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The Effects of Monetary Policy Surprises on Net Wealth Inequality in Portugal: The Housing Market Channel

David Elias Ribeiro Issá

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David Issá †

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Abstract

We study the transmission of monetary policy shocks in wealth inequality in Portugal, via the housing market channel. We compute the impulse response functions (IRFs) of mortgage interest rates, housing and rental prices, after surprises in both an aggregate and two dismembered policy instruments corresponding to the Target Rate and Forward Guidance components of monetary policy. These effects are distributed across individual households through a microdata simulation using the Household Finance and Consumption Survey. We find that the rise in house prices and the decline in mortgage rates and rental prices following the policy shocks all positively contribute to a redistribution of wealth, with the overall wealth redistribution being greatly felt at the extreme deciles of the distribution.

JEL: D31, E21, E52, E58 and G51

Keywords: Monetary Policy, High Frequency Identification, Structural Vector Autoregression, Housing Market, Wealth Inequality

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† Nova School of Business and Economics, Universidade Nova de Lisboa. Email: 32135@novasbe.pt

1. Introduction

Inequality is increasingly present in the international economic policy debate, occupying a prominent place in policy discussions. The persistent growing of wealth and income inequality within major economies has sparked discussions regarding its economic consequences. Not only is this true for structural and fiscal policies, but also for monetary policy. Since the start of the Great Financial Crisis, monetary policy has been given increasingly attention on its distributional consequences, mainly due to its higher accommodative nature. Thus, many monetary policymakers have started to discuss the potential effects of monetary policy on inequality, apart from the more traditional aggregate effects (([Bullard 2014](#)); ([Mersch 2014](#)); ([Forbes 2015](#)); ([Bernanke 2015](#)))

In this work, we empirically identify the redistributive impacts of monetary policy shocks on wealth in Portugal through a partial equilibrium analysis, focusing solely on the housing market as the transmission channel. Firstly, we estimate housing market aggregate variables' (mortgage interest rates, housing prices and rental prices) responses to monetary policy shocks (aggregate and dismembered) in Portugal, using structural VARs and identifying the shocks by using external high-frequency instruments. Using the EA-MPD database of [Altavilla et al. \(2019\)](#), we define the changes in the 1-year Euro Overnight Index Average (EONIA) swap rate around the ECB policy announcements, equivalent to the Overnight Index Swap (OIS) rate for the euro area, as our aggregate policy instrument, as it constitutes a comprehensive measure of monetary policy surprises, incorporating all of its channels of communication. Then, we disaggregate the monetary policy shock, and compute two additional external instruments, using a dynamic factor model to extract factors resulting in Target Rate and Forward Guidance surprises.

Finally, we perform a simulation where we update the household level variables from the Household Finance and Consumption Survey with the previous obtained IRFs, in order to observe

the changes in the household's net wealth after the shocks, through each individual macroeconomic response (keeping everything else constant) and through the whole housing market responses. Then, we analyze both the evolution in each quarter after the shock and the cumulative changes of the well-known Gini coefficient, complementing it with the 90/10 and the 75/25 percentile ratios.

Following this procedure, we find that both the aggregate and disaggregated expansionary policy shocks lead to a decrease in mortgage interest rates and rental prices, while increasing the housing prices, which goes in accordance with theory. After the microdata simulation, we find a positive redistributive effect in net wealth, with each housing market variable contributing to a decrease in inequality. Using the aggregate policy shock – 1y EONIA – as a benchmark (although the qualitative part of this analysis remains true for the dismembered shocks), at the peak responses, we observe a reduction of the Gini Index by 0,06%, a much lower percentual fall when compared the P75/P25 ratio which falls by 0,5%, and the P90/P10 ratio which decreases by 2%. Cummulatively, 20 quarters after the shock, the Gini Index sees a total reduction of 0,50%, while the P90/P10 percentile ratio displays a much greater percentual variation (-7,87%) when compared to the P75/P25 ratio (-2,00%). This means that the redistributive effects from the monetary policy shocks, through the housing market channel, “*ceteris paribus*”, are greatly felt at the top and bottom 10% of the wealth distribution, with the latter having disporportionally larger net wealth gains.

The remainder of the paper proceeds as follows. Section 2 presents the existing literature that motivated our work. In section 3 we present the data used in our analysis. Section 4 explains the methodology employed. In section 5 we present the main findings. Finally, section 6 concludes.

2. Literature Review

Motivating our analysis on how does monetary policy affects wealth inequality through the housing market channel is the literature that investigates how the housing market may be correlated

with wealth inequality. [Kuhn, Schularick, and Steins \(2016\)](#) analyze the evolution of wealth inequality since World War II in the US, finding that heterogeneity in the compositions of household's portfolios along the wealth distribution have majorly contributed to the evolution of wealth inequality. Due to the concentrated and leveraged portfolios on houses and mortgages, respectively, fluctuations in real estate prices are found to greatly affect wealth of middle-class households in the US. In consequence, the middle class profited from major gains in the overall wealth in the two decades before the crisis, when housing prices became hugely inflated, whereas the bust in the house prices speculative bubble in the 2008 financial crisis originated the largest spike in wealth inequality in postwar history. [Garbinti, Goupille-Lebret, and Piketty \(2021\)](#) document this same relationship for France.

Another major building block below our work is linked to the studied DSGE models, which when allowed to have heterogeneous agents, show that monetary policy changes have redistributive impacts on both income and wealth, which ultimately influence the policy intended transmission the real economy. [Auclert \(2019\)](#) studied the winner and losers from monetary policy changes and how does this affect the policy transmission channel to aggregate consumption. Through a HANK model, it is showed that the increase in both income and inflation and the fall in interest rates following monetary policy expansions leads to a redistribution of income and wealth in favor of agents with a higher marginal propensity to consume (that is, agents who are debtors and have a larger amount of liabilities), concluding that the redistribution originated of monetary policy amplifies its transmission channel to consumption. In the same token, but focusing on the housing market as a transmission channel from monetary policy to the real economy, [Hedlund et al. \(2017\)](#), [Eichenbaum, Rebelo, and Wong \(2018\)](#) and [Berger et al. \(2020\)](#) argue that a reduction in the policy rate will reduce the debt payments (mortgage interests) of borrowers, leading to a redistribution

between debtors and lenders, which ultimately influence the effectiveness of the transmission of monetary policy, due to the different propensities to consume between the two type of agents.

Empirically, various studies have looked into how monetary policy changes directly affect wealth redistribution. One major studied channel through which wealth inequality is affected is the portfolio composition channel. Monetary policy leads to changes in asset prices, and consequently affects the household's value of real and financial assets. Several studies find this channel to have an ambiguous effect on wealth inequality. [Adam and Tzamourani \(2016\)](#) and [Lenza and Slacalek \(2018\)](#) for the euro area; [Bivens \(2015\)](#) for the US; [Pugh, Bunn, and Yeates \(2018\)](#) for the UK; and [O'Farrell, Rawdanowicz, and Inaba \(2017\)](#) for OECD countries found that while higher house prices reduce wealth inequality due to the asset's high percentage in the total wealth of low-wealth groups, higher financial asset's prices have the opposite effect, as richer households own more of these financial assets. [Casiraghi et al. \(2018\)](#) consider also a savings redistribution channel, observed to reduce inequality after an expansionary monetary shock, as the poor household's net wealth improves due to the reduced liabilities, stemming from lower interest payments on debt.

Therefore, knowing that 1) the housing market is correlated with wealth inequality, 2) that monetary policy changes have redistributive impacts on household's income and wealth, and 3) the already studied impacts, as in [Corsetti, Duarte, and Mann \(2020\)](#), that monetary policy shocks have on macroeconomic housing market variables (mortgage rate, house prices, and rental prices), we conduct an empirical experiment where we analyse the redistributive impacts of monetary policy on wealth in Portugal, specifically through the perspective of the housing market as a transmission mechanism of monetary policy shocks to wealth redistribution. One novelty that this work brings to the existing literature is that we consider how changes in the rental prices after the policy shock may contribute to the redistribution of wealth, apart from the houses and mortgages price changes, which have already been evidenced to have an impact on wealth inequality.

3. Data

The following section focuses in describing the datasets used in each one of the three main stages of the process of investigating how monetary policy may affect net wealth distribution through the housing market in Portugal. Firstly, it describes the EA-MPD dataset from where monetary policy instruments are retrieved and included in the Structural Vector Autoregressions (SVARs) to identify the exogenous policy shocks. Then, it presents the remaining variables used in the SVAR models, what transformations were made, and the intuition behind their inclusion. And finally, it will describe the Household Finance and Consumption Survey (HFCS), the dataset used to input the responses of the VAR variables after the monetary policy shocks, and where we observe the effects of such shock in the net wealth distribution.

3.1. Monetary policy surprises

In order to effectively identify all the monetary policy shocks (one covering surprises in all monetary policy channels, and two more corresponding to the dismemberment of the former into Target Rate and Forward Guidance surprises), we use the EA-MPD policy event-study database developed by [Altavilla et al. \(2019\)](#), which reports changes in different assets prices with different maturities following both the Governing Council's and the European Central Bank's announcements of monetary policy. Firstly, we proceed to a brief explanation of the communication of monetary policy announcements.

Ever since the creation of the ECB in 1999, monetary policy meetings and announcements have changed several times. It began with two policy meetings every month, changing after November 2001 to one meeting per month,. However, since January 2015, they started to occur every six weeks. After the meetings conclusion, the policy decisions' communication is organized as follows: a press release begins at 13:45 (Central European Time), where it is provided a

statement containing all the decisions taken during the meeting. The explanations of those decisions are presented later, in the press conference which starts at 14:30. The ECB president starts by reading a 15-minute Introductory Statement (IS), explaining all the rationale leading to the adoption of each of those decisions. Following the IS, there is a 45-minute session, ranging between 14:45 and 15:30, dedicated to answer the journalist questions.

During this whole time window, market participants most probably identify the present and future of the monetary policy stance, reacting according to their perceptions, then reflected in different asset prices. Therefore, for each of those assets, [Altavilla et al. \(2019\)](#) compute the median price/yield in both the 13:25–13:35 and 14:00–14:10 intervals, defining them as the pre- and post-press-release quotes, respectively. Applying the same procedure for the press conference window, the median price/yield in both the 14:15–14:25 and 15:40–15:50 intervals is computed and determined as pre- and the the post-conference quotes, respectively. The whole “monetary policy event” window is then defined as the union of the press release and press conference.

Finally, the EA-MPD incorporates each asset price/yield changes for each of the three event windows in separate worksheets, defined as the difference between the pre- and the post-event quotes for each communication window. Consequently, the changes in each asset price originated from the whole event window is defined as the change in the respective price between the pre-press release quote and the post-conference quote. The main idea here is that, by choosing a sufficiently narrow time window and looking at the assets price changes around the policy announcement, then any surprises occurring within that window are most certainly associated solely with monetary policy shocks, with no other major structural shock occurring during that same window ([Corsetti, Duarte, and Mann 2020](#)). Therefore, one is assuming that around policy announcements, monetary policy does not react to asset prices, meaning that causality follows from monetary policy to asset prices ([Altavilla et al. 2019](#)).

3.2. Structural Vector Autoregression (SVAR) – variables

To study the impact of the monetary policy shocks in the main macroeconomic variables of interest, three SVARs are estimated, differing only the monetary policy instrument used to identify the policy shock between them. All other variables remain unchanged across the models. The three monetary policy instruments used are: 1) changes in the one-year Euro Overnight Index Average (EONIA) swap rate measuring surprises in all monetary policy channels altogether; and then, for analysis richness, we dismember these aggregate surprises into 2) surprise changes in the policy rate - Target Rate factor - and 3) surprise changes in the guidance about the monetary policy future path in the medium-run - Forward Guidance factor - both obtained by estimating a dynamic factor model using changes in the Euro Overnight Index Average (EONIA) swap rate for several maturities, and by properly rotating the obtained factors. This process is further explored in the methodological section.

The remaining variables that we include in the VARs correspond to the Euro area 1-year maturity par yield of nominal government bond's whose rating is triple A, which corresponds to the monetary policy representative rate; the mortgage interest rate for Portugal, measured by the bank interest rates on loans to households for house purchase; the Portuguese House Price Index (HPI); and the rental prices for Portugal, obtained from the Harmonized Index of Consumer Prices. All variable sources and transformations applied are described in Appendix 7.1. We include such variables in order to observe what is the impact from the monetary shock in both the Portuguese house market core variables and the EU stock market. Then, using the variable's responses to the shock, we are able to perform a partial equilibrium analysis on the redistributive impact of monetary policy on the net wealth in Portugal, through the lens of the housing market.

3.3. Household Finance and Consumption Survey (HFCS)

To empirically capture how monetary policy partially affects the net wealth inequality in Portugal through the housing markets channel, we update the variables corresponding to the house price, annual paid rent, and mortgage interest payments at the household level in the data from the Household Finance and Consumption Survey (HFCS). How this was actually done is further explored in the methodology section.

Concerning the actual dataset, we use the third wave of the HFCS, whose reference year is 2017, focusing our analysis on Portugal, which contains 5924 households. The HFCS is an ex-ante comparable household level micro dataset, containing detailed information on the composition of household's income, assets, liabilities, socio-demographics and consumption indicators. HFCS data provides multiply imputed values in relation to the household variables, covering for non-response via stochastic imputation. This means that missing observations are estimated conditional upon observed variables which may explain the respective missingness. For each missing value, five imputed values are provided in order to take into account imputation uncertainty. Information from all five implicates should be used to generate best estimates for parameters of interest, achieved by first analyzing each of the five data sets and then combining the results across implicates, by taking the average of the five estimates.

One important piece of information that can be obtained from this dataset, which will be crucial on understanding the impact that each housing market variable has on the net wealth distribution in Portugal, is how are households distributed across the different tenure status of their main residence – a household may own the whole property, own only a part of it while paying a mortgage, or may be renting it. As we observe in Figure 1(a), the distribution of households owning the whole residence is rightly skewed, with very few households from the poorest 20% of the distribution owing the whole property, whereas the proportion of households owning all the

property in the middle and right tail of the distribution is more uniform. Secondly, we see that the distribution of households partially owning their main residence follows a bell-shaped distribution, indicating that it is the middle class that possesses a higher proportion of mortgages vis-à-vis the poorest and richest households, with the richest 40% having the lowest representation in this sub-population. The behavior of these two distributions means that owning a house is a middle-class asset, as verified by Figure 1(b), where we observe the middle quintiles of wealth displaying a greater percentage of their total assets portfolio allocated to their main residence. Finally, the distribution of households renting their main residence is extremely left skewed, confirming that it

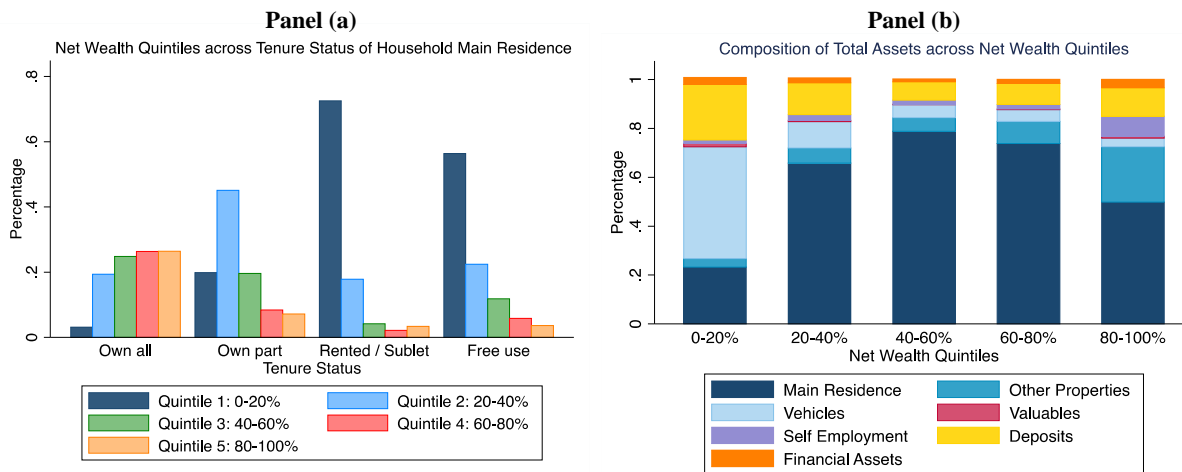


Figure 1 – HFCS descriptive statistics: (a) Net wealth distribution across each tenure status of household's main residence; (b) Composition of Total Assets across Net Wealth Quintiles

is in the poorest part of the population where most of the rent payers are concentrated. As we will see in the Results section, these statistics will be of huge importance to justify our findings on how the net wealth distribution is affected after a monetary policy shock.

4. Methodology

To investigate the effects of a monetary policy surprises on the net wealth distribution in Portugal, through the housing market, firstly, we need a variable that can be used as a monetary policy instrument to properly identify the monetary policy shock, in order to evaluate the respective reactions of the housing market macroeconomic variables. We start off our analysis by using the

changes in the one-year Euro Overnight Index Average (EONIA) swap rate as the policy instrument (containing all monetary channels aggregated), which is then used in a vector autoregressive model, using the internal instrument approach (Plagborg-Møller and Wolf 2021), to compute impulse response functions for the required macroeconomic variables. Then, we perform a simulation, where we update the household level variables of the HFCS with the previous obtained IRFs, in order to observe the changes after the monetary shock in each household net wealth.

We take our analysis one step further, and we disaggregate the initial overall monetary policy instrument into surprises in the current monetary policy (Target Rate) and surprises in the guidance about the future path of monetary policy in the medium-run (Forward Guidance). To do this, we follow Altavilla et al. (2019) methodology, where we estimate a dynamic factor model using changes in the EONIA swap rate for several maturities, obtained from the EA-MPD database, both for the press release window (where the Target Rate factor will be observed), and for the press conference window (where the Forward Guidance factor is found). We repeat the previous process for each one of the obtained policy instruments.

4.1. Constructing the instruments of monetary policy surprises

4.1.1. Aggregate monetary policy instrument – 1y EONIA

We select changes in the 1-year Euro Overnight Index Average (EONIA) swap rate from the EA-MPD database, the corresponding Overnight Index Swap (OIS) rate for the euro area, as an initial aggregate monetary policy instrument, and we build a quarterly series by summing the intra-day values for each quarter. The intuition of using such database of high frequency surprises around monetary policy announcements, is that because the changes in the swap rate are considered within a sufficiently narrow window around policy announcements, then such changes are most likely only associated with policy shocks, fulfilling the necessary requirement that the instrument must only be correlated with the monetary policy shocks, and with no other major structural shocks

occurring during the chosen window. The choice of a 1-year maturity was made when considering the trade-off that a longer dated swap is better suited to analyze the effects of monetary policy on the interest rate's yield curve, but term premia is more frequently found at longer horizons, potentially contaminating future short rates (Corsetti, Duarte, and Mann 2020).

For a better understanding of the chosen initial instrument, its time series is plotted in Appendix 7.2, where we also analyze the events that led to the instrument's more volatile values (positive or negative), with the objective of developing a solid intuition on the behavior of the series¹.

Concerning what causes the instrument to change in value, because expected policy rate changes are already priced in, only unexpected policy shocks will cause the swap to be affected instantly. Thus, the rate will only adjust when the announcement of a rate increase or decrease is not predicted in beforehand. Similarly, any policy action regarding the future rates that is out of line of expectations, the so-called "forward guidance", will affect the swap rate. So, our instrument captures not only the current state of monetary policy, but also expectations about its future path, also shown by the S. Lloyd (2018) and S. P. Lloyd (2020) finding that 1-month to 2-year OIS rates accurately measure interest rate expectations.

4.1.2. Target Rate and Forward Guidance Surprises - dismembering monetary policy shocks

In this section we show the procedure we followed to dismember the monetary policy surprises into surprises in the current monetary policy stance (Target Rate) and in the guidance regarding the monetary policy's future path in the medium-run (Forward Guidance). We do this in order to enrich our analysis, allowing us to separate the effects that each component of monetary policy may have

¹ Note that the sample for the analysis starts in 2002, because Altavilla et al. (2019) argues that from 1999 (the start of the single currency in the Euro Area) until the end of 2001 the intraday OIS data are very noisy, with large volatility in the quotes.

on net wealth distribution, and confirming (or not) the initial findings obtained when 1y EONIA is used as a policy instrument which aggregates all monetary policy channels.

We construct the dismembered (Target and Forward Guidance) surprises by adopting the methodology employed in [Altavilla et al. \(2019\)](#), who build on the work of [Gurkaynak, Sack, and Swanson \(2005\)](#) and [Gurkaynak \(2005\)](#), in which Federal Funds futures quotes are used to measure policy surprises in the US. More specifically, we use a dynamic factor model (specified in [Appendix 7.3](#)) to extract factors from changes in yields of OIS rates from one-month to ten-year maturity, through a dynamic factor model in each one of the two windows (press release and press conference) of the EA-MPD database. However, because high-frequency data on the OIS rates is only available after August 2011 for maturities larger than 2 years, [Altavilla et al. \(2019\)](#) use yields on the German sovereign yields as a substitute of OIS rates, defending that it makes no significant difference due to their same low risk nature. Afterwards, to obtain the intended monetary policy surprises to be used as instruments, we apply identifying rotations in those factors. Similar to the aggregate policy instrument, this approach guarantees us that the instruments obtained are only correlated with the monetary policy shock, as we are obtaining the factors from narrow time windows around policy announcements.

Two factors are extracted from the press release window, as in [Gurkaynak, Sack, and Swanson \(2005\)](#), while three factors are extracted from the press conference window, as in [Swanson \(2017\)](#). These have not any clean interpretation. Therefore, in order to make the latent factors F interpretable as monetary policy surprises, we need to properly rotate them. The following restrictions are imposed on the rotation matrix U , which is then used to multiply the factors F , obtaining the cleaned and interpretable factors $Z = FU$: for the factors in the press release window, 1) they should be orthogonal to each other and 2) the second factor should not influence the one-month OIS. For the press conference window, 1) the second and third factors must be orthogonal

to the one-month OIS, not loading in this yield rate and 2) one must minimize the variance that the third factor has in the pre-crisis period, that is, between January 2002 and August 2008, having only impact in the yields with longer maturity.

We proceed as in [Altavilla et al. \(2019\)](#) and conclude that the only significant factor found in the press release window is the “Target” factor, loading only on the shorter maturity rates. In the press conference window, we find a “Forward Guidance” factor, capturing the expectations regarding the policy rate’s future path, loading on more medium maturity yields. These are the two factors that we are going to use as instruments in order to dismember monetary policy surprises. Because the factors are identified only up to sign and scale, we scale the Target and FG factors such that they are positively correlated with the one-month and the two-year OIS rate, respectively, allowing us to interpret the factor’s positive values as restrictive monetary surprises.

However, apart from these, even though less important for the purpose of our analysis, we find two more policy factors in the press conference window. The “Timing” factor, which captures changes in market expectations over the following policy meetings, leaving at the same time longer maturity rates unchanged, and the Quantitative Easing (QE) factor, contributing mostly to movements in longer maturity rates, and having greater importance in the post-crisis period.

After the estimation, and focusing on the factors of interest, we are left with two series (the Target and Forward Guidance factors), in which the number of observations is the same as the number of policy announcements between 2002 and 2019. We sum each factor’s values for each quarter and get two regular quarterly time series, now defined as the new dismembered monetary policy instruments. These are plotted and further analyzed in [Appendix 7.4](#).

4.2. Vector Autoregressive Model estimation for monetary shocks

After the obtention of the monetary policy instruments, we need to estimate a simple SVAR for each one of the obtained instruments. So, firstly, we estimate one VAR using the aggregate

policy instrument – 1y EONIA surprises – in order to observe the responses of the macroeconomic variables after a shock in policy instrument that aggregates all policy channels. Afterwards, for analysis richness, we estimate the two VARs for the dismembered policy instruments – Target Rate and Forward Guidance surprises – in order to confirm (or not) if the behavior of the IRFs after a shock in each policy channel is similar to those after a shock in the aggregate policy instrument.

The macroeconomic variables that we include in all three VARs are the Euro area 1-year maturity par yield of nominal government bond's whose rating is triple A (our monetary policy interest rate representative variable), the mortgage interest rate for Portugal, the Portuguese House Price Index (HPI) and the rental prices for Portugal. All variables have a quarterly frequency, and the HPI and the rental prices variables enter the VAR in log-levels. As the series for the mortgage interest rate variable is only available from the third quarter of 2004 onwards, the period used in the analysis ranges from 2004Q3 until 2019Q4. For the specifications chosen, we include both a constant and a time trend.

To estimate the VARs, we use the internal instrument approach, shown by [Plagborg-Møller and Wolf \(2021\)](#) to estimate consistent impulse response functions, when an external instrument correlated with the shock under consideration is ordered first in a recursive VAR model. The ordering of the remaining variables entering the VAR does not have an influence on the resulting IRFs. The idea is that by including in the VARs external sources that control for the variation in interest rates (our instruments) which are highly correlated with the monetary policy rate representative variable, while at the same time uncorrelated with all remaining shocks, we are able to properly internally identify the exogenous monetary policy shock, without the need of imposing structural restrictions on the model, such as a specific ordering of the variables or sign restrictions. As argued by [Plagborg-Møller and Wolf \(2021\)](#), such approach holds equivalent results to when a Local Projection Instrumental Variable (LP-IV) is estimated for each variable of interest, with the

instrumental variables used to identify the monetary policy shock being the surprises in the 1y EONIA, and in the dismembered Target Rate and Forward Guidance factors.

Based on Schwarz Criterion (SC) and the Hannan Quinn (HQ) Criterion, we estimate all the VARs using 2 lags. The VARs are estimated using OLS, with the residuals of the estimated VARs being stationary (see Appendix 7.5 for corresponding statistics). Therefore, we are able to effectively compute the IRFs for each VAR in order to examine the response of all the macroeconomic variables to a one standard deviation expansionary shock on the monetary surprise.

4.3. Updating the HFCS to check for net wealth changes

Now we make use of the methodology from [Lenza and Slacalek \(2018\)](#), where we undertake a simulation using micro data from the Household Finance and Consumption Survey with the objective of distributing the effects from each macroeconomic variable (obtained in the IRFs) on the respective component of household's wealth. We multiply each wealth component of the micro data with the respective variable's IRF coefficients, which results in the change in each households' net wealth, used to obtain the new household's net wealth in each period of the IRF.

Finally, to have a meaningful aggregate measure translating how did each household's net wealth changed through time after the monetary policy shock, we compute inequality indicators – Gini coefficient and the 90/10 and the 75/25 percentile ratios – not only for the new net wealth obtained from the change in each updated wealth component, but also for the overall net wealth obtained from the summatory of all changes in the affected wealth elements.

Regarding the household's wealth components that are updated with the obtained IRFs, we multiply, for each household, the main residence current price by the House Price Index (HPI) response; the annual rent paid (for the households that pay a rent), obtained from the monthly rent multiplied by 12, by the symmetric of the response of the Rental Price variable; and finally, we multiply the total interest payments of the outstanding amount of mortgages that use the household

main residence as a collateral by the symmetric of the Mortgage Interest Rate response (for mortgages whose interest rate is variable). The results of these multiplications, concerning the housing prices, correspond immediately to the changes in the household's net wealth resulting from the change in the housing price index (HPI). However, for the annual rent paid and the total interest payments, they correspond to changes in the household's available income, which therefore can be allocated either to consumption or savings. So, we multiply this income change by a proxy variable of marginal propensity to save, obtaining the correct amount representing changes in net wealth. Finally, we sum all changes in net wealth coming from each variable response, obtaining the total net wealth change from the whole housing market. By summing it with its starting value, we obtain the new household's net wealth for each period, allowing us to compute the inequality indicators.

5. Results

5.1. Impulse Response Functions from SVARs estimation

Figure 2 displays percentage response of the macroeconomic variables of interest (the monetary policy rate representative variable and the Portuguese housing market variables) following a one standard deviation monetary shock in the 1y EONIA aggregate policy instrument. The blue solid lines represent the median response. Notice that since we are not interest in testing for significancy of the results, the dashed lines display 68% confidence bands. Using the response of the 1-year EU government's bond as a policy indicator, we normalize the responses to an expansion in the 1-year EU government's bond, that is, and expansionary monetary shock.

The expansionary nature of the shock is possible to be observed right away in the response of the policy indicator variable, in the top left panel of Figure 2, falling on impact after the shock in the 1-year EONIA surprises, and staying negative during the first year following the shock. Regarding the remaining responses of the portuguese housing market variables, all of them react

according to the theory. In the top right panel, the indicator for mortgage interest rate decreases in reaction to an expansionary shock, although displaying imperfect pass-through, possibly explained by a significant number of fixed rates mortgages (Corsetti, Duarte, and Mann 2020). Real house prices, in the bottom left panel, are also very responsive to monetary policy shock, suggesting that lower policy rates make mortgages less expensive, thus leading to an increase in the demand for houses, increasing its price level, in line with economic theory. Several literature has documented such behavior following a monetary shock (for example, Lenza and Slacalek (2018), Iacoviello (2002), Giuliadori (2005)). Finally, in the bottom right panel, the housing rents' response decreases in reaction to a monetary shock, contrary to that of the house prices. As Dias and Duarte (2019) argue, the decrease in the mortgage rate leads agents to substitute renting with house purchase, due to the good's substitutability nature, thus decreasing the pressure on rental prices.

Figure 3 displays the percentage responses for the same macroeconomic variables, obtained from the two estimated SVARs whose instruments are now the monetary policy dismembered surprises. Again, the responses are obtained from a one standard deviation shock in the policy instruments. The blue (Target Rate) and red (Forward Guidance) solid lines represent the median response, while the dashed lines display the respective 68% confidence bands. The responses are also normalized so that the shocks have an expansionary nature. When attempting to observe whether the results obtained by shocking the aggregate policy instrument are confirmed when such shock is disaggregated into Target Rate and Forward Guidance surprises, we indeed observe that the economic theory is still supported. Only the rental prices responses differ in the sense that, for both instruments, they do not fall instantaneously on impact after the respective shock, although they still show the same depressing behavior following the initial quarters.

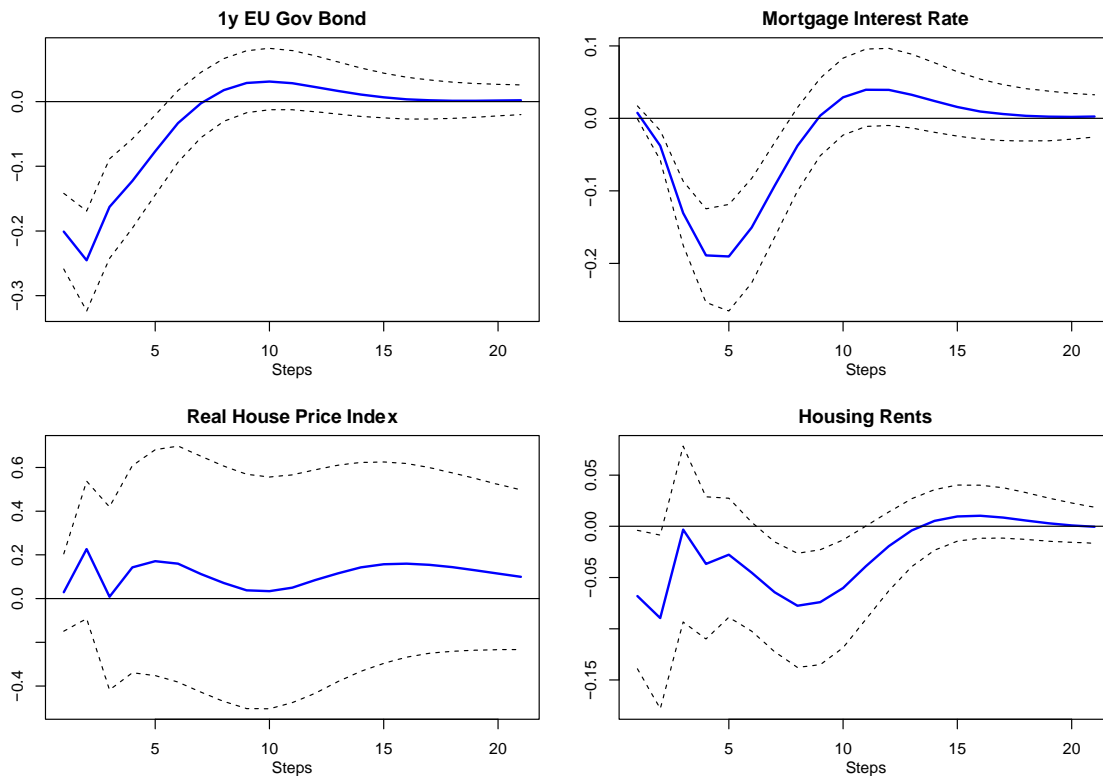


Figure 2 - Impulse responses of the 1y EU government bond, Portuguese mortgage interest rate, Portuguese house prices and Portuguese housing rental prices from a contractionary monetary surprise of one standard deviation in 1y EONIA. Note: The blue line represents the median responses. The dashed lines represent 68% confidence bands.

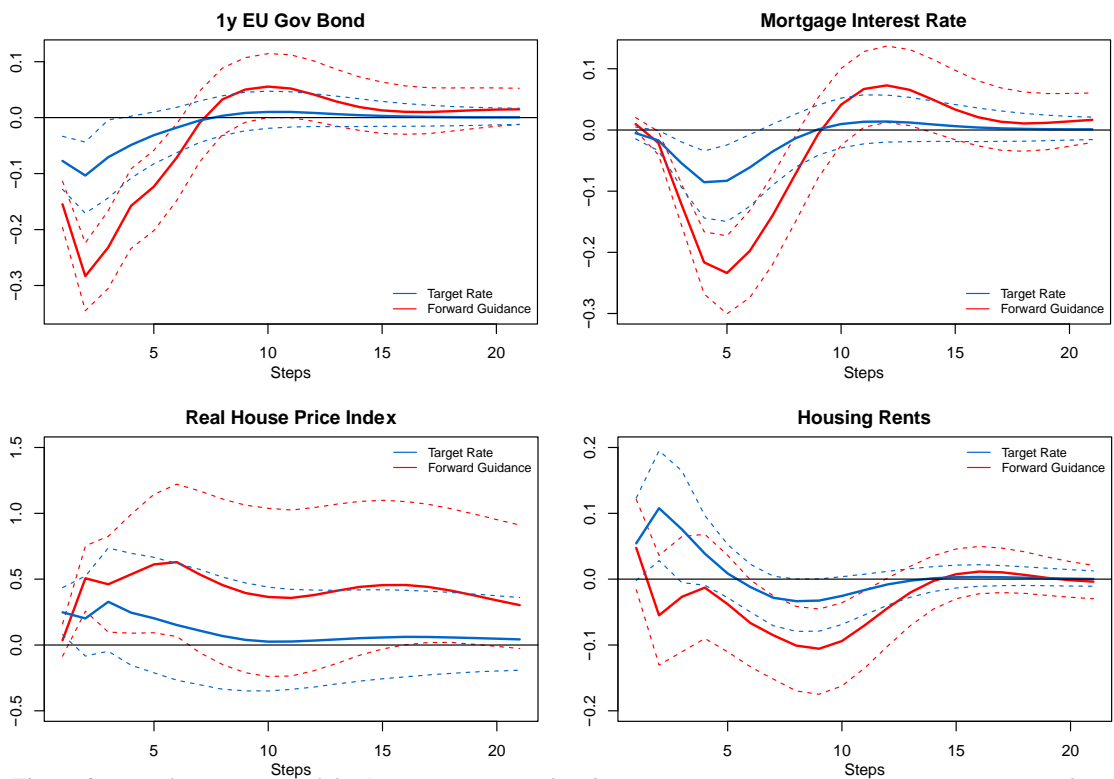


Figure 3 - Impulse responses of the 1y EU government bond, Portuguese mortgage interest rate, Portuguese house prices and Portuguese housing rental prices from a contractionary monetary surprise of one standard deviation in Target Rate and Forward Guidance. Note: The blue and red lines represent the median responses for the Target Rate and Forward Guidance, respectively. The dashed lines represent the corresponding 68% confidence bands.

5.2. Net Wealth Distribution changes

We now observe how is the net wealth distribution partially affected in Portugal by each monetary policy shock through the lens of the housing market channel, “*ceteris paribus*”. We first have a look at how does the total net wealth distribution evolves after the shocks, obtained by adding, to the initial wealth level, all net wealth changes originated from each variable’s response.

In the left panels of Figure 4, we can observe, represented by the blue solid lines, the total changes in the net wealth inequality indicators coming from the whole housing market, after the aggregate expansionary policy shock (1y EONIA/OIS). Not only does the Gini Index decreases abruptly in the initial quarters, remaining below its initial level in the remaining period, but the proportions of households in the 75th relative to those in the 25th percentile (P75/P25 ratio), and households in the top vis-a-vis the lowest decile of the distribution (P90/P10 ratio), fall as well.

At the peak responses (when the impact in the inequality indicators is the greatest), we observe a reduction of the Gini Index from 0,6593 to 0,6589, corresponding to a -0,06% fall. This is a much lower percentual fall when compared to the percentile ratios: the P75/P25 ratio falls from 2,245 to 2,234, (a 0,5% fall), while the P90/P10 ratio falls from 139,79 to 137,04 (a 2% fall). This means that the impact of the aggregate monetary policy shock through the whole housing market channel, keeping everything else constant, is greatly felt in the extremes of the net wealth distribution, more specifically, in the extreme deciles, that is the top and bottom 10% of the wealth distribution, with the latter having disporportionally larger net wealth gains. Such findings are confirmed when one disaggregates the policy shock, with the inequality indicators displaying a similar depressing behaviour after the dismembered policy shocks, as one observes in the right panels of Figure 4.

Understanding the decrease in net wealth inequaity becomes more interesting when looking at how each housing market variable individually affects it. The changes in inequality indicators originated from each housing market variable are shown in the left panels of Figure 4 for the

aggregate policy shock, represented by the dashed lines. For all indicators, each housing market's individual variable contribute to the fall in wealth inequality, although for the housing rents changes in the indicators are barely unnoticed. On the other hand, changes in both mortgages interest rates and specially in housing prices are highly explicative on why the inequality indicators fall, when affected by the overall housing market channel. This differences are explained by the fact that annual rents are a considerably lower amount in absolute terms when compared to the the value of a big asset such as the household's residence, meaning that a fall in the former expenses will be much lower in comparison to a rise in the value of the latter. The same graphs for the dismembered policy shocks are presented in Appendix 7.6, and the qualitative conclusions are the same.

To understand why each variable positively affects wealth inequality, one must refer back to Figure 1(a). Looking at the distributions of households that fully and partially own their main residence, with the latter being more concentrated towards the low-middle end of wealth distribution, and to how real estate is allocated in the household's assets portfolios across wealth quintiles in Figure 1(b) we infer that owning a house is a middle class asset. Thus, households in the middle and low-end of the distribution will be disporportionally positively affected after the increase in housing prices. Such fall in wealth inequality happens via a portfolio composition channel, as shown by O'Farrell, Rawdanowicz, and Inaba (2017) and Lenza and Slacalek (2018).

On the other hand, households that pay a mortgage and those that pay a rent are more centered around the lower-end of the distribution. For mortgages, this is verified by the distribution of household's that partially own their main residence, in Figure 1(a), suggesting that households possessing a mortgage are concentrated in the left-side of the wealth distribution, a prediction which is confirmed by the descriptive statistic in Appendix 7.7. For rents, one is able to observe its concentration in households with lower net wealth levels by looking at the distribution of houhsehods paying a rent in Figure 1(a). Therefore, a savings redistribution channel is also in

place (Coibion et al. 2017), contributing to a increase in weath redistribution through the fall in either mortgage interest rates or rental prices (although at a vey low level for the rents), as the reduction on the debt servicing/ rental costs after the monetary shock will increase these houghsehold’s available income, enabling them to increase their savings and consequent net wealth.

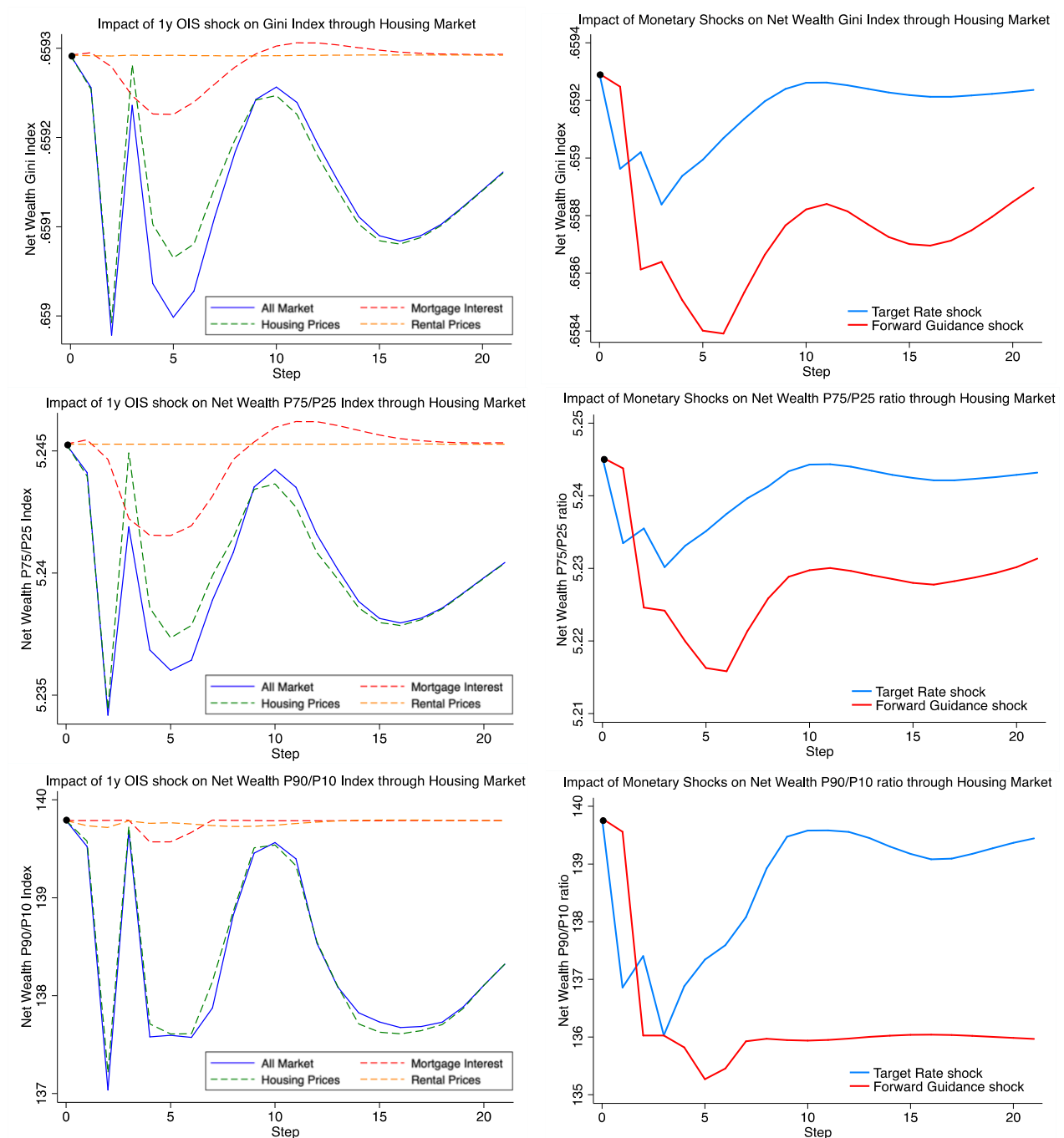


Figure 4 - Inequality indicators – Gini Index, P75/P25 ratio, and P90/P10 ratio – change through time, after the 1y EONIA shock (left side) and dismembered policy shock (right side). Note: dots represent the baseline indicators level, before the occurrence of the shocks.

Finally, we analyze the long-run impact of the monetary shock on the inequality indicators, by looking at the cumulative impact of these shocks. This is done by first computing the cumulative IRFs of the housing market variables – mortgage interest rate, housing prices and rental prices – and then perform the exact same microdata simulation as before to see the cumulative impact of the monetary shocks on net wealth distribution. In Table 1 one is able to observe the cumulative effect of each policy shock after 20 quarters in the net wealth inequality indicators, both through each individual variable and the whole housing market channel.

	<i>Initial</i>	Mortgages		Housing Prices		Rental Prices		All Market	
	-	20Q	Δ%	20Q	Δ%	20Q	Δ%	20Q	Δ%
1y EONIA Shock									
Gini Index	0,6593	0,6591	-0,03%	0,6562	-0,47%	0,6593	0,00%	0,6560	-0,50%
P75/P25 ratio	5,2453	5,2373	-0,15%	5,1584	-1,66%	5,2453	0,00%	5,1402	-2,00%
P90/P10 ratio	139,79	139,58	-0,15%	129,05	-7,68%	139,18	-0,43%	128,79	-7,87%
Target Rate Shock									
Gini Index	0,6593	0,6592	-0,01%	0,6563	-0,45%	0,6593	0,00%	0,6563	-0,46%
P75/P25 ratio	5,2453	5,2411	-0,08%	5,1626	-1,58%	5,2453	0,00%	5,1563	-1,70%
P90/P10 ratio	139,79	139,57	-0,15%	129,43	-7,41%	139,86	0,05%	128,92	-7,77%
FG Shock									
Gini Index	0,6593	0,6591	-0,03%	0,6481	-1,69%	0,6593	0,00%	0,6480	-1,72%
P75/P25 ratio	5,2453	5,2375	-0,15%	4,9668	-5,31%	5,2453	0,00%	4,9634	-5,37%
P90/P10 ratio	139,79	139,58	-0,15%	120,69	-13,66%	139,14	-0,46%	120,34	-13,91%

Table 1 - Cumulative effect of policy shocks on net wealth inequality indicators after 20 quarters

Focusing on the effects of the whole housing market channel on net wealth inequality, it is possible to observe that, 20 quarters after the shocks, net wealth inequality is lower than its initial level for both aggregate and dismembered policy shocks. Using the aggregate policy shock – 1y EONIA – as a benchmark, the Gini Index sees a total reduction of 0,50%, while the P90/P10 percentile ratio displays a much greater percentual variation (-7,87%) when compared to the P75/P25 ratio (-2,00%). Again, this signals that it is in the extreme deciles of the net wealth distribution that the most wealth redistribution is verified. Furthermore, housing prices continues to be the most explicative variable of the fall in the inequality indicators when seen through the whole housing market, while rents have a very low impact on the net wealth redistribution.

6. Conclusion

Using structural VARs to estimate the impact of expansionary monetary policy (aggregate and dismembered) shocks on Portuguese housing market macroeconomic variables and respective IRFs, afterwards performing a microdata simulation by updating the household's net wealth components with the respective macroeconomics' responses, this paper documents a positive relationship between monetary policy rates and net wealth inequality in Portugal, when looking specifically through the lens of the housing market.

In our findings, we observe that after the policy shocks, the responses of the housing market variables react according to theory. Each variable contributes positively to a redistribution of wealth. While housing prices decrease inequality through a portfolio composition channel, mortgage rates and rental prices decrease inequality through a savings redistribution channel, meaning that when seen a whole, the housing market channel leads to a decrease in net wealth inequality. The Gini Index falls, and the percentual variation in the P90/P10 ratio is higher than that of P75/P25, indicating that a higher redistribution of wealth is concentrated in the extreme deciles. All findings are supported when cumulative effects after 20 quarters are computed.

We find that this analysis can add new evidence to the existing literature on monetary policy redistributive effects, as it shows another way of looking into its effects, performing a partial equilibrium analysis where we explore only one market as a transmission channel. We provide more evidence on how micro simulations may be used, when time series with higher frequencies are unavailable to be incorporated in multivariate models, as it is the case for Euro Area countries. This work may also constitute a basis for further research. Given the housing market's heterogeneity present in the Euro Area, as shown by [Corsetti, Duarte, and Mann \(2020\)](#), it would be interesting to perform this same analysis for other Euro Area countries, and justify any

differences on the transmission of monetary policy to wealth inequality, across countries, with market structural factors, such as home ownership rates or the share of adjustable mortgage contracts.

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7. Appendix

7.1. Sources and Transformations of macroeconomic variables

Variable	Description	Transf	Source	Geography
1y_bond	Par yield curve rate, 1-year maturity - Nominal Gov bonds whose issuer's rating is triple A	levels	ECB-SDW	EA19
RHPI	Real house price index, 2015=100	log-levels	OECD	Portugal
Rent	HICP Actual rents for housing, 2015=100	log-levels	Eurostat	Portugal
MIR	Bank interest rates - loans to households for house purchase (outstanding amounts)	levels	ECB-SDW	Portugal

7.2. Monetary policy aggregate instrument (1y EONIA) plot and analysis

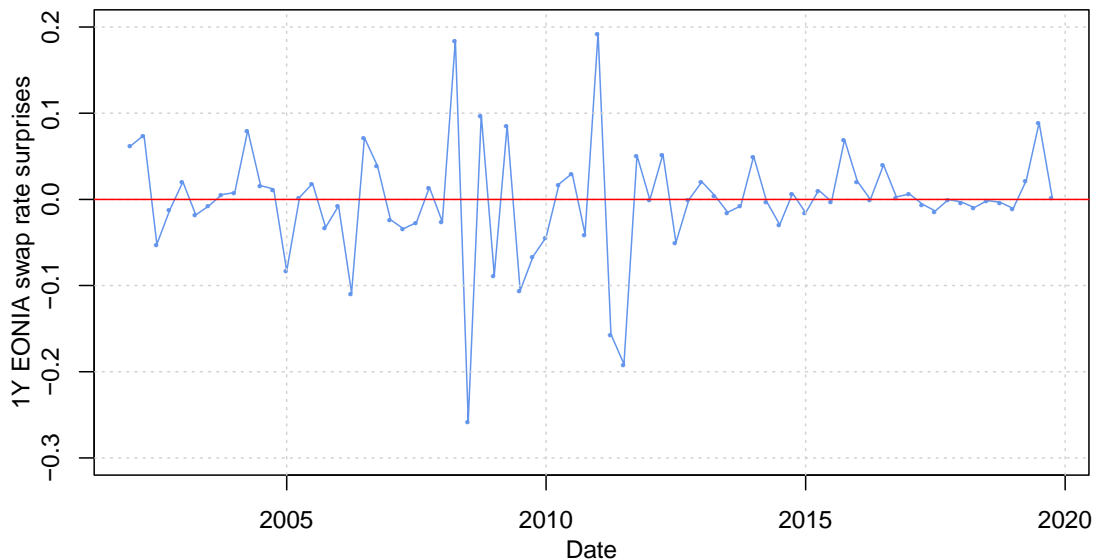


Figure 5: Instrument – Quarterly 1-year EONIA swap rate surprises from 2004Q3 to 2019Q4

The first large positive surprise is found in the second quarter of 2008, with a value of 0.185, which is mostly influenced by the monetary policy decision on 5 June 2008, with the surprises being originated majorly during the press conference window. There were no changes in the interest rates on the day, as it was expected. However, President Trichet highlighted that a policy change could be possible to happen in the following month. Then, in the next quarter, (2008Q3),

the instrument records its lowest reading across the period under analysis, registering a value of -0.258. This goes back to an expansionary monetary policy surprise occurring during the meeting of 3 July 2008, which although met by an interest rate increase of 25 basis points in order to counteract the increasing upside risks to price stability by the ECB, an expansionary sentiment still dominated, as it was transmitted the message that no more hikes were intended, leading markets to price out further increases. Next, we observe a second large positive shock during the first quarter of 2011, justified mainly by the meeting of 3 March 2011, where although interest rates were kept unchanged, similarly to what had happened in the meeting of 5 June 2008, President Trichet passed the message that a rate change could be possible to happen in the following month. Finally, we analyze what led the instrument during Q3 2011 to a negative value of -0,191. It is justified by the policy decision on 4 August 2011. Although policymakers left interest rates unchanged on the day, the ECB announced during the press conference the decision of conducting a longer-term refinancing operation (LTRO), translating into a surprise which led our instrument rate to fall.

7.3. Dynamic factor model estimated to extract disaggregated policy factors

The dynamic factor model to estimate is:

$$X^i = F^i \Lambda^i + \epsilon^i, \quad (1)$$

where $i = \{\textit{press release window}, \textit{press conference window}\}$, X are the changes in the 1, 3, and 6-month and in the 1, 2, 5, and 10-year yields retrieved from the EA-MPD database, F are the unobserved factors, Λ are the factor loadings, and ϵ are the idiosyncratic variation of each yield.

7.4. Monetary policy disaggregated instruments (Target and FG) plot and analysis

It is possible to observe that their behavior has not always been the same since the beginning of the period under analysis. While between 2002 and 2008 the corresponding volatility is rather low, it increased considerably in both series during the great recession and sovereign debt crisis. Then, around 2015 until the end of the period, the instrument's behavior of having almost none variability, translate the fact that the ECB's interest rates became much closer to the zero lower bound due to the use of unconventional policies. Therefore, we are able to conclude that both instrument's series closely matches the Euro Area's macroeconomic narrative during the past two decades



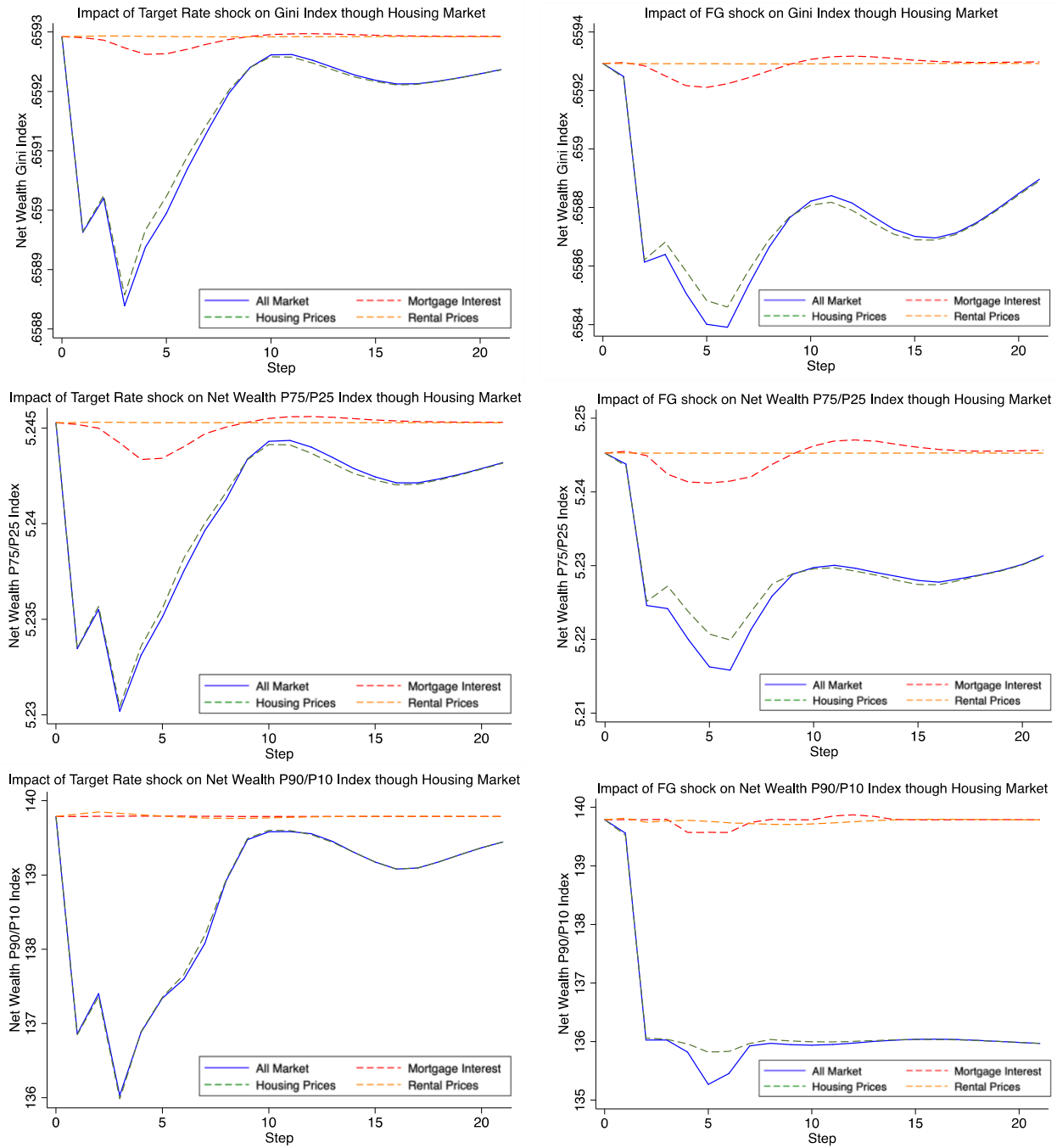
Figure 6: Instruments - Quarterly Target Rate and Forward Guidance surprises from 2004Q3 to 2019Q4

7.5. Augmented Dickey-Fuller tests on VAR residuals

VAR model	Test on Residuals of Variable:				
	<i>1y_EONIA</i> ADF	<i>1y_bond</i> ADF	<i>MIR</i> ADF	<i>RHPI</i> ADF	<i>Rents</i> ADF
1y EONIA VAR					
0 lags	-7,78 (0.01)	-7,83 (0.01)	-5,74 (0.01)	-7,94 (0.01)	-7,60 (0.01)
1 lag	-6,09 (0.01)	-6,41 (0.01)	-6,27 (0.01)	-5,14 (0.01)	-6,24 (0.01)
2 lags	-5,68 (0.01)	-6,01 (0.01)	-4,61 (0.01)	-4,37 (0.01)	-4,78 (0.01)
3 lags	-4,39 (0.01)	-4,11 (0.01)	-3,07 (0.01)	-4,45 (0.01)	-3,16 (0.01)
Target Rate VAR					
0 lags	-7,36 (0.01)	-7,50 (0.01)	-5,59 (0.01)	-7,63 (0.01)	-7,50 (0.01)
1 lag	-5,62 (0.01)	-6,92 (0.01)	-6,11 (0.01)	-5,06 (0.01)	-6,56 (0.01)
2 lags	-4,31 (0.01)	-5,66 (0.01)	-4,58 (0.01)	-4,29 (0.01)	-4,77 (0.01)
3 lags	-4,90 (0.01)	-4,37 (0.01)	-3,08 (0.01)	-4,67 (0.01)	-3,06 (0.01)
Forward Guidance VAR					
0 lags	-7,45 (0.01)	-7,75 (0.01)	-6,17 (0.01)	-8,19 (0.01)	-7,65 (0.01)
1 lag	-5,61 (0.01)	-5,89 (0.01)	-5,75 (0.01)	-5,24 (0.01)	-6,38 (0.01)
2 lags	-5,00 (0.01)	-6,53 (0.01)	-5,2 (0.01)	-4,6 (0.01)	-4,63 (0.01)
3 lags	-5,05 (0.01)	-5,31 (0.01)	-3,44 (0.01)	-4,30 (0.01)	-2,93 (0.01)

Values in parentheses correspond to the p-value: p-value of 0.01 means p-value $\leq 0,01$

7.6. Overall and each housing market variable impact on net wealth inequality indicators, through Target Rate (left) and Forward Guidance (right) shocks



7.7. HFCS Descriptive statistics – proportion of households with Outstanding mortgage loans, across net wealth quintiles

