Household Inequality and the Transmission of QE in Euro Area Countries *

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Abstract

We estimate the dynamic effects of a high-frequency identified union-wide quantitative easing (QE) shock on real GDP, inflation and unemployment in all euro area countries. We document that the effects of QE are very heterogenous across countries as regards size, significance and timing, especially with respect to GDP and unemployment. Exploiting the panel structure of our dataset, we show that the effect of QE on real GDP is amplified by a larger fraction of liquidity-constrained households in a country. The latter result seems to be driven by the general equilibrium impact of QE on unemployment.

Keywords: Quantitative easing, inequality, LP-IV, DSGE, Household Finance and Consumption Survey (HFCS), Europe

JEL: E52, E58, E56, E24, C23, C26

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1 Introduction

In Latvia about 63% of households are *hand-to-mouth* (HtM), i.e., they hold so little liquid wealth that they are not able to smooth consumption when faced by unexpected shocks. In Malta this share of households amounts to only 10%. For the entire euro area the fraction is 28%. In the last decade, a significant part of research in monetary economics has been devoted to analyzing the role of such liquidity-constrained households in the transmission of monetary policy. Most notably, it was shown that the intertemporal substitution channel, which takes center stage in the monetary policy transmission mechanism in a Representative Agent New Keynesian (RANK) model, is significantly outweighed by other channels, in particular, by general equilibrium effects via labor markets, when considering Heterogenous Agent New Keynesian (HANK) models instead (e.g., Kaplan et al., 2018). As the different channels affect different types of households unequally, monetary policy can have redistributive consequences. Beyond this new consensus, it remains a debated question whether such a redistribution is a side effect of monetary policy, or whether it is a channel itself through which monetary policy affects macroeconomic variables (Auclert, 2019; McKay and Wolf, 2023). Furthermore, it is not unambiguous whether the redistribution channel potentially amplifies or dampens the aggregate response to shocks (Bilbiie, 2020).

We add to this discussion. In particular, based on a panel of euro area countries, we show that the effect of quantitative easing (QE) on real GDP is amplified by a larger fraction of liquidity-constrained households and by more responsive labor markets. A Two Agent New Keynesian (TANK) model is used to rationalize our empirical results. We are the first to provide evidence for the existence of a redistribution channel in the transmission of QE, which has been the main monetary policy tool of the European Central Bank (ECB) during the recent effective-lower-bound (ELB) episode.

Our analysis proceeds in three steps. First, we estimate the country-specific impulse responses of real GDP, inflation and unemployment to a high-frequency identified union-wide QE shock, using local projection instrumental variable (LPIV) regressions (e.g., Jordà et al., 2015; Ramey, 2016; Stock and Watson, 2018). Our sample covers the months 2014m6-2019m6 and all euro area member countries at that time. As instrument for our policy shock we use the monthly change in the the so-called 'QE-factor' (Altavilla et al., 2020). The latter is identified through a factor analysis of high-frequency movements in the yields of different assets with different maturities in a narrow time window around ECB press conferences. Altavilla et al. (2020) show that the 'QE-factor' has been the dominant policy factor during the recent ELB episode. Our first result is that, on average, QE shocks behave as demand shocks, i.e., in reaction to expansionary (contractionary) shocks real GDP and inflation increase (decrease) while unemployment decreases (increases). However, country-specific responses of GDP and unemployment to a union-wide QE shock are very heterogenous. In seven out of nineteen countries, the effects of a loosening shock on GDP are negative over the first quarter. This number reduces to five over the first year. With respect to unemployment, we find that, with a lag of about 4–6 months, unemployment is significantly reduced in reaction to a loosening shock in more than half of the countries. However, five countries actually experience an increase in unemployment over the first year. Our results regarding the macroeconomic consequences of a QE shock and also the observed cross-country heterogeneity are broadly in line with the results of previous studies (e.g., Altavilla et al., 2020; Lenza and Slacalek, 2024).

In the second part of our analysis, we analyze whether the share of liquidity-constrained households can account for parts of the observed cross-country heterogeneity with respect to the GDP response. To this end, we employ a panel LPIV estimation with country and time fixed effects (FE), in which we interact the QE shock with a measure of the degree of financial constraint of households. This approach allows us to obtain conditional estimates of the role of household heterogeneity in the transmission of QE, i.e., it ensures that our estimates do not capture the role of other structural heterogeneities or parallel trends in the euro area. The degree of financial constraint of households is approximated via six different measures which are constructed using data from the Household Finance and Consumption Survey (HFCS) and the European Union Statistics on Income and Living Conditions (EU-SILC). We obtain the result that a higher share of liquidity-constrained households significantly increases the strength of the repercussions of the QE shock. This effect is robust to using different measures of asset market participation of households and holds at various horizons. Our finding lends support to the view that the redistribution channel amplifies the aggregate effects of QE, because those households who gain most from a monetary expansion have higher marginal propensities to consume (MPC) (Auclert, 2019). Our result corroborates empirical evidence by Almgren et al. (2022), who find that euro area countries with a higher fraction of liquidity-constrained households exhibit a stronger output response to an unexpected interest rate change.

In the third part of our analysis, we shed further light on the transmission channels of household heterogeneity and QE shocks. As liquidity-constrained households are affected by monetary policy mainly through general equilibrium effects via labor markets, the strength of the redistribution channel hinges on the labor market response to monetary policy shocks. Hence, to provide further evidence for this channel, we analyze whether the responsiveness of labor markets can account for parts of the observed cross-country heterogeneity with respect to the GDP response. To isolate the marginal effect of the responsiveness of labor markets, we adopt an approach proposed by Cloyne et al. (2021) which applies the Kitagawa-Blinder-Oaxaca decomposition to a local projections estimation. This procedure involves, first, estimating the sensitivity of the unemployment rate to the QE shock, and, second, interacting the estimated unemployment sensitivity with the QE shock when estimating our panel LPIV. We find that a higher responsiveness of labor markets significantly amplifies the real GDP response to the QE shock over the entire first quarter. We interpret this result as further evidence for a significant role of the redistribution channel in the transmission of QE. Our finding is in the same vein as empirical evidence by Slacalek et al. (2020) which suggests that the differing effects of interest rate shocks on income inequality in Spain vis-à-vis Germany can be explained with differing labor market responses.

Furthermore, we employ a New Keynesian dynamic stochastic general equilibrium (DSGE) model with hand-to-mouth (HtM) households (Tsiaras, 2023) to rationalize the joint role of liquidity-constrained households and labor market responsiveness in the transmission of QE shocks.

Our paper essentially contributes to two strands of literature. First, to the strand of empirical literature which analyzes the role of household heterogeneity in the monetary policy transmission mechanism and, second, to the strand of research conducting cross-country studies of monetary policy transmission in the euro area. The study of Almgren et al. (2022), which also combines these two strands, is closest to ours. However, it focuses on the effects of a high-frequency identified *conventional* monetary policy shock. Therefore, quite naturally, also their time sample is different to ours (2000m1-2012m12). They find some heterogeneity in output responses to the monetary policy shock, however, cross-country differences are much smaller than for our QE shock, and most countries display significant positive real GDP reactions to an expansionary monetary policy shock. Using scatterplots, they show that the fraction of liquidity-constrained households and output responses to the shock correlate positively. Compared to our estimation procedure, their correlation analysis yields unconditional results. The bulk of further studies belonging to the first strand of the literature, analyze the effect of monetary policy on inequality. Most of them concentrate on the effects of *conventional* monetary policy. With respect to the effects of central bank asset purchases, coverage is much scarcer. Closest to ours is the analysis by

Lenza and Slacalek (2024) which studies the effects of the same high-frequency identified QE shock on inequality in four euro area countries. They show that general equilibrium effects via the labor market play the most important role in reducing consumption inequality after QE shocks.[1] To our knowledge, we are the first to provide evidence for the relevance of the redistribution channel in the transmission of QE shocks. The second strand of literature to which we contribute conducts cross-country studies of monetary policy transmission in the euro area. Again, the bulk focuses on *conventional* monetary policy and, hence, is not further discussed here. Burriel and Galesi (2018) and Boeckx et al. (2017) are the only exceptions in this regard. Both estimate Global Vector Autoregressions (GVAR) to analyze the effects of common unconventional monetary policy shocks in euro area countries. They measure policy as unexpected changes in the size of the ECB's balance sheet and cover time periods different from ours (2007m1 to 2015m9 and 2007m1 to 2014:m1, respectively). They find positive GDP responses to expansionary unconventional monetary policy shocks in most countries. However, "financially stressed" countries (Cyprus, Greece, Ireland, Italy, Portugal, and Spain) or countries whose banks were less capitalized during the period of interest display relatively smaller or even negative GDP responses. To our knowledge, we are the first to document the heterogenous transmission of a state-of-the-art identified QE shock across all euro area countries during the ELB period, and to show that the effects of QE on GDP and unemployment have been insignificant or even significantly adverse in some of the countries.

Our results are important in various regards. First, the large cross-country heterogeneity in the impulse responses, and, especially, the finding that some countries exhibit sizable and significant adverse reactions to expansionary QE shocks call for further investigation. We restrict our attention to the fraction of liquidity-constrained households and the responsiveness of labor markets as

[1] Colciago et al. (2019) provides an excellent overview of the empirical studies analyzing the effect of monetary policy on inequality.

potential drivers of the observed cross-country heterogeneity. However, there might be further important structural differences between countries that explain our result and that need to be identified and taken into account when designing future asset purchase programs. Second, our result on the role of liquidity-constrained households in the transmission of QE shocks adds to the discussion on the existence and the direction of the redistribution channel of monetary policy. It can guide future modeling efforts as well as inform policy makers about the likely consequences of their policy actions.

Section 2 explains how the QE shock is identified. In section 3, we outline the data, explain the specification of the LPIV regression and discuss its results. In section 4, we analyze the role of liquidity-constrained households in the shock transmission. We provide information on the measures of liquidity constraint and the estimation strategy and discuss the results. Section 5 provides insights on the role of labor markets in the shock transmission. Section 6 discusses our results in the light of a DSGE model. The last section concludes.

2 Identification of QE Shocks

In order to quantify the effects of quantitative easing by the ECB, we need to first identify the exogenous unexpected component of the ECB's asset purchase programs. We resort to a high-frequency approach to identifying monetary policy surprises. In particular, we use the dataset and the method provided by Altavilla et al. (2020). The dataset is the euro area Monetary Policy Event-Study Database (EA-MPD), which contains changes in a variety of European interest rates with different maturities within narrow time windows around the press release and the press conference following the regular meetings of the ECB's Governing Council.

Altavilla et al. (2020) use principal component analysis to estimate the common drivers of the yield changes in their dataset (see also Gürkaynak et al., 2005; Swanson, 2021). Over the entire time period they consider (2002m1 - 2018m9), they find one statistically significant factor in the press release window and three statistically significant factors in the press conference window. However, if they split the sample into pre-QE and QE, they find that the third factor is only significant during the QE period (2014m1 to 2018m9). As the common latent factors do not have a clear-cut interpretation as monetary policy surprises, the factors are rotated imposing some restrictions on the rotation matrix (see also Swanson, 2021). The three rotated factors are dubbed "target rate", "forward guidance" and "QE" and the authors show that they capture almost all the variation in the yield curve. The QE factor has been dominant in the recent period (from 2014m1 onwards). Its effects get larger with increasing maturity, peaking at 10-year maturity. It has substantial immediate effects on yields and the effects are long lasting (half-life of one year).

The instrument series obtained from this method is at the same frequency as the meetings of the Governing Council. As these meetings take place at different days of the month we follow Gertler and Karadi (2015) and convert the shock series to monthly frequency by weighing the shocks by their date of occurrence. In particular, we set the cumulated QE factor, QE_d^{cum} on a particular day to its value of the previous day if no meeting takes place, and to its value of the previous day plus the value of the QE factor, QE_d^{PCA}, on this particular day, otherwise.

$$QE_d^{cum} = \begin{cases} QE_{d-1}^{cum} & \text{if } QE_d^{PCA} = 0 \text{ on day } d \\ QE_{d-1}^{cum} + QE_d^{PCA} & \text{otherwise.} \end{cases} \tag{1}$$

Then, we calculate the QE shock of a particular month as the difference between this month' and the previous month' average cumulated QE factor

$$QE_m = \frac{1}{D_m} \sum_{D \in m} QE_d^{cum} - \frac{1}{D_{m-1}} \sum_{D \in m-1} QE_d^{cum}, \tag{2}$$

where D_m is the number of days in month m.

3 Macroeconomics Effects of QE Shocks in Euro Area Countries

In order to analyze the effectiveness of QE in the euro area, we estimate country-specific Impulse Response Functions (IRF) to quantitative easing shocks relying on the Local Projections (LP) approach pioneered by Jordà (2005). The following section provides the estimation strategy and information on our dataset. In section 3.2 we present the results.

3.1 Estimation Strategy and Data

We interpret the identified QE shock as an instrument for the true (unobserved) policy shock, and, hence, rely on a Local Projections Instrumental Variable (LPIV) approach to obtain impulse responses (see, e.g., Jordà et al., 2015; Ramey, 2016; Stock and Watson, 2018). In particular, we follow Ramey (2016) and implement a one-step instrumental variable regression, i.e., we treat our instrument directly as the shock. This approach has the advantage that the shock is exactly the same for each country.[2]

We estimate the effect of the QE shock at time t on certain macroeconomic variables, y, in country n using the following sequence of regressions

$$\begin{aligned} y_{n,t+h} - y_{n,t-1} &= \alpha_n^h + \beta_n^h \mathrm{QE}_t + \sum_{j=1}^{p} \Gamma_{n,j}^h X_{t-j} \\ &\quad + \sum_{j=1}^{p} \Lambda_{n,j}^h y_{n,t-j} + u_{n,t+h} \ , h = 0, \ldots.., H, \end{aligned} \tag{3}$$

where X denotes a set of lagged union-wide control variables. The latter include

[2] A common alternative to our approach, advocated, e.g., by Stock and Watson (2018), entails a two-step procedure, in which, first the variable to be instrumented is regressed on the instrument, and, second, the fitted values of the first-stage regression are used as the policy shock of interest in the second-stage regression. As both regressions need to contain the same set of regressors and our regression equation contains country-specific regressors, the two-step procedure yields country-specific fitted values of the policy shock in our case. As a robustness check, we re-estimated all of our equations using the two-step procedure and obtained largely the same results. They are available upon request.

the log of the deseasonalized Harmonised Index of Consumer Prices (HICP), the log of the real gross domestic product (GDP) and the QE shock itself.[3] The number of lags, p, is set to three, which is common in the literature. As dependent variables (y) we use log real GDP, log HICP, and the unemployment rate.

Most data used in the regressions is available at monthly frequency from Eurostat and the ECB Statistical Data warehouse. GDP data is only available at quarterly frequency. As common in the related literature (Boeckx et al., 2017; Burriel and Galesi, 2018; Almgren et al., 2022), we use the Chow-Lin interpolation to construct a monthly GDP measure based on industrial production and retail trade data, which is available at monthly frequency. We restrict our sample to cover the ELB episode 2014m6-2019m6.

3.2 Results

In the following, we present and discuss the effects of a QE shock on real GDP, HICP and the unemployment rate. To be comparable to the related literature, we scale the shock to reflect a 30 bps impact reduction in the long-term euro area interest rate, following Lenza and Slacalek (2024). The latter, in turn, reference Altavilla et al. (2020) with respect to the shock scale. However, it should be noted that Altavilla et al. (2020) run a daily VAR. Hence, the 30 bps impact reduction in the euro area long-term interest rate yield reported by Altavilla et al. (2020) should translate into a much smaller reduction when considering the entire first month after the shock. Therefore, we consider our impulse responses and the ones by Lenza and Slacalek (2024) to reflect a rather large shock.

Figure 1 shows the dynamic effects of a QE shock on real GDP in 19 euro area countries and the euro area in total. As shown in the last panel, on average, effects are negative and slightly significant in the first month, but positive and partly significant thereafter. Eleven months after the shock, real euro area GDP

[3] Lags of the QE shock are included following Ramey (2016), who notes that the construction of the instrument as described by equations (1) and (2) introduces serial correlation which can be taken care of by including lagged values of the instrument.

is on average 1.5% larger than in the month before the shock hit and the effect is significant at a 90% confidence level. Considering the individual countries, the effects are very heterogenous. Austria, Finland, Germany, Ireland, Italy, and Slovakia experience a slightly signifiant drop in real GDP within one month after the shock. Of these countries, in Austria, Italy and Slovakia, the GDP response turns positive and (slightly) significant thereafter. On the other hand, in Belgium, Cyprus, France, Greece, Latvia, Lithuania, Portugal, Slovakia, Slovenia and Spain already the initial reaction (on impact or first month) is positive and (slightly) significant. Taking into account the entire first year after the shock, the largest positive and significant responses are shown by Ireland and Malta. Greece also exhibits a large positive and significant GDP reaction. This is quite remarkable, as Greece was excluded from actual asset purchases. Belgium, Estonia, France, Italy, Latvia, Portugal, Slovakia and Spain also show large positive and significant responses at some horizons over the first year. Luxembourg and the Netherlands exhibit significant negative effects approximately 6-12 months after the shock.

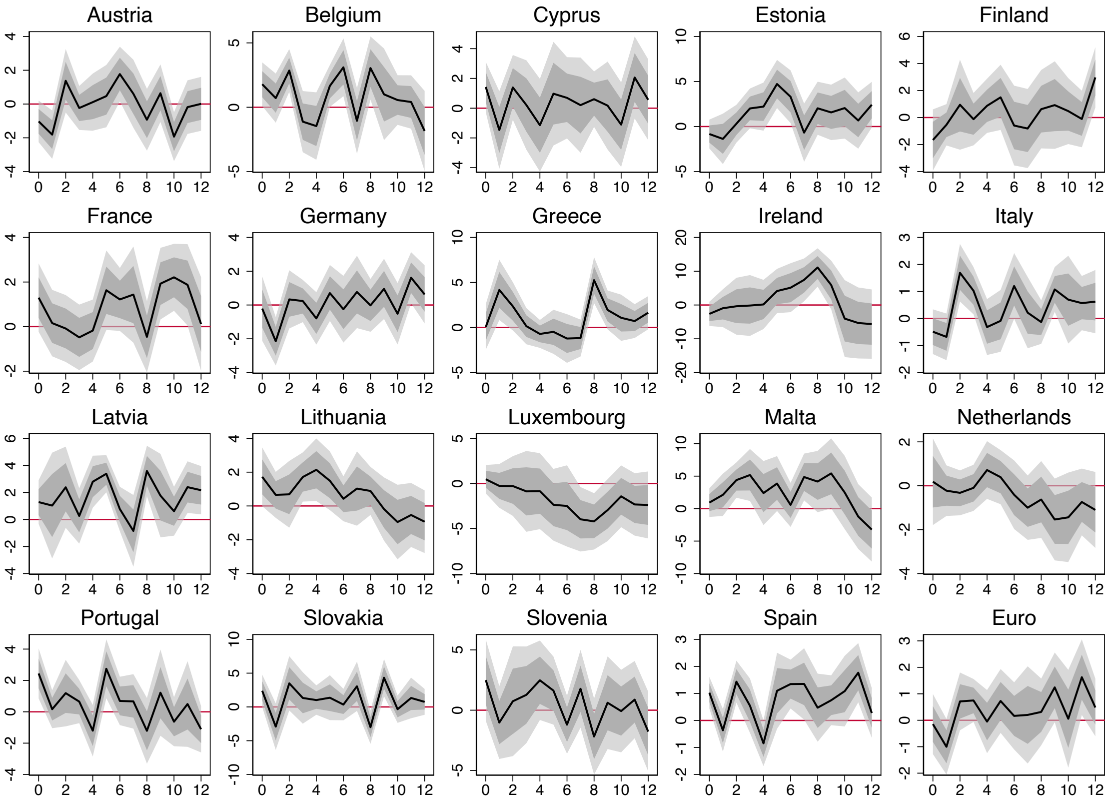

Figure 1: ***Impulse responses of real GDP to an expansionary QE shock.*** QE shock is scaled to reflect a 30 bps impact reduction in the long-term euro area interest rate. Y-axis measures the percentage change in GDP relative to the period before the shock hit. Light and dark gray areas represent 68 and 90 per cent confidence intervals, respectively.

With respect to prices (figure 2), the shock transmission is more homogenous across countries. The QE shock behaves as a classic expansionary monetary policy shock, significantly raising consumer prices over the first 10 month in almost all euro area countries.

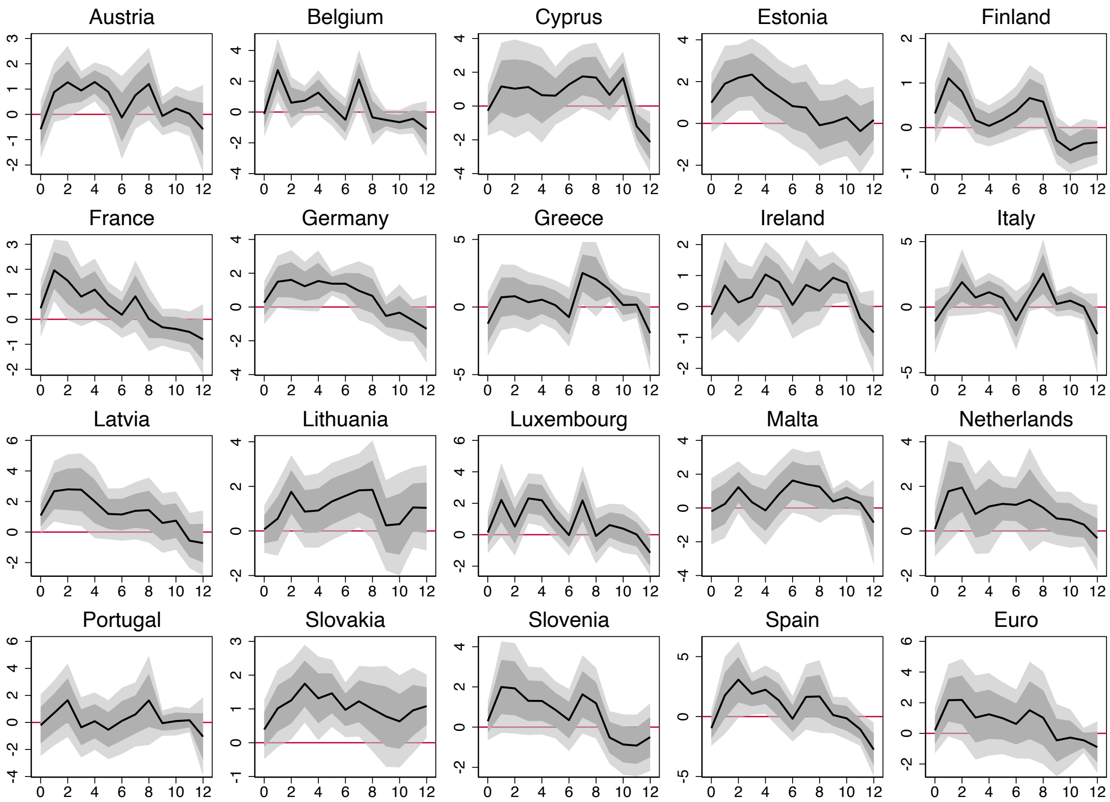

Figure 2: ***Impulse responses of the HICP to an expansionary QE shock.*** QE shock is scaled to reflect a 30 bps impact reduction in the long-term euro area interest rate. Y-axis measures the percentage change in the HICP relative to the period before the shock hit. Light and dark gray areas represent 68 and 90 per cent confidence intervals, respectively.

Figure 3 shows the reaction of the unemployment rate to the shock. Most countries and also the euro area in total experience a (slightly) significant decline in the unemployment rate. On the other hand, in Germany, Lithuania and Malta, the unemployment rate exhibits a significant increase starting approximately 6 months after the shock. The impulse responses we obtain for Spain are qualitatively and quantitatively very similar to those obtained by Lenza and Slacalek (2024). However, contrary to their results, we do not find a reduction in the unemployment rate in France and Germany, and we find a persistent reduction of unemployment in Italy.

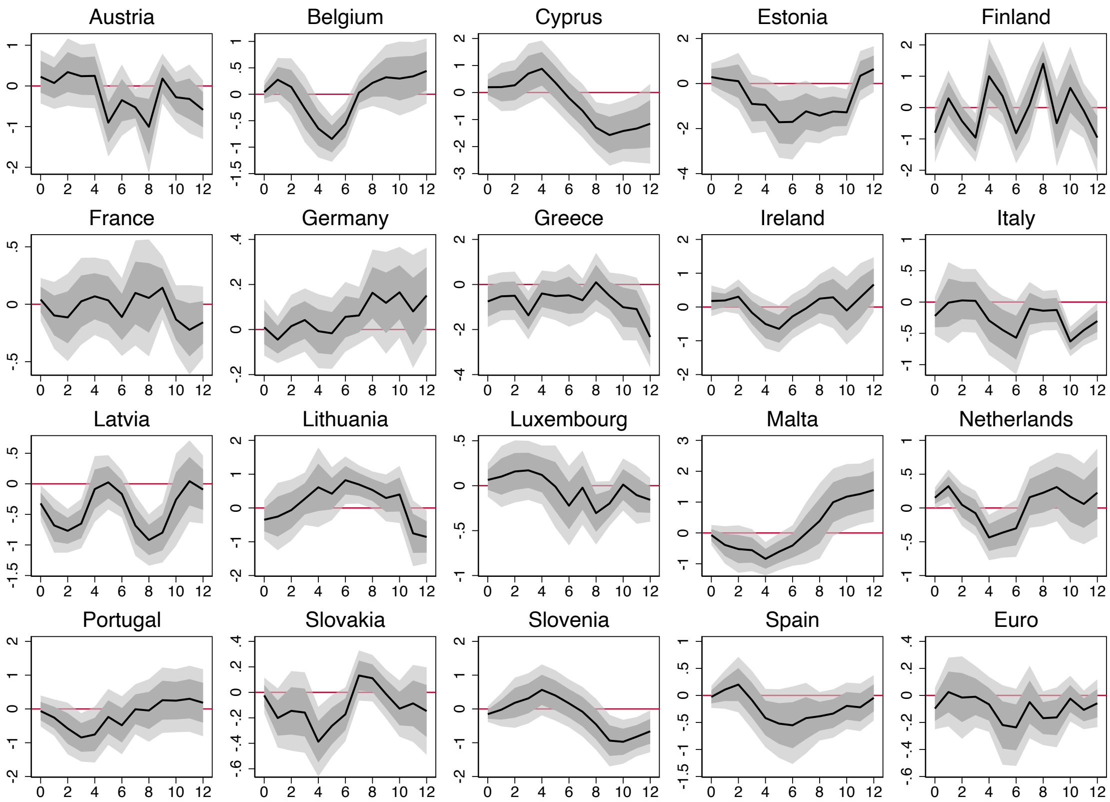

Figure 3: ***Impulse responses of the unemployment rate to an expansionary QE shock.*** QE shock is scaled to reflect a 30 bps impact reduction in the long-term euro area interest rate. Y-axis measures the percentage point change in the unemployment rate relative to the period before the shock hit. Light and dark gray areas represent 68 and 90 per cent confidence intervals, respectively.

In summary, we find that in most countries quantitative easing, by and large, has expansionary effects. However, the cross-country heterogeneity with respect to the size and the timing of the effects is large. In the remaining sections, we analyze whether the share of liquidity-constrained households and the responsiveness of labor markets can account for parts of the observed cross-country heterogeneity with respect to the GDP response to the QE shock.

4 Limited Asset Market Participation and the GDP Response

We now turn to an analysis of how household heterogeneity matters for the transmission of QE to real GDP. The role of household heterogeneity in the transmission of monetary policy is rooted in two factors. First, households exhibit different MPCs, depending on their degree of asset market participation and their income. HtM households spend all of their available resources in every period, i.e., have a marginal propensity to consume out of transitory income changes close to one (e.g., Kaplan et al., 2014). Second, monetary policy can have unequal or even opposing effects on the income and wealth of households with different MPCs and, thereby, have redistributive effects. These effects can be classified into direct and indirect ones (e.g., Ampudia et al., 2018). Direct effects refer to the immediate effects of the change in the interest rate on households' incentives to save and consume and on households' financial income. Indirect effects of monetary policy refer to the general equilibrium impact of monetary policy on wages and employment. A priori, it is not clear whether and how the share of liquidity-constrained households matters for the GDP response to monetary policy shocks: While households with high asset holdings might profit from an asset price increase in response to expansionary shocks, households with little (liquid) wealth might be overproportionately affected by an increase in labor income and employment, leaving the total effects of monetary policy on the income distribution negligible.[4] And even if an expansionary shock compresses the income distribution because households with a high MPC overproportionately profit from it, their share in total consumption might be small compared to that of households with a lower MPC, leaving the effects of the shock on aggregate consumption and GDP negligible.

In this section, we shed further light on this issue by estimating a panel LPIV

[4] Ampudia et al. (2018), Colciago et al. (2019) and McKay and Wolf (2023) provide excellent surveys of empirical and theoretical studies analyzing and quantifying such effects.

regression, in which we interact the QE shock with different measures of asset market participation of households. Section 4.1 outlines the estimation strategy, section 4.2 explains the measures of liquidity constraints of households we use, and section 4.3 provides the results.

4.1 Estimation Strategy

We estimate the following sequence of panel regressions,

$$\begin{aligned} y_{n,t+h} - y_{n,t-1} &= \alpha_n^h + \alpha_t^h + \beta^h (x_n - \bar{x}) \mathrm{QE}_t \\ &+ \sum_{j=1}^{p} \Gamma_{n,j}^h y_{n,t-j} + u_{n,t+h} \ , h = 0, \ldots.., H, \end{aligned} \tag{4}$$

where $x_n - \bar{x}$ is the demeaned country-specific measure of asset market participation of households. The coefficient of interest is now β^h. It captures the marginal effect of a one standard deviation higher value of the measure of asset market participation on the responsiveness of the variable of interest with respect to a QE shock.

The inclusion of the time FE, α_t^h, accounts for covariates which are equal for all countries, including macroeconomic variables, in a flexible way. Hence, including common covariates such as macroeconomic controls and the shock itself, is no longer necessary. The inclusion of the country FE, α_n^h, ensures that β^h indeed only captures the heterogeneity caused by the parameter of interest.

4.2 Measures of Liquidity Constraints of Households

To measure the fraction of financially constrained households in euro area countries, we rely on data from the Eurosystem Household Finance and Consumption Survey (HFCS) and the European Union Statistics on Income and Living Conditions (EU-SILC). The former contains data from over 84,000 households and, thus far, three waves have been conducted (2013, 2016, 2020). The latter survey is conducted yearly by the national statistical authorities.

For our analyses, we use the average holdings of financial assets per household from the HFCS 2016 and five measures of liquidity constraint of households constructed by Almgren et al. (2022). The latter rely on data from the 2016 wave of the HFCS and the EU-SILC survey from 2005. The older vintage from the EU-SILC is used to overcome potential biases stemming from the fact that the sample periods of the HFCS-based measures coincide with the end of the European sovereign debt crisis (2013) or might have been affected by the QE shocks we analyze. Table 1 gives an overview of the six measures we employ. All measures apart from "Financial Assets" are taken from Almgren et al. (2022). Note that the Almgren et al. (2022) measures indicate the degree of asset market exclusion while our measure "Financial Assets" captures the degree of asset market participation. The variable "Potentially Financially Vulnerable Type 3" (PFV3) measures the most extreme form of exclusion from asset markets. It reflects the share of households who are already in financial difficulties while the other indicators reflect the potential of not being able to meet the bills. The correlation between all measures is quite high, as table 2 in the appendix shows.

Measure	Definition	Source
HtM	Fraction of hand-to-mouth households, i.e., households whose liquid wealth is smaller than 50% of their monthly income	HFCS 2016
Lottery	Mean percentage of a hypothetical lottery win households would spend over the next 12 months	HFCS 2020
Financial Assets	Mean financial asset holdings of households (in thousand euros)	HFCS 2016
PFV1	Fraction of households whose expenses were about the same as or exceeded income over the last 12 months	HFCS 2016
PFV2	Fraction of households, who out of their own resources, would not be able to cover a hypothetical, unexpected, required financial expense equal to the national monthly at-risk-of-poverty threshold	EU-SILC 2005
PFV3	Fraction of households who were unable to pay utility bills on time during the last year (have been in arrears) due to financial difficulties	EU-SILC 2005

Table 1: ***Measures of Liquidity Constraints of Households*** All measures apart from "Financial Assets" are taken from Almgren et al. (2022). PFV stands for Potentially Financially Vulnerable.

Figure 9 in the Appendix provides an overview of the distribution of the parameter values across our set of countries. With respect to the fraction of HtM consumers, cross-country variation is quite high, ranging from around 10% in Malta to about 63% in Latvia. The same holds for PFV3, however, this measures takes on much smaller values, ranging from about 2% in Austria to about 26% in Greece. Notably, these two measures show the highest pairwise correlation (0.8).

4.3 Results

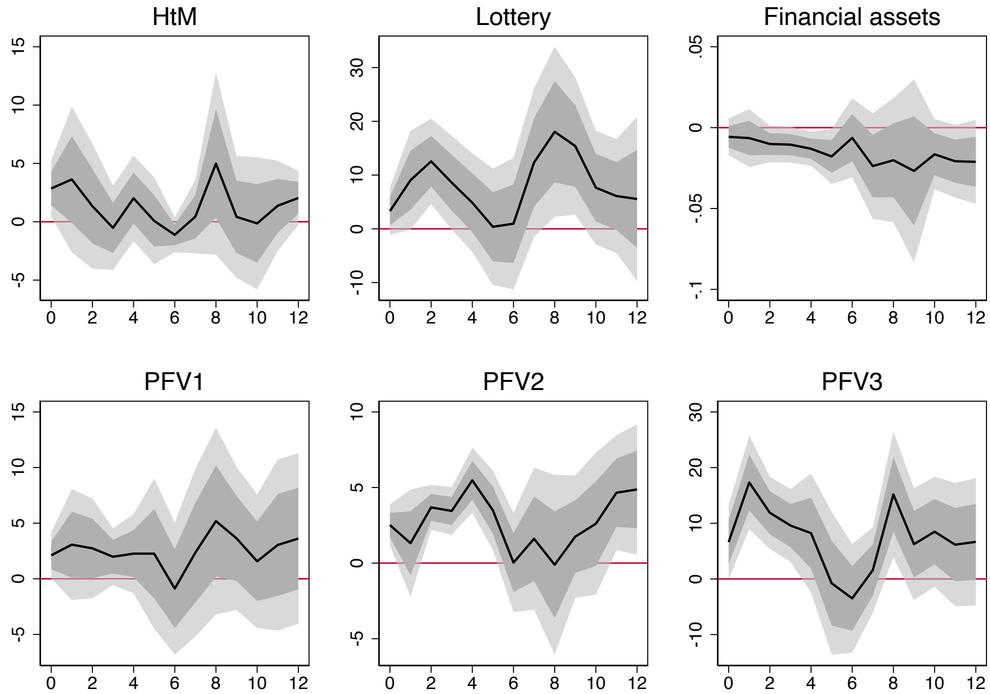

Figure 4: ***Marginal Contribution of the Financial Constraint of Households to the GDP Response to the QE Shock.*** Y-axis measures effect of a one standard deviation higher value of the given measure of asset market participation on the responsiveness of real GDP with respect to an expansionary QE shock. Light and dark gray areas represent 68 and 90 per cent confidence intervals, respectively.

Figure 4 shows how the reaction of GDP to the QE shock is altered by a one standard deviation higher degree of financial constraint of households. First of all, it should be noted that plots suggest, that lower asset market participation of households significantly increases the reaction of GDP to an expansionary QE shock. The fraction of household with little liquid assets (HtM) and the fraction of households with expenses which were approximately the same or even above their income (PFV1) display the least explanatory power with respect to the effectiveness of QE. The marginal propensity to consume out of a lottery win (Lottery), the fraction of households which are afraid to be unable to cover unexpected expenses on their own (PFV2) and the fraction of households not being able to meet their utility expenses over the last year (PFV3) significantly contribute to the effectiveness of QE on impact and over most of the periods. In the same vein, average financial assets per household, contribute negatively to the effectiveness of QE on a 68% confidence level at most horizons.

To conclude, we show that the effect of quantitative easing (QE) on real GDP is amplified by a larger fraction of liquidity-constrained households. This supports the view that a redistribution of income towards households with a high MPC in response to expansionary monetary policy shocks amplifies the effects of the latter with respect to macroeconomic aggregates (e.g., Auclert, 2019).

5 Labor Markets and the GDP Response

The HANK literature has shown us that liquidity-constrained households are affected by monetary policy mainly through general equilibrium effects via labor markets. Hence, the redistribution channel of monetary policy hinges on the responsiveness of labor markets.

In this section, we shed further light on the role of the redistributive channel by analyzing how labor market responsiveness matters for the transmission of QE to real GDP. We start by estimating a panel LPIV regression, in which we interact the common QE shock with the unemployment rate of a country, assuming that labor market slack is an indicator of labor market responsiveness (section 5.1). In section 5.2, we estimate a panel LPIV regression in which we interact the common QE shock with an estimate of labor market responsiveness.

5.1 Labor Market Slackness

The labor market response to QE shocks can be expected to be particularly large when the labor market is slack. Therefore, we begin our empirical analysis of the importance of the general equilibrium effects of QE by estimating the marginal effect of labor market slackness on the GDP response to a QE shock. We proxy labor market slackness with the unemployment rate. In particular, we first estimate equation (4), setting $x_n - \bar{x}$ equal to the mean unemployment rate of a country over the months 2014m6–2019m6 minus its cross-sectional mean. In this case, coefficient β^h measures the marginal effect of a *structurally* larger unemployment rate on the GDP response to QE. The results are shown in the left panel of figure 5. Second, we estimate a version of (4), in which we replace $x_n - \bar{x}$ by $x_{n,t} - x_n$, whereby $x_{n,t}$ is the unemployment rate of country n in the period in which the shock hits. In this case, coefficient β^h measures the marginal effect of a *cyclically* larger unemployment rate on the GDP response to QE. The results are shown in the right panel of figure 5.

Figure 5 shows that labor market slack significantly amplifies the expansionary effects of QE on GDP on various horizons. This holds for the cross-section (left panel) as well as for the time dimension (right panel). However, the effects are larger when the labor market slack is cyclical (right panel), i.e., when a country experiences higher unemployment than usual when the QE shock hits. Furthermore, it can be noted that countries with a structurally larger unemployment rate (left panel) experience a significantly smaller GDP expansion than the average about one quarter after the shock hits.

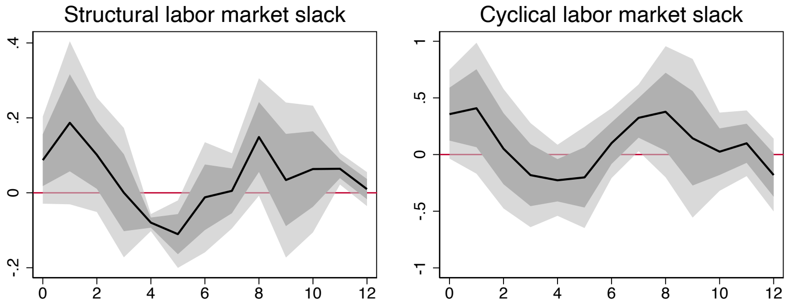

Figure 5: ***The Marginal Effect of Labor Market Slackness on the GDP Response.*** *Y-axis measures effect of a one standard deviation higher value of the given measure of unemployment on the responsiveness of real GDP with respect to a an expansionary QE shock. The measure "Structurally larger unemployment" captures the average unemployment rate of a country over the months 2014m6–2019m6, relative to the cross-sectional mean. The measure "Cyclically larger unemployment" captures the unemployment rate of a country at the time when the shock hits, relative to its country-specific mean. Light and dark gray areas represent 68 and 90 percent confidence intervals, respectively.*

5.2 Labor Market Responsiveness

In the previous section we analyzed the role of the labor market responsiveness as implied by the slackness of the labor market. However, aside from slackness, there a many more factors that influence the responsiveness of labor markets to monetary policy shocks, e.g., labor laws, strength of unions, social security, work culture etc. These factors are very heterogenous across euro area countries and, hence, it can be expected that the responsiveness of labor markets inherits this heterogeneity. In this section, we estimate the marginal effect of the labor market responsiveness on the GDP response to a QE shock, measuring labor market responsiveness as the country-specific reaction of the unemployment rate to QE shocks. In order to isolate this marginal effect, we adopt an approach proposed by Cloyne et al. (2021). It applies the Kitagawa-Blinder-Oaxaca decomposition to a local projections estimation. In the given setup, it involves the following two steps: (1) the estimation of the unemployment sensitivity to QE shocks, reflecting – in parts[5] – the strength of the indirect transmission channel of QE, and (2) the inclusion of these unemployment sensitivities into a local projection panel estimation of real GDP.[6]

To assess the role of indirect effects for real GDP responses, we explicitly account for cross-sectional differences in unemployment sensitivities to QE shocks when estimating dynamic GDP responses. In particular, we modify specification (4) to

$$\begin{aligned} y_{n,t+h} - y_{n,t-1} &= \alpha_n^h + \alpha_t^h + \beta_{\text{KBO}}^h \Theta_n^h \text{QE}_t \\ &\quad + \sum_{j=1}^{p} \Gamma_{n,j}^h y_{n,t-j} + u_{n,t+h} \ , h = 0, \ldots.., H, \end{aligned} \tag{5}$$

where Θ_n^h denotes the demeaned and standardized sensitivity for country n's unemployment rate in period $t+h$ to a QE shock in period t. The coefficient of interest is now β_{KBO}^h. It captures the marginal effect of the unemployment sensitivity on the real GDP response to a QE shock. In other words, a country with an unemployment sensitivity one standard deviation above the mean reacts by β_{KBO}^h more to the QE shock relative to the mean response.

Estimates of the unemployment sensitivity to a QE shock are obtained by running the following sequence of local projections,

$$u_{n,t+h} - u_{n,t-1} = \alpha_n^h + \sum_{j=1}^{p} \gamma_j^h u_{n,t-j} + \sum_{i=1}^{N} \text{QE}_t \cdot \mathbb{1}_{n=i} \cdot \tilde{\Theta}_n^h + u_{n,t+h} \tag{6}$$

where u_n denotes the log unemployment rate in country n and coefficient $\tilde{\Theta}_n^h$ represents the estimated sensitivity of country n's unemployment rate to a QE shock. We follow Cloyne et al. (2021) in keeping the specification parsimonious,

[5] With our approach, we only capture the indirect effects of QE with respect to employment, not with respect to wages. However, given that Lenza and Slacalek (2024) showed that the "employment channel" is quantitatively much more important than the "wage channel", we expect to capture the largest part of the general equilibrium effects of the QE shock.

[6] To account for the fact that the unemployment sensitivities are estimated regressors we bootstrap 1,000 replications of the two-step process. To take account of the panel structure of our dataset, we resample along the cross sectional dimension as suggested by Kapetanios (2008)

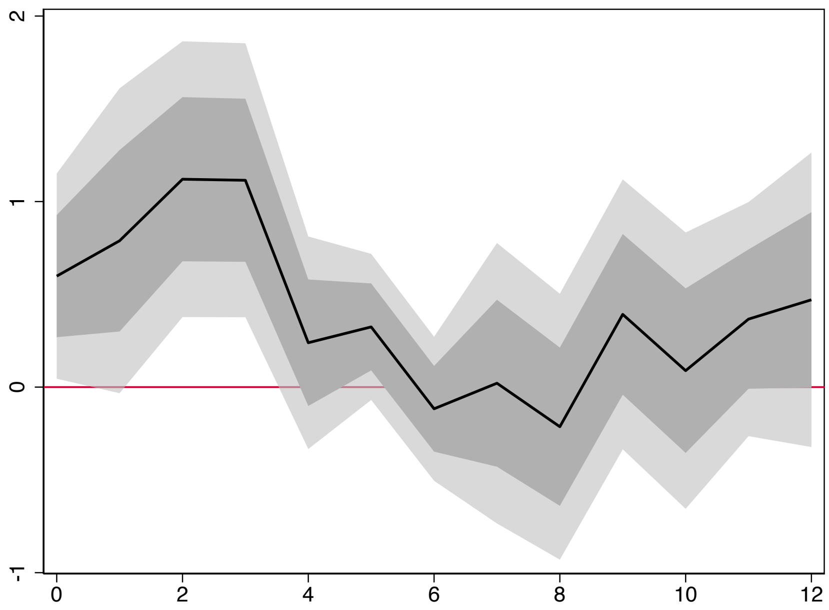

Figure 6: ***The Marginal Effect of the Unemployment Sensitivity on the GDP Response.*** *Y-axis measures effect of a one standard deviation higher responsiveness of the unemployment rate to QE shocks on the real GDP reaction to QE shocks. Light and dark gray areas represent 68 and 90 percent confidence intervals, respectively.*

which helps to improve the precision of the estimates. In particular, we only use lags of the dependent variable and lags of the shock as controls.[7]

Figure 6 shows the result of the analyses. Over the first quarter, a higher responsiveness of the labor market has a significant positive effect on the reaction of real GDP to the QE shock. In particular, the graph shows that a country with an unemployment sensitivity one standard deviation above the mean reacts by about 1 pp more to the QE shock relative to the mean response. After the first quarter the effect mainly remains positive, however, is insignificant.

In summary, our results obtained from the analyses in sections 5.1 and 5.2 show that countries which exhibit a larger reduction (increase) in unemployment in response to expansionary (contractionary) QE shocks also exhibit a larger increase (drop) in real GDP in response to the shock. Given that low-income and liquidity-constrained households overproportionately profit from an increase in employment, we take this as further evidence that the redistribu-

[7] Cloyne et al. (2021) only use lags of the dependent variable, however, as our shock displays autocorrelation (see 2), we additionally include lags of the shock.

tion towards liquidity-constrained households amplifies the output response to a QE shock in the euro area.

6 Household Heterogeneity, Labor Markets and the GDP Response in a DSGE Model

In this section we use the TANK model by Tsiaras (2023) to rationalize our results regarding the role of liquidity-constrained households and labor market responsiveness in the transmission of QE shocks. For a detailed description of the model the reader is referred to the original source. Briefly, the model economy is populated by infinitely-lived households which provide labor to intermediate goods producing firms and derive utility from consumption goods. Utility is separable in consumption and leisure. The fraction $1-\lambda$ of households are *optimizers*, i.e., have access to capital markets. *HtM* households account for the remaining fraction λ. They are excluded from financial markets. Hence, their consumption tracks their labor income. Wage decisions are delegated to a continuum of labor unions which negotiate nominal wages in a staggered fashion. In particular, each period, there is a probability $1-\xi_w$ that the nominal wage for a particular labor service is set optimally. Hours are determined by firms taking the wages set by unions as given. Firms are indifferent to the type of household they employ. Therefore, all households types supply the same working hours. Banks receive deposits from optimizers and hold loans to non-financial corporations, government bonds and reserves. They face a moral hazard problem similarly as in Gertler and Karadi (2011) and Gertler and Kiyotaki (2010). The central bank has two policy tools. First, it adjusts the policy rate according to a standard Taylor rule. Second, it conducts QE by purchasing government bonds from banks in exchange for reserves. Since reserves are considered to be safer than loans and bonds, QE relaxes the incentive constraint of the bank, reducing the prevailing external finance premium, which breaks QE's neutrality.

In the benchmark case, the parameters of the model are set such that their values in the steady state are in line with euro area long run averages.[8] Notably, the share of HtM households, λ, is set to 0.28 in the benchmark case. This value corresponds to the mean value of the share of HtM households in our set of countries. The upper left panel of figure 9 shows that the variation of this measure is large, ranging from 10% in Malta to 63% in Latvia. Therefore, in the alternative scenario depicted in figure 7 (yellow dashed line) we consider an economy with $\lambda = 0.4$. The responsiveness of the labor market, in which we are particularly interested, is determined by several model parameters. We chose to analyze its role by varying the probability of keeping the wage constant, γ^w. It is set to 0.72 in the benchmark version of the model. This is the value Coenen et al. (2018) estimate based on the the New Area-Wide Model. Country-specific values provided by Knell (2013) range from 0.64 in Lithuania to 0.8 in Italy. Therefore, in the alternative scenario depicted in figure 7 (solid red line), we consider an economy with γ^w equal to 0.65.

[8]A calibration table can be found in the appendix. For more details on the calibration, the reader is referred to Tsiaras (2023).

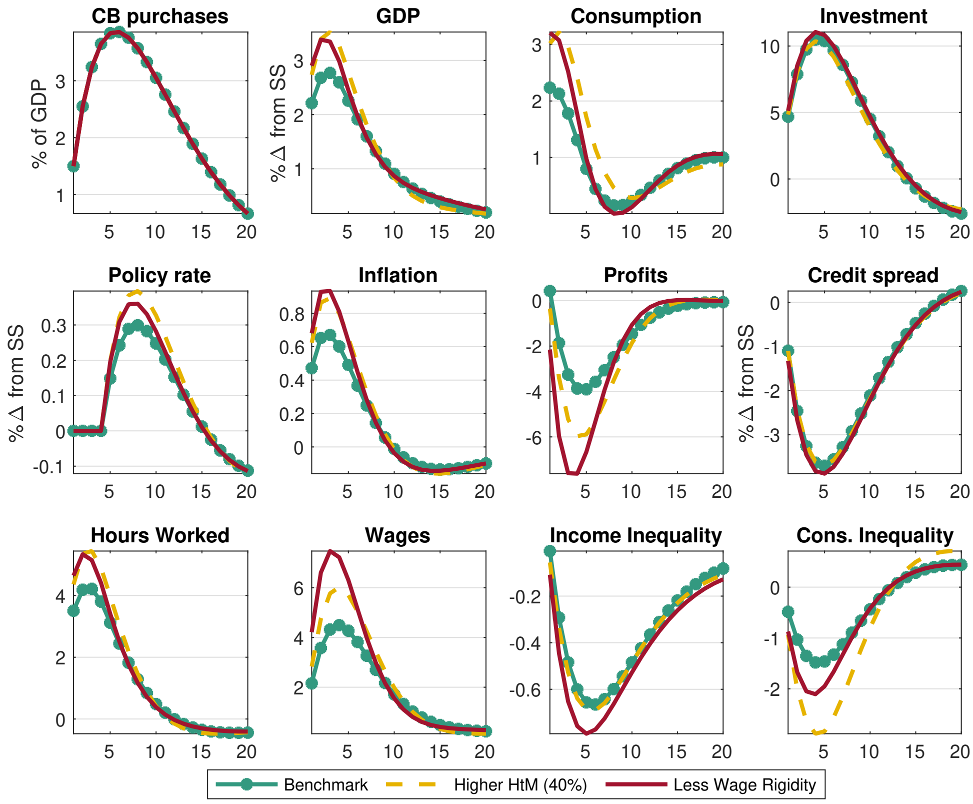

Figure 7: Model Impulse Responses to QE Shock The figure shows the impulse responses to an expansionary QE shock. In the benchmark case (green line), the share of HtM consumers (λ) is equal to 0.28, and the degree of wage rigidity (γ^W) is 0.72. The yellow line depicts the impulse responses for an economy with a higher share of HtM consumers ($\lambda = 0.4$) and the dark red line depicts a case with a more flexible labor market ($\gamma^W = 0.65$).

Figure 7 provides the model's impulse responses to a QE shock which is modeled as an AR(2) process.[9] The policy rate is assumed to stay constant for the first four quarters.[10] In all cases, the bond purchases have a stimulative effect on the economy, e.g., GDP, investment, labor, consumption, wages and prices increase. The main reason for this is the loosening of the banks' leverage constraint which allows the increase in bond prices and the associated drop in the bond spread to spill over to private asset prices and the credit spread. This stimulates invest-

[9]In modeling the shock process as AR(2) we follow Andrade et al. (2016).

[10]This simulates the inability of the central bank to use conventional monetary at times it is forced to use unconventional measures.

ment and production. Higher inflation caused by the increase in economic activity reduces the real rate which further boosts aggregate demand and, hence, production and employment. The QE shock increases the labor income of all households to the same extend. However, lower asset returns lead to a reduction in the optimizers' income. These two effects lead to a reduction in consumption and income inequality. Hence, in our model the indirect effects of QE outweigh direct effects.

Considering the alternative scenarios, it can be observed that a larger share of hand-to-mouth consumers (dashed yellow line) amplifies the effects of the shock. Reminiscent of the 'Standard Aggregate Demand Logic' (SADL) (Bilbiie, 2008), the reason for this is the higher MPC of non-optimizing agents, which reinforces the original link between the QE shock and aggregated demand when the share of HtM households becomes larger. Less wage rigidity (solid red line), which is associated with a larger responsiveness of the hours worked, also increases the effects of the QE shock. This essentially works through an amplification of the labor income channel which overproportionately profits households with a high MPC.

Figure 8 shows the impact effect of the QE shock on output, profits, income inequality and hours worked, conditional on asset market participation (λ), and for different probabilities of not being able to change the nominal wage (γ^w). It can be noted that our model features a non-linearity related to the share of HtM households, reminiscent of the 'Inverse Aggregate Demand Logic' (IADL) (Bilbiie, 2008), as indicated by the kinks. That is, when the share of HtM households exceeds a certain threshold, the direct positive demand effect of the monetary loosening becomes insignificant and HtM households no longer profit from an increase in wages and employment. This causes a drop in GDP in reaction to an expansionary shock. The higher the wage flexibility, the lower the level of HtM households at which the IADL sets in. Nevertheless, for our purposes, we are interested in the region in which the SADL holds, i.e., to the left of the kink. In this area a larger share of HtM households and greater wage flexibility (smaller γ^w) both amplify the effects of the QE shock. What is more, the graphs show an interaction between the two parameters of interest: the impact of a larger share of high-MPC households on the impulse responses is amplified by a larger responsiveness of the labor market (lighter lines are steeper than darker lines).

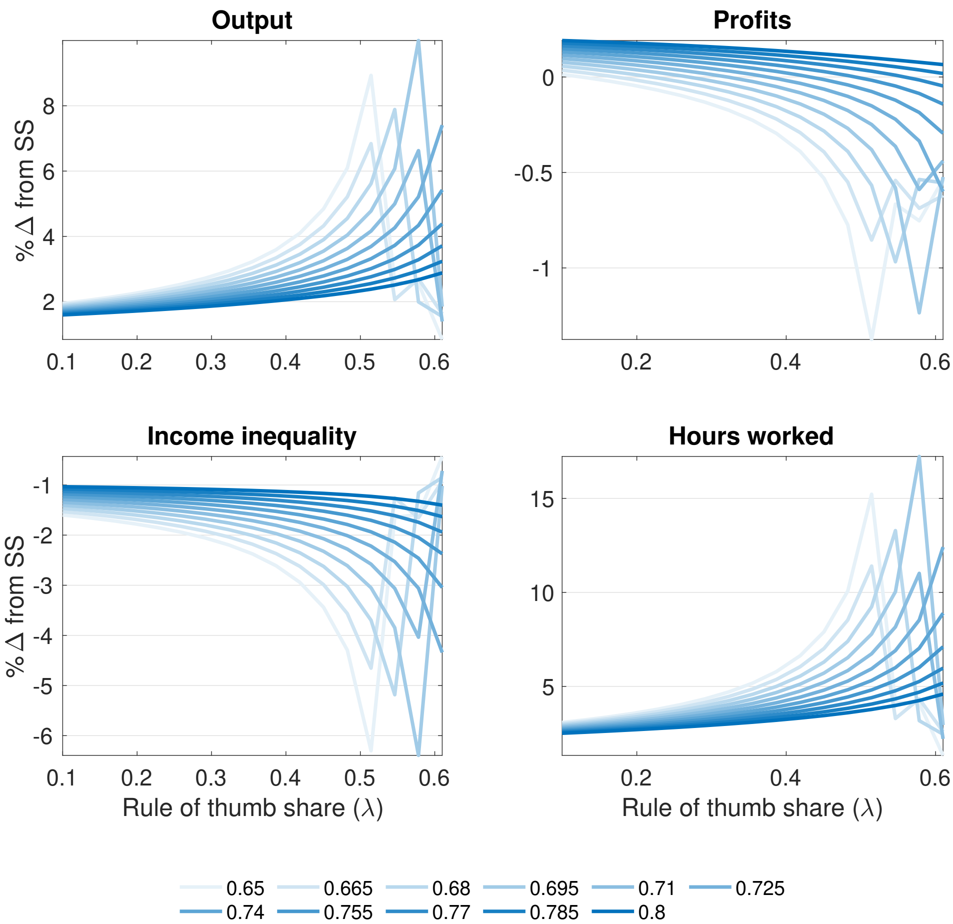

Figure 8: ***Impact Effect of QE Shock Conditional on Asset Market Participation and Wage Stickiness*** The different lines reflect different degrees of wage stickiness, γ^w (from 0.65 to 0.8). The X-axis depicts the share of rule-of-thumb consumers, λ.

7 Conclusion

To sum up, we analyze the macroeconomic effects of a state-of-the-art identified QE shock in euro area countries by estimating dynamic impulse responses. We, first, document that on average over the first year expansionary QE shocks significantly increase GDP and inflation, and reduce unemployment. However, the effects of QE are very heterogenous across countries as regards size, significance and timing, especially with respect to GDP and unemployment. Notably, we find that Greece experiences a significant reaction to QE shocks even though it was excluded from the measures itself.

We proceed by exploiting the panel structure of our dataset to analyze whether the share of liquidity-constrained households can account for parts of the observed cross-country heterogeneity in the responsiveness of GDP. We find that, if a country features a higher share of liquidity constrained households relative to the mean, it is likely to experience larger repercussions of QE shocks. This result is robust to using different measures of asset market participation of households. This is in line with recent empirical evidence with respect to *conventional* monetary policy shocks in Europe (Almgren et al., 2022).

In the last sections, we shed more light on the transmission channels of household heterogeneity and QE shocks. To this end, we apply a Kitagawa-Blinder-Oaxaca decomposition to a local projections estimation. We find that a higher sensitivity of the unemployment rate to QE shocks is associated with larger repercussions of QE shocks, suggesting that the indirect effect, related to the general equilibrium impact of QE on employment, is likely to be the most important determinant of the distributional consequences of QE. This result is in line with recent empirical evidence by Lenza and Slacalek (2024).

A DSGE model with HtM households and central bank asset purchases, calibrated to an average euro area country, can account, first, for the positive impact of a higher share of liquidity constrained households on the responsiveness of GDP to QE shocks, and, second, for the positive impact of a higher labor market sensitivity on the responsiveness of GDP to QE shocks. Furthermore, in the model, these two parameters mutually reinforce each other in their effect on the QE shock transmission.

A Appendix

	HtM	Lottery	Fin. Assets	PFV1	PFV2	PFV3
HtM	1					
Lottery	0.496	1				
Fin. Assets	-0.604*	-0.535*	1			
PFV1	0.678**	0.395	-0.619**	1		
PFV2	0.674**	0.575*	-0.556*	0.616**	1	
PFV3	0.798***	0.639**	-0.567*	0.562*	0.668**	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: ***Correlation Between Measures of Liquidity Constraints of Households***

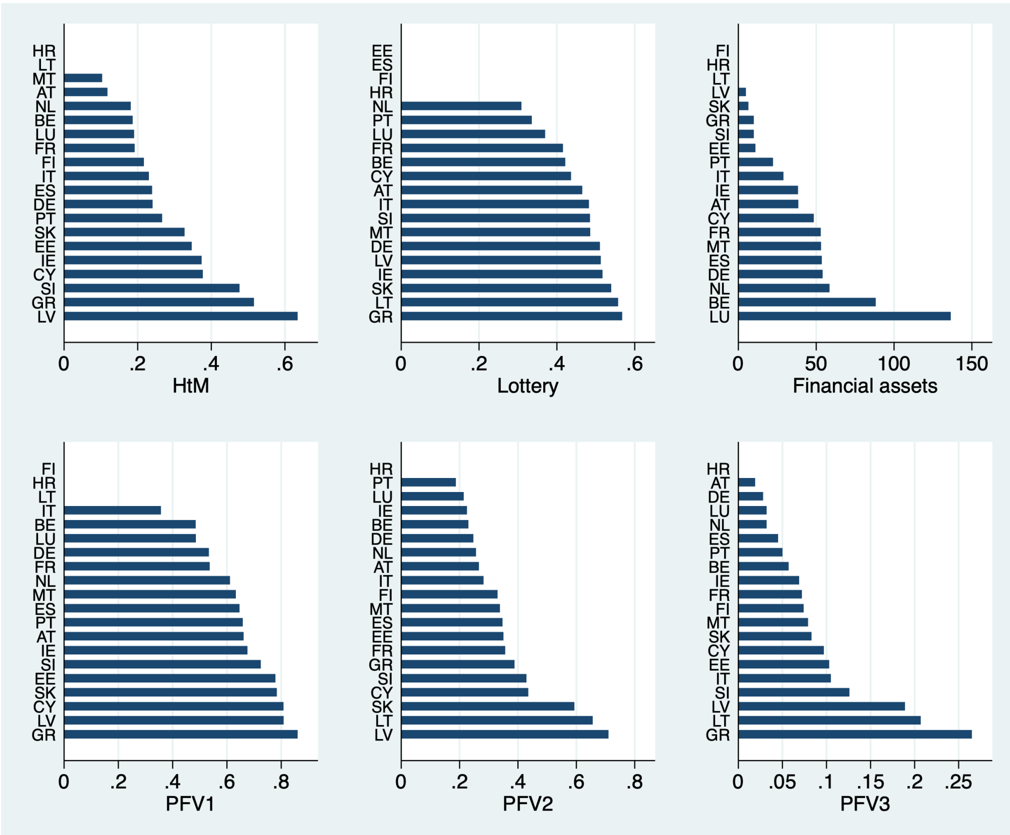

Figure 9: ***Distribution of Liquidity-Constrained Households Across Euro Area Countries.*** Data for certain countries – depicted without a bar – is missing.

Parameter	Value	Definition
		Households
β	0.998	Discount rate
χ	4.152	Relative utility weight of labor
λ	0.28	Share of rule of thumb agents
ϵ	2	Inverse Frisch elasticity of labor supply
$\bar{S}^R/S$	0.5	Proportion of shares of the optimizers
$\bar{B}^R/B$	0.75	Proportion of bond holdings of the optimizers
κ	1	Portfolio adjustment cost parameter
		Banks
θ	0.2	Absconding rate
Δ	0.842	Absconding fraction for bonds
ω	0	Absconding fraction for reserves
ξ_B	0.0014	Entering bankers initial capital
σ_B	0.95	Bankers' survival rate
		Intermediate and Capital Goods Firms
δ	0.025	Depreciation of capital
α	0.36	Capital share
η	5.77	Inverse elasticity of net investment to the price of capital
		Wage and Price Setting
ζ	2.54	Elasticity of substitution between goods
γ	0.89	Probability of keeping the price constant
γ_p	0.48	Price indexation parameter
ζ^W	4.33	Elasticity of labor substitution
γ^W	0.72	Probability of keeping the wages constant
γ_p^W	0.41	Wage indexation parameter
		Treasury Policy
γ^G	0.2	Steady state fraction of government expenditures to output
τ_{pr}	0	Optimizers' profit tax rate
		Monetary Policy
κ_π	1.86	Inflation coefficient in the Taylor rule
κ_y	0.147	Output gap coefficient in the Taylor rule
ρ_m	0.86	Interest-rate smoothing
ρ_1	1.7	First AR coefficient of the bond purchase shock
ρ_2	-0.73	Second AR coefficient of the bond purchase shock
ψ	0.015	Initial asset purchase shock

Table 3: Parameter Values

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