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Abstract

This paper takes stock of the literature on the relationship between central bank policies and inequality. A new paradigm which integrates sticky-prices, incomplete markets and heterogeneity among households is emerging, which allows to jointly study how inequality shapes macroeconomic aggregates and how macroeconomic shocks and policies affect inequality. While the new paradigm features multiple distributional channels of monetary policy, most empirical analyses analyse each potential channel of redistribution in isolation. Our review suggests that empirical research on the effect of conventional monetary policy on income and wealth inequality yields very mixed findings, although there seems to be a consensus that higher inflation, at least above some threshold, increases inequality. In contrast to common wisdom, the conclusions concerning the impact of unconventional monetary policies on income inequality are also not clear cut. This is so since these policies may reduce income inequality by stimulating economic activity, but may also increase inequality by boosting asset prices. Similarly, results concerning the impact of unconventional monetary policies on wealth inequality are rather mixed. The scant literature on the impact of macro-prudential policies on inequality finds evidence for redistributive effects, but in view of its limitations it may be too early to come to conclusions.

"The degree of inequality we see today is primarily the result of deep structural changes in our economy that have taken place over many years, including globalization, technological progress, demographic trends, and institutional change in the labor market and elsewhere. By comparison to the influence of these long- term factors, the effects of monetary policy on inequality are almost certainly modest and transient." (Bernanke, 2015).

1. Introduction

Since the early 1980s, income and wealth inequality have risen in many advanced economies (Piketty, 2014; Atkinson, 2014).[†] Across OECD countries, the average Gini coefficient of disposable income reached 0.318 in 2013/14, the highest value since the mid 1980s (OECD, 2016).[‡] The recent economic recovery has not reversed the trend towards increasing inequality observed over the past decades (see Figure 1).

Figure 1. Gini coefficient of disposable income inequality in 2007-2014 (or latest year)
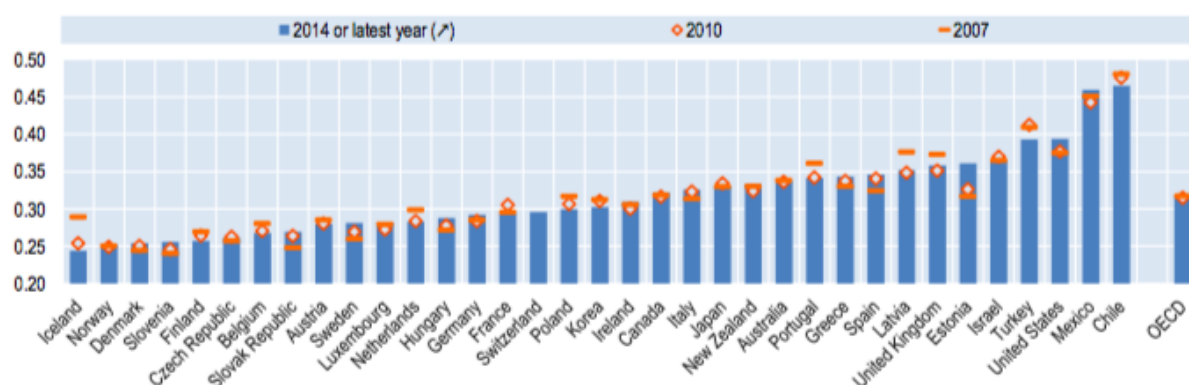
Note: The figure shows the Gini coefficient of disposable income for three years: 2007, 2010 or 2014 (or latest year available) for 35 OECD countries.
Source: OECD (2016)

Wealth inequality is generally higher than income inequality. The bottom 60% of the wealth distribution in OECD countries only hold a very limited fraction of total net wealth, while the top 10% hold on average more than 50% of total wealth (see Figure 2).

[†] A number of explanations for this have been put forward, like skills-biased technological change (Jaumotte *et al*., 2013; Dabla-Norris *et al*., 2015), trade and financial globalization (Jaumotte *et al*., 2015; Dabla-Norris *et al*., 2015), capital account liberalization (Furceri and Loungani, 2017), the growth and liberalization of the financial sector (de Haan and Sturm, 2017), and labour market institutions (Jaumotte and Osorio Buitron, 2015). Although it is often believed that capitalism leads to more inequality, Sturm and de Haan (2015) show that there is no robust link between economic freedom and market inequality.

[‡] The Gini coefficient is a standard measure of income inequality which takes the value 0 when everyone has the same income and 1 when one person has all the income.

Figure 2. Wealth shares of top percentiles of net wealth distribution in 2010 (or last available year)
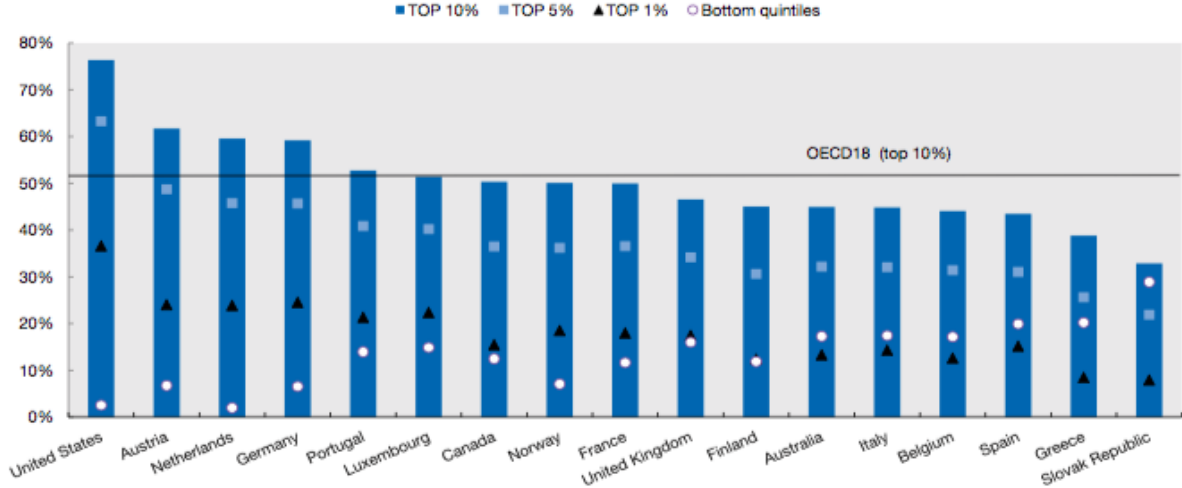
Note: The figure shows the share of total wealth owned by the top1%, top5%, top10% and the bottom 60% of the wealth distribution in 17 OECD countries in 2010 (or latest year available).
Source: Murtin and d'Ercole (2015)

Although some degree of inequality could promote growth by strengthening incentives to work and invest, recent research suggests that inequality is associated with lower growth in the medium run (Berg and Ostry, 2011; Ostry *et al.*, 2014). Long periods of rising inequality may also incite political instability and may lead to protectionist pressures, limiting the ability of economies to benefit from globalization (Dabla-Norris *et al.*, 2015). Furthermore, income inequality may limit opportunities for the poor to invest in education and entrepreneurial activity, which ultimately undermines potential growth (Jaumotte and Osorio Buitron, 2015). Finally, it has been argued that more income inequality leads to higher household indebtedness, fuels asset market bubbles, and raises financial instability (Coibion *et al.*, 2014; Kumhof *et al.*, 2015; Kirschenmann *et al.*, 2016).

According to Bernanke (2015), monetary policy is not a key driver of increased inequality, as "monetary policy is "neutral" or nearly so in the longer term, meaning that it has limited long-term effects on "real" outcomes like the distribution of income and wealth." However, several recent studies challenge this view. For instance, Coibion *et al* (2017) report statistically and economically significant effects of monetary policy changes on income inequality. Furthermore, while conventional monetary policy may be argued to be "neutral" over the cycle, this may not hold for unconventional monetary policy measures adopted in the aftermath of the financial crisis. In fact, several observers are convinced that these policies contributed to increased inequality. For instance, according to Cohan (2014), "Quantitative easing adds to the problem of income inequality by making the rich richer and the poor

poorer. By intentionally driving down interest rates to low levels, it allows people who can get access to cheap money on a regular basis to benefit in extraordinary ways." But this view has been challenged. For instance, Auclert (2016) argues that lower interest rates do not favour asset holders in general. He shows that the difference between all maturing assets and liabilities at a point in time is the correct measure of households' balance sheet exposures to real interest rate changes.

This paper takes stock of the burgeoning literature on the relationship between central bank policies and income and wealth inequality.[§] Recent theoretical research on monetary policy is based on general equilibrium models characterized by incomplete financial markets and heterogeneity among households. For this reason, we first discuss studies examining the conditions under which financial market incompleteness and household heterogeneity (including inequality) matter for the propagation of aggregate shocks, such as monetary policy shocks. Then we discuss the effects of central bank policy measures on inequality both from a theoretical and empirical point of view. In line with the emphasis in recent empirical research, we focus on studies analysing the impact of monetary policy on inequality. However, since the outburst of the financial crisis central banks have increasingly also become responsible for macro-prudential policies (Blinder *et al.*, 2017). A few recent studies analyse the relationship between this new instrument in central bankers' toolkit and inequality. For instance, the results of Frost and van Stralen (2017), which are based on a panel of 69 countries over the period 2000-2013, suggest a positive relationship between the use of specific macro-prudential policies and income inequality. We therefore also include studies on the impact of macro-prudential policies on inequality in our survey.

Inequality is about differences among individuals. Thus, studying the relationship between inequality and central bank policies requires deviating from the representative agent framework. Although models with heterogeneous agents and incomplete markets provide a proper framework for assessing the link between inequality and policy measures, they have not yet been broadly adopted to evaluate the distributional and aggregate effects of central bank policies. Instead, most policy analyses still employ the Representative Agent New Keynesian (RANK) framework. There are three main reasons for this.

First, the solution of models with heterogeneous agents requires the use of nontrivial computational techniques, given the need to keep track of the distribution of wealth, and potentially to deal with occasionally binding constraints. The second one is that, until recently, most macroeconomists believed that heterogeneity had only minor additional explanatory power for aggregate phenomena. This view is based on the influential work by Krusell and Smith (1998, KS henceforth) who concluded that household income and wealth inequality

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[§] See Bundesbank (2016) for an earlier survey of this literature. The present survey not only covers more recent empirical work and includes studies on the impact of macro-prudential policies on inequality, but also discusses recent theoretical heterogeneous agents models examining how inequality affects the aggregate effects of central bank policies.

have little impact on the aggregate dynamics of consumption, investment, and output. This result reinforced the continued use of the representative agent assumption in studying the macro economy. Third, as illustrated by the quote from Bernanke (2015) at the beginning of this paper, conventional wisdom sees redistribution as a side effect of monetary policy, separate from the issue of aggregate demand management (Auclert, 2016). However, recent research suggests that these reasons may no longer be valid grounds to neglect heterogeneity.

The rest of the paper is structured as follows. Section 2 outlines the role of wealth and income inequality for the transmission of monetary policy. Section 3 discusses how the relationship between monetary policy and inequality has been modelled. Section 4 summarizes empirical research on this relationship, while section 5 discusses research on the impact of macro-prudential policies on inequality. Section 6 concludes.

2. Transmission of Monetary Policy and Households Heterogeneity

Monetary policy propagates to the household sector by exerting three main effects. The first one is an income effect, as monetary policy directly affects interest rates received by savers and paid by borrowers. The second one is a wealth effect coming from the reaction of the values of assets such as bonds, equities and real estate to monetary policy. The third one is a substitution effect, as a change in real interest rates alters the price of current vis-à-vis future consumption.

The interaction of these effects with certain dimensions of heterogeneity among households results in transmission channels of monetary policy which, in turn, can potentially affect inequality. We define these channels as *Distributional Channels*. How monetary policy affects inequality depends on how households are distributed along relevant heterogeneity dimensions, such as wealth and income. As argued by Dolado *et al*. (2018), the same monetary policy action can have different, and potentially offsetting, effects on inequality along different dimensions of heterogeneity. For this reason, the overall effect of monetary policy on inequality is ambiguous a priori. In what follows we list the *distributional channels* together with the dimensions of heterogeneity along which they propagate.

Saving Redistribution Channel. The relevant heterogeneity dimension for this channel is net wealth. Monetary expansion makes borrowers better off by reducing their interest payments on debt, while savers holding deposits face lower returns.

Inflation Channel. The relevant heterogeneity dimensions for this channel are nominally fixed debts and cash holdings. Higher (unexpected) inflation reduces the real value of nominally fixed debts, which favors borrowers at the expense of creditors. Doepke and Schneider (2006) measure the balance sheet exposures of various sectors and groups of households in the United States to different inflation scenarios. They find that the distributional effects of inflation not only depend on the size of nominal positions but also on the maturity structure

of assets and liabilities. They argue that inflation hurts rich households more than other groups, as rich households hold more long-term bonds than poor and middle-class households. However, Erosa and Ventura (2002) observe that poor households hold more cash relative to other financial assets than rich households. Consequently, through the inflation channel the poor pay a disproportionate share of the inflation tax and are hurt more by inflation. Inflation also encourages precautionary savings and thereby leads to a higher concentration of wealth. Albanesi (2007) derives a positive correlation between inflation and income inequality in a model similar to that in Erosa and Ventura (2002), where the inflation tax rate is set in a political bargaining game.

Interest Rate Exposure Channel. A fall in real interest rates increases financial asset prices. However, Auclert (2016) argues that it is not generally correct to claim that this favours asset holders. He shows that the difference between all maturing assets and liabilities at a point in time is the correct measure of households' balance sheet exposures to real interest rate changes. Net savers whose wealth is concentrated in short-duration assets and net borrowers whose liabilities are of relatively long duration benefit from expansionary monetary policy that decreases real interest rates. They do so at the expense of net savers whose wealth is concentrated in long-duration assets and of net borrowers whose liabilities are of relatively short duration. To quantitatively assess this channel, it is thus key to understand how assets with different maturity are distributed across households.

Portfolio Composition Channel. By raising financial asset prices, a fall in the interest rate can also affect balance sheets of households through differences in the composition of the portfolio of assets (Coibon *et al*. 2017; Inui *et al*. 2017). Higher equity prices result in capital gains that benefit high-income households who hold most of financial assets. This raises wealth inequality. At the same time, higher house prices increase the value of real estate assets; this could have equalizing effects if homeownership is broadly distributed among the population, or escalate wealth inequality if homeownership is concentrated at the top end of the wealth distribution.

Earnings Heterogeneity Channel. Heathcote *et al.* (2010) show that while earnings at the top of the distribution are mainly affected by changes in hourly wages, earnings at the bottom are mainly affected by changes in hours worked and the unemployment rate. To the extent that monetary policy affects these forces differently it will produce redistributive income effects. Dolado *et al*. (2018) study how capital-skill complementarity interacts with monetary policy in affecting inequality between high- and low-skilled workers. They find that an unexpected expansionary monetary policy shock increases earnings inequality by lowering the labour share of income for low-skilled workers and raising it for high-skilled workers.

Income Composition Channel. Households obtain their incomes from different sources, each of which may respond differently to changes in monetary policy. Low-income households tend to rely more on transfers, while middle-income households rely on labour income and those

at the upper tail of the income distribution will rely relatively more on business and capital income. If a fall in interest rates stimulates economic activity, expansionary monetary policy may result in increased wages and decreased unemployment, thereby increasing inequality at the lower end of the distribution.[**] On the other hand, lower interest rates decrease interest income, and inequality at the top of the distribution may decrease.

Thus, the link between monetary policy and inequality through the distributional channels identified above depends on the distributions of households along various dimensions. For this reason, in the next section we provide an overview of Dynamic, Stochastic, General Equilibrium (DSGE) models characterized by a rich degree of heterogeneity.

3. Modelling Monetary Policy and Inequality

3. 1 Monetary Policy and Inequality in DSGE Models

In the standard DSGE model, an infinitely lived representative agent (RA) uses complete markets to smooth consumption over time and states of nature. By construction, the RA framework does not feature inequality in income and wealth. As a result, it is not suitable to study inequality or redistribution.

Further, as argued by Kaplan *et al.* (2017), in the Representative Agent New Keynesian (RANK) benchmark economy the response of aggregate consumption to a change in interest rates is driven entirely by the Euler equation of the representative household. Therefore, monetary policy in RANK models works almost exclusively through a substitution effect, while income and wealth effects are small.

However, the strong response of aggregate consumption to movements in real rates which characterize RANK models is at odds with the data. Macro-econometric analysis of aggregate time-series data finds a small sensitivity of consumption to changes in the interest rate after controlling for income (Campbell and Mankiw, 1989; Yogo, 2004; Canzoneri *et al.*, 2007).

In addition, U.S. data on the distribution of wealth suggest that there are many households for which saving is no common practice and which have near zero liquid wealth. One striking comparison is between the income distribution and the wealth distribution. According to Krueger *et al.* (2016), the lowest three quintiles of the income distribution earn about 15 percent of aggregate income. By contrast, the lowest three quintiles of the wealth distribution hold only 4 percent of total net worth (see also Figure 2).

A growing literature has emerged in recent years, using models with incomplete markets and agents which are heterogeneous in terms of both income and wealth. Heterogeneous agent models often have strikingly different implications for monetary and fiscal policies than

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[**] Parker and Vissing-Jorgensen (2010) show that in the U.S. taxes and especially transfers significantly reduce the cyclicality at the bottom of the income distribution, while making less difference to the cyclicality of the top.

representative agent (RA) models, and allow to study the distributional implications of these policies. Importantly, they can deal with the interplay between inequality and the macro economy that characterizes the economic environment. On the one hand, inequality shapes macroeconomic aggregates; on the other hand, macroeconomic shocks and policies also affect inequality.

3.2 Theoretical Developments of DSGE Models with Incomplete Markets and Heterogeneous Agents

We classify the papers we review in this section into the following two categories. The first one, titled *From Micro to Macro*, includes papers that explore the conditions under which heterogeneity, in terms of households' wealth and income, and financial market incompleteness have implications for the propagation of aggregate shocks and thus also for the transmission of monetary policy shocks.

The distributional effects of monetary policy are discussed in the second subsection which, for this reason, we title *From Macro to Micro*. We follow this distinction because "getting the micro right" helps reconciling the models' implications with the empirical evidence concerning the transmission of monetary policy and allows to embed the relevant dimensions of heterogeneity that affect the link between monetary policy and inequality in a unique framework.

3.2.1 From Micro to Macro: Inequality Matters

As observed by De Nardi and Fella (2017), the workhorse framework used to study aggregate effects of wealth and income inequality is based on the theory by Bewley (1977). In Bewley's model, agents are *ex ante* identical. They are *ex post* heterogeneous, because they are hit by idiosyncratic earning shocks. At any point in time, there are agents with low endowments while others have high endowments. As a result, it would be optimal to sign state-contingent contracts that insure the endowment risks and allow for consumption smoothing. With these contracts, agents receive payments when their endowments are low and make payments when their endowments are high. If markets were complete, the framework would reduce to one with a representative agent. With incomplete markets, however, the model leads to heterogeneity. Even if agents are *ex ante* homogeneous, in the long run there will be a continuum of asset holdings. In the basic Bewley model, precautionary savings are the key force driving wealth concentration. This, however, leads to a saving behaviour which is not consistent with the evidence. The nature of precautionary savings implies that households save to self-insure against earnings risk but that, as a result, the saving rate decreases and then turns negative when net worth is large enough. Hence, the saving rate of the very wealthy in these models is negative. In contrast, U.S. data show that rich people save at high rates.

General equilibrium and quantitative properties of this theory were studied by Imrohoroglu (1989), Huggett (1993), and Aiyagari (1994). Aiyagari (1994), in particular, provides a general equilibrium Bewley model with borrowing constraints. The perspective of being constrained in future periods together with market incompleteness imply that agents accumulate more capital than in a complete market environment to smooth consumption in response to idiosyncratic income shocks. Krusell and Smith (1998, KS henceforth) consider a Bewley (1977) type of model with aggregate uncertainty. They assume that the discount rate of individual agents is stochastic. However, the model delivers less inequality than observed in the U.S. economy. They argue that in order to describe the equilibrium of their economy the mean of the wealth distribution is a sufficient statistic. This result led subsequent research to consider microeconomic heterogeneity as a factor of second order of importance to describe the dynamics of aggregate variables in response to shocks or to policies changes.

However, recent studies have revisited the influential conclusion by KS. Two key contributions are those by Werning (2015) and by Krueger *et al.* (2016). Werning (2015) emphasizes the conditions under which market incompleteness matters for aggregate outcomes and affects the sensitivity of aggregate demand to interest rate changes. Krueger *et al*. (2016) emphasize, instead, how the wealth distribution, and its shape, affect the response of individual and aggregate variables to an aggregate shock.

Werning (2015) argues that the effect of market incompleteness on the interest rate elasticity of aggregate demand depends on the cyclicality of liquidity and of income risk. Specifically, he shows that when both liquidity, defined as the value of available assets and the amount of borrowing permitted, and income risk are a-cyclical, then the response of aggregate consumption to interest rate changes is not affected by financial market frictions. In other words, under these conditions the elasticity of aggregate demand to the interest rate is isomorphic to that in a representative agent model with complete markets. The sensitivity of aggregate demand to (especially future) interest rate changes is magnified by market incompleteness when income risk is countercyclical, meaning that it increases during a recession, and when liquidity is pro-cyclical.

Krueger *et al*. (2016) study the importance of household heterogeneity for aggregate consumption and output dynamics. These authors build a macroeconomic model with aggregate shocks and household heterogeneity in incomes and preferences. They ensure that the model has cross-sectional wealth and consumption distributions that replicate those in the Panel Study of Income Dynamics (PSID).[††] In their model, highly persistent income shocks, coupled with unemployment insurance, imply that 40% of households in the model hold no wealth, but make up a significant share of consumption. A restricted group of patient households account for about 80% of all wealth in the economy. The authors compare the

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[††] The PSID is a U.S. household survey that has been running since 1968. It collects information about household wages, labour market outcomes, wealth, and comprehensive measures of household consumption expenditures.

performance of their model in response to a large negative shock to that of an economy where wealth is more evenly distributed. The shock is a drop of total factor productivity of 4% relative to trend, expected to last for 22 quarters. In the model with empirically-consistent wealth inequality, the consumption expenditure drop on impact is half a percentage point larger compared to that in the economy with little or no wealth inequality. Thus, unlike KS, they find that inequality has a significant impact on consumption dynamics. Gornemann *et al*. (2016) reach similar conclusions. A key ingredient for this result is to have a large fraction of the population with close to zero net worth, as in the data, but unlike in the KS economy. Krueger *et al*. (2016) stress that the aggregate drop in expenditures due to a shock is much larger in the economy with many low-wealth consumers due to a precautionary savings motive. Although in Krueger *et al*. (2016) the risk of unemployment is not fully micro-founded, it depends on the aggregate state of the economy. Thus, when a recession hits and unemployment risk increases, consumers drastically reduce their expenditure, even if their income has not dropped yet. Specifically, in the presence of unemployment risk, low-wealth households that face the risk of exhausting their savings during an unemployment spell will respond by reducing their consumption and increasing their precautionary savings. The increase in households' desire to save translates into a weaker fall in investment in response to a contractionary shock than in the case of no precautionary savings, which mitigates the effects of the shock on output. Notice that this is consistent with PSID data. During the Great Recession, households in the bottom quintile of the wealth distribution reduced their expenditure rates by roughly 4 percentage points, while those in the top quintile only cut their expenditure rates by 2 percentage points**.**

Thus, general equilibrium models can deliver empirically consistent dynamics of consumption and investment by households characterized by different level of wealth provided that the implied wealth distribution is consistent with that in the data. In particular, the wealth distribution should be characterized by a fat left tail as observed in most advanced countries (see Figure 2). Given that consumption and investment dynamics, as well as the distribution of wealth itself, play a crucial role for the propagation of monetary policy, matching the empirical wealth distribution is a desirable ingredient for a model aimed at studying the interplay between monetary policy and inequality.

A very recent literature assesses the merits of Heterogeneous Agents New Keynesian (HANK) models (see below) for the understanding of aggregate dynamics, relative to a simpler alternative that assumes the existence of two types of consumers, namely "Ricardian" and "Keynesian" consumers, each with constant shares in the population. Ricardian consumers are standard utility maximizing agents who can use financial markets to smooth consumption over time, while Keynesian consumers are hand-to-mouth agents who consume their disposable labour income in each period. This type of models is now referred to as Two Agents New Keynesian Models (TANK). In TANK models an exogenous fraction of agents has zero net wealth, while the remaining fraction of agents equally share aggregate wealth in the economy.

Early contributions to this literature are Galì *et al*. (2007), Bilbiee (2008) and Colciago (2011). More recently, Debortoli and Galì (2018) outlined a TANK model characterized by heterogeneity among Ricardian households together with homogeneous Keynesian households. They compare the response to a monetary policy shock of their TANK model to that of the standard HANK model. The authors show that a simple TANK model may provide a good approximation of a prototypical HANK model, even when the latter generates predictions that are sizeably different from its RANK counterpart. However, TANK models may not be a good approximation of actual data when aggregate shocks have large effects on consumption heterogeneity, and in particular on the heterogeneity within unconstrained households. As stressed by Debortoli and Galì (2018), this could be the case in economies with countercyclical unemployment risk as in Ravn and Sterk (2017), or where financial market participants have heterogeneous portfolios of assets. However, if one's interest is solely that of studying the impact of aggregate shocks, such as monetary policy shocks, on the economy then TANK models could be a valid framework, with the advantage that they are much simpler to handle, and to estimate than a fully-fledged HANK model.

3.2.2 From Macro to Micro: Distributional Effects of Monetary Policy

In this section, we focus on models that emphasize redistributive effects spreading from monetary policy changes. Early studies, such as Albanesi (2007) and Doepke and Schneider (2006), focused on the redistributive effects of long-run inflation. A more recent literature studies the redistributive effects of monetary policy in New Keynesian models. The work by Kaplan *et al.* (2018) has become a benchmark in this literature. These authors introduced financial market incompleteness in NK models, generating inequality in income, wealth and consumption. They dubbed them Heterogeneous Agents New Keynesian (HANK) models. The model of Kaplan *et al.* (2018) features two assets, a liquid and an illiquid one, characterized by different rates of return. This setting delivers a wealth distribution, also across liquid and illiquid assets, and a distribution of the marginal propensities to consume which is consistent with that in the data. As such they feature most of the redistributive channels described above.

Their analysis delivers two key messages. First, the effect on aggregate variables of an interest rate change can be disentangled into two components: an indirect and a direct one. The indirect effect spreads from the change in consumption due to general equilibrium forces, while the direct effect comes from the intertemporal substitution effect which is also present in RANK models. Contrary to RANK models, the indirect effect is much stronger than the direct effect. The strength of the general equilibrium effect spreads from the heterogeneity delivered by the model and which is consistent with empirical evidence. In particular, the model delivers a sizeable group of hand-to-mouth households. These agents are not sensitive to interest rate changes, but are highly sensitive to changes in disposable income. A change in the interest rate which affects disposable income will thus have a strong effect on consumption even if the substitution effect is small. Second, since Ricardian equivalence fails

in HANK models, the transmission of monetary policy and its aggregate effects may vary significantly depending on the fiscal stance. This is so since the fiscal stance affects how monetary policy affects the distribution of individual income and wealth among agents with different marginal propensities to consume.

The implications for the conduct of monetary policy are relevant. In the RANK model, where direct effects are dominant, monetary policy can boost consumption by lowering the real rate and rely on substitution effects. In HANK models, it will have to rely on indirect effects in order to boost aggregate demand. This may prove a more difficult task, as simply manipulating the policy rate may not be enough to increase disposable income.

In a similar spirit Auclert (2016), using an Aiyagari type model, also emphasizes the importance of considering agents with different marginal propensities to consume in order to understand the redistributive effects of monetary policy. He argues that those who gain from accommodative monetary policy have higher marginal propensities to consume (MPCs) than those who lose. This is so since the income effect of a monetary expansion makes borrowers better off by reducing their interest payments on debt, while at the same time assets held by savers face lower returns. As long as savers are richer on average, and thus have a lower MPC, this reduces income inequality. Gornemann *et al*. (2012) consider the importance of the earnings and income composition channels in the context of a model in which households differ in their employment status, earnings, and wealth. They find that the redistributive effects of monetary policy are such that contractionary monetary policy shocks increase inequality. The unemployed, in particular, are made worse off by monetary policy tightening; a contractionary shock tends to prolong their unemployment spell, as firms reduce labour demand.

Turning to TANK models, Bilbiie (2017) outlines an economy where agents are hand-to-mouth just occasionally. He shows that the effect of a monetary policy shock is amplified compared to that in RANK models when the elasticity of income of Keynesian households to aggregate income is larger than one. Furthermore, the magnification goes through an indirect effect as in a HANK model and is consistent with the empirical evidence described in the previous section. Menna and Tirelli (2017) consider a TANK with cash holdings and show that a combination of higher inflation and lower income taxes shifts the tax burden on asset holder thereby reducing inequality. Ascari *et al*. (2017) consider a TANK model with constant shares of Ricardian and Keynesian agents, and provide a micro-founded welfare loss function for the monetary authority. They show that the heterogeneity in TANK models is irrelevant for the design of optimal monetary policy as long as both prices and wages are sticky.

4. Empirical Evidence

4.1 Methodological Approaches and Data

Empirical research on the effects of monetary policy on inequality faces challenges related to data and methodology. <u>Measuring inequality</u> remains a difficult task. Ideally, both wealth and income inequality measures are constructed from household surveys which provide comprehensive granular data on households' income and wealth composition over a long period. Having quarterly or monthly micro-data would allow examining distributional effects of monetary policy in a higher frequency setup over a long horizon. Longitudinal household surveys have been used to study the impact of monetary policy on inequality, in the U.S. (Doepke and Schneider, 2006; Montecino and Epstein, 2015; Cloyne *et al.*, 2016, Coibon *et al.*, 2017), the U.K. (Cloyne *et al.*, 2016; Mumtaz and Theophilopoulou, 2015; 2017), Japan (Saiki and Frost, 2014; Inui *et al.*, 2017) and Italy (Casiraghi *et al.*, 2018). For other countries, continuous higher-frequency household surveys are rarely available or of poor quality.

One of the comprehensive data sources on income distribution and inequality in the European Union (EU) is the EU Statistics on Income and Living Conditions (EU-SILC), which provides annual cross-sectional and longitudinal multidimensional microdata on income, poverty, social exclusion and living conditions. A more recent granular data source on income and wealth distribution in the EU is the Household Finance and Consumption Survey (HFCS). The latter consists of two waves so far (2013 and 2016). Lenza and Slacarek (2018) use HFCS to simulate the short-run impact of ECB non-standard monetary policies on wealth and income distribution in the four largest euro area countries through changes in asset prices, wages, and unemployment. However, having only two data points prevents a long-run dynamic analysis. Guerello (2018) addresses this problem by computing income dispersion based on the monthly Consumer Survey of the European Commission, which provides qualitative answers on a five-option ordinal scale. Income dispersion is defined as a percentage of positive responses to a question concerning a change of a household's financial situation over the last 3 months. According to the author, this inequality measure is comparable to the Gini coefficient from EU-SILC.

To overcome the described data limitations, studies use annual inequality measures from national or international sources, and apply mixed-frequency techniques (Mumtaz and Theophilopoulou, 2015; Samarina and Nguyen, 2018) or consider a panel of countries over a long period (Furceri *et al.*, 2018). Some studies use microsimulations to replicate the wealth distribution from sporadic household surveys in the absence of long time series data on households' portfolio composition (see below).

Another data issue is that inequality indexes can be subject to measurement issues related to income and wealth of individuals at the top end of the distribution (Deutsche Bundesbank, 2016). The tails of the distribution could contain measurement errors, as their inclusion causes

unpredictable swings in inequality measures which could drive results in an empirical analysis (Brewer and Wren-Lewis, 2016). Additionally, wealth measurement at the upper tail of the distribution is biased due to non-response and underreporting (Vermeulen, 2016). A crude way to deal with this issue is to disregard the top and bottom 1% of distribution, if included in the primary data source (Mumtaz and Theophilopoulou, 2017) or use surveys that already exclude the very upper end of the distribution (Coibion *et al.*, 2017; Inui *et al.*, 2017). While such approaches reduce measurement bias, they may underestimate the distributional effects of monetary policy due to excluding the richest households with a relatively large share of income. Davtyan (2017) notes that the variation in income inequality in the U.S. is driven by the top 1%. He uses a Gini index from the OECD to examine the effect of monetary policy on the whole income distribution, including the top 1% of households. Casiraghi *et al*. (2018) correct the household survey bias due to underreporting and missing responses by using adjusted income and asset data from other sources.

Empirical studies also differ in terms of the analysed <u>measures for monetary policy</u>. Conventional monetary policy is commonly proxied by short-term or policy interest rates (e.g., Furceri *et al.*, 2018; Mumtaz and Theophilopolou, 2017; Coibion *et al.*, 2017). Measures used for unconventional monetary policy are central bank assets (Saiki and Frost, 2014; Guerello, 2018), government bond spreads (Mumtaz and Theophilopolou, 2017) or a shadow rate (Inui *et al*., 2017).[‡‡] One issue in analysing the inequality effects of unconventional policy is to identify whether any distributional impact is due to near-zero interest rates policy, QE, or the interaction of both, as the period when QE was introduced overlaps with the Effective Lower Bound (ELB) period. Montecino and Epstein (2015) address this problem by focusing exclusively on QE policy and examining changes in net income distribution between pre-QE (2008-2010) and post-QE (2011-2013) periods. However, this approach does not offer a causal analysis of the effects of QE on inequality. Casiraghi *et al*. (2018) separate the effects of conventional and unconventional monetary policy by analysing different, mutually exclusive scenarios of implemented policy instruments.

The dominant <u>methodological approach</u> to examine the distributional effects of monetary policy relies on multivariate time series analysis. It is used to examine the dynamic reactions of income and wealth inequality to a monetary policy shock. For this purpose, studies estimate VAR models and construct impulse responses of inequality to a monetary policy shock (e.g., Saiki and Frost, 2014, Mumtaz and Theophilopoulou, 2015; 2017; Guerello, 2018; Davtyan, 2017) or use local projections to produce impulse responses (Furceri *et al.*, 2018; Coibion *et*

[‡‡] The shadow rate is a synthetic summary measure that is derived from yield curve data and essentially reflects the degree to which intermediate and longer maturity interest rates are lower than would be expected if a zero policy rate prevailed in the absence of unconventional policy measures. This measure is better at capturing the effect of monetary policy on financial institutions' assets, especially in the effective lower bound (ELB) period. Studies providing estimates of shadow rates for the U.S., U.K., the euro area, and Japan include Krippner (2015), Wu and Xia (2016), and Lemke and Vladu (2017).

al., 2017, Inui *et al.* 2017).[§§]

Besides time-series models, other approaches have been used, based on regression analysis. For instance, Montecino and Epstein (2015) follow an approach proposed by Firpo *et al.* (2007) which combines recentered influence function regressions with the Oaxaca-Blinder decomposition method. It is similar to a standard regression except that it replaces the dependent variable with a recentered influence function for a chosen distributional statistic (e.g., Gini coefficient).[***]

Scenario analyses is another widely-used method to examine distributional effects of monetary policy. Doepke and Schneider (2006) assess wealth redistribution due to a surprise inflation in the U.S. Recent studies employ policy scenarios in macro models (Meh *et al.*, 2010; Casiraghi *et al.*, 2018). These models include a large set of macroeconomic and financial variables and examine channels of monetary policy transmission under different assumptions for implemented policy instruments. Meh *et al.* (2010) calibrate an overlapping generations (OLG) model using data for Canada, to evaluate the impact of a price-level shock on the wealth distribution under inflation- or price-level targeting. Casiraghi *et al.* (2018) employ the Bank of Italy's quarterly model of the Italian economy (BIQM) and compare three scenarios of monetary policy expansion (one conventional, i.e. a reduction in interest rates, and two unconventional, i.e. asset purchases and liquidity injections) to evaluate their aggregate effects on macroeconomic and financial variables. These variables are later used to explain channels through which monetary policy influences income and wealth inequality.

One limitation of several studies is the absence of a counterfactual analysis – that is, what would have happened to income and wealth distribution if the monetary policy stance had remained unchanged (O'Farrell *et al.*, 2016). A counterfactual can be evaluated through scenarios, in combination with other methods. For instance, Mumtaz and Theophilopoulou (2017) conduct a no-QE counterfactual experiment in a VAR with alternative paths for the long-term interest spread and compare inequality forecasts under 'policy' versus 'no-policy' scenarios. Bivens (2015) reviews the empirical evidence from previous studies and uses it to compare the impact of the Fed's monetary easing in recent years on inequality to two policy counterfactuals. First, he assesses distributional effects of QE relative to distributional effects of a fiscal stimulus with a similar impact on employment. Second, he evaluates the impact of low interest rates and QE relative to a neutral monetary policy (i.e. no macroeconomic

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[§§] Local projections (Jordà, 2005) are robust to misspecifications with respect to the choice of variables and the number of lags and do not require imposing a specific order or restrictions on the causal relations between variables.

[***] Cross-sectional or longitudinal regression analysis has often been applied by earlier studies (Bulíř and Gulde 1995; Romer and Romer, 1999; Easterly and Fischer, 2001). Those papers, though, did not examine the impact of monetary policy per se, but focused on the effect of high inflation (as a counterfactual to stabilizing monetary policy) on poverty and inequality.

stimulus).

Several other studies use microsimulations to analyse the impact of a sudden drop in interest rates, unexpected deflation or an increase in asset prices on changes of wealth and income inequality (Adam and Tzamourani, 2016; Adam and Zhu, 2016; Domanski *et al.*, 2016; O'Farrell *et al.*, 2016). Simulations accurately replicate the actual wealth and income distribution when time series data on the composition of households' balance sheets are not available. The drawback is that these studies only offer a partial equilibrium exercise and ignore monetary policy effects on macroeconomic conditions, such as growth and employment. Furthermore, they do not identify a direct link between monetary policy and inequality, but look at channels through which monetary policy might have distributional effects (Domanski *et al.*, 2016). Finally, they make simplifying assumptions about the portfolio composition of households, its stability over time, access to asset markets, and the monetary policy impact on interest rates and asset prices; as a result, simulated effects might be smaller than the actual ones (O'Farrell *et al.*, 2016).

4.2 Impact of Monetary Policy on Income Inequality

4.2.1 Inflation

Earlier studies focused on the impact of the *inflation channel* on income distribution. While conclusions are somewhat mixed,[†††] many studies report that inflation significantly increases income inequality (e.g., Bulíř and Gulde, 1995; Romer and Romer, 1999; Easterly and Fischer, 2001). While this channel is associated mainly with wealth distribution in theoretical studies, the exact mechanism of how inflation influences income inequality is not clear from the empirical work. Easterly and Fischer (2001) argue that inflation hurts poor households who are more reliant on state-determined income that is not fully indexed to inflation. Inflation reduces the real minimum wage and transfers to the bottom quintiles of the income distribution, whereas rich households are less affected. Romer and Romer (1999) examine the effects of monetary policy on the well-being of the poor in the short run (based on the relation of poverty with unemployment and inflation in the U.S. during 1969-1994) and in the long run (based on cross-country regressions of income shares of the poor on inflation in 1988). They find that monetary policy aimed at high output growth is associated with a temporary decline in unemployment and income inequality in the short run, while policy aimed at low inflation and steady output growth reduces poverty and inequality in the long run. Galli and von der Hoeven (2001) argue that the impact of inflation on inequality is non-linear as it depends on the initial inflation level. In a panel of 15 OECD countries, they find a U-shaped relation; expansionary monetary policy reduces income inequality when initial inflation is low, but increases it when inflation is above a certain threshold (estimated around 8% for the U.S. and

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[†††] See Galli and von der Hoeven (2001) for a survey of empirical research on the effects of inflation on income inequality and poverty.

just above 12% for OECD countries).

There is a fair amount of work concerning conventional monetary policy and inequality. On the contrary, research on the inequality effects of unconventional policy is scarce. This is so since the experience of central banks with applying non-standard measures is recent, and not all central banks have introduced these policies (Blinder *et al*., 2017).

Table 1 summarizes empirical research on the impact of conventional monetary policy on income and wealth inequality, while table 2 summarizes research on the impact of unconventional monetary policy on inequality. For each study included in Tables 1 and 2 we specify the research set-up, including the analysed country sample, time period, applied methodology, and the monetary policy measure used, and indicate the type of monetary policy shock (expansive or restrictive) and its size. Next, we summarize the impact of these monetary policy measures on income or wealth inequality and attribute it to the distributional channels discussed in these studies.

[insert table 1 and table 2 here]

4.2.2 Conventional monetary policy

Most recent empirical studies on the distributional effects of conventional monetary policy only identify a few of the transmission channels described in the theoretical literature (see section 2). Several studies attribute the redistributive effects of a policy shock on income inequality to the *income composition* and *earnings heterogeneity* channels. The first channel refers to heterogeneity across households in primary income sources (relative share of labour, business, or financial income), while the second suggests different effects of interest rate shocks on labour earnings of low- and high-income households (Coibion *et al*., 2017).

Several papers find that contractionary monetary policy, by raising interest rates, increases income and earnings inequality in the U.S. (Coibion *et al*., 2017), the U.K. (Mumtaz and Theophilopoulou, 2015, 2017), the euro area (Guerello, 2018), and in a panel of advanced and emerging countries (Furceri *et al*., 2018). Monetary contraction depresses economic activity, employment, and wages, notably hurting low-income households for which labour earnings constitute the main income source. At the same time, households at the upper end of the income distribution benefit from higher interest-bearing income (Coibion *et al*., 2017); they are also less likely to become unemployed and lose their labour income. Furceri *et al*. (2018) find that the effect of monetary policy shocks on income inequality is larger in countries with higher labour income shares in total income. Davtyan (2017) conducts an analysis for the U.S. but, unlike Coibion *et al*. (2017), he measures income inequality with a Gini coefficient that includes the top 1% of the income distribution, and uses a different identification strategy. Contrary to Coibion *et al*. (2017), he finds that restrictive monetary policy lowers income inequality. It is not explained though what drives this result.

Other empirical evidence suggests that it is expansionary monetary policy, which is associated with higher income inequality in the U.K. and the U.S. (Cloyne *et al.*, 2016) and Japan before the 2000s (Inui *et al.*, 2017). Inui *et al.* (2017) argue that this could be due to labour market rigidities and nominal wage stickiness, which lead to a structural dispersion of wages across workers and result in rising earnings inequality. Cloyne *et al.* (2016) distinguish income groups based on housing tenure. They find that expansionary monetary policy raises incomes for mortgagors relatively more than for other groups, which could increase inequality. In contrast, O'Farrel *et al.* (2016) report that the distributional effects of expansionary monetary policy on average are negligible, but differ considerably across OECD countries, i.e. income inequality increases in some countries and decreases in others in response to a monetary policy shock.

The impact of monetary policy shocks on inequality may vary over the business cycle. Furceri *et al.* (2018) find that contractionary monetary policy has stronger effects on income inequality during booms, while expansionary shocks have larger dis-equalizing effects during recessions. Similarly, O'Farrel *et al.* (2016) argue that monetary policy might be less effective in reducing income inequality in downturns than increasing it in upturns.

4.2.3 Unconventional monetary policy

The distributional effects of unconventional monetary policy are not yet well understood. The analysed non-standard policy measures are mainly based on large-scale asset purchases, or quantitative easing (QE), while other measures (e.g., low/negative rates, forward guidance) have not received much attention. An exception is the work by Montecino and Epstein (2015) discussed above.

There is no consensus in the literature about the impact of unconventional monetary policy on income inequality. Two contrasting results emerge based on distributional channels. The first one - *earnings heterogeneity channel* - shows that QE reduces income inequality by stimulating economic activity, job creation, and wage growth. Montecino and Epstein (2015) relate this to employment effects which mainly benefit the poor through the extensive margin. In addition, higher wages benefit poor and middle-class households, as they are more sensitive to changes in labour earnings than the rich. Supporting evidence for this channel is found for the U.S. (Bivens, 2015), Italy (Casiraghi *et al.*, 2018), and the euro area (Guerello, 2018; Lenza and Slacarek, 2018). The second result points to the dis-equalizing effect of unconventional policy which, by boosting asset prices, increases capital incomes of the rich and raises income inequality (*income composition channel*).[‡‡‡] This is reported for Japan (Saiki and Frost, 2014), the U.S. (Montecino and Epstein, 2015), and the U.K. (Mumtaz and

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[‡‡‡] Note that higher asset prices could have both income and wealth effects. Changes in asset prices affect financial incomes of households and income inequality via the *income composition channel*. At the same time, changes in asset prices influence the value of assets and liabilities on households' balance sheets and thus affect wealth distribution via the *portfolio composition channel*.

Theophilopoulou, 2017).

The relative strength of the *earnings heterogeneity* and *income composition* channels determine the overall effect of unconventional policy on income distribution. For instance, Montecino and Epstein (2015) find that while employment changes due to QE in the U.S. reduce income inequality, these effects are smaller than the inequality-raising effects of equity price appreciations. The opposite is reported by Casiraghi *et al*. (2018) for Italy where distributional effects via economic activity and employment benefit the less well-off more and exceed the dis-equalizing effects via asset prices. Inui *et al*. (2017) use Japanese household micro-data and, contrary to Saiki and Frost (2014), find that unconventional monetary policy since the 2000s had insignificant distributional effects. Inui *et al*. (2017) conjecture that this is possibly due to a change in response of earnings inequality associated with a change in economic conditions, such as more labour market flexibility and higher demand for temporary workers. As a result, a decline in earnings inequality due to higher employment offsets a rise in inequality due to earnings heterogeneity.

To conclude, the empirical evidence on the impact of monetary policy on income inequality is mixed. Distributional effects vary depending on the examined policy measure, the distributional channel, as well as on the economic structure of the country studied and characteristics of household income.

4.3 Impact of Monetary Policy on Wealth Inequality

Monetary policy may affect wealth inequality through the *savings redistribution, inflation, interest rate exposure,* and *portfolio composition* channels. The literature on conventional monetary policy mainly considers the *inflation* channel that shows how unexpected inflation redistribute wealth from lenders/savers to borrowers. Since nominal assets and liabilities of households are sensitive to price valuations, monetary policy can directly influence the wealth distribution. Several studies refer to this channel and find that expansionary monetary policy reduces wealth inequality in the U.S. (Doepke and Schneider, 2006), Canada (Meh *et al*., 2010), and most of the euro area (Adam and Zhu, 2016). According to Doepke and Schneider (2006) and Adam and Zhu (2016), unexpected inflation benefits (young) middle-class households who are net borrowers with mortgage debts, but hurts (old) rich households who are net lenders with large savings, invested primarily in long-term bonds. While the rich see their net wealth fall due to a lower value of savings, low- and middle-class people benefit from a decrease in liabilities caused by lower interest rates and higher inflation. Voinea *et al.* (2018) focus on Romania during 2008-2014 and find that households' responses to changes in policy rates depend on their income and indebtedness profiles. Expansive monetary policy is beneficial for middle-income households, as higher inflation lowers their debt repayments, while low-income households do not respond to changes in policy rates due to their limited access to financial markets.

Monetary policy may also affect wealth inequality through the *portfolio composition channel*: it influences asset prices and - through them - the value of financial and real estate assets owned by households. Recent studies examine wealth effects of changes in asset prices as channels of monetary policy transmission. Hence, the outcomes are often not associated with either conventional or unconventional policy, as they could in theory apply to both. Nevertheless, the *portfolio composition channel* is typically attributed to unconventional monetary policy, which is claimed by some to have stronger wealth effects than conventional measures, due to portfolio rebalancing of households and financial institutions (Adam and Tzamourani, 2016; Domanski *et al.*, 2016).

However, several studies examining the *portfolio composition channel* find a negligible effect of unconventional monetary policy on wealth inequality through asset prices in the euro area (Adam and Tzamourani, 2016; Lenza and Slacarek, 2018), the U.S. (Bivens, 2015), and OECD countries (O'Farrel *et al.*, 2016). These papers analyse equity, bond, and house prices and discover the overall effect to be ambiguous as different asset prices have offsetting distributional impacts: higher house prices tend to reduce wealth inequality while higher equity and bond prices increase it. Casiraghi *et al.* (2018) find that rich households benefit more from unconventional policy thanks to capital gains on financial assets, but the net wealth of poor households improves as well due to lower liabilities. Inui *et al.* (2017) argue that the overall effect of expansionary monetary policy (both conventional and unconventional) on the wealth distribution in Japan is insignificant as the *portfolio composition* and *savings redistribution* channels balance out. On the one hand, higher asset prices benefit rich households with a large share of financial assets; on the other, their savings depreciate due to lower interest rates.

Thus, most empirical research suggests that the effect of monetary policy on wealth inequality depends on the strength and direction of responses of asset prices and interest rates to a monetary policy shock as well as on the importance of different financial assets and liabilities in the portfolio composition of households. With various forces driving inequality in opposite directions, the total distributional effect is small or insignificant. But there is also some evidence that large-scale asset purchases by central banks and a resulting asset prices boom have increased wealth inequality in advanced countries (Bank of England, 2012; Domanski *et al.*, 2016).

The effect of asset prices on wealth inequality will depend on the composition, size and distribution of households' assets and liabilities (O'Farrell *et al.*, 2016). Financial assets are generally concentrated among households at the top end of the wealth distribution, who benefit most from an increase in bond and equity prices. Meanwhile, home-ownership is more equally distributed, with the middle- and upper-middle class gaining most from house price increases (as documented by Adam and Tzamourani (2016) for the euro area). Given that this social group represents a much larger proportion of the population, higher house prices could reduce wealth inequality. Thus, to understand the mechanism behind the *portfolio*

composition channel, one needs to study characteristics of households' wealth and its distribution, which vary across countries.[§§§]

Additionally, the sensitivity of wealth distribution to different asset prices varies. Equity returns and house prices are found to be the key drivers of wealth inequality since the Great Financial Crisis (Domanski *et al.*, 2016), while bond prices had a minor or insignificant impact (Adam and Tzamourani, 2016; Domanski et al., 2016). Higher house prices have a strong effect on reducing wealth inequality as it benefits a larger group of households, while equity prices have a small to moderate dis-equalizing effect as capital gains only contribute to the wealth of the top percentile (Bivens, 2015; Adam and Tzamourani, 2016; Lenza and Slacarek, 2018).

5. Macro-prudential Policy

5.1 Theoretical literature

The aim of macro-prudential policy is to address financial stability concerns by taming credit cycles and reducing crisis risks (Thwaites, 2017). It may influence income and wealth distribution mainly by restricting credit availability or by making credit more expensive. Theoretical literature in this area is scant; the impact of macro-prudential instruments is often modelled through the housing market. The analysed policy tools include asset-based (LTV ratios, collateral requirements), and capital-based measures (bank capital requirements). Different measures could have diverse effects on inequality.

Several studies focus on LTV caps as a main macro-prudential tool to influence credit access. Their effects on borrowers with an already acquired mortgage may be different from the effects for those who intend to take out a mortgage. Stricter LTV caps at the time of acquisition make credit costlier and harder to obtain, as low-wealth households could finance a smaller fraction of the house value with a mortgage (Carpantier *et al.*, 2017). However, as argued by Rubio and Carrasco-Gallego (2014), this macro-prudential policy is welfare improving – lower LTV leads to lower household indebtedness and reduces the risk of future defaults, while borrowers benefit from financial stability. This increases the net worth of low-wealth households, pushing wealth inequality downwards. The opposite effect occurs for high-LTV borrowers with existing mortgages. Rabitsch and Punzi (2017) show in a DSGE model with heterogeneous borrowers that a drop in LTV ratios and a subsequent tightening of credit conditions will hurt high LTV-type low-wealth households more, leading to the re-evaluation of their riskiness and a wave of defaults on mortgage debt when house prices collapse. Low- and medium-income households could find themselves 'underwater', with mortgage repayments exceeding the current house value. This worsens their financial conditions and

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[§§§] For instance, studies for the euro area report that financial asset holdings are concentrated among the richest households (Adam and Tzamourani, 2016; Claeys *et al.*, 2015). Denk and Cazenave-Lacroutz (2015) find that two-thirds of all stocks in the euro area are owned by the top 20%, while less than 10% in the bottom of the wealth distribution buy stocks. The home and other real estate ownership rate is heterogeneous across euro area countries.

lowers net worth, raising wealth inequality. Conditional on this model, Punzi and Rabitsch (2018) show that optimal macro-prudential policy should restrict excessive borrowing only for high LTV-type households that react the most – i.e. deleverage – after a housing price shock.

Macro-prudential policy could affect inequality also through collateral requirements. Rubio and Unsal (2017) study their distributional implications in a DSGE model for low-income and developing countries. They find that a passive policy of permanently increasing collateral requirements leads to lower steady-state level of output. This long-run output loss is unevenly distributed among agents, leading to higher inequality. Entrepreneurs (borrowers in this economy) are hurt the most, as higher collateral requirements restrict their access to credit, resulting in lower production, consumption, and income. In contrast, Stiglitz (2015, p. 27) argues that "lowering of collateral requirements … does not result in an increase in the overall efficiency of the economy, but leads to more inequality." A reduction in loan collateral results in higher land prices and larger capital gains for land owners, while banks profit from increased lending. This benefits high-wealth or high-income households disproportionately more.

The recent study by Mendicino *et al*. (2018) evaluates the distributional impact of bank capital requirements, extending the 3D model of Clerc *et al*. (2015). The 3D model is a medium scale, micro-founded general equilibrium model designed for conducting macro-prudential policy analysis. The model considers three components. First, households borrow from banks for the purchase of housing; default occurs when the value of the mortgage is larger than the real value of the house. Second, firms borrow from banks to fund investment; default occurs when firm revenues are insufficient to repay the debt. Third, there is a bank-centred financial system where intermediaries fund themselves with equity and insured deposits and lend to firms and households. Banks are subject to capital requirements (CR) and default when loan revenues are insufficient to repay deposits. In this model, liquidation of assets after bankruptcy is costly as a large fraction of assets depreciates. Since banks have limited liability and the government taxes households to cover the loss incurred by depositors after a bank's default, banks receive a subsidy from the government when the default probability is positive. This causes moral hazard, as banks are inclined to finance risky loans to households and firms with deposits.

The effects of CRs on welfare are asymmetric. On the one hand, higher CRs reduce the distortion caused by subsidy of deposit insurance, probability of bank default and taxes. This increases the welfare of savers. On the other hand, higher CRs hinder financial intermediation and harm the welfare of borrowers. Mendicino *et al*. (2018) find that increasing CRs from a baseline level is Pareto-improving up to a point and redistributive afterwards. When CRs start from low levels, as under the pre-crisis Basel II rules, both savers and borrowers gain from their increase. Beyond a certain threshold, savers continue benefiting from low financial fragility, while borrowers start to lose. Savers gain from a lower tax burden of deposit insurance and higher profits from holdings of bank equity. Borrowers also benefit from lower costs of bank default, but lose from higher loan interest rates. Once bank default is close to zero, the second effect dominates. Thus, CRs imply a trade-off between the welfare of savers

and that of borrowers. The optimal CRs are defined as those which maximize the long-run welfare of borrowers.

5.2 Empirical Evidence

The distributional effects of macro-prudential policies have not received much attention in the empirical literature to date; the existing evidence is scarce and insufficient to provide definitive answers. This research area faces several limitations. First, the time period during which macro-prudential instruments have been implemented is short. Macro-prudential policies have not been broadly used in advanced economies before the global financial crisis, and became widespread only since 2007. Second, these policies are heterogeneous, as different instruments are used for different purposes, with varying economic and financial repercussions. Third, the effect of macro-prudential policies might be difficult to disentangle from the effects of monetary and other policies as well as non-policy driven changes in financial systems. Fourth, the data on macro-prudential policies are of recent origin. Several databases have emerged in recent years, with the most comprehensive one by Cerutti *et al*. (2017), covering annual data for 12 macro-prudential instruments implemented by 119 countries over 2000-2013. This dataset has been extensively used in research, also to analyse distributional effects of macro-prudential policies.

Three empirical papers examine the impact of macro-prudential policy on inequality. Frost and van Stralen (2017) use macro-prudential instruments from the database of Cerutti *et al.* (2017) for 69 countries over the period 2000-2013 and analyse their relation with Gini coefficients of market and net income inequality. The other two papers use household surveys for 12 euro-area countries based on HFCS data (Carpantier *et al*., 2017) and for the state of Oregon in the U.S. (Zinman, 2010) to study wealth and consumption effects of macro-prudential measures. All papers find evidence for redistributive effects of macro-prudential policy. Tighter measures, such as stricter loan-to-value (LTV), concentration and interbank exposure limits, as well as higher reserve requirements are associated with higher income inequality (Frost and van Stralen, 2017).[****] Likewise, restrictions on consumer lending could have detrimental distributional effects as it forces households to shift into inferior substitutes (such as checking account overdrafts of various types and late bills), worsening their financial condition and hindering productive investment and consumption smoothing (Zinman, 2010). On the other hand, caps on LTV ratios can reduce wealth inequality: low-wealth households find it harder to get a mortgage, which lowers their indebtedness, pushing wealth inequality downwards (Carpantier *et al*., 2017).

It remains unclear through which mechanism macro-prudential policy may generate distributional effects. Arregui *et al*. (2013) conjecture that it is due to unintended side effects

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[****] While the authors explore the effects of different macro-prudential instruments on income inequality, they emphasize that these are correlations rather than causal relationships. The authors do not explain the mechanisms behind those effects.

of macro-prudential measures through 'leakages'. Stricter capital regulations and lending requirements encourage rent seeking, by migration of financial activities to shadow banking, greater reliance on wholesale funding to cover higher costs of capital rules, cross-border lending, and regulatory arbitrage. These 'leakages' create economic rents for mainly high-income agents (Frost and van Stralen, 2017); they would see their incomes rise disproportionately more than low- and middle-income agents, who are financially constrained and have limited access to financial markets.

6. Conclusions

A new paradigm which integrates sticky-prices, incomplete markets and heterogeneity among households is emerging, which allows to jointly study how inequality shapes macroeconomic aggregates and how macroeconomic shocks and policies affect inequality. The analysis of conventional monetary policies in the new paradigm is advancing at high speed. We reviewed models belonging to the new paradigm and discussed the conditions under which household heterogeneity and financial market incompleteness have aggregate implications as well as the distributional effect of conventional monetary policies. The analysis of the distributional effects of unconventional policies is still in its infancy, but the new paradigm has the potential to also shed light on this matter. However, most empirical analyses on the distributional implications of central bank policies are not yet linked to this new paradigm.

The main limitation of most empirical studies on the distributional effects of monetary policy is that they cannot identify simultaneously the transmission channels described in the theoretical literature. To date, the empirical evidence on the effect of conventional monetary policy on income and wealth inequality yields very mixed findings, although there seems to be a consensus that higher inflation, at least above some threshold, increases inequality. The scant literature on the impact of macro-prudential policies on inequality finds evidence for redistributive effects of macro-prudential policy, but in view of the many limitations it may be too early to come to definite conclusions.

The empirical literature has recently concentrated on understanding the distributional impact of unconventional monetary policy. In contrast to popular beliefs, also the conclusions concerning the impact of unconventional monetary policies on income inequality are not clear cut. This may reflect that these policies may reduce income inequality by stimulating economic activity, but may increase income inequality by boosting financial asset prices. Also results for the impact of unconventional monetary policies on wealth inequality are rather mixed. Again, this may be caused by offsetting influences: whereas higher financial asset prices lead to higher inequality, higher house prices reduce wealth inequality.

The focus in studies is also shifting from examining the direct effect of a monetary policy shock towards a more structured framework analyzing the channels through which monetary policy impacts income and wealth inequality, based on the theoretical literature.

Future contributions might attempt to fill in some gaps. For instance, future research needs to consider to what extent the effects of monetary policy on inequality depend on the phase of business and financial cycles. This issue has, so far, received limited attention in the literature. Additionally, using micro-data and examining the composition and distribution of individual household's income and wealth could improve our understanding of how monetary and macro-prudential policies impact inequality. Finally, the distributional effects of monetary policy cannot be evaluated in isolation from other policies that might have a stronger and more direct impact on inequality, such as fiscal policy. And that issue has also not received much attention in the empirical literature to date.

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Table 1. Summary of empirical studies: distributional effects of conventional monetary policy

Study:	Country sample:	Period:	Method:	Monetary policy measure:	Impact on inequality:	Distributional channel:
Income inequality						
Bulíř and Gulde (1995)	18 countries	1960-1992	Pooled and single-country regressions	Expansionary (+ inflation)	Increase income inequality	Inflation
Romer and Romer (1999)	76 countries	1970-1990	Cross-sectional regressions	Expansionary (+ inflation)	Increase income inequality	Inflation
Easterly and Fischer (2001)	38 countries	1995 poll	Cross-sectional regressions	Expansionary (+ inflation)	Increase income inequality	Inflation
Galli and von der Hoeven (2001)	15 OECD countries U.S.	1973-1996 1966-1999	Panel and time-series regressions	Expansionary (+ inflation)	Decrease inequality if inflation low; increase if inflation high	Inflation
Mumtaz and Theophilopoulou (2015)	U.K.	1968-2008	MF-SVAR	Restrictive (+1 s.d. policy rate)	Increase income and labour earnings inequality	Income composition Earnings heterogeneity
Cloyne *et al*. (2016)	U.K. U.S.	1975-2007 1981-2007	Romer and Romer (2004) procedure	Expansionary (-25bps policy rate)	Increase income inequality	Income composition
O'Farrel *et al*. (2016)	8 OECD countries	2007-2012 surveys	Microsimulations	Expansionary (- 1 pp. interest rate)	Reduce income inequality in Canada, the Netherlands, and the U.S; increase in most European countries; effects negligible	Income composition Earnings heterogeneity
Coibion *et al*. (2017)	U.S.	1980-2008	Local projections	Restrictive (+100 bps policy rate)	Increase income and labour earnings inequality	Income composition Earnings heterogeneity
Davtyan (2017)	U.S.	1983-2012	VAR, VECM	Restrictive (+1 s.d. policy rate)	Decrease income inequality	N/A
Inui *et al*. (2017)	Japan	1981-1998	Local projections	Expansionary (- shadow rate)	Increase income and labour earnings inequality	Earnings heterogeneity
Mumtaz and Theophilopoulou (2017)	U.K.	1969-2012	SVAR	Restrictive (+1 s.d. policy rate)	Increase income and labour earnings inequality	Income composition Earnings heterogeneity
Furceri *et al*. (2018)	32 advanced and emerging countries	1990-2013	Local projections	Restrictive (+100 bps policy rate)	Increase income inequality	Earnings heterogeneity
Guerello (2018)	Euro area	2001-2015	Panel VAR; country VAR	Expansionary (-100 bps short-term rate)	Reduce income inequality in the euro area; no effect in individual country analysis	Income composition Earnings heterogeneity

Wealth inequality						
Doepke and Schneider (2006)	U.S.	1952-2004	Scenario analysis	Expansionary (+ inflation)	Reduce wealth inequality	Inflation
Meh *et al.* (2010)	Canada	2005 survey	Macro model, scenario analysis	Expansionary (+1% price level)	Reduce wealth inequality	Inflation
Adam and Zhu (2016)	Euro area	2010 survey	Microsimulation	Restrictive (-10% price level)	Increase wealth inequality in the euro area; reduce inequality in Germany, Austria, Malta	Inflation
O'Farrel *et al.* (2016)	8 OECD countries	2007-2012 surveys	Microsimulation	Expansionary (+ 10% asset prices)		Portfolio composition
Inui *et al.* (2017)	Japan	1981-1998	Local projections	Expansionary (- shadow rate)	Insignificant	Savings redistribution Portfolio composition

Note: +(-) means increase (decrease)

Table 2. Summary of empirical studies: distributional effects of unconventional monetary policy

Study:	Country sample:	Period:	Method:	Monetary policy measure:	Impact on inequality:	Channels:
Income inequality						
Saiki and Frost (2014)	Japan	2008-2014	VAR	+ 1 s.d. Bank of Japan assets	Increase income inequality	Income composition
Bivens (2015)	U.S.	2008-2014	Counterfactual analysis	QE (-100 bps long-term Treasury yields)	Reduce income inequality	Earnings heterogeneity
Montecino and Epstein (2015)	U.S.	2010-2013	RIF regressions	QE introduction	Increase income inequality	Earnings heterogeneity Income composition
Mumtaz and Theophilopoulou (2017)	U.K.	2009-2010	SVAR, counterfactual analysis	-100 bps long-term government bond yields	Increase income inequality	Income composition
Inui *et al*. (2017)	Japan	1981-2008	Local projections	Expansionary (-100 bps shadow rate)	Insignificant	Earnings heterogeneity
Guerello (2018)	Euro area	2001-2015	Panel VAR; country VAR	+ 1% ECB's assets	Reduce income inequality in the euro area	Earnings heterogeneity
Casiraghi *et al*. (2018)	Italy	2011-2013	Macro model, scenario analysis	Asset purchases, liquidity injections	Reduce labour income inequality	Earnings heterogeneity Income composition
Lenza and Slacarek (2018)	Germany, France, Italy, Spain	1999-2016	BSVAR, microsimulation	ECB's asset purchases (- term spread)	Reduce income inequality	Earnings heterogeneity
Wealth inequality						
Bank of England (2012)	U.K.	2009-2011	Survey data analysis	Asset purchases	Benefit top 5% of households holding 40% of financial assets	Portfolio composition
Bivens (2015)	U.S.	2008-2014	Counterfactual analysis	QE (-100 bps long-term Treasury yields)	Negligible	Portfolio composition
Adam and Tzamourani (2016)	Euro area	2010 survey	Microsimulation	Asset purchases (+ asset prices)	Negligible	Portfolio composition
Domanski *et al*. (2016)	France, Germany, Italy, Spain, U.S.,U.K.	2000-2012 surveys	Microsimulation	Expansionary (- interest rates, + asset prices)	Increase wealth inequality	Portfolio composition
Inui *et al*. (2017)	Japan	1981-2008	Local projections	- shadow rate	Insignificant	Savings redistribution Portfolio composition
Casiraghi *et al*. (2018)	Italy	2011-2013	Macro model, scenario analysis	Asset purchases, liquidity injections	Negligible	Portfolio composition
Lenza and Slacarek (2018)	France, Germany, Italy, Spain	1999-2016	BSVAR, microsimulation	ECB's asset purchases (- term spread)	Negligible	Portfolio composition

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