Monetary Policy and Inequality: the Role of Hand-to-Mouth Households and Imperfect Insurance*

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Abstract

We study the transmission of monetary policy in the presence of heterogeneous households and examine the implications when the share of constrained households is a function of monetary policy. We build an analytically tractable heterogeneous agent New Keynesian (THANK) model with an endogenous share of hand-to-mouth households. The transmission of monetary policy on aggregate demand is amplified in this setup by inequality between saver and hand-to-mouth households. The amplification effect depends on monopolistic rents (enhancing) and redistribution (mitigating). Unlike most THANK models, we refrain from the assumption of a full insurance steady state.

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1 Introduction

Many contributions in the last years have shown that inequality matters for monetary policy. The share of constrained or so-called hand-to-mouth (HtM) households is relevant for monetary policy as a larger share enhances its transmission on aggregate demand (e.g. Almgren et al. 2022, Corsetti et al. 2022). However, empirical evidence suggests that monetary policy itself influences the share of constrained households by shaping the financial conditions. Tighter financial conditions (e.g. by means of interest rate rises) exclude more households from the credit market (Bosshardt et al. 2023) and increase the debt burden for indebted households. Financially vulnerable households are being at risk of falling into financial distress and switching status to a HtM household (Ampudia et al. 2016, Byrne et al. 2022). Somewhat surprisingly, the theoretical literature on monetary policy has not yet addressed this issue in a convincing manner. In this paper, we follow the call of Yellen (2016)[1] and augment the model of Bilbiie (2020) to show how monetary policy affects (income and consumption) inequality and how the transmission mechanism of monetary policy on aggregate demand changes with the endogeneity of the share of HtM households.

Moreover, this paper addresses a second shortcoming in the theoretical literature. It is common to assume that inequality in income and consumption across household types is a purely transitory phenomenon. Only in the adjustment process to a shock or a policy measure do income and consumption diverge across household types. In the long run, i.e. in a steady state, all households consume the same amount. This assumption of full insurance is achieved by a subsidy to firms such that no profits exist in equilibrium (e.g. Bilbiie 2020) or by an appropriate redistributive policy. The advantage of these premises is the analytical manageability, the disadvantage: inequality is not an equilibrium phenomenon. Since we see neither a subsidy nor a corresponding redistribution in reality, but a permanent inequality, we allow for steady state inequality (imperfect insurance) in our model. As it turns out, this modification is a necessary condition for the endogenization of the share of HtM households to be quantitatively significant.

We build an analytically tractable heterogeneous agent New Keynesian (THANK) model with an endogenous share of constrained households and imperfect insurance. We find that the endogenization leads to an additional aggregate demand effect making the transmission of monetary policy more efficient. Inequality (in terms of share of constrained households and in terms of steady state inequality) amplifies the transmission of

[1] In her speech "Macroeconomic Research After the Crisis", Yellen underlines the importance of heterogeneities on the household and firm side for a better understanding of the occurrence and the severity of the recession after the global financial crisis and the slow recovery from it. She asks: "[...] what effect does such heterogeneity have on aggregate demand?".

monetary policy on aggregate demand. Furthermore, monetary policy impacts inequality. A contractionary interest rate shock leads to an increase of income inequality.

To motivate our framework we refer to several sources. Based on U.S. mortgage data from 2021 and 2022, Bosshardt et al. (2023) emphasize the credit supply channel of monetary tightening. Interest rate hikes tighten credit supply conditions and exclude more households from the credit market, especially young and middle-income households. Fewer households get approved for a loan compared to the situation without higher interest rates as more households face binding debt-to-income constraints. Thus, higher interest rates increase the share of constrained households. The extensive margin (being constrained or unconstrained) shifts.

Additionally, monetary policy has an impact on households being already borrowers. Monetary tightening increases their default risk (Ampudia et al. 2016, Byrne et al. 2022). Increasing interest rates lead to higher financing costs for indebted households, decreasing demand for housing putting a downward pressure on house prices. Credit constraints tighten, more households are getting in trouble with their mortgage payments, the default risk increases (Hedlund et al. 2017). As a consequence, more households are excluded from the credit market. In the following of the U.S. subprime crisis, declining house prices increased the number of credit constrained households which were the main driver of the large consumption decline during the Great Recession (Aruoba et al. 2022). Ampudia et al. (2016) analyze the financial vulnerability of euro area households based on the Household Finance and Consumption Survey. Conducting a stress test, they show that contractionary interest rate shocks increase the number of households in financial distress with an increased default risk.[2] Furthermore, the number of households being prone to interest rate shocks is not negligible. According to Cloyne et al. (2020), almost half of the U.S. and U.K. population are mortgagors. A large fraction (40% to 50%) of these mortgagors have only little liquid wealth (less than half of their monthly income).

Monetary tightening rises the number of constrained households. As more households are facing credit constraints, it shifts the extensive margin of credit market participation. We account for this link in our model in a tractable way by an increasing idiosyncratic risk of unconstrained (also called saver) households following interest rate hikes. It is harder to stay unconstrained, the probability to switch to the constrained state increases, the share of constrained households rises. We focus in our model on the effect of monetary policy on the extensive margin as Bosshardt et al. (2023) show that monetary tightening is more important for the extensive than the intensive margin.

[2]In more detail, the number of indebted households in financial distress increases by 6.8% in Spain for an increase of 100 basis points (bps). By 18.7% and 18.8% for increases of 200 and 300 bps, respectively. The largest increases are given for Portugal with 8.3% to 30.1% (for 100 and 300 bps, respectively) and 7.9% to 28.3% (for 100 and 300 bps, respectively) for Cyprus.

Furthermore, we refer to Bank for International Settlements (2021) and Colciago et al. (2019) to motivate steady state inequality as the more plausible case. The income inequality has risen in advanced economies since 1980 with an average Gini coefficient of disposable income larger than 0.3 across OECD countries in 2014-2016 according to Colciago et al. (2019). We interpret this as an indicator that there is no convergence process to steady state equality over time. The assumption of full insurance is often used in the literature to get a first best equilibrium. An optimal New Keynesian (NK) subsidy is introduced to avoid a distortion through monopolistic rents. However, this subsidy is more or less artificial as we do not observe such a subsidization of monopolistic firms in reality. Additionally, steady state equality can be reached through full redistribution of firm profits. As the optimal subsidy, we do not observe full redistribution either. For a similar view, see Challe (2020).

As a first step, we implement endogenous household shares into the THANK model of Bilbiie (2020). The model contains households of two types (constrained and unconstrained), monopolistically competitive firms, a government redistributing firm profits from unconstrained to constrained households and a central bank directly controlling the real interest rate. Constrained households are excluded from asset markets, thus are living HtM. Recent research has shown that these HtM households hold only little liquid wealth, referring to them as being liquidity-constrained (Almgren et al. 2022, Ampudia et al. 2018, Kaplan et al. 2014). Households may switch between the constrained and unconstrained state. The probability of staying unconstrained depends on the real interest rate. Higher interest rates make it harder for saver households to stay unconstrained in the future (higher idiosyncratic risk). In terms of the model, some of the saver households are pushed out of the unconstrained into the constrained state. From the framework it follows that the share of constrained households is a function of monetary policy.

The main results are as follows. At first, the assumption of full insurance is decisive. Implementing an endogenous share is neutral according to monetary policy. The adjustment process after an interest rate shock remains unaffected in comparison to an exogenous share. The neutrality depends on the assumption of full insurance. When a contractionary monetary policy shock occurs, the share of constrained households rises (and accordingly the share of unconstrained households decreases). As the households have the same consumption in steady state, the net effect is zero.

As a second step, we extend the model with imperfect insurance (steady state inequality) and refrain from the assumption of an optimal NK subsidy. Saver households have a higher income and consumption in equilibrium. We show that the transmission of a monetary policy shock on aggregate demand is amplified in comparison to a model with an exogenous share. The endogenization leads to an additional aggregate demand effect:

Higher interest rates decrease aggregate demand through intertemporal substitution effects, but they additionally lead to a higher share of constrained households consuming less than unconstrained households. This further dampens aggregate demand, thus making monetary policy more efficient. It is important to note that this new channel only operates with imperfect insurance. Moreover, income inequality rises during the adjustment process as a consequence of contractionary monetary policy. This positive effect of contractionary monetary policy on income inequality is empirically confirmed by Coibion et al. (2017) and Furceri et al. (2018). It is noteworthy that there are mixed empirical findings as there is also empirical evidence for expansionary monetary policy having a positive effect on income inequality (Colciago et al. 2019). Bilbiie (2008, 2020) shows that the efficiency of monetary policy increases with the share of constrained households (in case of countercyclical inequality). Our model confirms this finding. As these papers assume an exogenous share of constrained households and Bilbiie (2020) assumes steady state equality, our model is a generalized version of Bilbiie (2020).

We examine further how this channel depends on the NK subsidy and redistribution. An optimal subsidy as well as full redistribution lead to income equality in equilibrium. Choosing no subsidy or no redistribution at all lead to imperfect insurance amplifying the transmission of monetary policy as mentioned previously. In case of no subsidy, the NK markup distortion leads to positive profits in steady state delivering an income gap between saver (as the only shareholders) and constrained households. The NK markup distortion is complementary to the amplification effect. The larger the monopolistic rents, the higher the amplification. In case of no redistribution, HtM households only earn labor income resulting in steady state inequality. Redistribution between the households mitigates the new channel. To sum up, the amplification effect is complementary to imperfect insurance. The higher the steady state inequality, the stronger the amplification effect, thus making monetary policy more efficient.

Even though our findings are of course model-specific, they have consequences for monetary policy, particularly in the current environment as the Federal Reserve and the European Central Bank have tightened their monetary policy at a tremendous speed last seen in 1980 (with respect to the Federal Reserve). From 2022 to 2023, the Federal Reserve increased their interest rates by 525 basis points within 17 months, the European Central Bank by 425 basis points within 14 months. Furthermore, we emphasize in our model imperfect insurance and the share of constrained households as drivers of the transmission of monetary policy on aggregate demand. As these factors differ across countries, central banks should take country characteristics into account. Additionally, the results have consequences for central bank communication. As strong monetary tightening could lead to substantial distributional effects, central banks should emphasize price stabilization as one of their primary goals to increase the acceptance of their monetary policy decisions.

Structure of the paper. Section 2 discusses the related literature. Section 3 describes the THANK model with an endogenous share of constrained households and steady state inequality (imperfect insurance). Section 4 examines the impact of a contractionary monetary policy shock in the THANK model with steady state equality (4.1) and inequality (4.2), shows the amplification effect and discusses its dependence on the NK markup distortion and redistribution (4.3). Section 4.4 shows some robustness checks. Section 5 concludes.

2 Related Literature

This paper contributes to the fast growing body of literature on NK models with heterogeneous agents. More specifically, it takes up two strands of literature: On the one hand, it contributes to the literature on THANK models with an endogenous share of constrained households. On the other hand, it joins contributions about THANK models with steady state inequality.

Many analytically tractable heterogeneous agent models contain an exogenous share of HtM or constrained households (for example Bilbiie 2020, Eskelinen 2021, Komatsu 2023 or Pfäuti & Seyrich 2022). If we want to examine the link between interest rates and share of constrained households, we need to refrain from this assumption. There are already heterogeneous agent models implementing an endogenous share of constrained households in different ways. Hedlund et al. (2017) combine a HANK model with housing, long-term debt and frictions in the housing market to examine the meaning of the housing channel for monetary policy. They build on a directed search approach in the housing market endogenizing its price and liquidity. Monetary policy may shift the distribution of leveraged households through contractionary and expansionary shocks. They do not model the switching process between the states explicitly, the shares arise endogenously dependent on the distribution. Debortoli & Galí (2022) implement endogenous borrowing constraints depending on aggregate output and interest rate. They conclude that the role of heterogeneity in NK models is especially large when there are constrained households for which the borrowing constraint actually binds. Harding & Klein (2022) also underline the importance of households' financial position for the transmission of monetary policy shocks. The more households face a binding borrowing constraint, the more efficient monetary policy is.

We model the switching process between unconstrained and constrained state by a Markov chain as in Bilbiie (2020) to implement idiosyncratic uncertainty. In contrast to Bilbiie (2020), we endogenize the transition probability of staying unconstrained by explicitly modelling the link between the tightness of financial conditions and how easy it is to stay a saver household. This approach is similar to Masson & Ruge-Murcia (2005), but with another application: They model the transition between different exchange rate regimes with Markov chains. The time-varying probabilities depend on the explanatory variables such as annual inflation or openness to trade. We adopt their approach to endogenize the share of constrained households in our model. With our framework, we emphasize the role of changes in the share of constrained households driven by monetary policy.

The change in the share of constrained households is one of three channels identified by Debortoli & Galí (2018) operating in HANK models. Additionally, with the modelling of the switching process, we examine another channel of heterogeneity within the group of unconstrained households. There is limited heterogeneity between saver households as some of them are pushed out of the unconstrained state. The Markov switching process with endogenous transition probabilities is more suitable for our application as we want to focus on these households being at risk of becoming constrained. Neither of these two channels operate in two agent NK models.

Most THANK models assume full insurance to get a first best equilibrium. In our framework, this assumption is not as innocuous as in other frameworks (for example Bilbiie et al. 2022 or Pfäuti & Seyrich 2022) as it drives our results. For questions about redistribution and heterogeneity, the full insurance steady state is less useful. To display the more realistic case of steady state inequality, we refrain from full insurance and work with a second best equilibrium. Bilbiie et al. (2022) build a THANK model with (physical) capital and assess a complementarity between income and capital inequality. Saver households invest in a productive asset that firms use for production. Constrained households have no access to capital. The authors assume an optimal NK subsidy and consumption equality in equilibrium. Their results are not driven by these assumptions as the model includes net savings and capital income leading to income inequality. Capital and income inequality amplify the transmission of monetary policy, respectively. When they operate simultaneously, the amplification effect is greater than the sum of the amplification effects of both inequalities in isolation. In contrast to our model, they assume an exogenous share of constrained households. Challe (2020) analyzes optimal monetary policy in a THANK model with uninsurable unemployment risk. Monetary policy should react more expansively to contractionary shocks in his framework. Steady state distortions (through setting not-optimal subsidies) impact the optimal monetary policy responses, but the main implication survives.

In a THANK model with liquidity, Bilbiie & Ragot (2021) show that it is optimal for monetary policy to provide positive liquidity (in terms of money). They identify a liquidity-insurance channel: Stabilizing the consumption of constrained households by providing liquidity is welfare-enhancing. However, this channel only operates with imperfect insurance. Bilbiie & Ragot (2021) need to implement the distorted steady state for the welfare-enhancing effect. Steady state inequality increases the incentive to self-insure. Similar to our framework, imperfect insurance is a necessary condition for their new channel and their liquidity-insurance channel is complementary to the NK markup distortion. The larger monopolistic rents, the more important their liquidity-insurance channel. In the case of steady state equality, zero liquidity is optimal in their model. In contrast to our paper, Bilbiie & Ragot (2021) assume exogenous transition probabilities and a fixed labor supply for constrained households.

3 Model

In this section we build an analytically tractable heterogeneous-agent New Keynesian (THANK) model based on Bilbiie (2020) and implement an endogenous share of constrained households by endogenizing the switching process similar to Masson & Ruge-Murcia (2005). The share depends on the interest rate directly set by the central bank. Additionally, we resign from the assumption of an undistorted steady state (full insurance) and analyze the (more realistic) case of steady state inequality (imperfect insurance). The heterogeneity is based on profit income of the saver households. Thereby, we are also able to capture income composition heterogeneity in this framework.

The model includes different household types, monopolistically competitive firms, a government and a central bank. Prices are fixed and output is demand-determined. We want to keep the model as simple as possible to isolate the effect of an endogenous share of constrained households as a function of monetary policy.[3]

Households. There is a continuum of households with a total mass of 1 and two possible states: being a saver (S) or a hand-to-mouth (H) household. The household types (indexed by $j \in \{S, H\}$) optimize their life-time utility $E_0 \sum_{t=0}^{\infty} \beta^t((C_t^j)^{1-1/\sigma}/(1-1/\sigma) - (N_t^j)^{1+\varphi}/(1+\varphi))$ over consumption C_t^j and labor supply N_t^j subject to their budget constraints. β displays the discount factor, σ the intertemporal substitution elasticity and φ the inverse Frisch elasticity, all parameters are identical for S and H. S is unconstrained and has free access to asset markets in contrast to H being constrained (no participation in asset markets). We introduce idiosyncratic uncertainty with a switching process between constrained and unconstrained state captured by a Markov process.

S optimizes consumption intertemporally and split income between consumption and saving taking into account being S or H in the next period. The following log-linearized Euler equation describes consumption of S, where variables with a hat ($\hat{x}_t$) describe log-deviations from their steady state: e.g. $\hat{c}_t^S = \ln C_t^S - \ln C^S$. Except for $\hat{r}_t$ which denotes absolute deviations of the real interest rate r_t from its steady state. Variables without time index describe steady state values:

$$\hat{c}_t^S = \frac{1}{1 + \frac{1-s}{s}\Gamma^{1/\sigma}} E_t \hat{c}_{t+1}^S + \frac{1}{1 + \frac{s}{1-s}\Gamma^{-1/\sigma}} E_t \hat{c}_{t+1}^H + \frac{\Gamma^{1/\sigma} - 1}{1 + \frac{1-s}{s}\Gamma^{1/\sigma}} \sigma \hat{s}_t - \sigma \hat{r}_t \tag{1}$$

with s displaying the (steady state) probability of staying unconstrained and $\Gamma = C^S/C^H = Y^S/Y^H$ denoting steady state (consumption and income) inequality. We restrict the anal-

[3]Appendix A contains a more detailed description of the model derivation. Appendix D.1 and D.2 summarize the log-linearized model equations for the THANK model with imperfect insurance (D.1) and full insurance (D.2). Appendix D.3 gives an overview of the steady state equations.

ysis to the more plausible case of $\Gamma \geq 1$. Households save for rainy days because they can become constrained (H) tomorrow (precautionary savings motive). An increasing probability to stay S ($\hat{s}_t > 0$) increases the consumption of S as the need to save for rainy days declines. A lower probability to stay S ($\hat{s}_t < 0$) leads to a higher incentive to save more. The higher the steady state inequality, the stronger the effect. In case of $\Gamma = 1$, the effect of $\hat{s}_t$ on $\hat{c}_t^S$ vanishes. The need to save for rainy days also declines if the drop in income from sunny to rainy days is small (low Γ).

Additionally, the effects of expectations over consumption tomorrow as S or H on consumption today are shaped by inequality: The higher steady state inequality, the less important positive expectations about consumption tomorrow as a saver household become. For $E_t\hat{c}_{t+1}^H$, it holds: Higher inequality enhances the effect of positive consumption expectations of H. This is comprehensible: Γ is a parameter displaying the cost of becoming H tomorrow. The higher the inequality, the higher the expected costs (as consumption loss through the transition to constrained state). The higher the consumption expectations of H, the lower the implied costs.

Because of imperfect insurance ($\Gamma > 1$), there is a higher incentive for precautionary saving. This leads to a lower interest rate in steady state (taken from the Euler equation):

$$1 + r = \frac{1}{\beta(s + (1 - s)\Gamma^{1/\sigma})}$$

For full insurance ($\Gamma = 1$), we get the well-known expression $1 + r = 1/\beta$.

S earns income $\hat{y}_t^S$ from labor $\hat{n}_t^S$ with real wage $\hat{w}_t$ and holding of shares (dividends $\tilde{d}_t$). S has free access to asset markets (bonds as liquid asset and share of firms as illiquid asset). Within the group of S households the shares of monopolistically competitive firms are equally split. The mass of saver households is given by $(1 - \lambda_t)$, with λ_t as the share of constrained households. Each saver household holds the same fraction of shares in equilibrium: $\Omega^S = (1 - \lambda)^{-1}$ (no trade in shares) with λ representing the steady state share of H. Fiscal policy introduces a redistribution scheme that redistributes firm profits from S to H, with τ^D as a redistribution parameter. For the income of S, with $\tilde{d}_t$ denoting the deviation of dividends from its steady state in relation to total consumption respectively production ($\tilde{d}_t = (D_t - D)/Y$), it holds:[4]

$$\hat{y}_t^S = \frac{WN^S}{Y^S}(\hat{w}_t + \hat{n}_t^S) + \frac{1 - \tau^D}{1 - \lambda}\frac{Y}{Y^S}\tilde{d}_t + \frac{\lambda}{1 - \lambda}(1 - \frac{WN^S}{Y^S})\hat{\lambda}_t \tag{2}$$

The influence of the labor income determinants ($\hat{w}_t$ and $\hat{n}_t^S$) is governed by the share of

[4] In line with the literature, we calculate the deviation in relation to Y to allow for the case of zero steady state profits, $D = 0$.

labor income relative to total income of S (WN^S/Y^S) mitigating it (as $WN^S/Y^S < 1$). The labor income determinants become less relevant with a decreasing share of labor income. Income composition heterogeneity is crucial here (split between labor and profit income). A growing share of H ($\hat{\lambda}_t > 0$) has a positive effect on the income of S, because the dividends are distributed over fewer saver households. The effect of a change in the share of H is weighted by the steady state shares and the share of profit income ($1 - WN^S/Y^S$). The higher the share of profit income, the stronger the effect of $\hat{\lambda}_t$ on income of S and vice versa. In case of steady state equality, the share of profit income is zero and the effect of a varying share of H drops out.

The H households are constrained in terms of being excluded from asset markets and face a binding borrowing constraint, thus living HtM and consuming all income in one period.[5] There is no consumption-smoothing over different periods (hence no Euler equation):

$$\hat{y}_t^H = \hat{c}_t^H. \tag{3}$$

They earn labor income and get transfer payments from S:

$$\hat{y}_t^H = \hat{c}_t^H = \frac{WN^H}{Y^H}(\hat{w}_t + \hat{n}_t^H) + \frac{\tau_D}{\lambda}\frac{Y}{Y^H}\tilde{d}_t - (1 - \frac{WN^H}{Y^H})\hat{\lambda}_t \tag{4}$$

Consumption and income of H depend on the share of labor income relative to total income of H (WN^H/Y^H). As for S, the effect of labor income determinants is governed and mitigated by the share of labor income. A higher share of H negatively impacts income and consumption of H, because the transfer payments of S are distributed over more households. This effect depends on the share of transfer income relative to total income ($1 - WN^H/Y^H$). The more H depends on transfers, the stronger the negative effect of $\hat{\lambda}_t$. In case of $\tau^D = 0$ (no redistribution), H only earns labor income. Due to the lack of intertemporal consumption-smoothing, H does not respond to interest rate changes in a direct manner, but indirectly through changes in labor income (through $\hat{w}_t$ and $\hat{n}_t^H$). The most important difference between S and H is participation in financial markets. S can buy bonds to self-insure against the idiosyncratic risk of becoming constrained. H has zero liquid wealth and cannot smooth consumption as it has no access to assets. Therefore, H shows a stronger reaction to an income shock.

For tractability, we follow the assumption of Zero-Liquidity HANK models (see e.g. Bilbiie 2020, 2021, Bilbiie et al. 2022, Challe 2020, Hansen et al. 2023, Pfäuti & Seyrich 2022 or Ravn & Sterk 2021) and implement idiosyncratic uncertainty and liquidity in

[5] In terms of the model, the constrained state can be, at least in a simplified way as Bilbiie (2020) states, interpreted as including poor and wealthy HtM households, as long as the wealthy HtM households are classified as having liquid reserves near zero and having no access to their illiquid assets in the constrained state. Poor HtM households have no wealth at all.

a tractable way: S can switch to the constrained state in future periods leading to a precautionary savings motive. There are two assets: Bonds are liquid and can be used to self-insure against the risk of becoming constrained tomorrow. Shares in monopolistically competitive firms are illiquid and cannot be transferred to constrained state. The bonds are priced by the Euler equation, but not traded.[6] H would like to borrow, but faces a borrowing limit of zero. The households are not allowed to borrow in each state and period. If no one borrows, no one can lend, thus bonds are in zero net supply.[7]

Labor supply is given by:

$$\hat{n}_t^S = \frac{\hat{w}_t}{\varphi} - \frac{1}{\sigma\varphi}\hat{c}_t^S \tag{5}$$

and

$$\hat{n}_t^H = \frac{\hat{w}_t}{\varphi} - \frac{1}{\sigma\varphi}\hat{c}_t^H \tag{6}$$

Firms. We assume a standard supply side as e.g. used in Bilbiie (2020). There is a continuum of monopolistically competitive firms with a total mass of 1. They use labor as input factor for production: $\hat{y}_t = \hat{n}_t$. It is common in the literature to introduce an optimal NK subsidy (τ^S) compensating the firms to undo the market power and get an undistorted steady state. We also introduce a subsidy (as we need it for the further analysis in section 4), but initially we refrain from the assumption of an optimal NK subsidy and set $\tau^S = 0$. Without an optimal NK subsidy, the firms earn profits in equilibrium ($D > 0$) as prices are greater than marginal costs (real wage). Savers (as firm owners) receive positive profit income and have, in consequence, a higher income and consumption level in equilibrium. There is real inequality between S and H and we have a distorted steady state (imperfect insurance). In section 4.1, we analyze the case of an optimal NK subsidy resulting in steady state equality (full insurance).

The optimal relative price of an individual firm producing an individual good k is given by $P_t(k)/P_t = \epsilon((1+\tau^S)(\epsilon-1))^{-1}W_t$ with $\epsilon > 1$ describing the substitution elasticity between different goods and $\epsilon((1+\tau^S)(\epsilon-1))^{-1}$ the mark-up on marginal costs. The wage is equal for all workers. Log-linearizing around the steady state with inequality leads to:

$$\tilde{d}_t = -\hat{w}_t(1 - \frac{D}{Y}) + \frac{D}{Y}\hat{n}_t \tag{7}$$

where $D/Y = (1-\tau^S(\epsilon-1))/\epsilon$ is the steady state profit share and $(1 - D/Y)$ the steady state labor share. In case of no subsidy ($\tau^S = 0$), the profit share is $1/\epsilon$. Increasing

[6] The Zero-Liquidity assumption in THANK models is based on the work of Krusell et al. (2011) and Ravn & Sterk (2017).

[7] The assumption of no bond trading leads to a degenerate wealth distribution and is a tractable way to get closed-form solutions. In case of positive net supply of bonds, we would have a looser borrowing constraint. The degenerate wealth distribution in THANK models contrasts with HANK models, which can depict a full distribution, as in Auclert (2019) and Kaplan et al. (2018).

wages reduce profits, therefore producing a negative externality on the saver households. Indeed, S earns labor income and benefits from higher wages, too, but as firm owners they also have to bear the wage payments. A higher profit share dampens the negative effect of higher wages (marginal costs) on profits because of a lower wage share and thus lower marginal costs. Additionally, we have a positive employment effect on $\tilde{d}_t$ weighted by the profit share as the firms keep the fraction D/Y from additional production as profits (remembering $\hat{n}_t = \hat{y}_t$).

Government. The government redistributes profits from saver to HtM households. Transfers are given by: $Tr_t = \tau^D \lambda_t^{-1} D_t$. In case of no redistribution, S keeps all profits. In case of $\tau^D = \lambda_t$ (full redistribution), the profits are redistributed such that S and H get the same dividends. For $\tau^D > 0$, H internalizes some of the negative income effect of increasing wages.

Central bank. The real interest rate is modelled in a simple manner. We assume that the central bank is able to directly set the real interest rate as prices are fixed as in Bilbiie (2020). The real interest rate develops according to the following AR (1) process:

$$\hat{r}_t = p\hat{r}_{t-1} + \upsilon_t \tag{8}$$

where υ_t displays a monetary policy shock and p a persistence parameter (with $0 \leq p < 1$). Assuming rational expectations, we can use $E_t\hat{c}^S_{t+1} = p\hat{c}^S_t$ and $E_t\hat{c}^H_{t+1} = p\hat{c}^H_t$ to rearrange consumption of S: $\hat{c}^S_t = (s + (1-s)\Gamma^{1/\sigma} - sp)^{-1}(-\sigma(s + (1-s)\Gamma^{1/\sigma})\hat{r}_t + (p(1-s)\Gamma^{1/\sigma})\hat{c}^H_t - \sigma s(1-\Gamma^{1/\sigma})\hat{s}_t)$.

Market clearing. Goods and labor market clear in equilibrium. Additionally, (aggregate) demand determines output: $\hat{y}_t = \hat{c}_t$. For total income and consumption, it follows:

$$\hat{y}_t = \hat{c}_t = \frac{1}{1 + \frac{1-\lambda}{\lambda}\Gamma}\hat{c}^H_t + \frac{1}{1 + \frac{\lambda}{1-\lambda}\Gamma^{-1}}\hat{c}^S_t - \frac{\Gamma - 1}{1 + \frac{1-\lambda}{\lambda}\Gamma}\hat{\lambda}_t \tag{9}$$

The third term of the RHS appears in case of steady state inequality and represents an additional aggregate demand effect. A higher share of H negatively impacts aggregate income and consumption in case of $\Gamma > 1$ as H consumes less than S. A higher share dampens aggregate income and consumption, whereby the effect is weighted by steady state inequality parameters (λ and Γ).

For aggregate labor supply, it holds:

$$\hat{n}_t = \lambda \frac{N^H}{N} \hat{n}_t^H + (1-\lambda) \frac{N^S}{N} \hat{n}_t^S + \lambda \frac{N^H - N^S}{N} \hat{\lambda}_t \tag{10}$$

Note that from allowing for different consumption levels ($C^S > C^H$) it follows different amounts of labor in equilibrium ($N^S < N^H$) with $\Gamma^{\frac{1}{\sigma\varphi}} = N^H/N^S$ displaying inequality in labor supply.

Steady state inequality. The following polynomial equation describes the inequality measure Γ:[8]

$$\frac{\Gamma^{\frac{\sigma\varphi+1}{\sigma\varphi}} - 1}{\lambda \Gamma^{\frac{1}{\sigma\varphi}} + (1-\lambda)} + \Gamma \frac{\tau^D}{\lambda} (\frac{1}{W} - 1) = \frac{1-\tau^D}{1-\lambda} (\frac{1}{W} - 1) \tag{11}$$

The steady state inequality Γ is a function of Frisch elasticity ($1/\varphi$), intertemporal substitution elasticity (σ), wage share in equilibrium (W respectively ϵ and τ^S, remembering the real wage is given by $W = (1+\tau^S)(\epsilon-1)/\epsilon$), redistribution ($\tau^D$) and the share of constrained households in equilibrium (λ): $\Gamma = \Gamma(\varphi, \sigma, \epsilon, \tau^S, \tau^D, \lambda)$. It is increasing in σ and φ. If for example the market power increases ($\epsilon \downarrow$), the steady state inequality increases due to a higher profit share (lower wage share). The more we redistribute ($\tau^D \rightarrow \lambda$), the more equal the agents are in equilibrium ($\Gamma \rightarrow 1$). The higher the share of constrained households in equilibrium (λ), the higher inequality in equilibrium.

For $\tau^D = 0$ (no redistribution), it follows:

$$\frac{\Gamma^{\frac{\sigma\varphi+1}{\sigma\varphi}} - 1}{\lambda \Gamma^{\frac{1}{\sigma\varphi}} + (1-\lambda)} = \frac{1}{1-\lambda} (\frac{1}{W} - 1) \tag{12}$$

In case of a full insurance steady state, Γ collapses to 1 and we end up to the model with steady state equality as section 4.1 discusses.

Switching process. The households may switch between two states. The switching process is described by a Markov chain. With a probability s_t a saver household stays in unconstrained state S and with $(1 - s_t)$ transitions to constrained state H. Similarly for H: h describes the probability of staying H, $(1 - h)$ of switching to S.[9] The transition probability s_t is time-varying as in Masson & Ruge-Murcia (2005). They use time-varying probabilities depending on explanatory variables to model the transition between different exchange rate regimes. Here we adopt their approach and let the transition probability s_t

[8] The derivation of (11) is described in Appendix B.

[9] h is a time-independent parameter as we focus on saver households being financially vulnerable. A constant fraction $(1 - h)$ of constrained households switches from H to S.

be dependent on the interest rate to capture the idea that monetary policy impacts the transition probabilities by governing the financial conditions. Higher interest rates lead to tighter financial conditions making it harder for saver households to stay unconstrained in the future, s_t decreases in r_t. The probability s_t also captures limited heterogeneity within the mass of saver households as some of them are pushed out of the unconstrained into the constrained state.

There is heterogeneity between S and H (between heterogeneity). Between the periods, the switching process takes place. Some of the S households may switch to the constrained state in the future and vice versa. After the switching occurs, we assume that households are homogeneous within their states in a period t (within homogeneity) and have the same asset holdings, income and consumption.

The probability of staying S is linked to the interest rate by a sigmoid function (as in Masson & Ruge-Murcia (2005) linking transition probabilities to their examined explanatory variables):

$$s_t = e^{\delta(\gamma - r_t)}(e^{\delta(\gamma - r_t)} + 1)^{-1} \tag{13}$$

The functional form fulfills the following properties: The variable s_t is a probability and should always be non-negative and between 0 and 1. It also displays the tightness of financial conditions. A monetary tightening leads to a lower probability of staying unconstrained, the idiosyncratic risk $(1 - s_t)$ rises.[10]

The parameter δ displays the link between s_t and r_t and can be interpreted as a sensitivity parameter. For $\delta < 0$ the linkage between interest rate and probability is positive, for $\delta > 0$ it is negative (the more plausible case). The parameter γ is used as a shift parameter. For $\gamma = r + \delta^{-1}\ln(s/(1-s))$, the function matches the values of r_t and s_t in equilibrium. Thus we can model the connection between real interest rate and probability of staying a saver. In the following, we concentrate on the more plausible case of $\delta > 0$ as it is motivated in the introduction. Log-linearizing around the steady state delivers:

$$\hat{s}_t = -\delta s \hat{r}_t \tag{14}$$

Share of hand-to-mouth households. The share of HtM households is given by λ_t. Accordingly, $(1 - \lambda_t)$ describes the share of saver households. The flow of agents transitioning from S to H in period t is given by $(1 - s_t)(1 - \lambda_t)$. The flow of constrained agents becoming unconstrained (transition from H to S) is given by $(1 - h)\lambda_t$. We assume

[10]The relation between the interest rate and the probability can also be modelled by an AR (1) process (e.g. $\hat{s}_t = -\delta\hat{r}_t + \epsilon_t^S$ with ϵ_t^S as a shock term to s_t) or captured by an e-function (with the following resulting equation: $\hat{s}_t = -\delta\hat{r}_t$) The difference to the use of a sigmoid function is weighting the effect with the steady state probability of staying unconstrained, but the alternatives do not ensure s_t being between 0 and 1.

equality of the flows in each period t. The variable λ_t is the share for which the two flows are equal in period t: $(1-s_t)(1-\lambda_t) = (1-h)\lambda_t$ (flow equilibrium condition). Between the periods, the flows can be different. The share λ_t can also be interpreted as the (unconditional) probability of being in the constrained state. From the flow equilibrium condition, it follows the share of constrained households in each period:

$$\lambda_t = \frac{1-s_t}{2-s_t-h} \tag{15}$$

In contrast to Bilbiie (2020), the share is endogenous depending on s_t and h. In log-deviations from steady state:

$$\hat{\lambda}_t = -\frac{s(1-h)}{(1-s)(2-s-h)}\hat{s}_t \tag{16}$$

The share λ_t changes if the transition probability s_t varies. The higher s_t, the lower the share of HtM households. A higher h implies a higher λ_t. The share of H can be described as a function of monetary policy: $\hat{\lambda}_t(\hat{r}_t) = \delta s^2(1-h)((1-s)(2-s-h))^{-1}\hat{r}_t$. The focus of the model on the effect of monetary policy on the extensive margin (being constrained or not) is justifiable as Bosshardt et al. (2023) show that interest rate hikes affect more the extensive than the intensive margin.

The model is a generalized version of Bilbiie (2020). In case of $\delta = 0$ and $\Gamma = 1$, it collapses to his THANK model as the share of H becomes exogenous and we have steady state equality (full insurance).

In summary, the endogenization of the share of constrained households has consequences for the individual incomes ($\hat{y}_t^S$ and $\hat{y}_t^H$), aggregate labor ($\hat{n}_t$) and aggregate consumption ($\hat{c}_t$). For $\hat{\lambda}_t \neq 0$, we get two additional effects in this model: On the one hand, we have an additional aggregate demand effect. On the other hand, a rising share of constrained households has consequences for the profit income of S (dividends are distributed over fewer households) and the transfer income of H (transfers are distributed over more households). The effect on transfer income of H drops out in case of $\tau^D = 0$ (no redistribution).

4 Monetary policy shock

We examine the impact of a monetary tightening (interest rate rise of 1 percentage point) with an endogenous share of constrained households and imperfect insurance in steady state. Additionally, we look at how the transmission of monetary policy is impacted through the endogenization, the NK market power distortion and the redistribution scheme as well as the distributional consequences. We start in section 4.1 with a monetary policy shock in the THANK model with an endogenous share of H ($\delta > 0$) and steady state equality ($\Gamma = 1$). In section 4.2 we refrain from a full insurance steady state and look at the same shock in the THANK model with imperfect insurance ($\delta > 0$ and $\Gamma > 1$). Section 4.3 discusses the complementarity between the transmission of monetary policy and imperfect insurance. Section 4.4 shows some robustness checks for different values for σ and φ. Appendix C summarizes the calibration.

4.1 Neutrality - the model with full insurance

We analyze monetary tightening in the THANK model with full insurance. We assume the optimal NK subsidy such that the firms price their goods in equilibrium as if they are in a competitive equilibrium to reach an undistorted steady state: $\tau^{S^\star} = (\epsilon - 1)^{-1}$. In this case, there is no mark-up on marginal costs leading to a real wage equal to 1 (which is equal to the wage share) and thus to zero profits in equilibrium ($D = 0$). Log-linearizing around the symmetric steady state leads to $\tilde{d}_t = -\hat{w}_t$. The optimal NK subsidy undoes the market power and equalizes the households in equilibrium as there is no income heterogeneity between S and H. We have steady state equality in income and consumption ($\Gamma = 1$).

For S, the equations for consumption and income collapse to

$$\hat{c}_t^S = sE_t\hat{c}_{t+1}^S + (1-s)E_t\hat{c}_{t+1}^H - \sigma\hat{r}_t \tag{17}$$

and

$$\hat{y}_t^S = \hat{w}_t + \hat{n}_t^S + \frac{1-\tau_D}{1-\lambda}\tilde{d}_t \tag{18}$$

In case of steady state equality, $\hat{s}_t$ and $\hat{\lambda}_t$ drop out. The share of profit income is zero and the labor income determinants become more important as the share of labor income is higher ($WN^S/Y^S = 1$) compared to the model with imperfect insurance.

For H, consumption and income are given by

$$\hat{c}_t^H = \hat{y}_t^H = \hat{w}_t + \hat{n}_t^H + \frac{\tau_D}{\lambda}\tilde{d}_t \tag{19}$$

In case of an optimal NK subsidy, the effect of a varying share of H drops out because the share of transfer income relative to total income becomes zero, there are no profits to redistribute (hence $WN^H = Y^H$). As for S, labor income determinants become more relevant.

Aggregate output, demand and labor supply collapse to

$$\hat{y}_t = \hat{c}_t = \lambda \hat{c}_t^H + (1 - \lambda)\hat{c}_t^S \tag{20}$$

and

$$\hat{n}_t = \lambda \hat{n}_t^H + (1 - \lambda)\hat{n}_t^S \tag{21}$$

If we assume steady state equality ($\Gamma = 1$), a change in the share of H does not have an influence on aggregate terms. The other model equations are unaffected by the assumption of full insurance. Appendix D.2 provides an overview of the equations of the collapsed model with steady state equality.

Contractionary monetary policy shock. After implementing an endogenous share of H we can now examine how monetary policy shocks (easing or tightening of financial conditions) transmit to the economy by impacting the share of H. We calibrate the quarterly persistence of a monetary policy shock to $p = 0.8$ (corresponding to a yearly persistence of 0.41) in line with Gornemann et al. (2016).

A rising interest rate transmits through intertemporal substitution of S on aggregate consumption. The impulse response functions (IRFs) of figure 1 illustrate the adjustment process after a contractionary monetary policy shock (the real interest rate rises by one percentage point, see panel A). The monetary policy shock dampens consumption of saver households leading to a negative impact on aggregate consumption (falling by 5.99% relative to steady state when the shock occurs, see panel B). Production (and hence labor demand) is demand-determined and thus decreases leading to a downward pressure on wages. The constrained households suffer more from dampened aggregate demand by completely relying on labor income. Their consumption drop ($\hat{c}_t^H = -0.07188$, see panel E) is approximately 33.36% greater than the consumption drop for unconstrained households ($\hat{c}_t^S = -0.0539$, see panel F) when the shock occurs. The saver households suffer from lower wages, too, but they benefit from higher profits. We observe a rise in income inequality (panel J). The negative effect on H is mitigated in case of transfer payments ($\tau^D > 0$; not shown in figure 1).

Neutrality result. In this model, a tightening of financial conditions additionally leads to a higher share of constrained households. It is harder to stay S due to higher interest

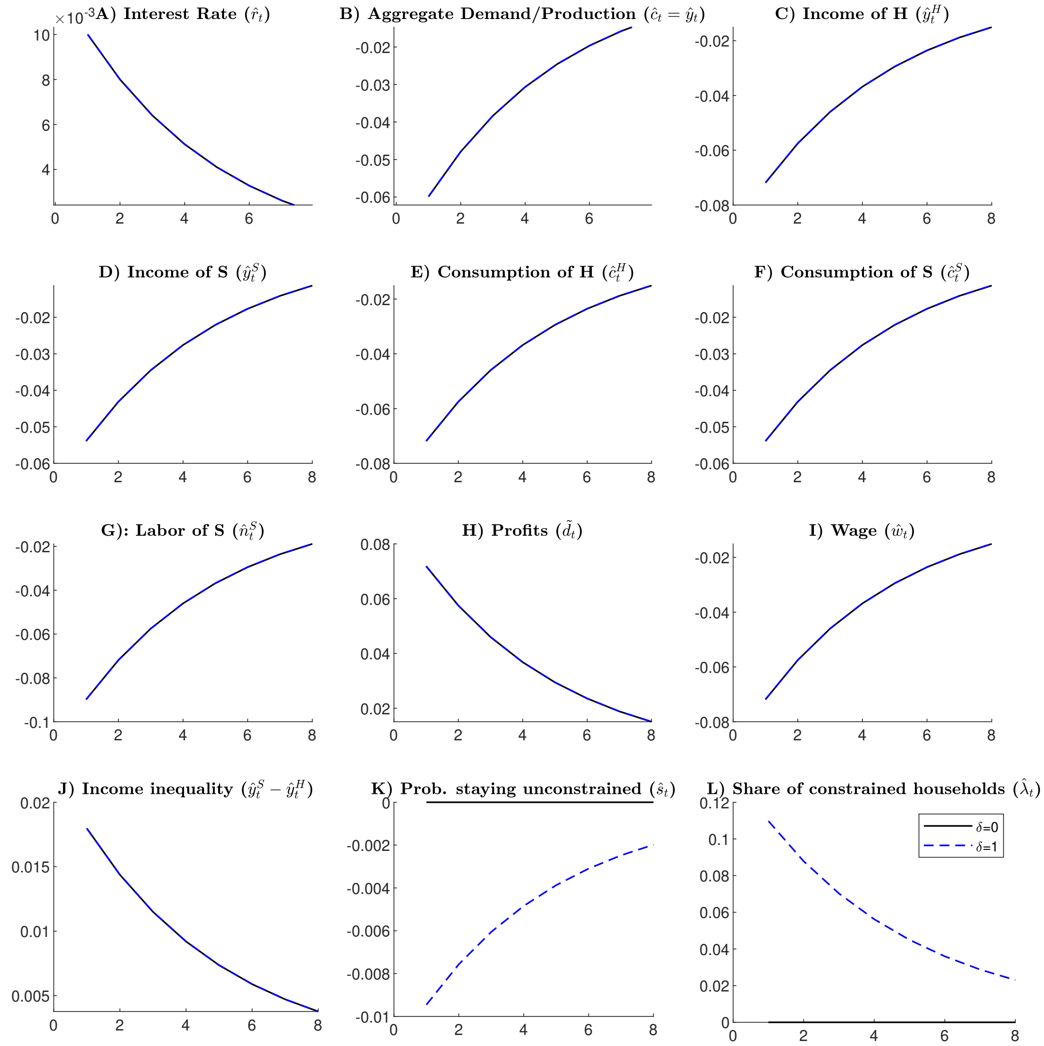

Figure 1: Impulse response functions (IRFs) of a contractionary monetary policy shock (interest rate rise of 1 percentage point) with $\delta = (0;1)$, optimal NK sbusidy ($\tau^S = \tau^{S^\star}$) and no redistribution ($\tau^D = 0$). The persistence of the shock is $p = 0.8$. Note: All IRFs except for $\hat{s}_t$ and $\hat{\lambda}_t$ (panel K and L) are stacked for both cases.

rate payments. However, the change in the share of constrained households does not impact the adjustment process after an interest rate shock. The adjustment process after a contractionary monetary policy shock is unaffected as figure 1 illustrates: The IRFs are stacked for different values for δ, except those for $\hat{s}_t$ and $\hat{\lambda}_t$. A change in s_t only impacts λ_t without any further effect. The adjustment process remains the same regardless of setting δ equal to 0 or 1.

The equation for aggregate consumption $\hat{c}_t$ (before using $C^S = C^H = C$) illustrates the relation:

$$\hat{c}_t = \lambda \frac{C^H}{C} \hat{c}_t^H + (1-\lambda) \frac{C^S}{C} \hat{c}_t^S + \lambda \frac{C^H - C^S}{C} \hat{\lambda}_t \tag{22}$$

If in the initial steady state, savers consume more than HtM households, $C^S > C^H$, the increase in λ_t is a switch from high consumption to low consumption households. Aggregate consumption declines, $\hat{c}_t < 0$. If, however, in the initial steady state, savers consume less than HtM households, $C^S < C^H$, the increase in the number of HtM households is a switch from low to high consumption households. Aggregate consumption goes up, $\hat{c}_t > 0$. If consumption is identical across groups, $C^S = C^H$, the size of the groups does not matter, the change in λ_t is neutral for aggregate consumption.

The optimal NK subsidy leads to $C^S = C^H$ delivering the collapsed equation of $\hat{c}_t$: $\hat{c}_t = \lambda \hat{c}_t^H + (1-\lambda)\hat{c}_t^S$. The additional aggregate demand term drops out, only the steady state shares of constrained and unconstrained households matter. The additional aggregate demand effect only operates in case of different consumption (and income) levels in equilibrium. In equilibrium, there are no transfer payments (zero profits to redistribute). Thus S and H only earn labor income (wage and labor supply are equal in equilibrium). They are equal in equilibrium with respect to consumption and income. From this it follows: $\partial \hat{c}_t / \partial \hat{\lambda}_t$ is equal to 0. A change in λ_t is neutral according to the economy. This is independent of the way the households get equalized. Full insurance is necessary for neutrality and can be reached through an optimal NK subsidy ($\tau^S = (\epsilon - 1)^{-1}$) or full redistribution ($\tau^D = \lambda$). Both neutralize the additional aggregate demand effect of a changing share of constrained households. When households have the same consumption and income in equilibrium (full insurance), there is no effect. Proposition 1 (ii) expresses the neutrality result.

There are already some other models underlining the importance of the assumption of full insurance. In the heterogeneous agent model of Bilbiie & Ragot (2021) the complementarity between the NK market power distortion and imperfect insurance in equilibrium is also decisive in the context of optimal monetary policy. Steady state inequality leads to an incentive for the central bank to provide positive liquidity in equilibrium to stabilize consumption of constrained households and to correct for the lack of insurance. In the Zero-Liquidity THANK model of Challe (2020), steady state distortions impact optimal monetary policy responses to contractionary shocks.

4.2 Monetary policy and Inequality

We analyze monetary tightening in the THANK model with imperfect insurance (steady state inequality, $\Gamma > 1$). To examine the effect of an endogenous share of constrained households on the transmission of monetary policy we start with the case of full market power ($\tau^S = 0$) and no redistribution ($\tau^D = 0$). Figure 2 shows the impulse response functions (IRFs) after a contractionary interest rate shock of 1 percentage point with different parameter values for δ. We focus our analysis on the case of restrictive monetary policy ($\hat{r}_t > 0$). For expansionary monetary policy ($\hat{r}_t < 0$), the analysis would be exactly the other way around.

The aggregate consumption response turns out to be 13.62% larger for $\delta = 1$ compared to $\delta = 0$ directly when the shock occurs.[11] The difference between the blue ($\delta = 1$ with $\hat{y}_1 = -0.06959$) and black line ($\delta = 0$ with $\hat{y}_1 = -0.06125$)[12] in panel B shows the amplification effect. The interest rate affects the consumption in two ways. Increasing the interest rate fosters the incentive for S to save, dampens its consumption today (through the Euler relation) and in the following aggregate demand. Output is demand-determined, hence production and labor demand decrease. Downward pressure on wages further dampens demand. This transmission of monetary tightening is enhanced through the share of constrained households reacting to the rise in interest rates as well. The adverse interest rate shock tightens the financial conditions and makes it harder to stay a saver. Some saver households are pushed out of their unconstrained into the constrained state. As a result, the share of constrained households rises, too. This leads to an additional negative aggregate demand effect, as the share of those households who are consuming less ($C^H < C^S$) rises, amplifying the negative effect as described above on the economy. The transmission of monetary policy is more efficient. Proposition 1 summarizes:

Proposition 1 *Consider a contractionary monetary policy shock ($\hat{r}_t > 0$) and suppose $\delta > 0$. The share of constrained households rises, $\hat{\lambda}_t > 0$.*

(i) In case of imperfect insurance ($C^S > C^H$), an additional negative aggregate demand effect occurs amplifying the transmission of an interest rate shock.

(ii) In case of full insurance ($C^S = C^H$), the sensitivity of λ_t with respect to r_t is neutral for aggregate demand, even for the adjustment process of an interest rate shock.

[11] The amplification effect depends, among other things, on the persistence p. For a lower persistence of $p = 0.5$, the response is amplified by 22.86%.

[12] For $\delta = 0$, we mute the link between financial conditions and the transition probability s_t. The model returns to an exogenous share of H.

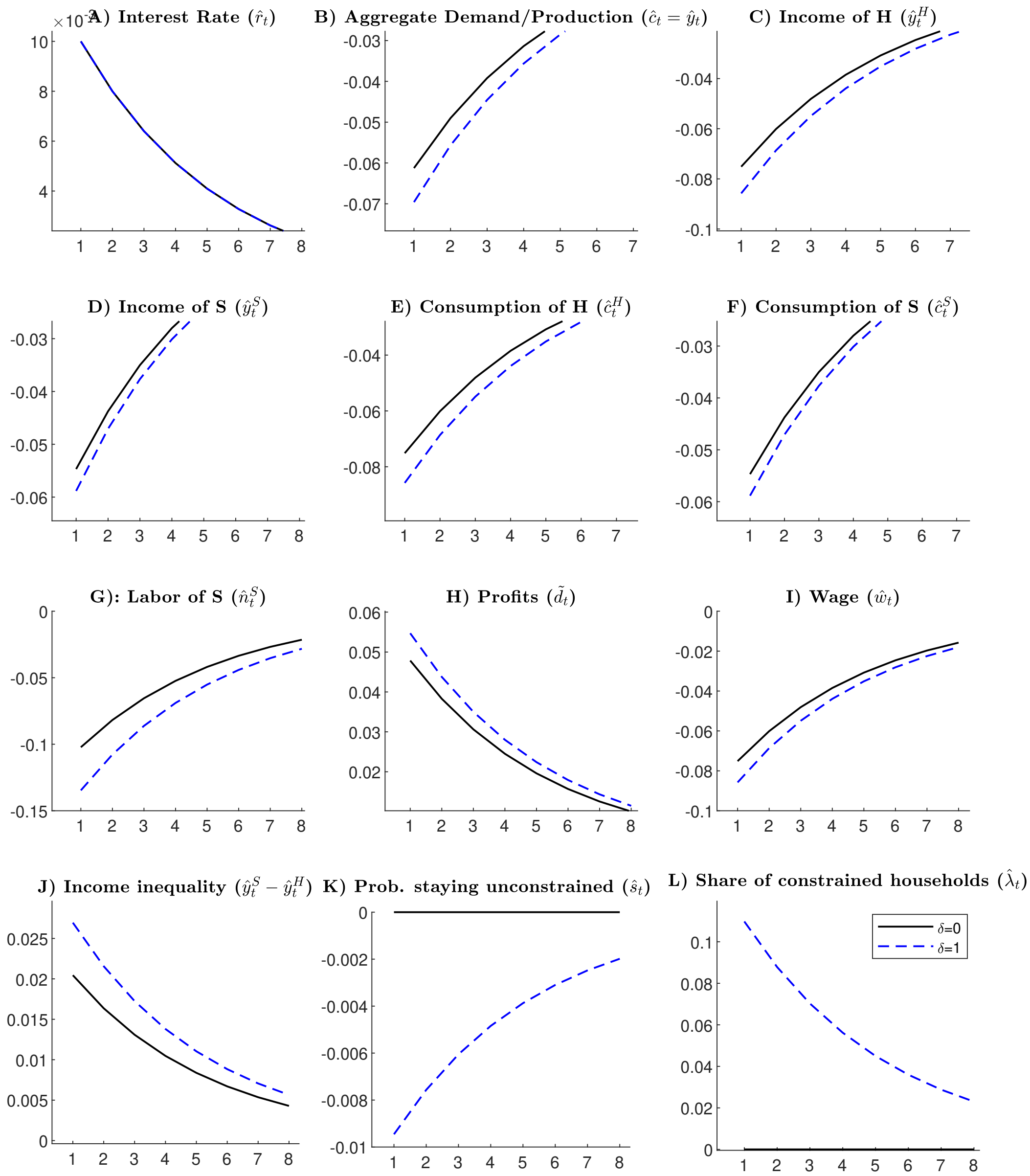

Figure 2: Impulse response functions (IRFs) of a contractionary monetary policy shock (interest rate rise of 1 percentage point) with $\delta = (0; 1)$, no subsidy ($\tau^S = 0$) and no redistribution ($\tau^D = 0$). The implied steady state inequality is $\Gamma = 1.0598$. The persistence of the shock is $p = 0.8$. Note: IRFs for $\hat{r}_t$ (panel A) are stacked for both cases.

The amplification of the transmission of monetary policy is driven by the income and consumption reaction of H. H suffers disproportionately from the aggregate consumption drop as H relies solely on labor income. The additional downward pressure on wages disadvantages the constrained households. S does not suffer as much as H from the wage decline as S benefits on the other side from higher profits. As a consequence, the consumption and income of H (panel E and C) drop more than those of S (panel F and D).

The drop in the consumption and income of H is amplified by 14.25% for $\delta = 1$, directly when the shock occurs. For $\delta = 0$, the consumption and income of H falls by 7.51%, for $\delta = 1$, it falls by 8.58% relative to its steady state (see panel C or E). The consumption and income of S (panel D and F) also drop more (by 7.57%) compared to the case of an exogenous share of constrained households ($\hat{y}_1^S = -0.05469$ for $\delta = 0$ and $\hat{y}_1^S = -0.05883$ for $\delta = 1$), but not as much as for H. In total, we observe a stronger negative response of aggregate demand. Inequality matters for monetary policy: The share of constrained households impacts its transmission on consumption. A higher share of constrained households ($\hat{\lambda}_t > 0$) enhances the negative effect of the monetary tightening on aggregate demand making its transmission more efficient as it is amplified. This is in line with Corsetti et al. (2022) finding out that higher shares of HtM households strengthen the transmission of monetary policy in euro area countries. As Bilbiie (2020) already emphasizes in his THANK model, the efficiency of monetary policy increases with higher idiosyncratic uncertainty and thus a higher share of constrained households. The self-insurance motive becomes more important.

Furthermore, steady state income inequality (Γ) enhances the transmission, too. The higher Γ, the stronger the transmission. The role of steady state inequality will be discussed further in the next subsections.

In case of an endogenous λ_t, contractionary monetary policy increases the inequality through a higher share of constrained households and a higher income inequality during the adjustment process (see panel J and L). The income inequality (${\hat{y}_t}^S - {\hat{y}_t}^H$) increases during the adjustment process in both cases as a result of the monetary tightening (panel J). However, the reaction is stronger in case of $\delta > 0$ as we have greater downward pressure on wages. A contractionary interest rate shock leads to an increase of income inequality. This result corresponds to the empirical work of Coibion et al. (2017) and Furceri et al. (2018).

The distributional effects on income inequality depend on the assumptions about δ. For $\delta > 0$, a contractionary monetary shock increases income and consumption inequality (${\hat{y}_t}^S - {\hat{y}_t}^H$) by amplifying the consumption and income reaction of H. The effect of monetary policy on income inequality vanishes over time. A persistence of 0.8 per quarter corresponds to an annual persistence of 0.41. After 10.32 quarters, 90% of the adjustment process is completed. Monetary policy has only a permanent impact on income inequality if the monetary policy shock is permanent ($p = 1$). Proposition 2 summarizes:

Proposition 2 *Consider a contractionary monetary policy shock ($\hat{r}_t > 0$). It increases income inequality $\hat{y}_t^S - \hat{y}_t^H$ during the adjustment process. The impact of monetary policy on income inequality is increasing in δ. In case of a persistent shock ($p = 1$), monetary policy has a permanent impact on income inequality.*

One might consider in this context whether resigning from the assumption of steady state equality itself makes the transmission of monetary policy more efficient even without the additional channel (hence $\delta = 0$). The answer is yes. If we compare the transmission on aggregate consumption in the case of steady state equality ($\Gamma = 1$) with the case of steady state inequality ($\Gamma = 1.0598 > 1$ with no subsidy and no redistribution), all others calibrated as before, we see a stronger drop in aggregate demand of 2.25% (with $\hat{y}_1 = -0.0599$ for $\Gamma = 1$ and $\hat{y}_1 = -0.06125$ for $\Gamma = 1.0598$; IRFs not shown) when the shock occurs.

4.3 Complementarity between the transmission of monetary policy and imperfect insurance

As we have already discussed, steady state income inequality enhances the effectiveness of monetary policy. The endogenization of the share of constrained households leads to an amplification of the transmission of monetary policy. This channel gets muted in case of full insurance. Full insurance can be reached in two ways: Introducing an optimal NK subsidy (zero profits) or full redistribution. Both, τ^S and τ^D, can be seen as redistribution parameters as they can equalize the household types: In case of $\tau^S \to \tau^{s^\star} = (\epsilon - 1)^{-1}$ (approximates marginal cost pricing), the profit share D/Y goes to 0 leading to steady state equality as the income difference between S and H arises from profit income.[13] In case of $\tau^D \to \lambda$, the redistribution of profits leads to equal household incomes by increasing the transfer income of H. Thus both factors can mitigate steady state income inequality (Γ) and hence weaken the effectiveness of monetary policy. Figure 3 and 4 clearly depict these complementarities. In this section, we examine in more detail the role of monopolistic rents and redistribution in this THANK framework with imperfect insurance. How does the new channel depend on monopolistic rents and redistribution?

[13] Another way to implement income inequality between household types could be to assume different productivity levels and wages.

The role of monopolistic rents (NK market power distortion). The difference between the blue ($\tau^S = 0$, full market power with $\Gamma = 1.0598$) and black line ($\tau^S = \tau^{S^\star}$, marginal cost pricing with $\Gamma = 1$) in panel B in figure 3 shows the complementarity between monopolistic rents and the endogenous share of constrained households. The larger the monopolistic rents (largest for $\tau^S = 0$ with a profit share of $1/\epsilon$), the more efficient the transmission of monetary policy on aggregate consumption. The more the firms are subsidized ($\tau^S \to \tau^\star$), the more equal the households become, the weaker the amplification effect. The negative effect of monetary tightening on aggregate consumption is 13.92% weaker if we compare the case of no subsidy at all ($\tau^S = 0$ with $\hat{y}_1 = -0.06959$) with the case of an optimal subsidy ($\tau^S = (\epsilon - 1)^{-1}$ with $\hat{y}_1 = -0.0599$), see panel B. The more equal the agents are, the lower the enhancing effect. The steady state inequality is decisive for amplification. The higher the steady state inequality, the stronger the effect of monetary policy on income inequality (panel J), consumption and income (panel B to F). Proposition 3 describes the complementarity:

Proposition 3 *Consider a contractionary monetary policy shock ($\hat{r}_t > 0$) and suppose $\delta > 0$. Monopolistic rents and the transmission of monetary policy are complementary as follows:*

(i) In case of monopolistic rents ($\tau^S < \frac{1}{\epsilon-1}$), the extent of the amplification effect on the transmission of monetary policy is larger, the larger the monopolistic rents ($\tau^S \to 0$).

(ii) In case of marginal cost pricing (optimal NK subsidy: $\tau^S = \frac{1}{\epsilon-1}$), the amplification effect on the transmission of monetary policy vanishes.

Heterogeneity in income composition is crucial here. The NK subsidy impacts the share of labor and profit income. The share of labor income plays an important role: The larger it is, the lower the amplification effect. The larger the monopolistic rents, the stronger the transmission of interest rate shocks. Contractionary monetary policy increases income inequality in both cases (panel J), whereby a larger share of labor income mitigates its effect on income inequality in this model. This result is contrary to the empirical findings of Furceri et al. (2018). They show that contractionary monetary policy increases income inequality, but this effect is larger for higher shares of labor income. However, it is important to consider that in our model, a higher share of labor income equalizes the households mitigating the amplification of interest rate shocks.

Another empirical analysis of Ampudia et al. (2018) emphasizes the importance of labor income for the effect of (unconventional) monetary policy on income inequality. Ampudia et al. (2018) find out that the asset purchase program reduced the income inequality in euro area countries by stabilizing employment. This positive effect on employment rates benefited especially low-income households.

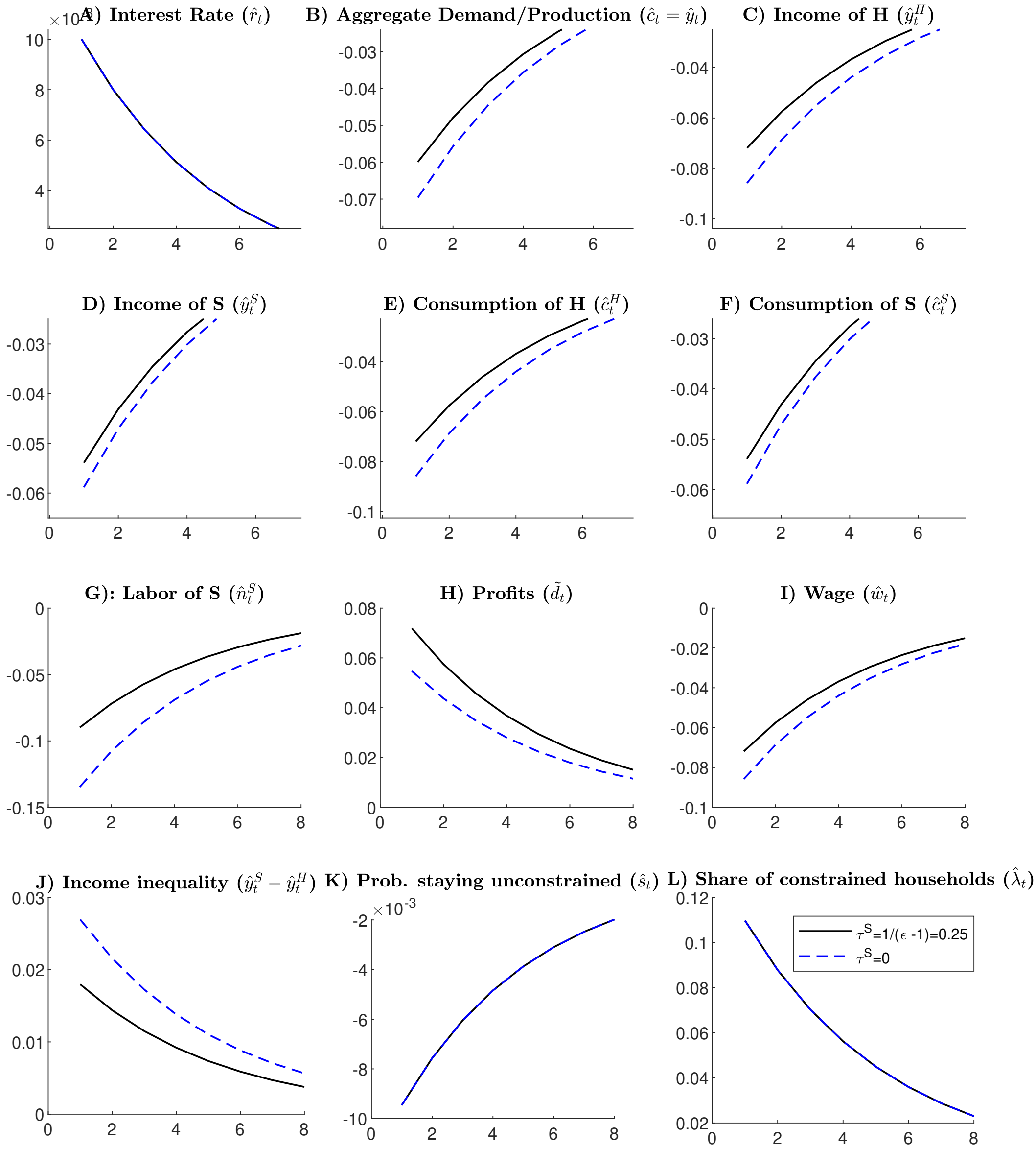

Figure 3: Impulse response functions (IRFs) of a contractionary monetary policy shock (interest rate rise of 1 percentage point) with $\delta = 1$, a subsidy ($\tau^S = (0; 0.25)$) and no redistribution ($\tau^D = 0$). The implied steady state inequality is $\Gamma = (1.0598; 1)$. The persistence of the shock is $p = 0.8$. Note: IRFs for $\hat{r}_t$, $\hat{s}_t$ and $\hat{\lambda}_t$ (panel A, K and L) are stacked for both cases.

The role of redistribution. Figure 4 shows the IRFs for an interest rate drop of 1 percentage point for different redistribution schemes and no subsidy. For $\tau^D = 0$, we have no redistribution with an implied steady state income inequality of $\Gamma = 1.0598$. For $\tau^D = \lambda$, the full redistribution case ($\Gamma = 1$) arises. The difference between the blue ($\tau^D = 0$ with $\hat{y}_1 = -0.06959$) and black line ($\tau^D = \lambda$ with $\hat{y}_1 = -0.05363$) in panel B shows how redistribution mitigates the amplification effect. The transmission of monetary policy to aggregate demand is weakened by 22.93% comparing no redistribution and full redistribution. The distribution of profits across the households is decisive for the transmission of monetary policy as it determines steady state income inequality. Full redistribution ($\tau^D = \lambda$) mutes the amplification effect. The additional aggregate demand effect vanishes as the households are equalized, similar to the THANK model of Bilbiie (2020) where full redistribution mutes the compounding in the NK cross. Proposition 4 summarizes the result:

Proposition 4 *Consider a contractionary monetary policy shock* ($\hat{r}_t > 0$) *and suppose* $\delta > 0$. *Redistribution of profits and the transmission of monetary policy are complementary as follows:*

(*i*) *In case of no full redistribution* ($0 < \tau^D < \lambda$)*, the amplification effect is mitigated. The higher the degree of redistribution* ($\tau^D \to \lambda$)*, the weaker the amplification effect.*

(*ii*) *In case of full redistribution* ($\tau^D = \lambda$)*, the amplification effect vanishes.*

Redistribution matters in two respects: It matters for the transmission of monetary policy on aggregate output by determining Γ. And it matters for the effect on income inequality $\hat{y_t}^S - \hat{y_t}^H$ (panel J) by determining how the profits are redistributed across the household types. Higher redistribution mitigates the effect of a contractionary interest rate shock on income inequality. This corresponds to the empirical work of Furceri et al. (2018).

The role of redistribution for the effectiveness of monetary policy shows how closely fiscal and monetary policy are connected. The linkage of fiscal and monetary policy is underlined by these results as in other THANK contributions. The higher the steady state inequality (through small redistribution or large monopolistic rents), the more effective monetary policy. In sum, higher inequality, in terms of steady state income inequality (Γ) and share of constrained households (λ_t), makes monetary policy more efficient in this THANK framework.

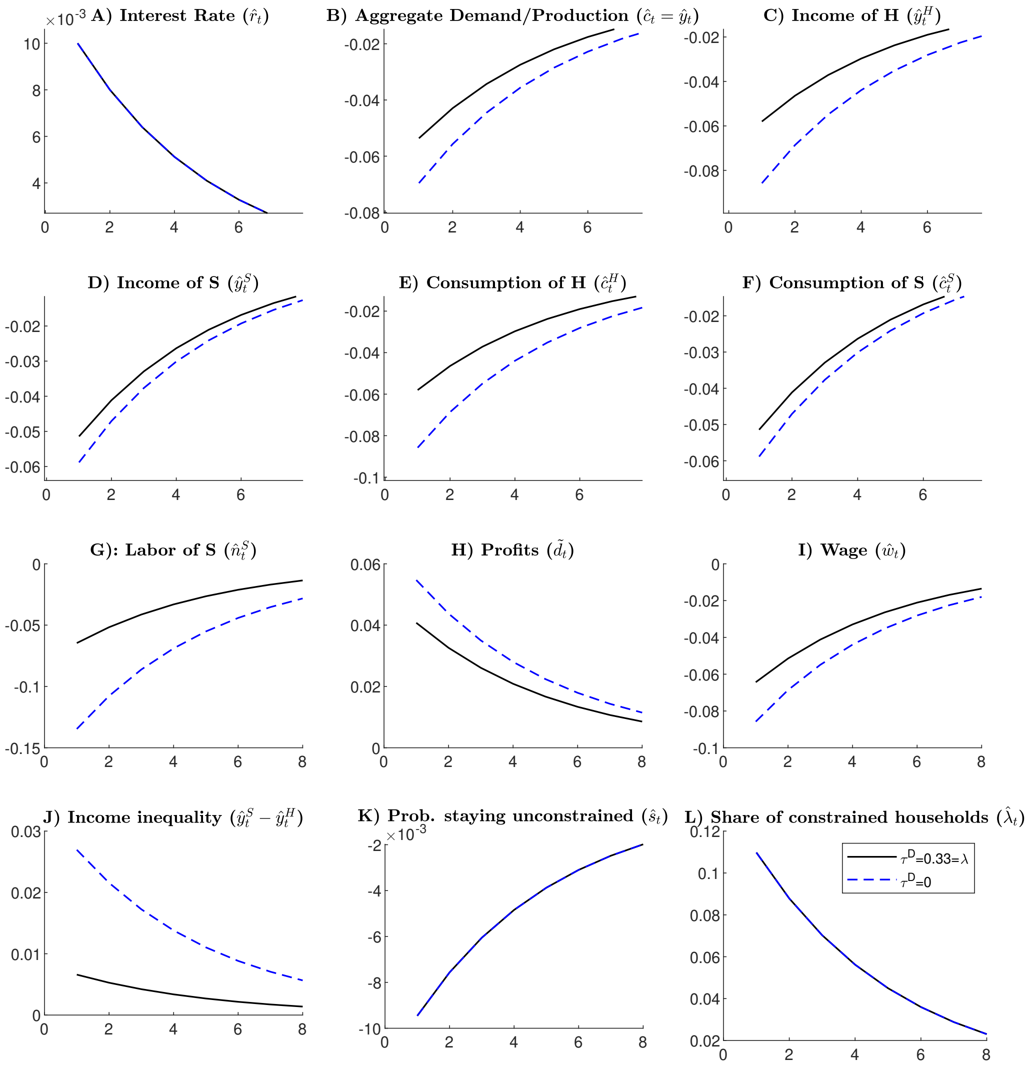

Figure 4: Impulse response functions (IRFs) of a contractionary monetary policy shock (interest rate rise of 1 percentage point) with different redistribution schemes with $\tau^D = (0; \lambda)$, $\delta = 1$ and no subsidy ($\tau^S = 0$). For $\tau^D = (0; \lambda)$ the implied steady state inequality is $\Gamma = (1.0598; 1)$. The persistence of the shock is $p = 0.8$. Note: IRFs for $\hat{r}_t$, $\hat{s}_t$ and $\hat{\lambda}_t$ (panel A, K and L) are stacked for both cases.

4.4 Robustness checks

For comparability with other heterogeneous agent models, the intertemporal substitution elasticity σ and the inverse Frisch elasticity of labor supply φ are calibrated to standard values ($\sigma = 1$ and $\varphi = 0.2$). There is no clear consensus in the literature on the empirical values for these elasticities (Chetty et al. 2011, Fiorito & Zanella 2012 and Havranek et al. 2015). In a meta-analysis of 169 empirical studies, Havranek et al. (2015) emphasize large heterogeneity across countries according to the estimates of σ with large standard deviations. They report a mean elasticity of 0.5 across all studies. The largest mean elasticity is reported for Austria with 3.149, the lowest for Switzerland with -0.434. This explains why Havranek et al. (2015) find a wide range of used calibration values for σ in different studies, ranging from 0.2 to 2. Chetty et al. (2011) propose 0.75 as a reasonable value for the Frisch elasticity of labor supply implying for the inverse a value of $\varphi \approx 1.33$. Fiorito & Zanella (2012) describe the value 0.75 of Chetty et al. (2011) as a lower limit for the Frisch elasticity of labor supply and report a range from 1.1 to 1.7 implying for the inverse values a range from approximately 0.588 to 0.909.

Because of the divergent empirical estimates for the two elasticities, we check how the amplification effect depends on the chosen values for σ and φ and look at values below and above the baseline calibration (see figure 5). We look at the amplification effect of section 4.2 and assume no subsidy ($\tau^S = 0$), no redistribution ($\tau^D = 0$) and an endogenous share of HtM ($\delta = 1$).

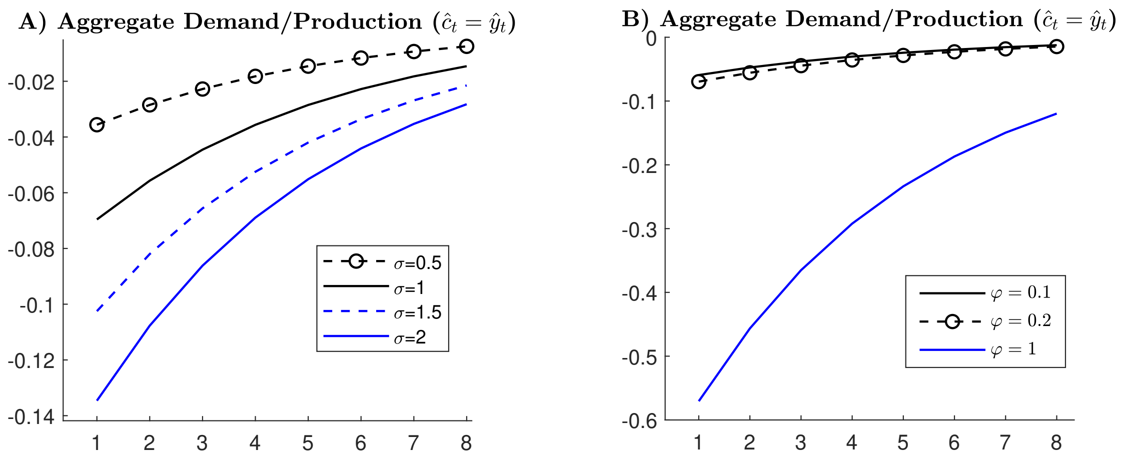

Figure 5: Impulse response functions (IRFs) of a contractionary monetary policy shock (interest rate rise of 1 percentage point) with different values for σ (panel A) and φ (panel B). We assume no redistribution ($\tau^D = 0$), no subsidy ($\tau^S = 0$) and an endogenous share of hand-to-mouth households ($\delta = 1$). The persistence of the shock is $p = 0.8$.

In the baseline calibration, σ is equal to 1. Here we additionally use the values 0.5, 1.5 and 2. For $\sigma = 0.5$, the steady state inequality is 1.0325, for $\sigma = 1.5$, $\Gamma = 1.0831$

and for $\sigma = 2$, $\Gamma = 1.1031$ (all other parameters as in section 4.2). Panel A of figure 5 shows the dependence of σ. The amplification effect is increasing in σ (see panel A) as it increases steady state inequality. For $\sigma = 1.5$, the aggregate demand response after an interest rate shock is 47.29% larger compared to $\sigma = 1$. For $\sigma = 2$, the corresponding increase is 93.45%. For $\sigma = 0.5$, the aggregate demand response is mitigated by 48.86% compared to the baseline scenario.

For φ, we check a more elastic ($\varphi = 0.1$) and a more inelastic labor supply ($\varphi = 1$). Steady state inequality is also increasing in φ. For $\varphi = 0.1$, $\Gamma = 1.0325$ and for $\varphi = 1$, $\Gamma = 1.1823$ (all other parameters as in section 4.2). For $\varphi = 0.1$, the aggregate demand response is mitigated compared to the baseline case as we have a lower steady state inequality. For an inelastic labor supply ($\varphi = 1$), the amplification effect is more than 8 times larger (see panel B) compared to $\varphi = 0.2$ as we have an even higher steady state inequality.

The amplification effect shows a high sensitivity according to σ and φ. Higher values for the two elasticities (compared to the baseline calibration) reinforce the amplification effect of monetary policy further. The robustness checks underline the importance of the additional channel through an endogenous share of constrained households and thus support our main results making our analysis more relevant.

5 Conclusion

In recent years, a fast growing body of literature emphasizes the effect of monetary policy on inequality, just as inequality matters for monetary policy (e.g. Auclert 2019, Kaplan et al. 2018, and more recently Acharya et al. 2023). On the one hand, restrictive monetary policy can increase income inequality (Coibion et al. 2017, Furceri et al. 2018). On the other hand, the literature stresses the importance of constrained households for the transmission of monetary policy. However, monetary policy can also impact the share of constrained households by affecting credit supply constraints. Monetary tightening increases the number of constrained households (Bosshardt et al. 2023). We examine the effect of monetary policy on the share of constrained households and how this effect impacts its transmission.

We implement the link between monetary policy shaping the financial conditions and the share of constrained households in a THANK framework based on Bilbiie (2020) by endogenizing the share of households living HtM. We endogenize the Markov switching process between HtM and saver households along the lines that Masson & Ruge-Murcia (2005) model the transition between different exchange rate regimes. The share is a function of monetary policy as the probability of staying unconstrained depends on the interest rate set by the central bank. Furthermore, we refrain from the assumption of a full insurance steady state (steady state equality) and build a THANK model with imperfect insurance (steady state inequality). In contrast to other THANK models, we work with a second-best equilibrium.

We find an amplification effect of inequality on the transmission of monetary policy. The endogenization leads to a stronger transmission. The negative effect of contractionary interest rate shocks on aggregate demand is amplified by the reaction of the share of HtM households. Higher interest rates increase its share leading to an additional negative aggregate demand effect. This new channel only operates in case of imperfect insurance (steady state inequality). The larger the steady state inequality, the more efficient the transmission of monetary policy. Furthermore, monetary tightening increases the income inequality between saver and HtM households during the adjustment process after an interest rate shock.

In addition, we examine how monopolistic rents and redistribution affect the new channel. Large monopolistic rents implying higher steady state inequality improve the efficiency of monetary policy. They are complementary to the amplification effect. Redistribution of firm profits equalizes the households and thus mitigates the amplification effect. Thus, steady state inequality plays a crucial role.

There are some limitations to mention. Empirics (Kaplan et al. 2014) show that the mass of HtM households can be split into poor and wealthy HtM households. As Bilbiie

(2020) states, the wealthy HtM households are only included in a “crude way” in this THANK framework. The assumption of no bond trading implies a degenerate wealth distribution, hence we cannot examine effects on wealth inequality in this setup. In addition, the link between interest rates and financial conditions depends on the variability of interest rates (Rubio 2011). In countries with adjustable rate mortgages as the prevalent case, the effect of interest rate changes on the number of financially distressed households is even stronger (Ampudia et al. 2016). Thus, the findings of this model should be more relevant for countries with a high share of adjustable rate mortgages.

A promising future avenue for research could be a THANK model including different countries forming a monetary union to capture heterogeneity across countries. As Ampudia et al. (2018) and Corsetti et al. (2022) underline, there are large differences across euro area countries regarding for example the share of HtM households and the proportion of adjustable rate mortgages. In such a framework, one could examine how the country differences impact the transmission of monetary policy and what optimal monetary policy should look like in such a setup. Additionally, it might be fruitful to look at financial stability in a heterogeneous agent model as Kumhof et al. (2015) emphasize in their model the role of increasing income inequality for higher leverage and financial crises.

The main take-aways are twofold. First, inequality (in terms of share of constrained households and in terms of steady state inequality) amplifies the transmission of monetary policy on aggregate demand in this setup. Second, we underline the importance of the assumption of full insurance (steady state equality) in THANK frameworks as our results are driven by imperfect insurance (steady state inequality).

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Appendix

A Detailed model description - derivation of model framework

This section describes the derivation of the model equations in the main text.

Based on Bilbiie (2020) the households sector contains a continuum of agents (indexed by $j \in (S, H)$) with unit mass. There are two household types: Saver (S) and hand-to-mouth (H) households. S participates in financial markets, H is excluded from them. An agent j optimizes life-time utility $E_0 \sum_{t=0}^{\infty} \beta^t (\frac{(C_t^j)^{1-1/\sigma}}{1-1/\sigma} - \frac{(N_t^j)^{1+\varphi}}{1+\varphi})$ over consumption C_t^j and labor supply N_t^j subject to a budget constraint.

Saver households. The intertemporal budget constraint of S can be derived as follows: We start with the sequence of flow budget constraints of S:

$$B_t^S + \Omega_{t+1}^S V_t \leq Z_t^S + \Omega_t^S (V_t + P_t D_t) + P_t W_t N_t^S - P_t C_t^S \tag{A1}$$

whereby B_t^S displays the nominal value of a portfolio containing all state-contingent assets at end of period t and Z_t^S its nominal value at beginning of period t. Share holdings in period t are represented by Ω_t^S (determined in $t-1$), its integral across all agents is 1. Real dividend payments in t are displayed by D_t and the nominal average market value of shares by V_t. The nominal wage in t is given by $P_t W_t$. The law of one price (no arbitrage) implies the existence of a stochastic discount factor $Q_{t,t+1}^S$ ensuring that $\frac{B_t^S}{P_t} = E_t[Q_{t,t+1}^S \frac{Z_{t+1}^S}{P_{t+1}}]$ and $\frac{V_t}{P_t} = E_t[Q_{t,t+1}^S (\frac{V_{t+1}}{P_{t+1}} + D_{t+1})]$ hold. The (riskless) real gross interest rate R_t is given by: $R_t^{-1} = E_t Q_{t,t+1}^S$. Inserting the expressions for $\frac{B_t^S}{P_t}$ and $\frac{V_t}{P_t}$ into the LHS of (A1):

$$E_t[Q_{t,t+1}^S \frac{Z_{t+1}^S P_t}{P_{t+1}}] + \Omega_{t+1}^S E_t[Q_{t,t+1}^S (\frac{V_{t+1}}{P_{t+1}} + D_{t+1}) P_t] = Z_t^S + \Omega_t^S (V_t + P_t D_t) + P_t W_t N_t^S - P_t C_t^S$$

$$\Leftrightarrow E_t[\frac{P_t}{P_{t+1}} Q_{t,t+1}^S (Z_{t+1}^S + \Omega_{t+1}^S (V_{t+1} + P_{t+1} D_{t+1}))] = Z_t^S + \Omega_t^S (V_t + P_t D_t) + P_t W_t N_t^S - P_t C_t^S$$

Using $X_t^S = Z_t^S + \Omega_t^S (V_t + P_t D_t)$ and dividing by P_t, we get the intertemporal budget constraint:

$$E_t[\frac{1}{P_{t+1}} Q_{t,t+1}^S X_{t+1}^S] \leq \frac{X_t^S}{P_t} + W_t N_t^S - C_t^S \tag{A2}$$

The FOCs deliver $\beta \frac{E_t U_C(C_{t+1}^S)}{U_C(C_t^S)} = Q_{t,t+1}^S$ and $W_t = -\frac{U_N(N_t^S)}{U_C(C_t^S)}$.

The expected marginal utility of consumption in $t+1$ ($E_tU_C(C^S_{t+1})$) takes into account that S can be unconstrained (with a probability of s_t) or constrained (with a probability of $(1-s_t)$) in $t+1$: $E_tU_C(C^S_{t+1}) = s_tU_C(C^S_{t+1}) + (1-s_t)U_C(C^H_{t+1})$.

Using $Q^S_{t,t+1} = \frac{1}{R_t} = \frac{1}{1+r_t}$, we get:

$$C_t^{S^{-1/\sigma}} = \beta(1+r_t)E_t[s_tC_{t+1}^{S^{-1/\sigma}} + (1-s_t)C_{t+1}^{H^{-1/\sigma}}] \tag{A3}$$

We log-linearize the Euler equation of S around the steady state with inequality ($C^S \neq C^H$). First, we approximate:

$$C^{S^{-1/\sigma}}(1-\frac{1}{\sigma}\hat{c}^S_t) = \beta(1+r_t)[(s(1+\hat{s}_t)C^{S^{-1/\sigma}}(1-\frac{1}{\sigma}E_t\hat{c}^S_{t+1})+(1-s(1+\hat{s}_t))C^{H^{-1/\sigma}}(1-\frac{1}{\sigma}E_t\hat{c}^H_{t+1})]$$

$$\Leftrightarrow C^{S^{-1/\sigma}}(1-\frac{1}{\sigma}\hat{c}^S_t) = \beta(1+r_t)[sC^{S^{-1/\sigma}} + (1-s)C^{H^{-1/\sigma}} + sC^{S^{-1/\sigma}}(-\frac{1}{\sigma}E_t\hat{c}^S_{t+1} + \hat{s}_t)$$
$$+(1-s)C^{H^{-1/\sigma}}(-\frac{1}{\sigma}E_t\hat{c}^H_{t+1} - \frac{s}{1-s}\hat{s}_t)]$$

We divide by its steady state relation $C^{S^{-1/\sigma}} = \beta(1+r)[sC^{S^{-1/\sigma}} + (1-s)C^{H^{-1/\sigma}}]$ and take the logarithm:

$$-\frac{1}{\sigma}\hat{c}^S_t = \hat{r}_t + \frac{1}{1+\frac{1-s}{s}\Gamma^{1/\sigma}}(-\frac{1}{\sigma}E_t\hat{c}^S_{t+1} + \hat{s}_t) + \frac{1}{1+\frac{s}{1-s}\Gamma^{-1/\sigma}}(-\frac{1}{\sigma}E_t\hat{c}^H_{t+1} - \frac{s}{1-s}\hat{s}_t)$$

with $\Gamma = C^S/C^H$. Multiplying with $-\sigma$ and rearranging lead to equation (1) in main text:

$$\hat{c}^S_t = \frac{1}{1+\frac{1-s}{s}\Gamma^{1/\sigma}}E_t\hat{c}^S_{t+1} + \frac{1}{1+\frac{s}{1-s}\Gamma^{-1/\sigma}}E_t\hat{c}^H_{t+1} + \frac{\Gamma^{1/\sigma}-1}{1+\frac{1-s}{s}\Gamma^{1/\sigma}}\sigma\hat{s}_t - \sigma\hat{r}_t \tag{A4}$$

Log-linearizing around the steady state with equality ($C^S = C^H = C$, also called full insurance steady state), we get the collapsed equation: $\hat{c}^S_t = sE_t\hat{c}^S_{t+1} + (1-s)E_t\hat{c}^H_{t+1} - \sigma\hat{r}_t$.[14]

From $W_t = -\frac{U_N(N^S_t)}{U_C(C^S_t)}$, it follows the (log-linearized) labor supply of S: $\hat{n}^S_t = \frac{\hat{w}_t}{\varphi} - \frac{1}{\sigma\varphi}\hat{c}^S_t$.

All S households hold the same fraction of shares in equilibrium: $\Omega^S = \frac{1}{1-\lambda}$. Additionally, we assume no bond trading as described in the main text. The income of S in t is the sum of labor and profit income in t: $Y^S_t = W_tN^S_t + \Omega^S_tD_t = W_tN^S_t + \frac{1}{1-\lambda_t}D_t$. S earns labor and profit income. Introducing redistribution of firm profits from S to H ($\tau^D > 0$), it follows:

$$Y^S_t = W_tN^S_t + \frac{1-\tau^D}{1-\lambda_t}D_t \tag{A5}$$

[14]Here we see an important difference to RANK and TANK models. Without switching between the two states (e.g. $s=1$), $E_tU_C(C^S_{t+1})$ is equal to $U_C(C^S_{t+1})$ delivering the RANK (without index S) and TANK Euler equation $\hat{c}^S_t = E_t\hat{c}^S_{t+1} - \sigma\hat{r}_t$.

Add $\frac{1-\tau^D}{1-\lambda_t}D - \frac{1-\tau^D}{1-\lambda_t}D$ to the RHS and divide by Y:

$$\frac{Y_t^S}{Y} = W_t \frac{N_t^S}{Y} + \frac{1-\tau^D}{1-\lambda_t}(\frac{D_t - D}{Y}) + \frac{1-\tau^D}{1-\lambda_t}\frac{D}{Y}$$

We replace $\frac{D_t-D}{Y}$ with $\tilde{d}_t$ and approximate:

$$\frac{Y^S(1+\hat{y}_t^S)}{Y} = W(1+\hat{w}_t)\frac{N^S}{Y}(1+\hat{n}_t^S) + \frac{1-\tau^D}{1-\lambda(1+\hat{\lambda}_t)}\tilde{d}_t + \frac{1-\tau^D}{1-\lambda(1+\hat{\lambda}_t)}\frac{D}{Y}$$

Rearranging:

$$Y^S(1+\hat{y}_t^S - \frac{\lambda}{1-\lambda}\hat{\lambda}_t) = WN^S(1+\hat{w}_t+\hat{n}_t^S - \frac{\lambda}{1-\lambda}\hat{\lambda}_t) + \frac{1-\tau^D}{1-\lambda}\tilde{d}_t Y + \frac{1-\tau^D}{1-\lambda}D$$

We subtract $Y^S = WN^S + \frac{1-\tau^D}{1-\lambda}D$:

$$Y^S(\hat{y}_t^S - \frac{\lambda}{1-\lambda}\hat{\lambda}_t) = WN^S(\hat{w}_t+\hat{n}_t^S - \frac{\lambda}{1-\lambda}\hat{\lambda}_t) + \frac{1-\tau^D}{1-\lambda}\tilde{d}_t Y$$

Rearranging leads to equation (2) in main text:

$$\hat{y}_t^S = \frac{WN^S}{Y^S}(\hat{w}_t+\hat{n}_t^S) + \frac{1-\tau^D}{1-\lambda}\frac{Y}{Y^S}\tilde{d}_t + \frac{\lambda}{1-\lambda}(1-\frac{WN^S}{Y^S})\hat{\lambda}_t \tag{A6}$$

In case of steady state equality, the income of S is given by: $\hat{y}_t^S = \hat{w}_t + \hat{n}_t^S + \frac{1-\tau_D}{1-\lambda}\tilde{d}_t$.

Hand-to-mouth households. For the hand-to-mouth (HtM) households H we assume that their borrowing constraint always binds. They are excluded from asset markets (no access to bonds or shares of firms) and face a borrowing limit of zero (extreme borrowing constraint). We have limited asset market participation leading to real HtM behaviour of H: $Y_t^H = C_t^H$ for all t, hence $\hat{y}_t^H = \hat{c}_t^H$. Taking into account the assumption of no bond trading (bonds are priced, but not traded in equilibrium), the budget constraint of H is (Transfers in t, Tr_t, are given by: $Tr_t = \frac{\tau^D}{\lambda_t}D_t$):

$$Y_t^H = W_t N_t^H + Tr_t = W_t N_t^H + \frac{\tau^D}{\lambda_t}D_t \tag{A7}$$

H earns labor income and receives transfer payments. There is no Euler equation for H, because H does not optimize intertemporally (not able to smooth consumption over several periods). Add $\frac{\tau^D}{\lambda_t}D - \frac{\tau^D}{\lambda_t}D$ to the RHS and divide by Y:

$$\frac{Y_t^H}{Y} = W_t \frac{N_t^H}{Y} + \frac{\tau^D}{\lambda_t}(\frac{D_t - D}{Y}) + \frac{\tau^D}{\lambda_t}\frac{D}{Y} = W_t \frac{N_t^H}{Y} + \frac{\tau^D}{\lambda_t}\tilde{d}_t + \frac{\tau^D}{\lambda_t}\frac{D}{Y}$$

Approximating:

$$\frac{Y^H(1+\hat{y}_t^H)}{Y} = W(1+\hat{w}_t)\frac{N^H}{Y}(1+\hat{n}_t^H) + \frac{\tau^D}{\lambda(1+\hat{\lambda}_t)}(\tilde{d}_t + \frac{D}{Y})$$

Rearranging:

$$Y^H(1+\hat{y}_t^H + \hat{\lambda}_t) = WN^H(1+\hat{w}_t + \hat{n}_t^H + \hat{\lambda}_t) + \frac{\tau^D}{\lambda}\tilde{d}_t Y + \frac{\tau^D}{\lambda}D$$

We subtract $Y^H = WN^H + \frac{\tau^D}{\lambda}D$ and divide by Y^H:

$$\hat{y}_t^H + \hat{\lambda}_t = \frac{WN^H}{Y^H}(\hat{w}_t + \hat{n}_t^H + \hat{\lambda}_t) + \frac{\tau^D}{\lambda}\tilde{d}_t\frac{Y}{Y^H}$$

Rearranging leads to equation (4) in main text:

$$\hat{y}_t^H = \hat{c}_t^H = \frac{WN^H}{Y^H}(\hat{w}_t + \hat{n}_t^H) + \frac{\tau_D}{\lambda}\frac{Y}{Y^H}\tilde{d}_t - (1 - \frac{WN^H}{Y^H})\hat{\lambda}_t \tag{A8}$$

In case of steady state equality, the income of H is given by: $\hat{y}_t^H = \hat{w}_t + \hat{n}_t^H + \frac{\tau_D}{\lambda}\tilde{d}_t$.

The optimization of life-time utility over labor supply (similar to S) leads to $W_t = -\frac{U_N(N_t^H)}{U_C(C_t^H)}$. After log-linearization, it follows the labor supply of H: $\hat{n}_t^H = \frac{\hat{w}_t}{\varphi} - \frac{1}{\sigma\varphi}\hat{c}_t^H$.

Firms. We assume a standard supply side as e.g. used in Bilbiie (2020). The households demand an aggregate basket of different goods C_t, an individual good is indexed by k with $k \in [0,1]$. C_t is given by the CES function: $C_t = (\int_0^1 C_t(k)^{\frac{\epsilon-1}{\epsilon}}dk)^{\frac{\epsilon}{\epsilon-1}}$. $\epsilon > 1$ describes the substitution elasticity between the different goods. $C_t(k)$ displays the demand for an individual good k and is given by: $C_t(k) = (\frac{P_t(k)}{P_t})^{-\epsilon}C_t$ depending on its individual price relative to the aggregate price index $(P_t(k)/P_t)$ and the total demand C_t. For the aggregate price index it holds: $P_t = (\int_0^1 P_t(k)^{1-\epsilon}dk)^{\frac{1}{1-\epsilon}}$.

The real profits of an individual firm producing an individual good k are given by $D_t(k) = \frac{P_t(k)}{P_t}Y_t(k) - W_tN_t(k)$. The production of an individual firm $Y_t(k)$ is linear in technology and uses labor $N_t(k)$ (with real wage W_t) as the only input factor: $Y_t(k) = N_t(k)$. We introduce the NK subsidy (τ^S): Firms can be compensated to set a price near or equal to marginal costs (in case of an optimal subsidy). The modified (real) profit function reads: $D_t(k) = (1+\tau^S)\frac{P_t(k)}{P_t}Y_t(k) - W_tN_t(k) - \tau^S Y_t$. The subsidy for each firm ($\tau^S \frac{P_t(k)}{P_t} Y_t(k)$) depends on its individual sales. The subsidy is paid by each firm as a lump-sum tax ($\tau^s Y_t$). An individual firm sets its optimal price in the inital steady state as follows: $P_t(k) = \frac{\epsilon}{(1+\tau^S)(\epsilon-1)} P_t W_t$. As there are no price adjustment processes afterwards, we can drop the time index for the individual and aggregate price ($P_t(k) = P(k)$ and $P_t = P$ for all t). Thus the optimal relative price (set in equilibrium) can be rewritten to $\frac{P(k)}{P} = \frac{\epsilon}{(1+\tau^S)(\epsilon-1)} W_t$. For deviations from steady state, this equation does not necessarily hold, as firms are not able to change their prices.

The subsidy ($\tau^S > 0$) mitigates the mark-up on marginal costs. In case of an optimal subsidy, the price equals marginal costs (real wage). The firms set their price as if they have no market power. In case of $\tau^S = 0$, we have full market power and no compensation. By setting τ^S (with $\tau^S \in [0, \tau^{S\star}]$), we decide by how much the market power should be undone. We assume that all firms make identical choices (therefore $P(k) = P, Y_t(k) = Y_t$ and $N_t(k) = N_t$). In aggregate terms, (real) profits are given by $D_t = Y_t - W_t N_t$.

In contrast to other NK models, we do not assume an optimal NK subsidy, hence we have profits in steady state ($D > 0$). Rearranging $D_t = Y_t - W_t N_t$ leads to:

$$\frac{D_t - D}{Y} = \frac{Y_t}{Y} - \frac{W_t N_t}{Y} - \frac{D}{Y} = \frac{1}{Y}(Y_t - W_t N_t - D) \tag{A9}$$

We set $\tilde{d}_t = \frac{D_t - D}{Y}$. Approximating around the steady state with imperfect insurance ($D > 0$) and using $WN = Y - D$:

$$\tilde{d}_t = \frac{1}{Y}(Y(1 + \hat{y}_t) - WN(1 + \hat{w}_t + \hat{n}_t) - D)$$

$$\Leftrightarrow \tilde{d}_t = \hat{y}_t - \hat{w}_t - \hat{n}_t + \frac{D}{Y}(\hat{w}_t + \hat{n}_t)$$

Considering the production function $\hat{y}_t = \hat{n}_t$, we get equation (7) in main text:

$$\tilde{d}_t = -\hat{w}_t(1 - \frac{D}{Y}) + \frac{D}{Y}\hat{n}_t \tag{A10}$$

with D/Y as the profit and $(1 - D/Y)$ as the labor share in equilibrium.

In case of an optimal subsidy, D is equal to zero and the equation collapses to: $\tilde{d}_t = -\hat{w}_t$.

Aggregate terms. Output is demand-determined ($\hat{y}_t = \hat{c}_t$). The equation $C_t = \lambda_t C_t^H + (1 - \lambda_t) C_t^S$ describes aggregate consumption which we approximate:

$$C(1 + \hat{c}_t) = \lambda(1 + \hat{\lambda}_t) C^H (1 + \hat{c}_t^H) + (1 - \lambda(1 + \hat{\lambda}_t)) C^S (1 + \hat{c}_t^S)$$

We rearrange terms and use the steady state relation $C = \lambda C^H + (1-\lambda)C^S$ to get:

$$\hat{c}_t = \lambda \frac{C^H}{\lambda C^H + (1-\lambda)C^S}\hat{c}_t^H + (1-\lambda)\frac{C^S}{\lambda C^H + (1-\lambda)C^S}\hat{c}_t^S - \lambda \frac{C^S - C^H}{\lambda C^H + (1-\lambda)C^S}\hat{\lambda}_t$$

$$\Leftrightarrow \hat{c}_t = \frac{1}{1 + \frac{(1-\lambda)}{\lambda}\frac{C^S}{C^H}}\hat{c}_t^H + \frac{1}{1 + \frac{\lambda}{1-\lambda}\frac{C^H}{C^S}}\hat{c}_t^S - \frac{\frac{C^S}{C^H} - 1}{1 + \frac{1-\lambda}{\lambda}\frac{C^S}{C^H}}\hat{\lambda}_t$$

Using $\Gamma = \frac{C^S}{C^H}$ we get equation (9):

$$\hat{y}_t = \hat{c}_t = \frac{1}{1 + \frac{1-\lambda}{\lambda}\Gamma}\hat{c}_t^H + \frac{1}{1 + \frac{\lambda}{1-\lambda}\Gamma^{-1}}\hat{c}_t^S - \frac{\Gamma - 1}{1 + \frac{1-\lambda}{\lambda}\Gamma}\hat{\lambda}_t \tag{A11}$$

For $\Gamma = 1$, it collapses to: $\hat{y}_t = \hat{c}_t = \lambda\hat{c}_t^H + (1-\lambda)\hat{c}_t^S$.

We approximate aggregate labor $N_t = \lambda_t N_t^H + (1-\lambda_t)N_t^S$:

$$N(1 + \hat{n}_t) = \lambda(1 + \hat{\lambda}_t)N^H(1 + \hat{n}_t^H) + (1 - \lambda(1 + \hat{\lambda}_t))N^S(1 + \hat{n}_t^S)$$

Subtracting its steady state relation $N = \lambda N^H + (1-\lambda)N^S$ and dividing by N, we get equation (10) for labor market clearing:

$$\hat{n}_t = \lambda\frac{N^H}{N}\hat{n}_t^H + (1-\lambda)\frac{N^S}{N}\hat{n}_t^S + \lambda\frac{N^H - N^S}{N}\hat{\lambda}_t \tag{A12}$$

In case of steady state equality, it collapses to: $\hat{n}_t = \lambda\hat{n}_t^H + (1-\lambda)\hat{n}_t^S$.

Share of constrained households. Here we show the derivation of the log-linearized equations (14) and (16).

We take the logarithm of $s_t = e^{\delta(\gamma - r_t)}(e^{\delta(\gamma - r_t)} + 1)^{-1}$ and approximate:

$$\ln s + \hat{s}_t = \delta(\gamma - r_t) - \ln(e^{\delta(\gamma - r)} + 1) + \delta\frac{1}{e^{\delta(\gamma - r)} + 1}\hat{r}_t$$

We subtract the steady state relation $\ln s = \delta\gamma - \delta r - \ln(e^{\delta(\gamma - r)} + 1)$:

$$\hat{s}_t = -\delta(1 - \frac{1}{e^{\delta(\gamma - r)} + 1})\hat{r}_t$$

Using $\gamma = r + \delta^{-1}\ln(\frac{s}{1-s})$ we get equation (14) in main text: $\hat{s}_t = -\delta s\hat{r}_t$.

The share of constrained households evolves according to $\lambda_t = \frac{1-s_t}{2-s_t-h}$. Taking the logarithm and approximating lead to:

$$\ln\lambda + \hat{\lambda}_t = \ln(1-s) - \hat{s}_t\frac{1}{\frac{1}{s} - 1} - \ln(2 - s - h) + \hat{s}_t\frac{1}{\frac{2}{s} - 1 - \frac{h}{s}}$$

We subtract the steady state relation $\ln \lambda = \ln(1-s) - \ln(2-s-h)$:

$$\hat{\lambda}_t = \hat{s}_t\left(-\frac{s}{1-s} + \frac{s}{2-s-h}\right)$$

Rearranging leads to equation (16) in main text:

$$\hat{\lambda}_t = -\frac{s(1-h)}{(1-s)(2-s-h)}\hat{s}_t \tag{A13}$$

B Derivation of steady state inequality Γ

Consumption and income inequality in steady state is described by Γ: $\Gamma = C^S/C^H = Y^S/Y^H$. Income and consumption inequality are interchangeable in this framework. The equation (11) can be calculated as follows: We start with

$$\Gamma = \frac{C^S}{C^H} = \frac{Y^S}{Y^H} = \frac{WN^S + \frac{1-\tau^D}{1-\lambda}D}{WN^H + \frac{\tau^D}{\lambda}D} \tag{B1}$$

and factor out Y:

$$\Gamma = \frac{Y(\frac{WN^S}{Y} + \frac{1-\tau^D}{1-\lambda}\frac{D}{Y})}{Y(\frac{WN^H}{Y} + \frac{\tau^D}{\lambda}\frac{D}{Y})} \tag{B2}$$

Remember $Y = N$ and $D = Y(1-W) \Leftrightarrow D/Y = 1 - W$:

$$\Gamma = \frac{\frac{WN^S}{N} + \frac{1-\tau^D}{1-\lambda}(1-W)}{\frac{WN^H}{N} + \frac{\tau^D}{\lambda}(1-W)} \tag{B3}$$

Factoring out W:

$$\Gamma = \frac{\frac{N^S}{N} + \frac{1-\tau^D}{1-\lambda}(\frac{1}{W}-1)}{\frac{N^H}{N} + \frac{\tau^D}{\lambda}(\frac{1}{W}-1)} \tag{B4}$$

Rearranging leads to:

$$\Gamma(\frac{N^H}{N} + \frac{\tau^D}{\lambda}(\frac{1}{W}-1)) - \frac{N^S}{N} = \frac{1-\tau^D}{1-\lambda}(\frac{1}{W}-1) \tag{B5}$$

$$\Leftrightarrow \Gamma\frac{N^H}{N} + \Gamma\frac{\tau^D}{\lambda}(\frac{1}{W}-1) - \frac{N^S}{N} = \frac{1-\tau^D}{1-\lambda}(\frac{1}{W}-1) \tag{B6}$$

Additionally, the labor supply inequality can be described by Γ (using $N^H/N^S = (C^S/C^H)^{\frac{1}{\sigma\varphi}} = \Gamma^{\frac{1}{\sigma\varphi}}$ from steady state labor supply from S and H): $N^H/N^S = \Gamma^{\frac{1}{\sigma\varphi}}$.
N^S/N is given by:

$$\frac{N^S}{N} = \frac{N^S}{\lambda N^H + (1-\lambda)N^S} = \frac{1}{\lambda N^H/N^S + (1-\lambda)} = \frac{1}{\lambda\Gamma^{\frac{1}{\sigma\varphi}} + (1-\lambda)} \tag{B7}$$

Accordingly N^H/N is given by:

$$\frac{N^H}{N} = \frac{1}{\lambda + (1-\lambda)\Gamma^{-\frac{1}{\sigma\varphi}}} = \frac{\Gamma^{\frac{1}{\sigma\varphi}}}{\lambda\Gamma^{\frac{1}{\sigma\varphi}} + (1-\lambda)} \tag{B8}$$

Inserting these expressions for N^S/N and N^H/N into (B6):

$$\Gamma \frac{\Gamma^{\frac{1}{\sigma\varphi}}}{\lambda\Gamma^{\frac{1}{\sigma\varphi}} + (1-\lambda)} + \Gamma\frac{\tau^D}{\lambda}(\frac{1}{W} - 1) - \frac{1}{\lambda\Gamma^{\frac{1}{\sigma\varphi}} + (1-\lambda)} = \frac{1-\tau^D}{1-\lambda}(\frac{1}{W} - 1) \tag{B9}$$

Rearranging LHS leads to the following polynomial equation (11) in the main text describing the steady state inequality Γ:

$$\frac{\Gamma^{\frac{\sigma\varphi+1}{\sigma\varphi}} - 1}{\lambda\Gamma^{\frac{1}{\sigma\varphi}} + (1-\lambda)} + \Gamma\frac{\tau^D}{\lambda}(\frac{1}{W} - 1) = \frac{1-\tau^D}{1-\lambda}(\frac{1}{W} - 1) \tag{B10}$$

Only non-negative and real numbers for Γ are taken as a solution.

In case of an optimal NK subsidy ($\tau^S = \tau^\star = \frac{1}{\epsilon-1}$ and thus $W = 1$), Γ collapses to 1 and we end up with the THANK model with full insurance. The same holds for $\tau^D = \lambda$ (full redistribution).

C Calibration

We choose a quarterly calibration, e.g. the discount factor is equal to 0.99 quarterly and $0.99^4 (\approx 0.96)$ yearly.

Table 1: Calibration

Parameters	Values	Description
	Standard parameters	
φ	0.2	Inverse Frisch elasticity
σ	1	Intertemporal substitution elasticity
β	0.99	Discount factor
p	0.8	Persistence of MP shock
ϵ	5	Substitution elasticity between goods
	THANK/Inequality parameters	
τ^D	$(0;\lambda)$	Redistribution
τ^S	$(0;\tau^{S^\star})$	NK subsidy
δ	$(0;1)$	Interest rate sensitivity of s_t
s	0.9457	St. st. probability of staying S
h	0.8915	St. st. probability of staying H
	Endogenous values	
λ	0.33	St. st. share of H
$\Gamma = \frac{C^S}{C^H} = \frac{Y^S}{Y^H}$	$(1;1.0598)$	St. st. consumption and income inequality
D/Y	$(0;0.2)$	St. st. profit share

The persistence parameter of a monetary policy shock is set to be 0.8 quarterly as in Gornemann et al. (2016). This corresponds to an annual persistence of $0.8^4 \approx 0.41$. The values for φ, σ, β and ϵ are standard values. We set $s = 0.9457$ and $h = 0.8915$ to get $\lambda = 0.3335 \approx 0.33$ (as in Pfäuti & Seyrich 2022).

Steady state inequality Γ is determined by labor market characteristics (φ), intertemporal substitution elasticity (σ), wage and profit share in equilibrium ($D/Y = 1 - W(\epsilon, \tau^S)$), redistribution ($\tau^D$) and the share of constrained households in equilibrium (λ). In case of $\tau^D = \lambda$, we have the full redistribution case (leading to steady state equality, $\Gamma = 1$). In case of $\tau^D = 0$, we have no redistribution at all. For $\tau^S = \tau^{S^\star} = 0.25$ we assume the optimal NK subsidy leading to marginal cost pricing (and thus steady state equality) and a steady state profit share D/Y of 0. In case of no subsidy ($\tau^S = 0$), D/Y is equal to 0.2. For $\tau^D = 0$, $\tau^S = 0$ and $\lambda = 0.33$ the implied steady state inequality is 1.0598.

D Overview about the THANK models

D.1 THANK model with steady state inequality

The table summarizes the log-linearized model equations of the THANK model with steady state inequality ($\Gamma = \frac{C^S}{C^H} > 1$) and an endogenous share of HtM households ($\delta > 0$).

Table 2: THANK model with $\Gamma > 1$ and $\delta > 0$

Description	Model equation
Labor supply of S	$\hat{n}_t^S = \frac{\hat{w}_t}{\varphi} - \frac{1}{\sigma\varphi}\hat{c}_t^S$
Labor supply of H	$\hat{n}_t^H = \frac{\hat{w}_t}{\varphi} - \frac{1}{\sigma\varphi}\hat{c}_t^H$
Labor market clearing	$\hat{n}_t = \lambda\frac{N^H}{N}\hat{n}_t^H + (1-\lambda)\frac{N^S}{N}\hat{n}_t^S + \lambda\frac{N^H - N^S}{N}\hat{\lambda}_t$
Consumption of S	$\hat{c}_t^S = \frac{1}{1+\frac{1-s}{s}\Gamma^{1/\sigma}}E_t\hat{c}_{t+1}^S + \frac{1}{1+\frac{s}{1-s}\Gamma^{-1/\sigma}}E_t\hat{c}_{t+1}^H$
	$+\frac{\Gamma^{1/\sigma}-1}{1+\frac{1-s}{s}\Gamma^{1/\sigma}}\sigma\hat{s}_t - \sigma\hat{r}_t$
Income of S	$\hat{y}_t^S = \frac{WN^S}{Y^S}(\hat{w}_t + \hat{n}_t^S) + \frac{1-\tau^D}{1-\lambda}\frac{Y}{Y^S}\tilde{d}_t + \frac{\lambda}{1-\lambda}(1 - \frac{WN^S}{Y^S})\hat{\lambda}_t$
Income and consumption of H	$\hat{y}_t^H = \hat{c}_t^H = \frac{WN^H}{Y^H}(\hat{w}_t + \hat{n}_t^H) + \frac{\tau_D}{\lambda}\frac{Y}{Y^H}\tilde{d}_t - (1 - \frac{WN^H}{Y^H})\hat{\lambda}_t$
Goods market clearing	$\hat{y}_t = \hat{c}_t = \frac{1}{1+\frac{1-\lambda}{\lambda}\Gamma}\hat{c}_t^H + \frac{1}{1+\frac{\lambda}{1-\lambda}\Gamma^{-1}}\hat{c}_t^S - \frac{\Gamma-1}{1+\frac{1-\lambda}{\lambda}\Gamma}\hat{\lambda}_t$
Real interest rate	$\hat{r}_t = p\hat{r}_{t-1} + \upsilon_t$
Probability of staying a saver	$\hat{s}_t = -\delta s\hat{r}_t$
Share of hand-to-mouth households	$\hat{\lambda}_t = \frac{\delta s^2(1-h)}{(1-s)(2-s-h)}\hat{r}_t$
Production	$\hat{y}_t = \hat{n}_t$
Profits	$\tilde{d}_t = \frac{D_t - D}{Y} = -\hat{w}_t(1 - \frac{D}{Y}) + \frac{D}{Y}\hat{n}_t$

Note: Variables with a hat describe log-deviations from their steady state (e.g. $\hat{\lambda}_t = \ln\lambda_t - \ln\lambda$). Except for $\hat{r}_t$ that describes absolute deviations. Variables without time index describe steady state values (e.g. λ).

D.2 THANK model with steady state equality

The table summarizes the log-linearized model equations of the THANK model with steady state equality ($\Gamma = 1$) and an endogenous share of HtM households ($\delta > 0$). In case of full insurance, the THANK model equations collapse to:

Table 3: THANK model with $\Gamma = 1$ and $\delta > 0$

Description	Model equation
Labor supply of S	$\hat{n}_t^S = \frac{\hat{w}_t}{\varphi} - \frac{1}{\sigma\varphi}\hat{c}_t^S$
Labor supply of H	$\hat{n}_t^H = \frac{\hat{w}_t}{\varphi} - \frac{1}{\sigma\varphi}\hat{c}_t^H$
Aggregate labor supply	$\varphi\hat{n}_t = \hat{w}_t - \frac{1}{\sigma}\hat{c}_t$
Labor market clearing	$\hat{n}_t = \lambda\hat{n}_t^H + (1-\lambda)\hat{n}_t^S$
Consumption of S	$\hat{c}_t^S = -\sigma\hat{r}_t + sE_t\hat{c}_{t+1}^S + (1-s)E_t\hat{c}_{t+1}^H$
Income of S	$\hat{y}_t^S = \hat{w}_t + \hat{n}_t^S + \frac{1-\tau^D}{1-\lambda}\tilde{d}_t$
Income and consumption of H	$\hat{y}_t^H = \hat{c}_t^H = \hat{w}_t + \hat{n}_t^H + \frac{\tau_D}{\lambda}\tilde{d}_t$
Goods market clearing	$\hat{y}_t = \hat{c}_t = \lambda\hat{c}_t^H + (1-\lambda)\hat{c}_t^S$
Real interest rate	$\hat{r}_t = p\hat{r}_{t-1} + \upsilon_t$
Probability of staying a saver	$\hat{s}_t = -\delta s\hat{r}_t$
Share of hand-to-mouth households	$\hat{\lambda}_t = \frac{\delta s^2(1-h)}{(1-s)(2-s-h)}\hat{r}_t$
Production	$\hat{y}_t = \hat{n}_t$
Profits	$\tilde{d}_t = -\hat{w}_t$

D.3 THANK model - steady state relations

The following table gives an overview of the equations in equilibrium.

Table 4: Model summary - steady state relations

Description	Model equation
Real wage	$W = (1+\tau^S)\frac{\epsilon-1}{\epsilon}$
Labor supply of S	$(N^S)^\varphi = W(C^S)^{-1/\sigma}$
Labor supply of H	$(N^H)^\varphi = W(C^H)^{-1/\sigma}$
Labor market clearing	$N = \lambda N^H + (1-\lambda)N^S$
Consumption of S	$(C^S)^{-1/\sigma} = \beta(1+r)(s(C^S)^{-1/\sigma}$
	$+(1-s)(C^H)^{-1/\sigma})$
	$\Leftrightarrow C^S = (\frac{1-s}{\frac{1}{\beta(1+r)}-s})^{-\sigma}C^H$
Real interest rate	$1+r = \frac{1}{\beta(s+(1-s)(C^H/C^S)^{-1/\sigma})}$
	$\Leftrightarrow 1+r = \frac{1}{\beta(s+(1-s)\Gamma^{1/\sigma})}$
Income of S	$Y^S = WN^S + \frac{1-\tau^D}{1-\lambda}D$
Income and consumption of H	$Y^H = C^H = WN^H + \frac{\tau^D}{\lambda}D$
Goods market clearing	$Y = C = \lambda C^H + (1-\lambda)C^S$
Production	$Y = N$
Profits	$D = Y - WN = Y(1-(1+\tau^S)\frac{\epsilon-1}{\epsilon})$
	$= Y(1-W)$
Profit share	$\frac{D}{Y} = 1-(1+\tau^S)\frac{\epsilon-1}{\epsilon} = \frac{1+\tau^S(1-\epsilon)}{\epsilon}$
	$= 1-W$
Steady state inequality	$\Gamma = \frac{C^S}{C^H} = \frac{Y^S}{Y^H}$
Steady state labor supply inequality	$\Gamma^{\frac{1}{\varphi\sigma}} = \frac{N^H}{N^S}$
Share of hand-to-mouth households	$\lambda = \frac{1-s}{2-s-h}$

In case of an optimal subsidy ($\tau^S = \frac{1}{\epsilon-1}$), the real wage is $W = 1$ and the profit share is zero. In case of no subsidy ($\tau^S = 0$), the profit share is $1/\epsilon$.