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CENTRAL BANK POLICIES AND INCOME AND WEALTH INEQUALITY: A SURVEY

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Abstract. This paper reviews recent research 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 for the joint study of how inequality shapes macroeconomic aggregates and how macroeconomic shocks and policies affect inequality. The new paradigm features multiple distributional channels of monetary policy. Most empirical studies, however, analyze each potential channel of redistribution in isolation. Our review suggests that empirical research on the effects of conventional monetary policy on income and wealth inequality yields mixed findings, although there seems to be a consensus that higher inflation, at least above some threshold, increases inequality. In contrast to common wisdom, conclusions concerning the impact of unconventional monetary policies on inequality are also not clear cut. To better understand policy effects on inequality, future research should focus on the estimation of General Equilibrium models with heterogeneous agents.

Keywords. Income inequality; Macroprudential policy; Monetary policy; Wealth inequality

"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 (Atkinson, 2015; Piketty, 2014).[1] Although income inequality varies across OECD countries (see Figure 1), the

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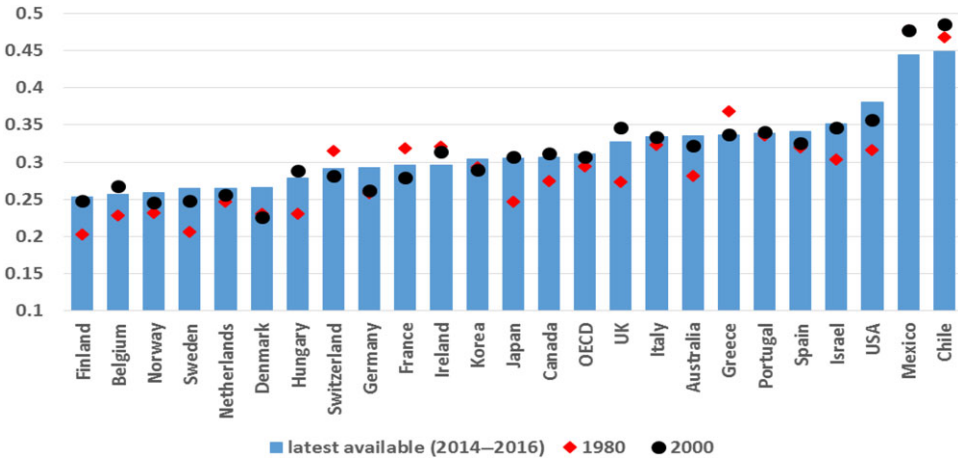

Figure 1. Gini Coefficient of Disposable Income Inequality in 1980, 2000, and 2016. [Colour figure can be viewed at wileyonlinelibrary.com]

Note: The figure shows the Gini coefficient of disposable income for 3 years: 1980, 2000, and 2016 (or the latest available over 2014–2016) for 24 OECD countries.

Source: SWIID (Standardized World Income Inequality Database); authors' calculations.

average Gini coefficient of disposable income reached 0.318 in 2013–2014, the highest value since the mid-1980s (OECD, 2016).[2] The recent economic recovery has not reversed the trend toward increasing inequality observed over the past decades. Wealth inequality in advanced economies, which is generally higher than income inequality, has also increased during the last decades. Recent figures show that 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).

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; Perugini *et al.*, 2016).[3]

In the aftermath of the global financial crisis, and following the advent of nonstandard monetary policy measures, a debate started about how monetary policy might affect inequality. Several observers express concerns that a highly accommodative monetary policy, such as quantitative easing (QE), favors richer households disproportionately, thereby contributing to a more unequal income and wealth distribution. In the words of Cohan (2014) in the *New York Times*: "Quantitative easing adds to the problem of income inequality by making the rich richer and the poor poorer." Some studies provide evidence for this. For instance, Coibion *et al.* (2017) report statistically and economically significant effects of monetary policy changes on income inequality in the United States.

Others support the view that expansionary monetary policy may reduce inequality by stimulating economic activity, job creation, and wage growth. These effects, so the argument goes, mainly benefit the poor. Bivens (2015) reports supporting evidence for this view for the United States.

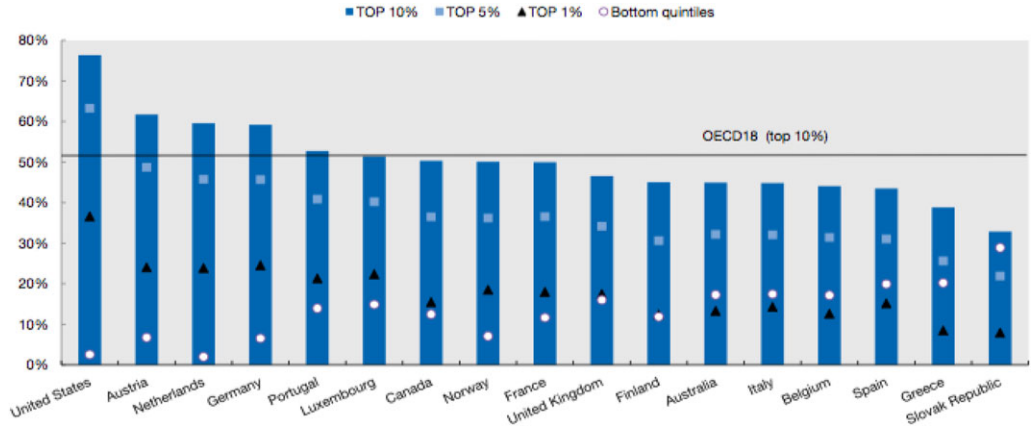

Figure 2. Wealth Shares of Top Percentiles of Net Wealth Distribution in 2010. [Colour figure can be viewed at wileyonlinelibrary.com]

Note: The figure shows the share of total wealth owned by the top 1%, top 5%, top 10%, and the bottom 60% of the wealth distribution in 17 OECD countries in 2010 (or latest year available).

Source: Murtin and d'Ercole (2015).

A third view in the debate is well exemplified by Bernanke (2015) who argues that "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." Proponents of this view point to the fact that inequality has been growing for a long time and is driven by structural factors. The impact of monetary policy on inequality is argued to be transitory, canceling out over the course of the business cycle (Bullard, 2014).

This paper contributes to this debate by reviewing the burgeoning literature on the relationship between central bank policies and income and wealth inequality.[4] This literature not only examines how central bank policies affect inequality, but also how inequality influences the transmission of these policies to the real economy. Following the work of Kaplan *et al.* (2018), we pose that household heterogeneity matters for the transmission of monetary policy if the model-implied wealth distribution features a large fraction of agents with close to zero liquid wealth, in line with the data for many advanced countries. These agents are not sensitive to interest rate changes, but significantly change their consumption in response to changes in income. In this case, monetary policy is not transmitted to the economy through the conventional interest rate channel, which alters households' incentives to save and consume, but through general equilibrium forces, namely, through the responses of prices and wages, hence of labor income and employment, to the policy shock.

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 analyzing the impact of monetary policy on inequality. However, since the outburst of the financial crisis central banks have increasingly also become responsible for macroprudential policies (Blinder *et al.*, 2017). A few recent studies analyze 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 2000–2013 period, suggest a positive relation between the use of specific macroprudential policies and income inequality. We therefore also include studies on the impact of macroprudential 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 inequality, they have not yet been broadly adopted to evaluate the relationship between inequality and central bank policies. 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. Second, 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) who concluded that household income and wealth inequality 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 macroeconomy. 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 general equilibrium models that we review identify several distributional channels of monetary policy. However, most empirical studies analyze each potential channel of redistribution in isolation. Furthermore, our review suggests that empirical research on the effects of conventional monetary policy on income and wealth inequality yields mixed findings, although there seems to be a consensus that higher inflation, at least above some threshold, increases inequality. 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.

Future research should focus on the estimation of general equilibrium models with heterogeneous agents. In our view, this would allow distinguishing between competing theories of the transmission of monetary policy and conducting a thorough quantitative assessment of the effects of monetary policy on both income and wealth inequality.

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 modeled. Section 4 summarizes empirical research on the impact of monetary policy on inequality, while Section 5 discusses research on the impact of macroprudential policies on inequality. Section 6 concludes.

2. Transmission of Monetary Policy and Household Heterogeneity

Monetary policy is transmitted to the household sector by exerting three main effects. The first one is an income effect, as monetary policy directly influences 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.

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

Unexpected Inflation Channel. The relevant heterogeneity dimensions for this channel are nominally fixed debts and cash holdings. Unexpected inflation causes revaluations of nominal balance sheets, with creditors losing and debtors gaining.

Interest Rate Exposure Channel. A fall in real interest rates increases financial asset prices. However, Auclert (2016) argues that it is generally not correct to claim that this favors asset holders. He shows that unhedged interest rates exposures (UREs), that is, the difference between all maturing assets and liabilities at a point in time, are the correct measure of households' balance sheet exposures to real interest rate changes. Agents whose financial wealth is primarily invested in short-term certificates of deposit tend to have positive UREs, while those with large long-term bond investments or adjustable-rate mortgage liabilities tend to have negative UREs. A drop in the real interest rate causes a redistribution from the first group toward the second group.[5]

Portfolio Composition Channel. By raising financial asset prices, a fall in the interest rate affects balance sheets of households through differences in the composition of their portfolio of assets (Coibion *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 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 (Amaral, 2017). To the extent that monetary policy influences 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 labor share of income for low-skilled workers and raising it for high-skilled workers.

Income Composition Channel. Households acquire their incomes from different sources, each of which may respond differently to changes in monetary policy (Amaral, 2017). Low-income households tend to rely more on transfers, while middle-income households mainly rely on labor income and those at the upper tail of the income distribution rely relatively more on business and capital income. If a fall in interest rates stimulates economic activity, expansionary monetary policy may result in higher wages and lower unemployment, thereby increasing inequality at the lower end of the distribution.[6] On the other hand, lower interest rates decrease interest income, which may reduce inequality at the top of the distribution.

Recently, Ampudia *et al.* (2018) proposed grouping the distributional channels we have just listed into two broad categories: *direct channels* and *indirect channels*. *Direct channels* of monetary policy are produced by the effect of a change in the policy rate on households' incentives to save and on households' net financial income, holding households' employment status, prices, and wages fixed. As such, they can be regarded as partial equilibrium effects. *The savings redistribution channel, the unexpected inflation channel, the interest rate exposure channel*, and *the portfolio composition channel* belong to this category. *Indirect channels* are due to the general equilibrium responses of prices and wages, hence of labor income and employment, to a change in monetary policy. After a change in policy rates, the change in households' expenditure and firms' investment lead to a change in output and to an adjustment in employment and wages. The changes in aggregate expenditure induced by variations in employment and wages represent the indirect effect of monetary policy. *The earnings heterogeneity channel* and *the income composition channel* belong to this category.

In the RANK model (as discussed in more detail in Section 3.1), the aggregate consumption response to a change in interest rates is driven entirely by the Euler equation of the representative household and monetary policy works almost exclusively through intertemporal substitution. As a consequence, direct effects account for the full impact of interest rate changes on the macroeconomy and indirect effects are negligible.

In the next section, we provide an overview of Dynamic Stochastic General Equilibrium (DSGE) models characterized by a rich degree of heterogeneity. We will argue that in heterogeneous agents models the indirect effects of monetary policy are quantitatively more sizeable than those spreading from the direct channel. This stands in sharp contrast with the implications of representative agent models, where monetary policy is transmitted only through direct channels. For this reason, the grouping in direct and indirect channels of monetary policy transmission could help distinguishing among competing theories.

3. Modeling Monetary Policy and Inequality

3.1 *Monetary Policy and Inequality in DSGE Models*

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

Furthermore, as argued by Kaplan *et al.* (2018), in the 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. This is so since the representative agent in RANK models is a permanent income consumer and transitory changes in income, due to monetary policy shocks, only exert a minor effect on consumption choices. However, the strong response of aggregate consumption to movements in real rates which characterizes RANK models is at odds with the data. Macroeconometric analysis of aggregate time-series data finds a low 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, the U.S. data on the distribution of wealth suggest that there are many households which hardly save 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% of aggregate income. By contrast, the lowest three quintiles of the wealth distribution only hold 4% 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 policies than representative agent models, and allow to study the distributional implications of these policies. Importantly, they can deal with the interplay between inequality and the macroeconomy 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 *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 transmission of monetary policy shocks. Following Ampudia *et al.* (2018), we argue that the effects of interest rate changes on the consumption of agents with little or no liquid wealth can substantially

differ from those experienced by other agents. 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," in the sense as discussed in Section 3.2.1, 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: When Inequality Matters*

In this section, we discuss the conditions under which heterogeneity among households and financial markets imperfections matter for the transmission of monetary policy. Following Werning (2015), we argue that financial market imperfections matter for the transmission of monetary policy when income risk is countercyclical. As we discuss below, this magnifies the sensitivity of aggregate demand to interest rate changes. In turn, as shown by Kaplan *et al.* (2018), heterogeneity matters for the transmission of monetary policy if a large fraction of agents in the economy has little or no liquid wealth and has a high marginal propensity to consume out of current income.

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, households have uncertain income and can only partially insure against this uncertainty. As a result, there are as many asset positions as there are income histories.[7] In this setting, precautionary savings are the key force driving wealth concentration. This, however, leads to a saving behavior 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, the 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 prospect 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 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 importance when describing the dynamics of aggregate variables in response to shocks or to policy changes.[8]

However, recent studies have revisited the influential conclusion of KS. Focusing on the transmission of monetary policy, two key contributions are those by Werning (2015) and Kaplan *et al.* (2018).

Werning (2015) emphasizes the conditions under which market incompleteness matters for aggregate outcomes and affects the sensitivity of aggregate demand to interest rate changes. Kaplan *et al.* (2018) emphasize, instead, how the wealth distribution, in particular the distribution of liquid assets across agents, affects the response of individual and aggregate variables to a monetary policy change. 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 acyclical, 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 procyclical.

Kaplan *et al.* (2018) introduce financial market incompleteness in New Keynesian models, generating inequality in income, wealth, and consumption. They dub the resulting framework as 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. Equilibrium distributions delivered by their model are consistent with the joint distribution of earnings and liquid and illiquid assets observed in the data. In particular, their model delivers a large fraction of agents with close to zero liquid net wealth.[9] Consumption of these agents is highly sensitive to small and temporary changes in income, but insensitive to interest rate changes. Kaplan *et al.* (2018) refer to these agents as hand-to-mouth households. In contrast, households holding wealth, in particular liquid wealth, have the means to smooth consumption in response to small and temporary shocks and adjust their consumption in response to interest rate changes.

The analysis of Kaplan *et al.* (2018) delivers a key message. 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, in HANK models the indirect effect is much stronger than the direct one.[10] The strength of the general equilibrium effect depends on the heterogeneity in wealth holdings across households. In particular, the consumption of hand-to-mouth agents is 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 (as suggested by the empirical evidence discussed above). This has implications for monetary policy. 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.

Identifying the response of consumption and savings of agents belonging to different wealth groups to a monetary policy shock could thus be a promising way to test for the validity of the monetary transmission mechanism implied by models with heterogeneous agents.

The HANK model by Kaplan *et al.* (2018) emphasizes that the presence of a large fraction of agents with close to zero liquid wealth alters the transmission mechanism of monetary policy. For this reason, a recent literature assesses the merits of HANK models 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 labor income in each period. This type of models is now referred to as Two Agents New Keynesian (TANK) models. In TANK models, an exogenous fraction of agents has zero net wealth, while the remaining fraction of agents equally shares aggregate wealth in the economy. Early contributions to this literature are Galì *et al.* (2007), Bilbiie (2008), and Colciago (2011). More recently, Debortoli and Galì (2017) 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 (2017), this could be the case in economies with countercyclical unemployment risk as in Ravn and Sterk (2016), 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.

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. In line with the findings of Werning (2015), the cyclicality of income is thus key for the propagation of monetary policy shocks. Furthermore, the magnification goes through an indirect effect as in a HANK model. Ascari *et al.* (2017) consider a TANK model with constant shares of Ricardian and Keynesian agents, and provide a microfounded 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. This is so since nominal wage stickiness dampens the cyclicality of income of hand-to-mouth households. Areosa and Areosa (2016) consider a framework where hand-to-mouth households are unskilled. The resulting wage differential between agents leads consumption inequality to affect the welfare loss function of the central bank. In this case, optimal monetary policy should stabilize inequality along the business cycle.

3.2.2 *From Macro to Micro: Distributional Effects of Monetary Policy*

In this section, we focus on models that study redistributive effects spreading from monetary policy changes. A recent literature studies the redistributive effects of monetary policy in New Keynesian models. The HANK model by Kaplan *et al.* (2018) has become a benchmark in this literature. As discussed above, 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. Ampudia *et al.* (2018) use available estimates of marginal propensities to consume (MPCs) to weight the relative importance of direct and indirect effects on aggregate consumption in the euro area. To evaluate the direct effect, they use detailed information on households' asset and liabilities exposed to interest rate risk and estimates of households' saving elasticity to interest rate changes. To assess the indirect effect, they consider estimates of the aggregate impact of monetary policy on unemployment and wages using household-level job finding rates. They find that the direct effects of changes in monetary policy rates have asymmetric effect on the consumption level of households. Hand-to-mouth households are rather insensitive or negatively exposed to interest rate risk, in which case they experience a gain in net financial income after a monetary policy easing. By contrast, the other households suffer a loss after the easing and they also reduce their saving due to the lower real returns in the economy. However, results also show that indirect effects are quantitatively more important than the direct ones and that they are beneficial for all households.

Auclert (2016), using an Aiyagari type model, emphasizes the importance of the distribution of wealth across agents for understanding the redistributive effects of monetary policy. Interest rate exposure is negative for agents with negative liquid wealth. These agents benefit from lower interest rates through the interest rate exposure channel. In contrast, agents with positive liquid wealth have a positive interest rate exposure and are negatively affected by a reduction in interest rates due to a loss of financial income.[11]

Gornemann *et al.* (2016) augment the HANK framework with search-and-matching frictions. They study 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. As a result, their framework makes unemployment risk endogenous to monetary policy. They find that contractionary monetary policy shocks increase inequality via a rise in precautionary savings by poorer households which leads to a higher value of the assets held by the wealthy. The unemployed, in particular, are made worse off by monetary policy tightening; a contractionary shock tends to prolong their unemployment spell, as firms reduce labor demand. In addition, they show that a systematic monetary policy rule which puts larger weight on stabilizing unemployment rather than inflation, is relatively more beneficial for poorer than for rich households, as it provides partial insurance against unemployment risk. Dolado *et al.* (2018) consider a

New Keynesian model with incomplete markets characterized by capital-skill complementarity and labor market heterogeneity in the form of asymmetric search-and-matching frictions. Their main finding is that an expansionary monetary policy shock increases earnings inequality by rising the labor share of income for high-skilled workers while decreasing it for lower-skilled workers. This is mainly driven by an increase in the wage premium for the high skilled, who also fare better in terms of employment rates. Bhandari *et al.* (2018) study Ramsey optimal monetary policy in a model with heterogeneous agents, incomplete financial markets and monopolistic competition between producers. In this framework, a markup shock redistributes resources among households. Higher markups shift factor income from wages to dividends. Since asset market participation is endogenously limited, this benefits asset holders and hurts workers. To provide insurance, the planner can decrease interest rates in order to boost aggregate demand and real wages.

Bayer *et al.* (2019) and Luetticke (2018) emphasize the redistributive effects due to the *portfolio composition channel*. Bayer *et al.* (2019) consider an economy inhabited by workers and entrepreneurs and analyze the effects of income uncertainty shocks. In their economy, when idiosyncratic income uncertainty increases, individually optimal asset holdings rise and consumption demand declines. Households also rebalance their portfolios toward liquid assets to enjoy better consumption smoothing.[12] This portfolio rebalancing toward liquid assets reinforces, through a decline in physical investment, the decline in consumption demand caused by higher uncertainty. Consequently, aggregate demand declines even more strongly than consumption. The decline in the demand for physical capital leads to a lower price of capital while the value of money increases upon an uncertainty shock. As result, the uncertainty shock has redistributive effects in favor of those who hold liquid asset at the expense of human and physical capital holders. An expansionary monetary policy reduces the negative effects on output of increased uncertainty and alleviates welfare consequences. In a spirit similar to that of Kaplan *et al.* (2018), Luetticke (2018) emphasizes the implications of heterogeneity in household portfolios for the transmission of monetary policy and the relative importance of the direct and indirect transmission channels of monetary policy.

Turning to the effect of inflation on inequality, Doepke and Schneider (2006) measure balance sheet exposures of various sectors and groups of households in the USA to inflation. 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 ones. 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 is set in a political bargaining game. Menna and Tirelli (2017) consider a TANK model with cash holdings and show that a combination of higher inflation and lower income taxes shifts the tax burden on asset holders, thereby reducing inequality.

Some of the papers discussed in this section calibrate the DSGE model proposed to assess the distributional consequences of monetary policy. In the next sections, we review the empirical literature using other methods to identify the effects of monetary policy shocks on both income and wealth inequality.

4. Monetary Policy and Inequality: Empirical Evidence

4.1 *Methodological Approaches and Data*

The empirical literature on the effects of monetary policy on inequality faces challenges related to data and methodology. This section identifies the main challenges and caveats in empirical research and discusses the solutions adopted to deal with them.

4.1.1 *Data Challenges: Measuring Inequality*

Measuring inequality is a nontrivial task. Research on wealth and income inequality often relies on household surveys which provide comprehensive granular data on households' income and wealth composition over a long period.[13] Quarterly or monthly microdata would allow examining distributional effects of monetary policy at a higher frequency over a long horizon. Longitudinal household surveys have been used to study the impact of monetary policy on inequality, in the USA (Doepke and Schneider, 2006; Montecino and Epstein, 2015; Cloyne *et al.*, 2016, Coibion *et al.,* 2017), the UK (Mumtaz and Theophilopoulou, 2015, 2017; Cloyne *et al.*, 2016; Bunn *et al.*, 2018), 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 are of poor quality.

A comprehensive data source 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 consisted of two waves so far (2013 and 2016). Lenza and Slačálek (2018) use HFCS to simulate the short-run impact of ECB nonstandard 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 the EU-SILC.

To overcome the described data limitations, some 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 are 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). In addition, wealth measurement at the upper tail of the distribution is biased due to nonresponse 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.[14] 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.

4.1.2 *Data Challenges: Measuring Monetary Policy*

Besides finding a suitable inequality measure, empirical studies need to address the issue of measuring and identifying monetary policy shocks. Conventional monetary policy is commonly proxied by short-term or policy interest rates (e.g., Coibion *et al.*, 2017; Mumtaz and Theophilopoulou, 2017; Furceri *et al.*, 2018). Measures used for unconventional monetary policy are central bank assets (Saiki and Frost, 2014; Guerello, 2018), government bond spreads (Mumtaz and Theophilopoulou, 2017), or a shadow rate

(Inui *et al.*, 2017).[15] The analysis of the distributional effects of unconventional policy faces an identification problem. Given that the period of QE overlaps with the period of the ELB, it is difficult to distinguish whether the impact on inequality is due to near-zero interest rates policy, QE, or the interaction of both. 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 analyzing different, mutually exclusive scenarios of implemented policy instruments.

4.1.3 *Methodological Challenges*

Another challenge in empirical research is choosing a suitable methodology for testing a causal link between monetary policy shocks and inequality in a tractable way. Several approaches have been used, each with its own strengths and weaknesses. The dominant methodological approach 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) or use local projections to produce impulse responses (Coibion *et al.*, 2017, Inui *et al.* 2017; Furceri *et al.*, 2018).[16] This approach is straightforward; however, it is not equipped for studying multiple distributional channels of monetary policy, as examined in theoretical models.

Besides time-series models, other approaches have been used, based on regression analysis, using cross-sectional or panel data.[17] Alternatively, Montecino and Epstein (2015) follow an approach suggested by Firpo *et al.* (2007) which combines recentered influence function regressions with a decomposition method to analyze distributional effects of QE in the USA. This approach allows estimating how much different factors influencing the income distribution contribute to changes in income inequality since the implementation of QE.[18]

Two recent papers employ large-scale econometric models of the Italian (Casiraghi *et al.*, 2018) and the U.K. economy (Bunn *et al.,* 2018) to evaluate the aggregate effects of nonstandard monetary policy on income and wealth inequality in the postcrisis period. The advantage of their approach compared to VARs or regression analysis is that they use microdata on households and consider multiple channels (direct channels via financial income and net wealth and an indirect channel via labor markets) to estimate the distributional effects of monetary expansion, captured by a reduction in policy rates, asset purchases, and liquidity injections.

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 stimulus).

Several other studies use microsimulations to analyze the impact of a sudden drop in interest rates, unexpected deflation, or an increase in asset prices on changes of wealth and income inequality (Doepke and Schneider, 2006; 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*

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 nonstandard 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 inequality, while Table 2 summarizes research on the impact of unconventional monetary policy on inequality. The upper part of both tables shows studies on the impact on income inequality, while the lower part focuses on the impact on wealth inequality (discussed in Section 4.3). For each study included in Tables 1 and 2, we specify the research setup, including the analyzed 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.

4.2.1 *Inflation*

Earlier studies on the impact of monetary policy on inequality focused on the *inflation channel.* While conclusions are somewhat mixed,[19] many studies report that inflation significantly increases income inequality (e.g., Bulíř and Gulde, 1995; Romer and Romer, 1999; Bulíř, 2001; and 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 USA 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 nonlinear as it depends on the initial inflation level. In a panel of 15 OECD countries, they find a U-shaped relationship; 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 USA and just above 12% for OECD countries). Bulíř (2001) also reports a nonlinear effect: inflation below 5% a year seems to affect income inequality less than annual inflation between 5% and 40%. De Mendonça and Esteves (2018) show that the monetary authority's transparency might condition the impact of inflation on income inequality. Based on an analysis for 37 developing countries over

Table 1. Summary of Empirical Studies: Distributional Effects of Conventional Monetary Policy.

Study	Country sample	Period	Method	Monetary policy change/shock	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
Bulíř (2001)	75 countries	1970–1991	Cross-sectional 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 USA	1973–1996 1966–1999	Panel and time-series regressions	Expansionary (+ inflation)	Decrease inequality if inflation low; increase if inflation high	Inflation
Villarreal (2014)	Mexico	2003–2012	Local projections	Restrictive (+1 st. dev. monetary policy shock)	Decrease income inequality	Earnings heterogeneity
Mumtaz and Theophilopoulou (2015)	UK	1968–2008	MF-SVAR	Restrictive (+1 st. dev. monetary policy shock)	Increase income and labor earnings inequality	Income composition Earnings heterogeneity
Cloyne *et al.* (2016)	UK USA	1975–2007 1981–2007	Romer and Romer (2004) procedure	Expansionary (−25 bps monetary policy shock)	Increase income inequality	Income composition

(*Continues*)

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Table 1. *Continued.*

Study	Country sample	Period	Method	Monetary policy change/shock	Impact on inequality	Distributional channel
O'Farrell *et al.* (2016)	8 OECD countries	2007–2012 surveys	Microsimulations	Expansionary (− 100 bps monetary policy shock)	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)	USA	1980–2008	Local projections	Restrictive (+100 bps monetary policy shock)	Increase income and labor earnings inequality	Income composition Earnings heterogeneity
Inui *et al.* (2017)	Japan	1981–1998	Local projections	Expansionary (− 100 bps monetary policy shock)	Increase income and labor earnings inequality	Earnings heterogeneity
Mumtaz and Theophilopoulou (2017)	UK	1969–2012	SVAR	Restrictive (+1 st. dev. monetary policy shock)	Increase income and labor earnings inequality	Income composition Earnings heterogeneity
Furceri *et al.* (2018)	32 advanced and emerging countries	1990–2013	Local projections	Restrictive (+100 bps monetary policy shock)	Increase income inequality	Earnings heterogeneity
Guerello (2018)	Euro area	2001–2015	Panel VAR; country VAR	Expansionary (−100 bps monetary policy shock)	Reduce income inequality in the euro area; no effect in individual country analysis	Income composition Earnings heterogeneity

(*Continues*)

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Table 1. *Continued.*

Study	Country sample	Period	Method	Monetary policy change/shock	Impact on inequality	Distributional channel
Aye *et al.* (2019)	USA	1980–2008	Local projections	Restrictive (+100 bps monetary policy shock)	Increase income inequality	Income composition Earnings heterogeneity
Samarina and Nguyen (2018)	Euro area	1999–2014	Panel VAR, local projections	Expansionary (− 1 st. dev. monetary policy shock)	Decrease income inequality	Earnings heterogeneity
Hohberger *et al.* (2019)	Euro area	1999–2017	Estimated open-economy DSGE model	Expansionary (− 1 st. dev. monetary policy shock)	Decrease income inequality	Earnings heterogeneity Income composition
Wealth inequality						
Doepke and Schneider (2006)	USA	1952–2004	Microsimulation	Expansionary (+ 10% price level)	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

(*Continues*)

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Table 1. *Continued.*

Study	Country sample	Period	Method	Monetary policy change/shock	Impact on inequality	Distributional channel
O'Farrell *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 (−100 bps monetary policy shock)	Insignificant	Savings redistribution Portfolio composition
Hohberger *et al.* (2019)	Euro area	1999–2017	Estimated open-economy DSGE model	Expansionary (− 1 st. dev. monetary policy shock)	Decrease wealth inequality	Savings redistribution Portfolio composition

Note: +(−) means increase (decrease).

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Table 2. Summary of Empirical Studies: Distributional Effects of Unconventional Monetary Policy.

Study	Country sample	Period	Method	Monetary policy change/shock	Impact on inequality	Channels
Income inequality						
Saiki and Frost (2014)	Japan	2008–2014	VAR	Expansionary (+ 1 st. dev. Bank of Japan assets)	Increase income inequality	Income composition
Bivens (2015)	USA	2008–2014	Counterfactual analysis	QE (−100 bps long-term Treasury yields)	Reduce income inequality	Earnings heterogeneity
Montecino and Epstein (2015)	USA	2010–2013	RIF regressions	QE introduction	Increase income inequality	Earnings heterogeneity Income composition
Mumtaz and Theophilopoulou (2017)	UK	2009–2010	SVAR, counterfactual analysis	QE (−100 bps long-term government bond yields)	Increase income inequality	Income composition
Inui *et al.* (2017)	Japan	1981–2008	Local projections	Expansionary (− 100 bps monetary policy shock)	Insignificant	Earnings heterogeneity
Bunn *et al.* (2018)	UK	2008–2014	Large-scale econometric model	Expansionary (Bank Rate cut to 0.5%; first £375 bln of QE)	Negligible	Earnings heterogeneity Income composition
Casiraghi *et al.* (2018)	Italy	2011–2013	Large-scale econometric model	Asset purchases, liquidity injections	Reduce labor income inequality	Earnings heterogeneity Income composition
Guerello (2018)	Euro area	2001–2015	Panel VAR; country VAR	Expansionary (+ 1% ECB's assets)	Reduce income inequality in the euro area	Earnings heterogeneity

(*Continues*)

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Table 2. *Continued.*

Study	Country sample	Period	Method	Monetary policy change/shock	Impact on inequality	Channels
Juan Francisco *et al.* (2018)	USA Euro area	2008–2013 2009–2016	SVAR	Expansionary (+ 1 st. dev. monetary base)	Increase income inequality in the USA; insignificant in the euro area	Income composition
Lenza and Slačálek (2018)	Germany, France, Italy, Spain	1999–2016	BSVAR, microsimulation	ECB asset purchases (− term spread)	Reduce income inequality	Earnings heterogeneity
Taghizadeh-Hesary *et al.* (2018)	Japan	2002–2017	VECM	Expansionary (+M1; −short-term interest rate)	Increase income inequality	Income composition
Hohberger *et al.* (2019)	Euro area	1999–2017	Estimated open-economy DSGE model	QE (long-term bond purchases of 1% of steady-state EA GDP)	Decrease income inequality	Earnings heterogeneity Income composition
Wealth inequality						
Bank of England (2012)	UK	2009–2011	Survey data analysis	Asset purchases	Benefit top 5% of households holding 40% of financial assets	Portfolio composition
Bivens (2015)	USA	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

(*Continues*)

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Table 2. *Continued.*

Study	Country sample	Period	Method	Monetary policy change/shock	Impact on inequality	Channels
Domanski *et al.* (2016)	France, Germany, Italy, Spain, USA, UK	2000–2012 surveys	Microsimulation	Expansionary (− interest rates, + asset prices)	Increase wealth inequality	Portfolio composition
Inui *et al.* (2017)	Japan	1981–2008	Local projections	Expansionary (− 100 bps monetary policy shock)	Insignificant	Savings redistribution Portfolio composition
Bunn *et al.* (2018)	UK	2008–2014	Large-scale econometric model	Expansionary (Bank Rate cut to 0.5%; first £375 bln of QE)	Negligible	Inflation Portfolio composition
Casiraghi *et al.* (2018)	Italy	2011–2013	Macro model, scenario analysis	Asset purchases, liquidity injections	Negligible	Savings redistribution Portfolio composition
Lenza and Slačálek (2018)	France, Germany, Italy, Spain	1999–2016	BSVAR, mi-crosimulation	ECB asset purchases (− term spread)	Negligible	Portfolio composition
Juan Francisco *et al.* (2018)	U. S. Euro area	2008–2013 2009–2016	SVAR	Expansionary (+ 1 st. dev. monetary base)	Increase wealth inequality in the USA; insignificant in the euro area	Portfolio composition
Hohberger *et al.* (2019)	Euro area	1999–2017	Estimated open-economy DSGE model	QE (long-term bond purchases of 1% of steady-state EA GDP)	Decrease wealth inequality	Savings redistribution Portfolio composition

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1992–2012, they find that higher central bank transparency attenuates the inequality-increasing effect of inflation.

4.2.2 *Conventional Monetary Policy*

Most recent empirical studies on the distributional effects of conventional monetary policy only focus on 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 labor, business, or financial income), while the second suggests different effects of interest rate shocks on labor 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 USA (Coibion *et al.*, 2017; Aye *et al*., 2019), the UK (Mumtaz and Theophilopoulou, 2015, 2017), the euro area (Guerello, 2018; Samarina and Nguyen, 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 labor 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 labor income. Furceri *et al.* (2018) find that the effect of monetary policy shocks on income inequality is larger in countries with higher labor income shares in total income.

Other empirical evidence suggests that it is expansionary (and not contractionary) monetary policy that increases income inequality. This is found for the UK, the USA (Cloyne *et al.*, 2016), and Japan before the 2000s (Inui *et al.*, 2017). Inui *et al.* (2017) argue that this could be due to labor 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'Farrell *et al.* (2016) report that the distributional effects of expansionary monetary policy on average are negligible, but differ considerably across OECD countries, that is, income inequality increases in some countries and decreases in others in response to a monetary policy shock.

It is likely that over the cycle, interest rates will not have strong distributional effects, as those who gain when interest rates go down due to expansionary monetary policy (for instance, households with inflation-linked assets and large debts) will lose when a central bank tightens its policies. Still, some studies suggest that the impact of monetary policy shocks on inequality varies over the business cycle.[20] Furceri *et al.* (2018) find that contractionary monetary policy has stronger effects on income inequality during booms, while expansionary shocks have larger disequalizing effects during recessions. Similarly, O'Farrell *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 analyzed nonstandard policy measures are mainly based on large-scale asset purchases, 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).

There is no consensus in the literature about the impact of unconventional monetary policy on income inequality. Two contrasting results emerge based on the distributional channels. The *earnings heterogeneity channel* suggests 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 labor earnings than the rich. Supporting evidence for this channel is found for the USA (Bivens, 2015), Italy (Casiraghi *et al.*, 2018), and the euro area (Guerello, 2018; Lenza and Slačálek, 2018). In contrast, the *income composition channel* suggests that unconventional policy increases income inequality: by boosting asset prices, capital income of the rich increase, and income inequality rises.[21] Evidence in support of this view is reported for Japan (Saiki and Frost, 2014; Taghizadeh-Hesary *et al.*, 2018), the USA (Montecino and Epstein, 2015; Juan Francisco *et al.*, 2018), and the UK (Mumtaz and Theophilopoulou, 2017).

The relative strength of the *earnings heterogeneity* and *income composition* channels determines 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 USA 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 disequalizing effects via asset prices. Inui *et al.* (2017) use Japanese household microdata 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 due to a change in response of earnings inequality associated with a change in economic conditions, such as more labor 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. Likewise, Bunn *et al.* (2018) find that the total effect of monetary policy easing in the UK between 2008 and 2014 on income inequality has been very small.

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, unexpected inflation, interest rate exposure,* and *portfolio composition channels*, which are comprised in theoretical models within a direct channel due to partial equilibrium effects of monetary policy (see Section 2). The literature on conventional monetary policy mainly considers the *unexpected inflation channel* that shows how unexpected inflation redistributes wealth from lenders/savers to borrowers. Several studies refer to this channel and find that expansionary monetary policy reduces wealth inequality in the USA (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 Slačálek, 2018), the USA (Bivens, 2015), the UK (Bunn *et al.,* 2018), and OECD countries (O'Farrell *et al.*, 2016). These papers analyze equity, bond, and house prices and report 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.

Other studies (Casiraghi *et al.*, 2018; Inui *et al.,* 2017) consider two distributional channels – *portfolio composition* and *savings redistribution* – and find that their effects on wealth inequality cancel out. Casiraghi *et al.* (2018) report that rich households benefit more from unconventional policy thanks to capital gains on financial assets (*portfolio composition)*, but the net wealth of poor households improves as well due to lower liabilities (*savings redistribution)*. 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.

Recently, the *interest rate exposure* channel has gained attention. Auclert (2016) defines net exposure as the difference between total maturing assets and liabilities. Ampudia *et al.* (2018) use survey data for the euro area and find that hand-to-mouth households benefit from a reduction of interest rates via this channel, while non-hand-to-mouth households are negatively affected due to a loss of financial income. Auclert (2016) also finds evidence for redistribution via the *interest rate exposure* channel, using Italian and U.S. household surveys. The overall effect of this channel on wealth inequality may depend on the proportion of poor and wealthy households in the economy. Further empirical contributions would be needed to better understand this channel.

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.[22]

In addition, 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 Global 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 disequalizing effect

as capital gains only contribute to the wealth of the top percentile (Bivens, 2015; Adam and Tzamourani, 2016; Lenza and Slačálek, 2018).

5. Macroprudential Policy and Inequality

5.1 *Theoretical Literature*

The aim of macroprudential policy is to address financial stability concerns by taming credit cycles and reducing crisis risks (Thwaites, 2018). It may influence income and wealth distribution mainly by restricting credit availability or by making credit more expensive. Theoretical research in this area is scant; the impact of macroprudential instruments is often modeled through the housing market. The analyzed policy tools include asset-based (loan-to-value (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 macroprudential 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 macroprudential 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 downward. 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-we households more, leading to the reevaluation 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 lowers net worth, raising wealth inequality. Based on this model, Punzi and Rabitsch (2018) show that optimal macroprudential policy should restrict excessive borrowing only for high LTV-type households that react the most – that is, deleverage – after a housing price shock.

Macroprudential 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 model of Clerc *et al.* (2015). This model is a medium-scale, microfounded general equilibrium model designed for conducting macroprudential 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-centered financial system where intermediaries fund themselves with equity and insured deposits and lend to firms and households. Banks are subject to capital requirements 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 capital requirements on welfare are asymmetric. On the one hand, higher capital requirements reduce distortions caused among others by the subsidy of deposit insurance. This increases the welfare of savers. On the other hand, higher capital requirements hamper financial intermediation and harm the welfare of borrowers. Mendicino *et al.* (2018) find that increasing capital requirements from a baseline level is Pareto-improving up to a point and redistributive afterward. When capital requirements start from low levels, as under the precrisis 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, capital requirements imply a trade-off between the welfare of savers and that of borrowers. The optimal capital requirements are defined as those which maximize the long-run welfare of borrowers.

5.2 *Empirical Evidence*

The distributional effects of macroprudential 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 macroprudential instruments have been implemented is short. Macroprudential 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 macroprudential policies might be difficult to disentangle from the effects of monetary and other policies as well as nonpolicy-driven changes in financial systems. Fourth, the data on macroprudential policies are of recent origin. Several databases have emerged in recent years, with the most comprehensive one by Cerutti *et al.* (2016), covering annual data for 12 macroprudential instruments implemented by 119 countries over 2000–2013. This data set has been extensively used in research, also to analyze distributional effects of macroprudential policies.

Three empirical papers examine the impact of macroprudential policy on inequality. Frost and van Stralen (2017) use macroprudential instruments from the database of Cerutti *et al.* (2016) for 69 countries over the period 2000–2013 and analyze their relation with Gini coefficients of market and net income inequality. The other two papers use household surveys for, respectively, 12 euro-area countries based on HFCS data (Carpantier *et al.*, 2017) and the state of Oregon in the USA (Zinman, 2010), to study wealth and consumption effects of macroprudential measures. All papers find evidence for redistributive effects of macroprudential policy. Tighter measures, such as stricter LTV ratios, concentration and interbank exposure limits, as well as higher reserve requirements are associated with higher income inequality (Frost and van Stralen, 2017).[23] 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 downward (Carpantier *et al.*, 2017).

It remains unclear through which mechanism macroprudential policy may generate distributional effects. Arregui *et al.* (2013) conjecture that it is due to unintended side effects of macroprudential 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 for the joint study of 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 effects 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.

To date, the empirical evidence on the effect of conventional monetary policy on income and wealth inequality yields mixed findings, although there seems to be a consensus that higher inflation, at least above some threshold, increases inequality. 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 scant literature on the impact of macroprudential policies on inequality finds evidence for redistributive effects of macroprudential policy, but in view of the many limitations it may be too early to come to definite conclusions.

The main limitation of empirical studies on the distributional effects of monetary policy is that they cannot identify simultaneously all distributional channels described in the theoretical literature. It often remains ambiguous whether the tested channels capture direct (partial equilibrium) or indirect (general equilibrium) effects.

For this reason, we believe that future research should focus on the estimation of General Equilibrium models with heterogeneous agents. This would allow distinguishing between competing theories and to provide a quantitative assessment of the effects of monetary policy on both income and wealth inequality.

Finally, it is worth pointing out that the current literature (both theoretical and empirical) discusses the distributional effects of monetary policy shocks, thus capturing cyclical effects on income and wealth distribution. Over the longer horizon, the distributional impact is likely to die out given the temporary nature of the effects of monetary policy shocks. Other factors, such as trade, labor market institutions, fiscal policy, and competition policies may be more relevant to explain trends in inequality. Studying the long-run distributional effects of monetary policy, if any, remains a prospective area for future research.

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Notes

1. 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.*, 2013; 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), labor market institutions (Jaumotte and Osorio Buitron, 2015) and macro-economic adjustments (Agénor, 2004). 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. Several studies on income inequality take the Kuznets curve, according to which there is an inverted-U-shaped relationship between the extent of income distribution and the level of economic development, as their starting point (see, for instance, Huang *et al.*, 2007 and references cited therein).
2. 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.
3. See van Treeck (2014) and Bazillier and Hericourt (2017) for extensive discussions of this line of literature.
4. See Brzoza-Brzezina *et al.* (2013) and Deutsche Bundesbank (2016) for earlier surveys of this literature. The present survey not only covers more recent empirical work and includes studies on the impact of macroprudential policies on inequality, but also discusses recent theoretical heterogeneous agents models examining how inequality affects the transmission of central bank policies.
5. For this reason, standard measures of wealth concentration should be treated with caution as they may not suffice to assess the redistributive effects of interest rate changes. To quantitatively evaluate this channel, it is also key to understand how assets with different maturity are distributed across households.
6. Parker and Vissing-Jorgensen (2010) show that in the United States 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.
7. More precisely: 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.
8. Stochastic discount factors improve the performance of the baseline KS model when it comes to address the empirical wealth distribution observed in the USA. However, even with this feature, the model is far from addressing the concentration of the actual distribution.
9. This is in line with micro survey data on household portfolios, which show that a sizable fraction of households, between 25% and 30% in the United States, holds close to zero liquid wealth and faces high borrowing costs (Kaplan *et al.*, 2018).
10. There is a second, important, message in their analysis. 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 impacts how monetary policy affects the distribution of individual income and wealth among agents with different marginal propensities to consume.
11. To the extent that agents with negative liquid wealth have higher MPCs than agent with positive liquid wealth, as suggested by available surveys, the effects on aggregate consumption of an interest rate cut will be magnified.

12. This pattern is consistent with the observed patterns of the share of liquid assets in the portfolios of U.S. households during the Great Recession. According to the 2010 Survey of Consumer Finances, the share of liquid assets in the portfolios increased relative to 2004 across all wealth percentiles, with the strongest relative increase for the lower middle class.
13. Using administrative records, like those of the Social Security Administration in the United States (see Guvenen *et al.*, 2015) would be a good alternative to using survey data. However, such data are generally even harder to access than survey data.
14. For instance, Atkinson *et al.* (2011) and Piketty *et al.* (2016) document that a substantial part of the rise in income inequality in the United States in recent decades was due to the rise of the top 1% income share, owing mainly to the upsurge in capital incomes.
15. 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 USA, UK, the euro area, and Japan include Krippner (2015), Wu and Xia (2016), and Lemke and Vladu (2017).
16. 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 relationships between variables.
17. Cross-sectional or longitudinal regression analysis has often been applied in earlier studies (Bulíř and Gulde 1995; Romer and Romer, 1999; Bulíř, 2001; 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 on poverty and inequality (see Section 4.2.1).
18. The recentered influence function regression is similar to a standard regression except that it replaces the dependent variable with a recentered influence function for a chosen distributional statistic (like the Gini coefficient). The advantage of using a recentered influence function as compared to a simple regression is that its expectation yields the original statistic of interest. Consequently, it is a linear function of explanatory variables which can be estimated by OLS. The linearity assumption makes it possible to calculate the observed change in the distributional statistic between two periods (pre- and post-QE) and measures how much of this change is due to channels associated with QE, such as changes in employment, returns on financial assets, and other covariates (Montecino and Epstein, 2015).
19. See Galli and von der Hoeven (2001) for a survey of empirical research on the effects of inflation on income inequality and poverty.
20. Some studies point out that inequality may exhibit cyclical behavior itself. For instance, Bonhomme and Hospido (2017) find that earnings inequality in Spain over 1988–2010 was strongly countercyclical; this evolution is partly explained by fluctuations in employment composition, construction sector, and housing market.
21. 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*.
22. For instance, studies for the euro area report that financial asset holdings are concentrated among the richest households (Claeys *et al.*, 2015; Adam and Tzamourani, 2016). 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.

23. While the authors explore the effects of different macroprudential instruments on income inequality, they emphasize that these are correlations rather than causal relationships. The authors do not explain the mechanisms behind those effects.

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