequality are arguably globalization, digitization and automation. They emphasize that the main driver of rising inequality " ... is exponential, digital, and combinatorial change in technology" [12] p. 133. Turner [64] provides a similar argument in one of his latest papers "Capitalism in the Age of Robots: Work, Income and Wealth in the 21st-Century".

Finally, facing sluggish growth in many post-crisis economies despite ultra-low interest and large QE measures, inequality manifesting itself in a form of secular stagnation could be the reason behind post-crisis recession. In this situation, inequality would rather be the cause of QE than its result. If this is the case, boosting bottom quantile household incomes through e.g. redistributive fiscal policies would lift growth and employment. Governmental investments in education, infrastructure or sustainability would be an alternative. Note, in the wake of rising competitive pressure between countries, a common coordination of monetary and fiscal policies might be necessary to achieve such redistribution. As Turner [63] p. 222 based on the famous economist Friedman points out, "... governments and central banks together can always overcome deficient nominal demand by printing and spending money."

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