# Mending the broken link: heterogeneous bank lending rates and monetary policy pass-through.

Carlo Altavilla, ECB*

Fabio Canova, Norwegian Business School †

Matteo Ciccarelli, ECB‡

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**Abstract**

We analyze the pass-through of monetary policy measures to households and firms' lending rates in the Euro area using novel bank-level datasets. Banks' characteristics such as the capital ratio, the exposure to domestic sovereign debt, the percentage of non-performing loans and the stability of the funding structure are responsible for the heterogeneity in pass-through of conventional monetary policy changes. The location of a bank is irrelevant. Non-standard measures reduced lending rate heterogeneities. Banks located in financially stressed countries and with weak balance sheets were most affected. Banks' lending margins fell considerably.

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*European Central Bank, Sonnemannstrasse 20, 60314 Frankfurt, Germany; email: carlo.altavilla@ecb.europa.eu

†Corresponding author, Norwegian Business School, CAMP, and CEPR. Department of Economics, BI Norwegian Business School, Nydalsveien 37, 0484 Oslo, Norway; email: fabio.canova@bi.no

‡European Central Bank, Sonnemannstrasse 20, 60314 Frankfurt, Germany; email matteo.ciccarelli@ecb.europa.eu.

# 1 Introduction

Lending conditions are crucial to determine the level of economic activity and of welfare. This is particularly true in the Euro area where bank loans are over 50% of the external balance sheet financing of both small and large non-financial corporations. For comparison, in the U.S. bank loans account for only 25%. If firms face working capital and wage bill constraints, quantity restrictions or lending rates inflexibility, constrain hiring, investment, and the level of aggregate activity. Lending conditions also matter for stabilization purposes: an impaired or time varying pass-through of policy rate changes to lending rates makes it much harder for a central bank to influence the dynamics of aggregate demand.

From the early 2000s to the end of 2007, the monetary policy pass-through in the Euro area was homogeneous (see Ciccarelli et al., 2013) and practically complete in the long run (see Hristov et al., 2014). Figure 1 plots the policy rate and the distribution of the average lending rate to non-financial corporations charged by banks in our dataset from 2007 to 2017, normalized so that the policy rate is zero in July 2007. Visual inspection highlights four distinct phases.

Up to the end of 2008 the dynamics of the distribution of the average lending rate closely tracks the dynamics of the policy rate and the spread of the distribution is small. From the beginning of 2009 to the middle of 2011, the median of the average lending rate distribution still follows policy rate changes, but the spread increased. Thus, in this subsample, several banks failed to adjust their lending rates in response to monetary policy changes. In the third phase, roughly from July 2011 to May 2014, the median of the lending rate distribution no longer follows policy rate changes, especially for banks operating in financially stressed countries – we term "stressed" Greece, Cyprus, Italy, Spain, Ireland and Portugal, while "non-stressed" are the remaining countries. During this period, average lending rate heterogeneity became considerable, even within each group of countries. For example, in non-stressed countries, the median of the distribution of the average lending rate fell from 3.2 to 2.3 percent, but the max-min range increased one percentage point. From May 2014 onwards, the median of the distribution of the average lending rate accompanied policy rate declines and the fall was large in stressed countries. In addition, the spread of the distribution declined to pre-2011 levels.

While these dramatic variations do not necessarily imply that the monetary pass-through has changed - the observed changes could be driven, e.g., by time varying heterogeneity in the riskiness of firms' projects - they beg obvious questions. Why is there time varying heterogeneity in lending rates? Why did banks respond differently to monetary policy changes since 2009? Why was the pattern reversed after 2014? Was the use of non-standard monetary instruments responsible for the return to normality?

The conventional view in normal times is that balance sheet characteristics determine how lending rates and loan volumes react to monetary policy contractions. In the US, the pass-through to lending rates was found to be stronger for small (Kashyap and Stein, 1995), illiquid (Stein, 1998; Kashyap and Stein, 2000), and poorly capitalized (Peek and Rosengren, 1995; Kishan and Opiela, 2000) banks. Gambacorta (2005) and Gambacorta and Mistrulli (2008, 2014) confirms these findings using a sample of Italian banks. Larger, better capitalized, and more liquid banks are more resilient to monetary contractions because they can more easily substitute sources of external financing and divert liquidity to satisfy loan demand. Contractionary policy decisions are thus transmitted to the real economy because the Modigliani-Miller theorem does not hold for small, illiquid, and poorly capitalized banks. In closed economies, where firms externally finance a large portion of their operations through banks, weak balance sheet positions amplify monetary policy actions powerfully restraining domestic real activity.

In periods of financial stress, this mechanism could be affected. In addition, apart from two episodes, Euro area monetary policy has been expansionary over the last 10 years and it is unclear as yet whether lending rates respond symmetrically to expansionary and to contractionary policy changes. Analyses of the Euro area pass-through during the last decade have produced contradictory conclusions. For example, Hristov et al. (2014), and Holton and Rodriguez d'Acri (2015) document a significant fall in the average pass-through relative to the pre-financial crisis period, while Von Borstel et al. (2015), Illes et al. (2015) only find a mild decline. Illes et al. also report that the fall is quantitatively similar in stressed and non-stressed countries, once banks' effective cost of funding is taken into account. On the other hand, Acharya et al.(2015) and Altavilla et al.(2017) find that the health of banks' balance sheet affect their portfolio choices. Thus, it may crucially affect the pass-through to lending rates.

This paper documents the presence of a time varying pass-through of monetary policy innovations to non-financial corporations and households lending rates in the Euro area during the last decade and relates its dynamic evolution to national and bank specific characteristics. Contrary to existing works, which examined banks from one country (e.g. De Graeve et al., 2007; Carpinelli and Crosignani, 2016), a small number of Euro area banks (Acharya et al., 2015), country level aggregates (Ciccarelli et al., 2013; Hristov et al., 2014; Ilies et al., 2015; Von Borstel et al., 2015), or lending volumes at a few points in time (Carpinelli and Crosignani, 2016), we employ two novel data sets providing monthly time series for lending rates and balance sheet characteristics of a large number of Euro area banks for the 2007-2017 period. The data sets are rich in many dimensions: the sample covers over 80% of the Euro area banking system;

we know the location, the legal status, the ownership structure, and the business model of the banks; a number of balance sheet characteristics; and the lending and deposit rates offered to their clientele. Moreover, the sample is sufficiently long to meaningfully distinguish between the pass-through of conventional and non-standard monetary policy decisions, and to measure the contribution of the latter to normalizing lending rates conditions.

In contrast to recent studies, which rely on cross sectional difference to identify the causal effects of monetary policy (see e.g. Rodynaski and Darmouni, 2016; Carpinelli and Crosignani, 2016, Chakraborty, et al., 2016), we exploit the time series dimension of the data to inform us about cross sectional differences in the pass-through. In addition, while these studies fail to consider the endogeneity of policy rate changes and the feedbacks on lending rates due to macroeconomic responses to policy changes, we construct pass-through measures which explicitly take them into account. Furthermore, while these analyses have little to say about the dynamic response of lending rates to monetary policy surprises because of the methodology employed to estimate the causal links, we are able to distinguish static from dynamic effects.

The analysis is divided in three parts. First, we examine how policy rate surprises affect the average lending rate to non-financial corporations for the period up to May 2014 - we call this conventional pass-through. The median long run pass-through is around 1.0, about the same value estimated for the early 2000s, but the cross sectional dispersion in pass-through estimates is large. For example, banks located in the top quartile of the distribution are more than twice as responsive to policy changes as banks located in the bottom quartile of the distribution. We demonstrate that standard "fixed effects", such as the location of a bank (in stressed vs. non-stressed countries) or the unconstrained access to European Central Bank (ECB) extraordinary liquidity programs (participation vs. non participation), are unable to explain why pass-through differences are large. Instead, banks' balance sheet characteristics such as the level of capitalization, exposure to domestic sovereign debt, share of non-performing loans, and the stability of their funding matter. We estimate that the difference between the top and the bottom quartiles of the distribution of pass-through sorted by these characteristics could be up to 40 basis points. These conclusions are robust in, at least, two dimensions: the sample of banks employed (all banks vs. large banks) and the way monetary policy shocks are identified (standard Taylor rule vs. high frequency instrumental variable scheme).

In the second part, we examine the pass-through of non-standard policy measures to non-financial corporations lending rates. Since June 2014, the ECB employed credit easing measures - the targeted longer-term refinancing operations (TLTROs) - to "enhance the transmission of monetary policy and to reinforce the accommodative monetary policy stance in view of the (...)

subdued monetary and credit dynamics" (ECB Economic Bulletin, October 2015). While credit easing policies were used prior that date, the extent and the scale of the measures adopted were unprecedented. In January 2015, the ECB also announced quantitative easing measures - the expanded asset purchase program (APP) - to further ease monetary policy.

We show that non-standard policies helped to normalize lending rate conditions by inducing banks, which were previously sluggishly in reacting to policy rate changes, to aggressively cut their lending rates. The programs solidify the balance sheet of all banks, but the most responsive to the measures were banks located in stressed countries and with poor initial balance sheet characteristics. In general, better and more homogeneous lending rate conditions materialized for three reasons: banks enjoyed funding costs relief, which improved the liability side of their balance sheet; asset revaluations, which ameliorated the asset side of their balance sheet, in particular, for banks whose net worth was low prior to 2014; and signaling effects, which made it clear that the extraordinary expansionary conditions would last for a while.

Although the lending market to Euro area households has different institutional and dynamic features, due to particular customer relationships and to the widespread use of non-competitive pricing (see e.g. De Grave et al., 2007), the dynamics of the pass-through to households and non-financial corporations lending rates are similar throughout the sample. Because banks did not strategically use market power to differentiate their response between firms and households, changes in the riskiness of firms' project was not the reason for the large pre-2014 cross bank heterogeneity in the pass-through and the following return to normality.

While some normalization could have also been achieved by relying only on standard policies (in particular, letting policy interest rates fall into negative territory), there would not have been any differential cross-country effect and only small differences across banks with different balance sheet characteristics. Similarly, while quantitative easing produced the bulk of the lending rate adjustments, it was the combination of negative interest rates, funding costs relief, and asset revaluation that reestablished the conditions for lending rates to adjust the increased liquidity in the system, and thus reduced the pre-2014 pass-through heterogeneities.

In the third part, we examine how non-standard measures affected banks' lending margins, the difference between the average lending rate and the average deposit rate. It is well known that, when there are pricing frictions in the deposit market, monetary policy may significantly affect lending margins (Gambacorta, 2008; Alessandri and Nelson, 2015). Changes in lending margins, in turn, might alter the returns from maturity transformation activities with adverse effects on banks' profitability and their market value. Lending margins were significantly compressed since the mid-2014 and the compression is larger for banks with poor balance sheet characteristics. Hence, while non-standard measures contributed to normalize lending conditions, they also hampered an important component of banks profitability, making the banking system more vulnerable to severe macroeconomic shocks.

Our work is related to three different strands of literature. Hannan and Berger (1991) and Neumark and Sharpe (1992) were among the firsts to measures how monetary policy changes affect bank lending rates. More recently, Gambacorta (2008), De Graeve et al. (2007), Ciccarelli et al. (2013), Hristov et al. (2014), Ilies et al. (2015) studied a similar issue for Euro area countries. We contribute to this literature by comparing the pass-through during and after the financial and sovereign debt crises, by providing a rationale for the time variations we observe, and by quantifying the effect of non-standard policy changes on lending rates and margins.

The paper is also related to the literature examining the bank lending channel (Kashyap and Stein 1995, 2000, Kishan and Opiela, 2000, and Gambacorta and Mistrulli, 2008), the net worth channel (Bernanke and Gertler, 1989, Mishkin, 1996), and the redistributive effects that monetary policy (Brunnemeir and Salnikov, 2016). In recent years, a number of studies have focused on the risk-taking channel, where reductions in policy rates cause financial institutions to take on larger risks (Acharya and Steffen, 2015, Rodynaski and Darmouni, 2016; Carpinelli and Crosignani, 2016, Chakraborty, et al., 2016, Koijen et al., 2016, Altavilla et al., 2017, Adrian et al., 2018). We contribute to this literature by showing that, in the Euro area, banks' characteristics matter for the lending rates response to monetary policy changes and that non-standard monetary policy changes have redistributive effects.

Our work is also linked to the growing literature studying the effect of non-standard policies on bank behavior (Ongena et al., 2015, Bluwstein and Canova, 2016, Boekx et al., 2016, Heider et al., 2017), on profitability (Alessandri and Nelson, 2015; Altavilla, et al., 2018), and on macroeconomic performance (Di Maggio et al., 2016). We contribute to this literature by showing how Euro area monetary stimuli influence a component of profitability and banks' portfolio choices.

The rest of the paper is organized as follows. Section 2 describes the data sets. Section 3 presents the empirical methodology. Section 4 discusses the pass-through of standard and section 5 the pass-through of non-standard policy measures. Section 6 examines the dynamics of profit margins. Section 7 concludes discussing some macroeconomic implications of our findings.

## 2 The data sets

Our analysis makes use of several data sets. We use two proprietary bank level databases, regularly updated at the ECB. The first, called Individual Monetary and Financial Institution

Interest Rates (IMIR), contains information on individual deposits and lending rates charged by banks for different maturities and for different loan sizes. We construct bank-level composite indicators of borrowing costs for non-financial corporations and households and of deposit rates, weighting the lending rates for different maturities and for different loan sizes by total new loan volumes. Thus, the rates we use are $r_{i,t} = \sum_{k=1}^{K} \sum_{\tau=1}^{l} w_{i,\tau,k,t} r_{i,\tau,k,t}$ where $i$ stands for bank, $\tau$ for maturity, $k$ for loan size and $t$ for time and $w_{i,\tau,k,t} = l_{i,\tau,k,t} / \sum_i \sum_\tau \sum_k l_{i,\tau,k,t}$ are time varying weights. It is important to use new loan volumes in constructing weights to make sure that the composite indicator correctly reflects the average lending (deposit) rate at each point in time. The weighting scheme implicitly takes into account the fact that loans may be issued at flexible or fixed interest rates (flexible rate loans generally have shorter maturity $\tau$ than fixed rate loans). The distinction is not crucial for lending rates to non-financial corporations since the vast majority of loan contracts are agreed upon at a flexible rate. However, it is important for household lending rates. For example, the share of fixed rate loans for mortgages is below 25% in Italy, Ireland, Austria, Finland, Portugal; on the other hand, in Belgium, Germany and France, more than 80% of mortgage agreements have a fixed rate. Similarly, while savings banks tend to prefer loans at a fixed rate, commercial banks have a more balanced portfolio of fixed and flexible mortgage loans. Clearly, these differences matter: the higher the share of fixed rate loans is, the slower is the transmission of policy rate changes to household lending rates. We checked that no compositional biases resulted from the fact that some banks lend primarily long term and others short term (about 60 percent of the loans of all banks have less than a year maturity), or that some lend to small and other to large corporations, which may give some banks some monopolistic power in the loan market. While one could work directly with the disaggregated data, the large number of categories of rates (by maturity and size) one could consider, makes the empirical time series techniques used in this study unfeasible. We plan to exploit the richness of the data in these dimensions in future work.

From a second proprietary data set, called Individual Balance Sheet Indicators (IBSI), reporting assets and liabilities items of 325 banks resident in the Euro area from July 2007 to October 2017, we obtain information on the exposure to domestic sovereign debt, the capital position, the funding structure, and other relevant bank balance sheet information. We exclude from the sample smaller units which appear in our dataset as groups or conglomerates, banks which were acquired, and restrict attention to head institutions and subsidiaries, so that each bank can be treated as independent (legal) entity. This would not have been possible if branches were also considered since a head institution must cover branch losses, with consequences for regulatory constraints, risk-taking behavior, and thus lending and deposit pricing policies.

This data set also has rich cross-sectional information: we know whether a unit is a head institution or a (domestic or foreign) subsidiary; whether it is a large or a regional/local bank, and the country where it is located; whether it is publicly or privately owned; and we can infer its business model (whether it lends more to non-financial corporations or to households, whether funds are obtained more through capital or wholesale markets, whether it does business in a competitive or protected environment, etc.). The sample is representative of the Euro area banking industry: it covers about 80% of the total banking system and the cross-country distribution reflects the concentration of banks in the area. As table 1 shows, most of the banks are from the four largest countries (Germany, France, Italy and Spain), about half are head institutions, and cross country linkages are as or more important than domestic linkages. The richness of the data can be put into perspective by noticing that the 2014 stress testing exercise conducted by the European Banking Authority included about 100 banks, less than half were head institutions, and balance sheet characteristics were only irregularly observed.

We also obtain information on bank bond yields (obtained from Markit - Iboxx), on regulatory capital ratios, on gross non-performing loans (obtained from the commercial bank data provider SNL Financial) and on CDS (obtained from Datastream). Table 2 summarizes the information we have. The average lending rate to non-financial corporations for banks in the upper quartile of the distribution is about 135 basis points higher than the average lending rate for banks in the lower quartile. This difference increases to 240 basis points when we consider lending rates to households. Average deposit rates are also heterogeneous. A bank belonging to the upper quartile of the distribution offers an average deposit rate which is about three times as large as the average deposit rate offered by banks in the lower quartile. Financing costs show large differences: the average interquartile spread in bank bond yields is 370 basis points and banks in the top quartile face financing costs which are four times as large as banks in the lower quartile. Since average deposit rate and average bank bond yields are correlated, the cost of financing operations could be up to five times larger for certain types of banks.

The heterogeneity in the distribution of domestic sovereign debt exposure, capital ratios, leverage, non-performing loans, and credit risk is also significant. In our sample there are banks with almost no sovereign bonds and banks with over 6 percent of their assets in sovereign bonds; banks with a small percentage and banks with up to 8.5 percent of non-performing loans; banks with low risk and banks with relatively high risk; and banks which are 50 percent more leveraged than median bank in our sample. Finally, banks in our sample are generally medium sized, but about 10 percent of them are large in terms of total assets.

The cross-sectional ordering of balance sheet characteristics is quite persistent: the average rank correlation across characteristics is about 0.68. There is also considerable persistence in the quartiles of the distributions. For example, if a bank had a characteristic in the lowest quartile of the distribution at the beginning of the sample, it will still have it in the lowest quartile at the end of the sample in 75 percent of the cases. Moreover, the probability that bank ranks in the lower (upper) quartile of the distribution at the beginning of the sample and ends up in the upper (lower) quartile at the end of the sample is only 0.03, on average across characteristics. This means that, although some banks recapitalized and others decreased their share of non-performing loans relative to the average, the ranking in the distribution of characteristics is fairy stable. Furthermore, very few banks with poor initial balance sheet conditions managed to solve their problems by the end of the sample. Thus, without loss of generality, we can condition on pre-sample characteristics when grouping monetary pass-through. Using pre-sample information allow us to bypass thorny issues regarding the endogeneity of the banks' balance items in our pass-through computations. For example, in response to monetary policy expansions, banks may delay recapitalization, since savings from lower financing costs may be set aside as reserves.

While for most of the analysis we use one bank characteristics at the time to sort the pass-through, for robustness, we will also consider, pass-through ranked using all balance sheet characteristics jointly. One would think that balance sheet characteristics are highly correlated: a bank with low level of capital may also be more leverage, have larger exposure to domestic sovereign bonds, and face higher risks. It turns out that this is not necessarily the case and the maximum rank correlation across characteristics is only 0.4. Boeckx et al. (2016) consider the available banks characteristics each interacted with monetary policy in a local projection regression of lending rates and lending volumes on monetary policy changes. Because the specification they employ does not jointly interact all banks characteristics and monetary policy shocks, the results they present are comparable to those we obtain with one characteristic at the time.

## 3 The econometric methodology

To study the questions of interest we use a two-step cross-sectional Vector Autoregressive (VAR) methodology. In the first step, we estimate the dynamic response of lending rates (margins) to monetary policy disturbances, bank by bank, taking into account the dynamic interactions between banks' lending rates and funding conditions, and between banks, country specific, and Euro area macroeconomic variables. In the second step, we sort the estimated distribution of pass-through using bank-specific characteristics and measure the difference between the upper and lower quartiles of the distribution of pass-through. Because the pass-through might depend on country-specific factors (such as unemployment or sovereign risk), on area wide factors (such as aggregate inflation or the state of the real business cycle), as well as on bank-specific characteristics, it is important to condition on country and area specific factors in determining the relevance of bank-specific characteristics for the pass-through of monetary policy decisions.

Relative to single equation pass-through regressions (see e.g. Ilies et al., 2015), our approach has two main advantages. First, it allows for endogenous interactions between lending and funding conditions within a bank in response to monetary policy disturbances. This interaction is crucial in pricing loans, and neglected in single equation approaches. Second, it permits dynamic feedbacks among macroeconomic and banking variables. These dynamic repercussions are disregarded in static regression models and improperly measured in single equation dynamic setups estimated with ordinary least square.

Our methodology is also preferable to standard approaches that restrict the dynamics of the endogenous variables to be homogeneous and employ standard pooled techniques (e.g. Kashyap and Stein, 2000; Gambacorta, 2008, De Santis and Surico, 2013, among others). The lending rate heterogeneities documented in figure 1 make such an assumption highly unpalatable. The heterogeneous panel VAR model of Canova and Ciccarelli (2009) allows for dynamic interactions between lending and funding conditions and does not restrict lending rate responses to be cross-sectionally homogeneous. However, the sparse nature of the dynamic interactions across banks makes the setup inefficient for our purpose.

In contrast to studies which exploit cross sectional difference to identify the causal effects of policy changes (see e.g. Rodynaski and Darmouni, 2016; Carpinelli and Crosignani, 2016, Chakraborty, et. al, 2016), we use the time series dimension of the panel to inform us about cross sectional differences in pass-through. In addition, since cross sectional approaches use a difference-in-difference methodology to estimate causal links and capture aggregate effects with time dummies, they unable to examine lending rate dynamics in response to monetary policy changes, nor do they account for macroeconomic feedbacks. Moreover, none of these studies accounts for the possibility that changes in the policy rate are endogenous. Thus, they provide only a roughly approximation to the impulse setting the adjustments in motion and to the magnitude of the static macroeconomic effects it generates.

Finally, in contrast to most of the recent literature, we focus attention on the dynamics of banks' lending rates and lending margins rather than banks' loan volume, their currency denomination (see e.g. Ongena, et. al, 2015), the composition of banks' portfolio of assets (see e..g Jimenez et al, 2012) or their overall riskiness (see e.g. Koijen et al., 2017).

Two other important points about our methodology should be stressed. First, banks do borrow and lend in the overnight market but, over a month, the positions are generally averaged out. Because dynamic interactions across banks are negligible and static interactions are likely to be small, computing the pass-through bank by bank entails little loss of information. Second, our two-step approach is equivalent to allowing the intercept, the slope, and the variance of the empirical model to be bank specific and to feature (non-linear) interaction terms with bank-specific characteristics. Sa et al. (2014) used a similar approach to study the dynamics of the UK housing market in response to monetary policy and capital inflows.

Letting the vector of variables including bank "$i$" operating in a country "$j$" at time "$t$" be $y_{i,j,t}$, the vector of country specific variables be $x_{j,t}$, and the vector of area-wide variables be $z_t$, where the $k$-th element is the policy rate, the VAR we estimate for each bank is

$$\begin{pmatrix} I & 0 & 0 \\ A_{0,xz} & I & 0 \\ A_{0,yz} & A_{0,yx} & I \end{pmatrix} \begin{pmatrix} z_t \\ x_{j,t} \\ y_{i,j,t} \end{pmatrix} = A(L) \begin{pmatrix} z_{t-1} \\ x_{j,t-1} \\ y_{i,j,t-1} \end{pmatrix} + \begin{pmatrix} v_t \\ e_{j,t} \\ u_{i,j,t} \end{pmatrix} \tag{1}$$

$y_{i,j,t}$ includes the lending rate, the deposit rate, and bank bond yields when available; $x_{j,t}$ the 10-year sovereign bond yields, the expected default frequency of non-financial corporations, and the unemployment rate; and $z_t$ the policy rate, the HICP inflation rate, and the unemployment rate. The area wide inflation rate and unemployment rate proxy for Euro area business cycle conditions, while the expected default frequency, the local unemployment rate and the sovereign bond yield are employed to capture deviation of local business cycle conditions from the area wide averages. It is important to include the expected default frequency to control for changes in the riskiness of banks' customers which may lead to demand driven variations in the distribution of lending rates distinct from those we are interested in. Note also that the cross sectional distribution of the expected default frequencies is highly correlated over time with the Euro wide VIX index and other measures of uncertainty. Thus, conditioning on this variable helps us to absorb endogenous variations due to financial market volatility and control for the effects that the financial and sovereign crises had on lending rates.

Yields on 10-year sovereign debt are from DataStream; the expected default probability of non-financial corporations is from Moody's; the country specific unemployment rate, the Euro area inflation and unemployment rates are from Eurostat. We use the EONIA rate as our monetary policy variable. Since the ECB directly controls the rate on the marginal lending facility, the rate on the main refinancing operations (MRO), and the rate on the deposit facility (DF), while the EONIA rate is market determined, the choice of EONIA as the policy rate requires a few words of explanation. First, note that the three ECB rates move discontinuously with discrete jumps when the Governing Council decides rate changes while the EONIA rate evolves daily. Second, the EONIA rate does not have a floor at zero, which is important when measuring the impact of non-standard policies. Third, the EONIA rate closely tracks the MRO rate in periods of normal liquidity and the DF rate when liquidity is abundant, making it a good indicator of monetary accommodation in normal and extraordinary times.

In (1) the contemporaneous relationships have a block recursive structure where area wide variables feed into national and bank specific variables and national variables into bank specific variables but not vice versa. This structure is justified by the observation that single banks, however large, have negligible effects on country specific and area wide variables within a month and that country specific variables affect area wide quantities only with a lag.

Note that since each bank specific VAR features different endogenous variables, we constrain policy shocks so that the response of area wide and of country specific variables is the same in each bank specific VAR. This is equivalent to making area wide and country specific variables weakly exogenous with respect to bank specific variables.

To identify monetary policy disturbances, we employ a standard methodology where we allow HICP inflation and the unemployment rate to affect the EONIA rate within a month, but not viceversa. For robustness, we discuss how our conclusions are affected when monetary policy shocks are identified using the IV methodology discussed in Stock and Watson (2017). In this case, we purge the dynamics of the EONIA rate of predicted movements due to own lags and past values of Euro area inflation and unemployment rate with the VAR. We then instrument the residuals in the policy rate equation using monetary policy announcements dates, as in narrative approaches to monetary policy (see e.g. Ramey, 2016). Gertler and Karadi (2015) have used information from the Federal Fund futures around FOMC announcement dates to estimate monetary policy shocks, after filtering Federal Funds dynamics with a VAR. Since future market information is not available for the Euro area, announcements dummies provide a conservative measure of monetary surprises (anticipatory effects are disregarded). We would like to stress that the results we present are insensitive to which Euro wide variables is included in the VAR. In particular, omitting the Euro wide unemployment and inflation rate or using a Euro area factor does not change any of our conclusions.

The results we obtain are robust to the way policy rate innovations are constructed because the pass-through we compute has the form of a dynamic multiplier (see later on). Thus, variations in the lending rate responses due to alternative identification assumptions are generally mirrored by variations in the policy rate responses in the same direction and of the same size. Moreover, since our analysis compares quartiles of the cross sectional distribution of pass-through, alternative identification assumptions may change the magnitude of the lending rate responses but not the relative pass-through differences.

Given the limited size of our sample and the dynamic heterogeneities in pass-through, it is not advisable to rely on classical asymptotic theory for inference. Thus, we derive the exact small sample distribution of the pass-through using Bayesian methods. Let $\beta_i$ be the vector of bank-specific VAR coefficients, $\beta = [\beta_1', \dots \beta_N']$, let $\Sigma_u = diag[\Sigma_{u,1}, \dots \Sigma_{u,N}]$ be the covariance matrix of the disturbances, and let $\theta = (\beta, \Sigma)$. We use a standard Normal-Inverse Wishart prior for $(\theta|\zeta)$, where $\zeta$ is a vector of prior hyperparameters, which incorporates three features: i) the empirical model for each unit is shrunk toward a vector of random walks with drifts; ii) the coefficients of each equation are restricted to produce roots which are less than one in absolute value; and iii) a "dummy-initial-observation" prior accounts for potential non-stationarities in the data, see Sims and Zha (1998). The vector $\zeta$ is treated as random and has a flat prior distribution. The marginal posterior of $\theta$ is obtained integrating out $\zeta$ from the joint posterior of $(\theta, \zeta)$ computed using the hierarchical structure of the model (see Canova, 2007). The VAR for each bank is estimated with 4 lags and a constant and sequences from the posterior distribution of $\theta$ are drawn with a Gibbs sampler.

Denote by $\beta_i^m$ a draw from the marginal posterior of $\beta_i$. An estimate of the responses of bank $i$ variables to a conventional-type monetary policy disturbance is:

$$y_{it}^m \equiv \omega_i^m(L) v_{kt} \ i = 1, 2, ...N \tag{2}$$

where $\omega_i(L)$ is a $3 \times 1$ vector for each $i$, and $v_{kt}^m$ denotes the monetary policy shocks. Letting $y_{it}^{1,m}$ be the response of the lending rate at time $t$ for bank $i$, the pass-through at horizon $h$ is:

$$PT_{i,m}^h \equiv \frac{\sum_{\iota=0}^h \omega_{i\iota}^{1,m}}{\sum_{\iota=0}^h \delta_\iota^m}, \ h = 1, 2, ...H \tag{3}$$

where $z_{kt} = \delta(L) v_{kt}$. The distribution of pass-through for each horizon is obtained exploiting both cross-sectional differences and individual bank parameter variations, that is, the $(i, m)$ dimensions of $PT_{i,m}^h$.

If lending rates responses were homogeneous, i.e. $\omega_i^m = \omega^m \ \forall i$, cross-sectionally averaging (3) gives the pass-through obtained pooling cross-sectional information. This quantity, however, would be different from the one computed in single pass-through equations, because the latter disregards the contemporaneous and lagged feedbacks from deposit rates and bank bond yields to lending rates and the dynamics of country specific and area specific variables.

When we analyze standard measures, we use the sample July 2007-April 2014. The pass-through of non-standard measures is obtained using the parameter estimates for this sample and a path for certain endogenous variables from May 2014, constructed as described in section 5.

Although the sample includes 325 banks, the actual number of banks we employ is smaller. In fact, bank bond yields are available only for a subset of (mostly large) banks, and some balance sheet characteristics are not available for at least 40 consecutive periods – a required selection criteria for a bank to be included in our sample. In the baseline exercise, we eliminate bank bond yields from the VAR and consider a larger sample of banks ($N = 174$). For robustness, we also consider the smaller sample of banks for which bank bond yields are available ($N = 105$). As we discuss in the text, the main conclusions we obtain hold in both samples.

## 4 The pass-through of conventional measures

The first column of Figure 2 shows the distribution of lending rate responses and of the pass-through for all banks in the sample. Responses are constructed assuming a persistent 100 basis point unexpected decline in the policy rate. The stylized evidence presented in Figure 1 hints at the fact that the average lending rate of banks located in financially stressed and financially non-stressed countries behave differently. However, this difference could be driven by group specific demand factors, such as a different share of non-performing loans. To examine whether the causal link between policy rate innovations and lending rates depends on the location of the bank, we sort the cross sectional distribution of lending rate responses and of the pass-through by type of countries. The second and third columns of Figure 2 plot the distributions for banks operating in stressed and non-stressed countries, respectively.

The median instantaneous pass-through is about 0.40, but after a few quarters it reaches 0.9, and in the long run it is basically 1.0, the same value estimated prior to 2007 (Hristov, et al. 2014). Thus, for the median bank, the bank lending channel of monetary policy is as strong as in the pre-crisis period. The distribution of pass-through, however, is very dispersed: after 36 months, the highest posterior 68 percent interval goes from about 0.4 to 1.5. The location of banks does not have much to do with this heterogeneity. The median of the distribution of pass-through in the two groups has, roughly, the same dynamic behavior, and the highest posterior 68 percent intervals overlap.

How, then, does one reconcile Figures 1 and 2? We can think of two reasons for why the information provided in the two figures is not necessarily inconsistent. The evidence in Figure 1 is unconditional; Figure 2 is constructed conditional on a monetary policy shock. Thus, there could be group specific disturbances driving the dynamics of lending rates in stressed and non-stressed countries: financial and technological shocks are two obvious candidates. Moreover, country-specific and area wide variables are explicitly accounted for in Figure 2. Thus, for example, different expected default probabilities, which are taken into consideration in Figure 2, could be responsible for the differences across groups present in Figure 1.

A concern when analyzing the impact of policy surprises in the 2007-2014 period is that the pass-through might be affected by the presence of non-standard policy measures. Since October 2008, the ECB has been lending liquidity to banks through fixed-rate full-allotment auctions. Since the EONIA rate adjusted accordingly, its innovations reflected both standard and non-standard monetary policy measures (see Ciccarelli et al, 2016). It turns out that the presence of non-standard provisions is inconsequential for the evidence presented in Figure 2. To show this, we matched the available data with confidential information about the participation of banks in the two 3-year Very Long-term Refinancing Operations (VLTROs) conducted on the 20th of December 2011 and the 28th of February 2012, and checked whether banks bidding in the operations (regardless of the amount actually taken up) displayed different pass-through than banks not participating the program. About half of the banks in our sample bid in one of the two auctions, making the comparison statistically relevant. Figure 3 shows that lending rate responses and the pass-through for the two groups of banks are indeed similar.

Figure 4 reports the mean values of the pass-through in the upper (solid line) and lower quartiles (dashed line) of the distribution, together with the point estimate and the 68 and 95 percent highest posterior intervals (shaded areas) for the differences. We cluster the pass-through distribution according to (i) the exposure to domestic sovereign bonds, (ii) the (Tier 1) capital ratio, (iii) the degree of stability of the funding structure, as defined by Basel III, and (iv) the gross share of non-performing loans.

The pass-through is low for banks heavily exposed to domestic sovereign debt, with a weak capital position, unstable funding, and a high level of non-performing loans. For example, a 100 basis point decline in the EONIA rate generates an average long run pass-through of about 0.85 for highly capitalized banks, and of about 0.45 for poorly capitalized banks. Note that the 95 percent posterior difference in the sorted average pass-through can reach 0.60. Because the instantaneous pass-through is roughly independent of bank characteristics, quartile differences are due to the fact that banks with a poor balance sheet sluggishly adjust their rates over time. Our finding that exposure to sovereign debt matters for pricing loans is consistent with the evidence in Drechsler et al. (2014), Altavilla et al. (2016) and Peydró et al. (2016) about risk-shifting incentives at crisis times. Van den Heuvel (2002) describes a model where lending rates of banks with weak capital position are sluggish because policy rate changes alter bank capital. Our evidence suggests that the effect on bank capital may be delayed, i.e., capital requirements may bind only on the dynamic adjustment path, but may be long lasting.

Although, banks characteristics are not necessarily cross-sectionally correlated, one expects the same conclusion to hold when we group pass-through of "weak" and "strong" banks, where the former are banks with low capital, high domestic sovereign exposure, unstable funding and high level of non-performing loans and the latter banks with high capital, low domestic sovereign exposure, stable funding and low level of non-performing loans. Figure 5 plots the mean differences between the two groups, together with 68 and 95 percent highest posterior intervals. Indeed banks with weak balance sheet position have a significantly lower pass-through and the difference in the long run could be up to 20 basis points. Interestingly, the pattern in Figure 5 looks very much like the one in Figure 4 when sorting the distribution of pass-through by capital ratio position. Thus, the capital position of a bank is a sufficient statistic for its balance sheet conditions and largely determines how different banks price their loans.

## 4.1 Robustness

We conduct two exercises to check the robustness of our results.

First, we identify monetary policy shocks differently. When an IV approach is used, instrumenting policy rate residuals with high frequency announcement information, the conclusion are unchanged (see Figures A1-A3 in the on-line appendix): the pass-through of banks located in stressed and non-stressed countries is similar; banks with low capital, high exposure to domestic sovereign bonds, unstable funding, and a high percentage of non-performing loans have pass-through which are significantly lower than those of banks with opposite characteristics; the capital position of a bank is a sufficient statistic to determine the health of its balance sheet. Quantitatively, some differences need to be noted: the instantaneous pass-through with IV identification is generally lower, but the long run pass-through for banks with healthy characteristics is typically higher, making long run difference larger and more significant.

When the smaller sample of banks is considered, results are qualitatively similar (see Figures A4-A5 in the on-line appendix). Quantitatively, quartile differences in pass-through sorted by capital ratio and sovereign debt exposure are generally smaller – differences are now up to 20 basis points. In addition, while in the larger sample the instantaneous pass-through was independent of balance sheet characteristics, in this smaller sample, both the instantaneous and the long-run pass-through depend on the health of banks' balance sheet position, but differences across quartiles stabilize after a few years. Recall that the banks in this sample are primarily large ones. Thus, while the conclusion that balance sheet characteristics matter is robust, large banks are less affected by exposure to domestic sovereign and insufficient capital ratio than smaller ones when it comes to translate policy rate changes into lending rates changes.

### 4.2 Summary

Our analysis has highlighted a number of important facts. The monetary pass-through for the median bank in the 2007-2014 period is similar to the one prior to 2007, but there is considerable cross sectional heterogeneity, which is not necessarily related to the location of a bank. The wide dispersion in pass-through is consistent with the idea that frictions for certain banks became binding (see Gerali et al., 2010) and interacted with balance sheet characteristics when pricing loans. In particular, certain banks became more prudent, charging customers rates higher than one would have expected from the dynamics of the policy rate, because the deterioration of the asset side of their balance sheet and difficulties in securing appropriate funding threatened their long-run viability. The interaction between frictions and balance sheet characteristics is more important for smaller banks, and is independent of the way monetary policy shocks are identified. Interestingly, as far as the monetary pass-through is concerned, the capital ratio is a sufficient statistic to determine the health of banks' balance sheet.

## 5 The pass-through of non-standard measures

Although the EONIA rate responded to liquidity changes induced by the credit easing package and by the quantitative easing package, the VARs have no variable capturing total market liquidity or the central bank balance sheet expansion, making it hard to directly characterize the effects of non-standard measures on lending rates.

To study whether and how non-standard measures changed the dynamics of the distribution of lending rates we proceed in two steps. In the first step, we calculate the responses of the EONIA rate, of sovereign bond yields, and banks credit risk, as reflected in the market price of bank debt, to announcements of non-standard measures from May 2014 to October 2017 using a high-frequency event-study methodology (see e.g. Krishnamurthy and Vissing-Jorgensen 2011; Altavilla et al. 2015). The effects of the announcements on these three variables can be broadly associated with the signaling, portfolio rebalancing, and cost relief channels non-standard monetary policy (Eggertsson and Woodford, 2003, Krishnamurthy and Vissing-Jorgensen, 2011, Joyce et al., 2011, and Bauer and Rudebusch, 2014). Note also, that while the induced changes in the EONIA rate affected all banks, those in sovereign bond yields and bank bond yields do not. Thus, we expect the effects of non-standard policies to be heterogeneous across banks and different from those obtained manipulating the EONIA rate alone. In the second step, we compare the VAR-based dynamics of individual bank lending rates in two situations: when EONIA, sovereign and bank bond yields take the values predicted in the first step; and when they evolve unconditionally since May 2014.

A high-frequency approach is necessary for the exercise because the instantaneous financial markets reaction to non-standard measures is likely to be washed out if monthly data are used (see e.g. Altavilla, et al., 2016; Bluwstein and Canova, 2016; Ghysels et al., 2015). The two step-approach we employ is appealing from a policy point-of-view because it captures the impact of non-standard measures on lending rate dynamics relative to the hypothetical situation where the ECB would had not taken any new measure from May 2014 onward. Note that, while non-standard measures may have been taken, in part, in response to the large heterogeneity of the pass-through distribution observed prior to 2014, the methodology we employ is statistically valid because announcement dates can be taken as predetermined to the distribution of pass-through when daily data are used.

### 5.1 The impact of non-standard policies on financial markets

Quantifying the impact of non-standard measures on financial variables is challenging because many concurrent events affected financial markets during the sample; expectations of US monetary policy tightening and oil price declines are two such events that come to mind. To isolate the effect of policy surprises we run an auxiliary regression and obtain the path of the EONIA rate, of sovereign and of bank bond yields that would have materialized if the Euro area had been hit only by non-standard policy announcements. The regression we run is

$$\Delta y_t = aD_t + bD_{t-1} + cX_t + \epsilon_t \tag{4}$$

where $D_t$ is a vector of dummy dates and $X_t$ a vector of macroeconomic surprises in the Euro area and the US and $\epsilon_t$ a iid disturbance. $D_t$ includes forty-two announcement dates: for credit easing measures we include the Governing Council meeting dates held in May and June 2014; for quantitative easing measures we follow Altavilla et al. (2015) and use official communications or hints about the likely implementation of the program. The decisions to start the APP program (announced on January 22, 2015), to extend the package reinvesting the principal payments and enlarging the set of eligible assets to regional and local government debt (announced on December 3, 2015), to increase the monthly purchases, to launch a second TLTRO and a new corporate sector purchase program (CSPP), where the set of eligible assets was enlarged to include also investment-grade euro-denominated bonds issued by non-bank corporations (announced on March, 3 2016), and then to recalibrate the amounts purchased (December 8, 2016 and October 26, 2017) may have created anticipatory effects. We take these into account by including all Governing Council meeting dates since September 2015 and six additional dates associated with ECB's official speeches and data releases that led financial markets to revise their expectations about the likelihood of additional measures.[1] $X_t$ is the standardised difference between the actual value of the data released and the consensus forecast made by professional forecasters – as collected by Bloomberg; and $\Delta y_t$ measures the daily change in either the EONIA rate, or bank bond or sovereign bond yields. In (4) we use a two-day announcement window to allow for a sluggish market reaction to the news, which could have been possible given the novelty of the programmes. The results with a one-day window are similar. The policy component of the changes in the three variables is retrieved cumulating monthly the path predicted by (4) between May 2014 and October 2017.

Figure 6 reports the median effect (solid blue line) and either the cross-country or cross-bank variations (red dashed lines). Banks located in stressed countries benefited most from the policies: in the median by October 2017, their funding costs fell by about 40 basis points and the sovereign bond yields fell by over 125 basis points. By comparison, a typical bank in non-stressed countries saw funding cost and sovereign bond yields reductions of 10 and 50 basis points, respectively, in the median. Thus, the portfolio rebalancing channel seems stronger than the cost relief channel. Note also that over three-fourths of the decline in the EONIA rate over the period is due the policy announcements.

### 5.2 From financial variables to lending rates

We use the VAR, bank by bank, to predict the dynamics of lending rates from May 2014 to October 2017 in two situations: i) conditional on the path of the EONIA rate, of sovereign and of bank bond yields displayed in Figure 6; ii) letting these three variables evolve unconditionally

[1] The six events are Mr Draghi's intervention in New York on 4 December 2015, which had clarified the easing potential of the December package; the speeches Mr Praet's speeches on 22 September and 27 October 2015; the Bloomberg interview by Mr Constancio on the 25 November 2015; the market commentaries associated with the better-than-expected Economic Sentiment Indicator release on 29 October 2015; and the Reuters news regarding the growing consensus across Governing Council members on further deposit rate cuts on 9 November 2015.

since May 2014. Formally, we compute:

$$\xi_{it+h} = E\left(y^1_{it+h} \mid \Omega_t, z^*_{kt+h}, y^*_{jt+h}\right) - E\left(y^1_{it+h} \mid \Omega_t, z_{kt+h}, y_{jt+h}\right) \tag{5}$$

where $\Omega_t$ is the state of the economy at $t$, $y^1_{it+h}$ is the path of the lending rate of bank $i$ at horizon $h = 1, 2, ....,$ $z^*_{1t+h}$ and $y^*_{jt+h}$are policy-induced paths and $z_{kt+h}$ and $y_{jt+h}$ the unconditional paths for the EONIA rate and yield variables and $\xi_{it+h}$ in (5) measures the response of lending rate of bank $i$ at horizon $h$ to non-standard policy surprises (see e.g. Canova, 2007). Expectations are computed using the distribution of parameter estimates obtained with information up to April 2014. Figure 7 presents the cross-sectional distribution of $\xi_{it+h}$ and the pass-through.

Non-standard measures significantly lowered lending rates – by October 2017 the median effect was about 60 basis points. In agreement with De Bortoli et al. (2018), who detected no difference in the transmission of monetary policy above or at the zero lower bound in the US, the median long pass-through of non-standard policies is similar to the one of standard policies, and the distribution of pass-through is large. As expected, the reduction in the lending rate and the pass-through are significantly larger for stressed countries. For example, while for the median bank in the stressed country group the lending rate falls by over 90 basis points, in the non-stressed country group the median fall is only 35 basis points. Thus, non-standard measures were transferred to borrowers more in countries where the monetary accommodation would have been most welcome.

One may wonder whether the results are applicable to banks located in, say, Greece or Cyprus, given that they were unable to obtain liquidity from the Central Bank. While market segmentation is a concern in theory, it is irrelevant for our conclusions because Greek and Cyprus banks are not in our sample – data on their share of non-performing loans is unavailable.

Balance sheet characteristics matter when it comes to explaining the reduction in the spread of the distribution of lending rate responses (see figure 8). Non-standard measures were particularly effective in lowering lending rates for banks with a low capital ratio, a high share of domestic sovereign exposure and of non-performing loans, and unstable funding. The median difference between the upper and lower quartiles of the lending rate distribution sorted by these characteristics is up to 30 basis points and differences are strongly significant. Interestingly, there is no evidence that banks with healthy characteristics exploited their stronger balance sheet position to aggressively decrease lending rates in order to acquire market shares.

### 5.3 Robustness

These conclusions are robust to the use of the sample with only large banks ( see figures A6-A7 in the on-line appendix).

The analysis has so far considered credit easing and quantitative easing policies jointly. However, the two types of measures act on the balance sheet of bank differently: credit easing policies directly affect the liability side by changing the marginal cost of borrowing funds; quantitative easing policies affect the asset side by altering the value of sovereign and corporate bonds. Thus, in principle, they may be transmitted to the real economy though different channels.

To check for this possibility, we rerun our high-frequency exercise using only the dates corresponding to quantitative easing announcements, computed the predicted path of EONIA, bank and sovereign bond yields, and constructed responses to non-standard policy measures conditioning on these new paths.

Figures A8 and A9 in the on-line appendix show that excluding credit easing announcements does not change any of the conclusions derived. The EONIA rate, bank and sovereign bond yield decline and the fall in sovereign bond yields is larger for banks located in stressed counties. These changes were accompanied, almost one to one, by a decline in the lending rate to firms and the magnitude of the effect is larger for banks operating in stressed countries and with weak balance sheet characteristics. Quantitatively, the reduction in EONIA, bank and sovereign bond yields is smaller than in the baseline exercise but the median pass-through is about the same. Nevertheless, differences in the lending rate decline for banks located in top and bottom quartiles of the distribution of banks' balance sheet characteristics is 30 percent smaller. Hence, quantitative easing measures were particularly effective in re-establishing normal lending conditions, but the importance of credit easing measures can not be overlooked as they interacted with quantitative easing measures to improve the health of banks' balance sheet.

Commentators have wondered about the relative importance of interest rate declines, in particular into negative territory, versus changes in bank and sovereign bond yields in normalizing lending conditions. This is an important issue because a few authors have suggested that when nominal interest rates become negative, banks' incentives may change and may lead them to take on higher risk (see, e.g., Koijen et. al., 2016; Adrian et al., 2018) thus hampering the balance sheet improvements that ECB programs have produced. To measure the importance of nominal interest rate declines, we conduct a counterfactual experiment, similar in all respects to the one described in section 5.2, except that we condition only on the path of EONIA rate that policy announcements generate. In other words, while banks and sovereign bond yields endogenously evolve in response to EONIA changes, they do not encode the direct effects of the announcements.

Figures A10 and A11 in the on-line appendix indicate that interest rate policies alone would have caused a fall in lending rates, but the pass-through would have been smaller and similar in stressed and non-stressed countries. Because the fall in the EONIA rate is common to all banks in all countries, this latter result is expected. When we sort the distribution of lending rate responses by bank characteristics we find that, once again, sovereign exposure and stable funding matter to determine which banks decrease their lending rates more aggressively. However, the capital ratio is no longer important and the share of non-performing loans only weakly matters. Thus, standard policies that would have allowed interest rates to become negative could have reduced somewhat the pre-2014 lending rate heterogeneities but would not have produced aggressive cuts in lending rates in countries which needed them most; and would not have produced significant differential effects for banks with poor balance sheets.

### 5.4 The dynamics of household lending rates

So far we have been concerned with lending rates to non-financial corporations. Since we also have information about lending rates to households, we repeat the exercises with this variable and two goals in mind: we want to see whether the effects of non-standard measures are robust; we are curious as to whether banks strategically used funding costs reliefs in the two markets to acquire market shares. Figures A12-A15 in the online appendix present the distributions of lending rate responses and of the pass-through by type of country and by bank characteristics following conventional and non-standard policy surprises. Qualitatively speaking, all the conclusions obtained for lending rates to firms also hold for lending rates to households. In particular, in response to conventional policy changes the cross-sectional distribution of pass-through is wide; the location of the bank does not explain the dispersion of the distribution of pass-through but indicators of banks' balance sheet do. Non-standard measures were more effective on the household lending rates in stressed countries, and affected most banks with a high share of non-performing loans, low capital, large exposure to domestic sovereign, and unstable funding. Quantitatively, the pass-through to households' lending rates is generally lower than to firms' lending rates both in response to conventional and non-standard policy innovations (0.75 and 0.8, respectively), but the cross-sectional dispersion of pass-through in response to non-standard measures is smaller than for firms' lending rates.

The finding that lending rates to households and firms display similar behavior confirms that frictions and banks' balance sheet constraints were responsible for the wide distribution of pass-through observed up to 2014 and for its reduction afterward that date. Loan demand driven explanation surely matter for the spread in the lending rates distribution but have no importance when it comes to explain heterogeneities in the distribution of the monetary pass-through.

### 5.5 Summary

Non-standard policies helped to reduce the heterogeneity of pass-through observed prior to 2014 by making banks with weak balance sheet positions more solid. This was reflected in aggressive cuts in lending rates, in particular, by banks which, up to that date, were unable to fully respond to policy rate changes because of frictions and of balance sheet constraints. Interestingly, lending rates to households and firms display similar pattern, despite the fact that banks typically enjoy monopolistic competitive advantages in the former and that loan contracts have different maturities and different conditions.

While banks in stressed countries gained most, because the value of their domestic sovereign bonds increased considerably, all banks benefited from non-standard policies, as funding costs relief and asset revaluation strengthened the liability and asset sides of their balance sheet.

Both credit and quantitative easing policies helped to mend the broken link between monetary policy and the real economy. The contribution of quantitative easing policies to the reduction of the heterogeneities is larger, but without credit easing policies balances sheet imbalances would not have been necessarily resolved. Reductions in the dispersion of pass-through would have been much more limited if only a standard interest rate policy would have been used. Negative interest rates would have driven lending rates to non-financial corporations down but they would not have produced differential effects across groups of countries or banks.

## 6 Side effects? The dynamics to lending margins

There are several reasons to be concerned with the dynamics of lending margins – defined as the difference between the lending rate to non-financial corporations and the deposit rate – in responses to non-standard measures. Several studies (e.g. Gambacorta, 2008; and Alessandri and Nelson, 2015, Altavilla, et al., 2018) noticed that in the presence of frictions in pricing loans and deposits, monetary policy changes affect the returns from maturity transformation activities and thus alter banks' profitability. In theory, the impact of non-standard measures on bank profitability is ambiguous since they have two contrasting effects. On the one hand, they flatten the yield curve, make maturity transformation less attractive, and thus hamper banks' profitability. On the other hand, they may improve the capacity of borrowers to honour their commitments, increase the value of the assets held in banks' portfolio, and lead to a decline in provisioning needs. Asset price increases also have a beneficial impact on bank equity through valuation gains. In addition, as suggested by Drechsler et. al (2016), when the banking sector is imperfectly competitive, changes in monetary policy alter banks' effective market power. Thus, when financial frictions matter, monetary policy influences not only how much the banking system lends, but also how it is funded, the quantity of safe and liquid assets it produces, and its riskiness.

The dynamics of lending margins also matter from a different perspective. The magnitude of the pass-through is typically used to gauge the effectiveness of the interest rate channel of monetary policy. However, the dynamics of deposit rates are equally important since they affect the incentives of households to save. When the pass-through is imperfect, but deposit rates track lending rates responses, monetary policy may be as effective as when the monetary pass-through is complete, but banks manipulate deposit rates to alter lending margins.

While an examination of the impact of monetary policy changes on banks profitability is beyond the scope of this paper, the dynamic responses of lending margins may give us some hints about the relevance of these concerns. Historically, lending margins fell in the Euro area since 2009, but the fall is more persistent and pronounced since non-standard measures were announced. Now lending margins are about half of what they were in 2007 and the post-2014 fall is due to the fast decline of lending rates and to very sluggish movement of deposit rates.

Non-standard surprises are associated with a substantial and statistically significant compression of lending margins - about 25 basis points by October 2017 in the median (see Figure 9) - and the maximum effect occurs around January 2016. The reduction is more pronounced for banks operating in stressed countries (30 vs. 20 basis points in the median). Because cross-sectional variations within each group are large, differences are not statistically significant.

Interestingly, the lending margin of banks with a low level of capital, high exposure to sovereign debt, unstable funding and a high share of non-performing loans falls significantly more than the lending margin of banks with healthy balance sheet position (see Figure 10). Thus, non-standard policy measures generate an important trade-off: mending the transmission channel of monetary policy and reducing borrowers' costs compressed lending margins for the class of banks most affected by the measures. This trade-off makes it important to consider the macroprudential consequences of non-standard measures, at least in the medium run.

# 7 Conclusions and macroeconomic implications

This paper documented the presence of a time varying pass-through of monetary policy innovations to non-financial corporations and households lending rates in the Euro area during the last decade and related its dynamic evolution to country and bank-specific characteristics. The analysis makes use of novel data sets covering lending and deposit rates and balance sheet characteristics of a large number of European banks. We exploit the time series dimension of the data, bank by bank, to construct the cross-sectional distribution of pass-through, use balance sheet characteristics to sort them, and measure the average difference between the top and bottom quartiles of the distribution.

When considering standard policy rate surprises, we find that the median long run pass-through is about the same as for the early 2000s, but the cross sectional dispersion in pass-through estimates is large. We demonstrate that standard "fixed effects", such as the location of a bank (in stressed vs. non-stressed countries) or the access to ECB extraordinary liquidity programs (participation vs. non participation), are unable to explain why pass-through differences are large. Instead, banks' balance sheet characteristics such as the level of capitalization, exposure to domestic sovereign debt, share of non-performing loans, and the stability of their funding matter. We estimate that the difference between the top and the bottom quartiles of the distribution of pass-through sorted by these characteristics could be up to 40 basis points. Following a monetary expansion, banks with poor balance sheets reduced their lending rates less than others because the deterioration of the asset side of their balance sheet and the difficulties in securing funding threatened their long run viability.

To evaluate the contribution of non-standard measures to the normalization of lending market conditions, we isolate the impact that announcements of these measures have on financial variables via an event-study methodology. We then compare the lending rate dynamics obtained by mapping the policy-induced component of the EONIA rate, of sovereign yields and of bank bond yields onto individual bank lending rates, with those obtained assuming that these variables evolved unconditionally since May 2014. The response of lending rates to non-standard measures was strong and the cross-sectional dispersion of responses smaller than in previous years. Conditions improved because of funding costs reliefs, asset revaluation, and signaling effects. Banks located in stressed countries and with poor balance sheets were the most responsive to the measures. Large and small banks reacted similarly and lending rates to both non-financial corporations and to households were equally affected. While some normalization could have also been achieved by letting policy rates fall into negative territory, or by using quantitative easing policies only, it was the combination of negative interest rates, funding costs relief, and asset revaluation that improved banks' balance sheet position and reduced heterogeneities in the pass-through.

Non-standard measures produced a significant compression of lending margins and the compression is larger for banks with poor balance sheet characteristics. Thus, while non-standard measures contributed to normalize lending conditions, they also hampered an important component of banks profitability, making the banking system more vulnerable to severe macroeconomic shocks.

In the working paper version (Altavilla et al., 2016) we examined the macroeconomic implications of the wide dispersion of pass-through in pre-2014 period. The imperfection of the pass-through has, under working capital constraints, implications for the evolution of the distribution of marginal costs that firms face. The distribution of marginal costs in turns imply a distribution of good specific (and average) inflation rate via a standard cost channel (see e.g. Ravenna and Walsh, 2008), Using a standard New Keynesian model with sticky prices, habit persistence, and working capital we estimated that, on average, the inflation rate should have been 52 basis points higher with the dispersion of pass-through observed in the data. Since core CPI average inflation rate in the pre-2014 period was roughly 1.0 percent, much lower than the reference value (2.0 percent) and the rate expected by the model, this puzzling outcome can be accounted for by a flattening of the Phillips curve or by changes in market power of firms (as suggested by Gilchrist et al, 2015).

With the same model, we also computed the effects of non-standard policies on macroeconomic variables and found that they had a positive and significant effect on inflation (0.6 percent) and a negative and significant effect on the output gap (0.5 percent). The mechanism producing the adjustments is simple: by decreasing the lending rate, non-standard policies decrease marginal costs for firms (borrowing costs are lower) and this expands the aggregate supply, with positive effects on employment. On the other hand, the fall in the deposit rate, increases the incentives of consumers to spend. Since aggregate demand effects are large, inflation increases and the output gap falls.

There are many important issues we did not address in the paper for reasons of space. For example, whether the quality of loans improved after the implementation of non-standard measures; whether small firms benefited from the improved lending conditions as much as large ones; and whether the maturity of the loans matters for the pass-through. In general, investigating the effects of non-standard measures on the quantity and quality of loans would complement the pricing analysis of this paper. As mentioned, a study of the effects of monetary policy on bank profitability is relevant from a macroprudential point of view, both for standard measures and for those non-standard measures. An investigation of the bank external finance premium, defined as the difference between the cost of issuing bonds and the cost of financing the operations in the interbank market, could also be very useful to understand whether models of the financial accelerator apply to banks facing collateral constraints. Such an analysis could provide a further link between this paper and the literature studying financial constraints in macroeconomic models. The dynamics of lending rates may be driven by numerous shocks. Characterizing whether lending rates are pro or countercyclical in response to these shocks may help us to select among various specifications of financial frictions proposed in the literature. We leave these issues for future research.

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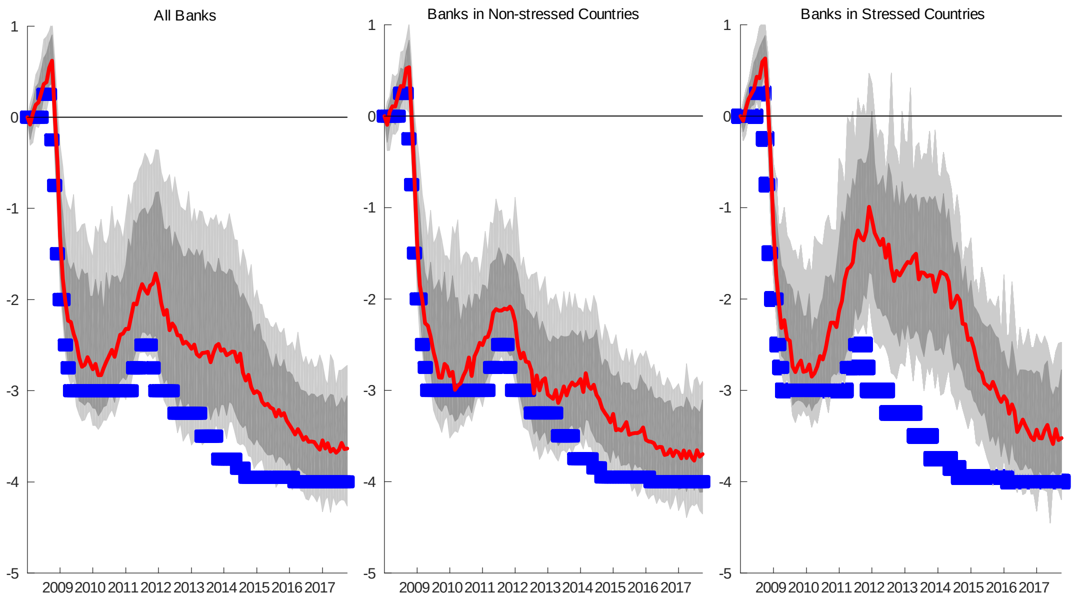


Figure 1: Evolution of the policy rate and of the distribution of lending rates to non-financial corporations.

Notes: The figure presents the policy rate (segmented blue line), the median value (continuous red line), and 68 and 95 percent of the distribution of lending rates to non-financial corporations (shaded areas) in deviation from the July 2007 value. Stressed countries: Greece, Cyprus, Italy, Spain, Ireland and Portugal.

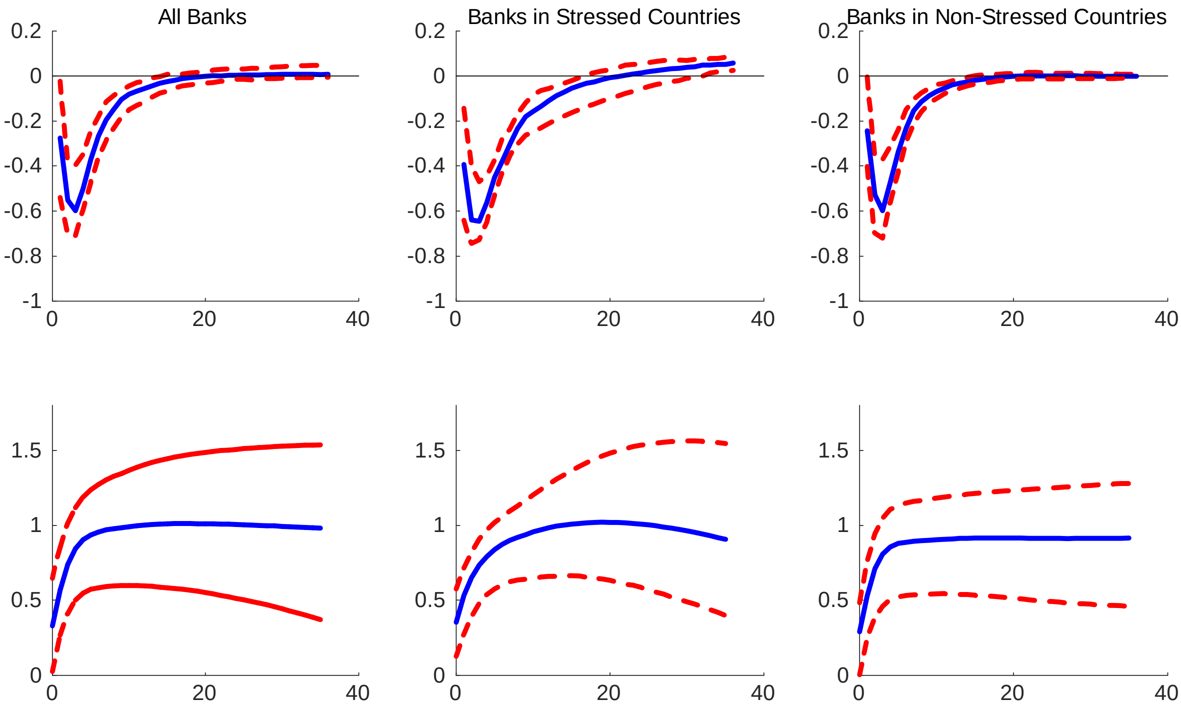


Figure 2: Distribution of lending rates responses and of pass-through. Conventional monetary policy.

Notes: The figure presents the median value and the 16 and 84 percentiles of the distribution of lending rates responses (top row) and of pass-through (bottom row) to conventional monetary policy surprises of all banks, and of banks located in stressed and non-stressed countries. Non-financial corporations.

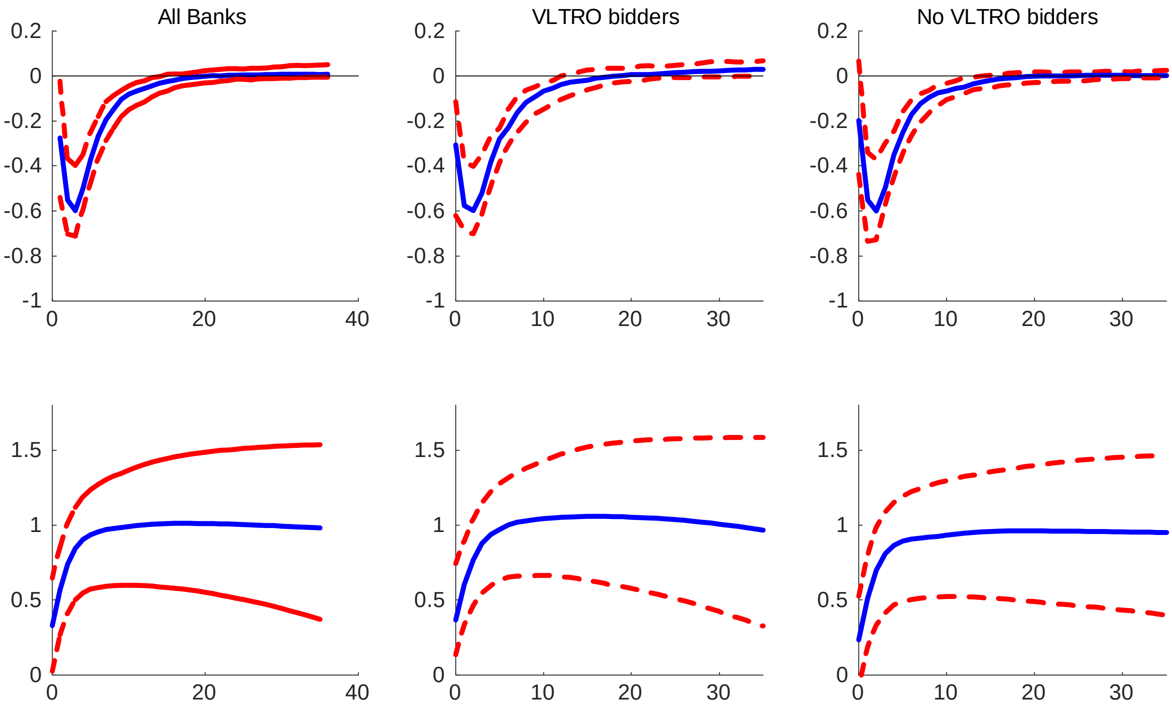


Figure 3: Distribution of lending rates responses and of pass-through. Conventional monetary policy.

Notes: The figure presents the median value and the 16 and 84 percentiles of the distribution of lending rates responses (top row) and of pass-through (bottom row) to conventional monetary policy surprises of all banks and of bidders and non-bidders in VTLRO program. Non-financial corporations.

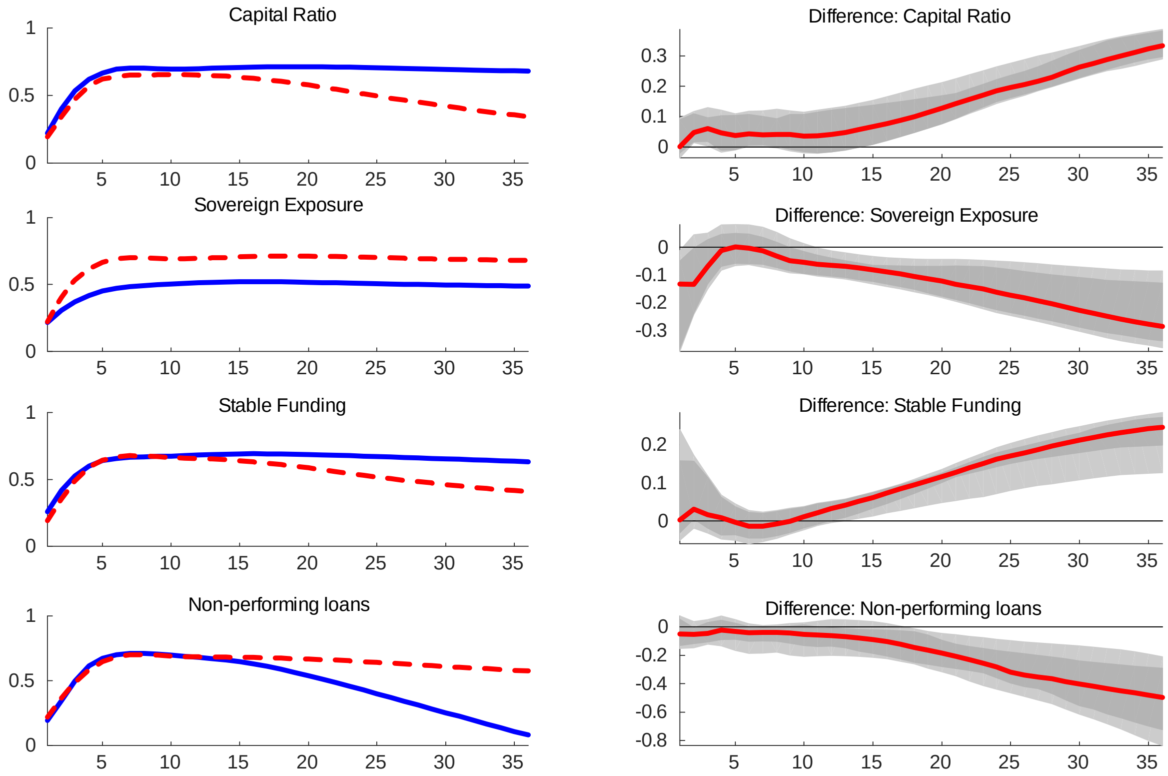


Figure 4: Pass-through sorted by banks' characteristics. Conventional policies.

Notes: The left panel presents the mean of the top quartile (blue solid) and of the bottom quartile (red dashed) of the pass-through distribution following conventional policy surprises. The right panel presents the mean differences in the two quartiles (red solid) together with 68 and 95 percentage bands for the differences (grey areas). Non-financial corporations.

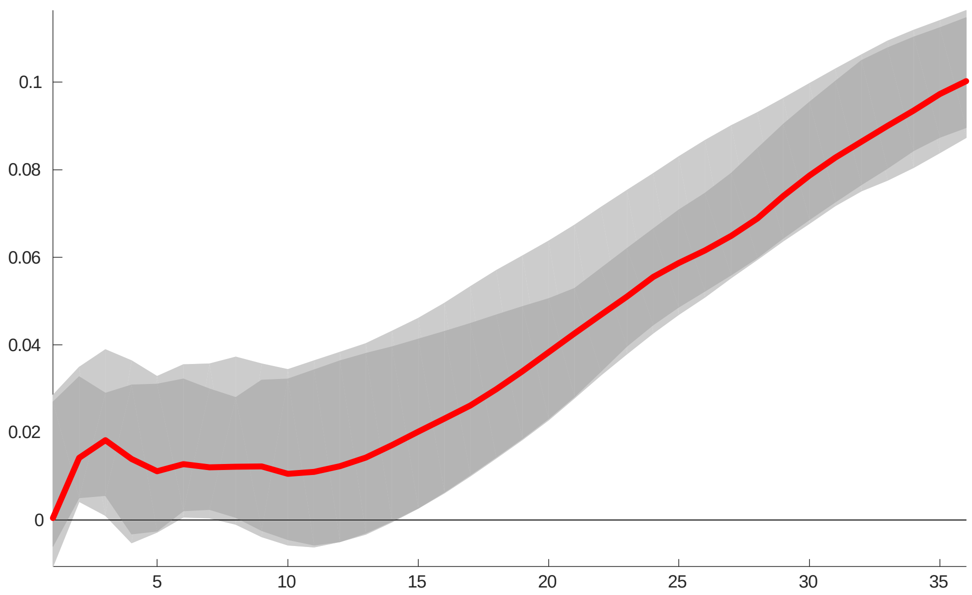


Figure 5: Difference in the pass-through between "healthy" and "unhealthy" banks. Conventional monetary policy.

Notes: The figure presents the mean differences between the top and bottom quartiles of the distribution of pass-through sorted by all balance sheet features jointly (solid line) together with 68 and 95 percentage bands for the differences (grey areas). Non-financial corporations.

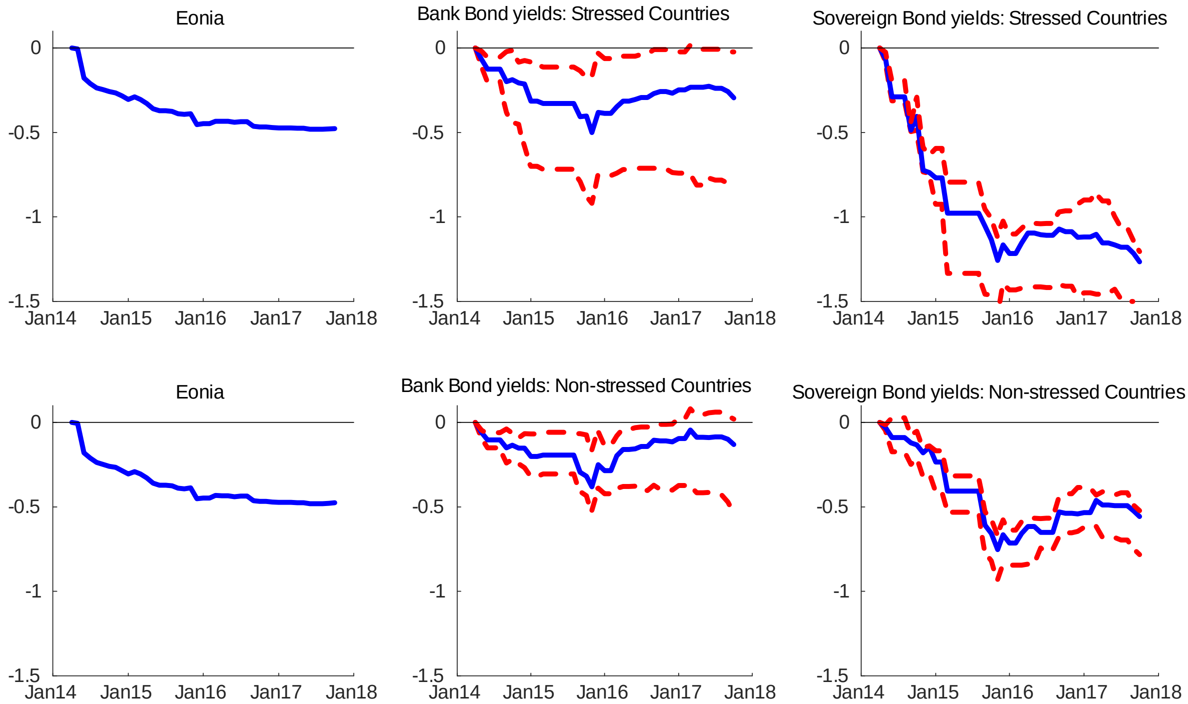


Figure 6: Counterfactual path for EONIA, bank bond and sovereign bond yields due to non-standard monetary policy announcements.

Notes: The figure presents the cumulated effects of non-standard measures on the EONIA rate (the same for all banks), on sovereign yields (the same for all banks operating in the same country) and on bank bond yields (different for each bank). The top row reports the paths for stressed countries, the bottom row the paths for non-stressed countries. Blue solid lines represent the value for the median bank, the dashed red lines the 16 and 84 percentile of the values across countries or banks. Non-financial corporations.

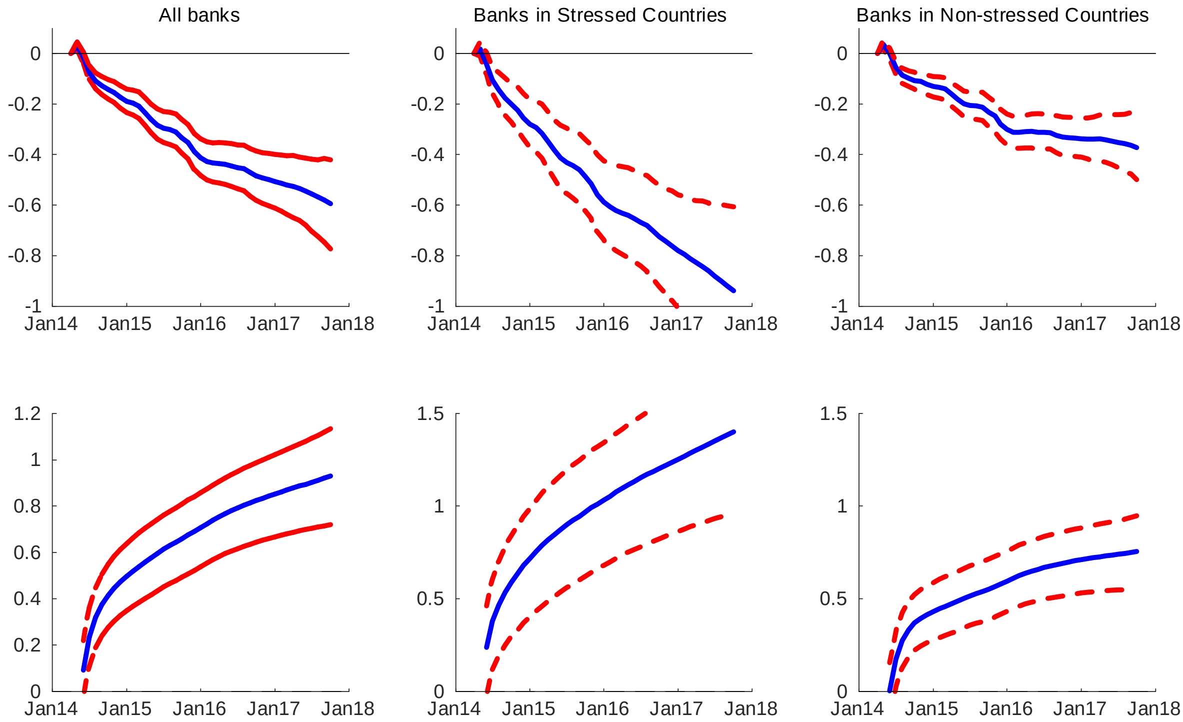


Figure 7: Distribution of lending rates responses and pass-through.Non-standard monetary policy.

Notes: The figure presents the distribution of lending rate responses (top row) and of pass-through (bottom row) to non-standard policy surprises. The blue solid line is the median, the dashed red lines the 16 and 84 percentiles of the distribution. Non-financial corporations.

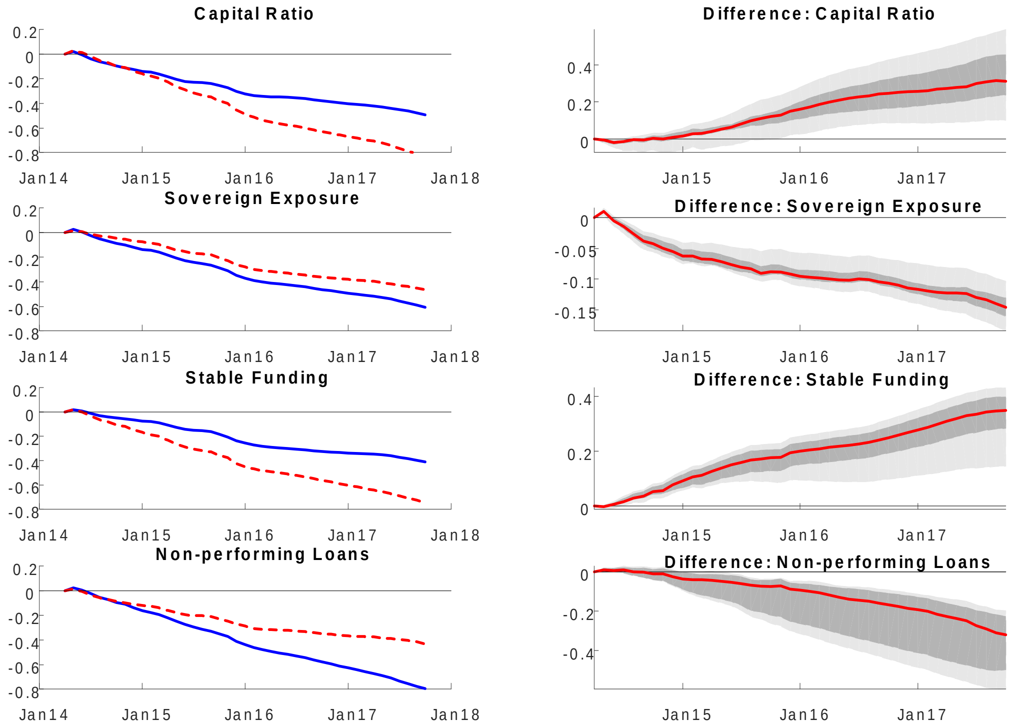


Figure 8: Lending rate responses sorted by banks' characteristics. Non-standard monetary policy.

Notes: The left panel has the mean of the top quartile (blue solid line) and bottom quartile (red dashed line) of the distribution of the lending rate responses following non-standard policy surprises. The right panel has the mean differences in the two quartiles (solid line) together with 68 and 95 percentage bands for the differences (grey areas). Non-financial corporations.

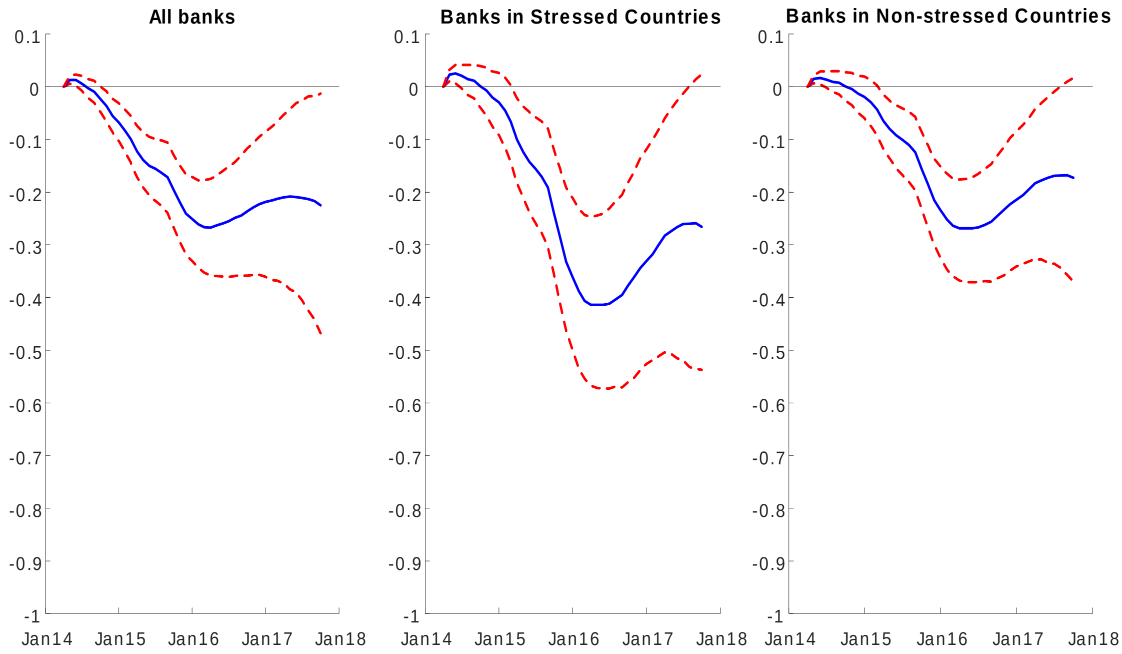


Figure 9: Lending margin responses to non-standard policy surprises.

Notes: The figure presents the distribution of lending margin responses to non-standard policy surprises in all banks and in banks located in stressed and non-stressed countries. The blue solid line represents the median value, the dashed red lines the 16 and 84 percentiles of the distribution.

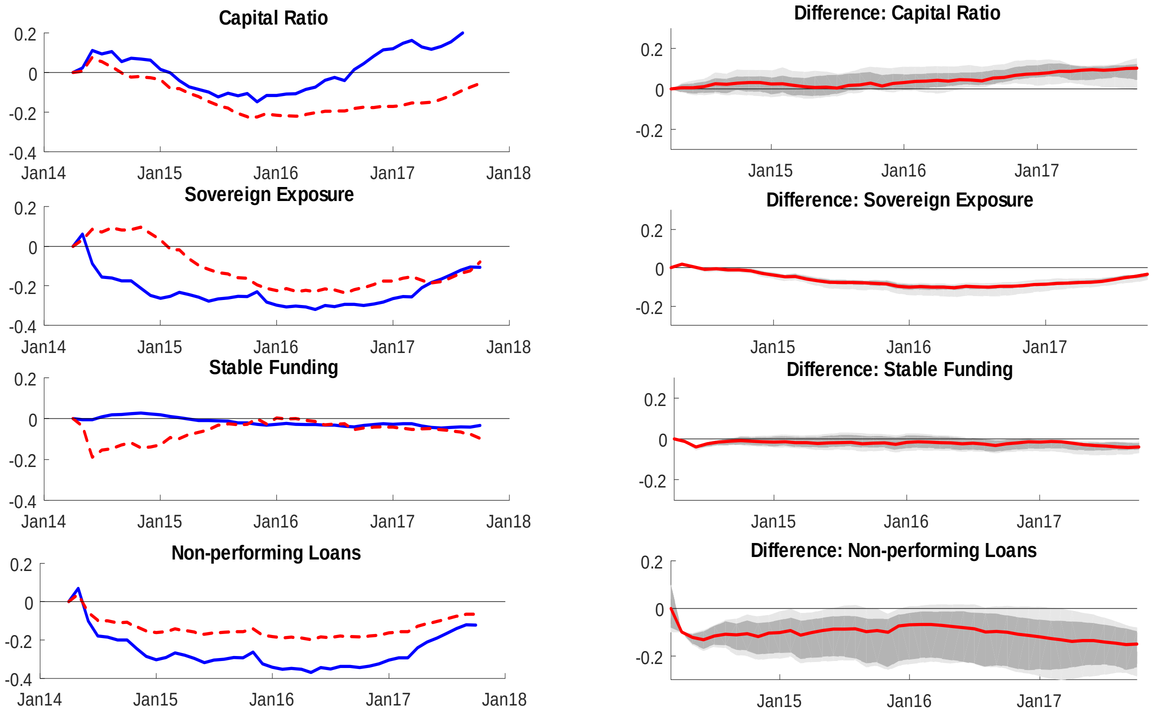


Figure 10: Lending margin responses sorted by banks' characteristics.

Notes: The left panel has the mean of the top quartile (blue solid line) and bottom quartile (red dashed line) of the distribution of the lending margin responses following non-standard policy surprises. The right panel has the mean differences in the two quartiles (solid line) together with 68 and 95 percentage bands for the differences (grey areas).

| Country | Head Institution | Domestic Subsidiaries | Foreign Subsidiaries | Branches | Groups | Total |
|---|---|---|---|---|---|---|
| Austria | 4 | 6 | 1 | | 3 | 14 |
| Belgium | | 6 | 6 | 1 | | 13 |
| Cyprus | 5 | | 2 | | | 7 |
| Germany | 40 | 13 | 6 | 6 | 3 | 68 |
| Estonia | | | 3 | 2 | | 5 |
| Spain | 21 | 7 | 2 | 4 | | 34 |
| Finland | 7 | 2 | 3 | 3 | 1 | 16 |
| France | 11 | 25 | 4 | 2 | | 42 |
| Greece | 6 | 2 | | | | 8 |
| Ireland | 4 | 2 | 8 | 3 | | 17 |
| Italy | 22 | 10 | 5 | 1 | | 38 |
| Lithuania | 1 | | 3 | 1 | | 5 |
| Luxemburg | 3 | | 9 | 2 | | 14 |
| Latvia | 3 | | 3 | 1 | | 7 |
| Malta | 3 | | 1 | | | 4 |
| Netherland | 8 | | 2 | 5 | | 15 |
| Portugal | 4 | | 2 | | | 6 |
| Slovenia | 4 | | 3 | | | 7 |
| Slovakia | | | 4 | 1 | | 5 |
| Total | 146 | 73 | 67 | 32 | 7 | 325 |

Table 1: Distribution of banks by country and type

| | Number Observations | Number Banks | Percentiles 0.25 | Median | 0.75 |
|---|---|---|---|---|---|
| Firms' Lending Rates | 28883 | 325 | 1.94 | 2.79 | 4.29 |
| Households' Lending Rates | 28740 | 325 | 2.58 | 3.66 | 5.01 |
| Bank Bold yields | 12197 | 114 | 0.75 | 2.34 | 4.42 |
| Deposit Rates | 25062 | 325 | 0.60 | 1.42 | 2.63 |
| Domestic Sovereign debt (in percentage of main assets) | 35613 | 325 | 0.03 | 1.89 | 5.99 |
| Non-Performing loans (gross) | 3484 | 234 | 2.40 | 4.50 | 8.48 |
| CET 1 capital | 4428 | 253 | 8.98 | 11.26 | 13.90 |
| Leverage ratio | 33758 | 325 | 4.48 | 7.29 | 10.92 |
| Credit Default Swaps | 23125 | 204 | 0.74 | 1.12 | 1.82 |
| Capital and Reserves (billions) | 36073 | 325 | 0.56 | 1.82 | 5.48 |
| Total assets (billions) | 36073 | 325 | 10.02 | 27.61 | 71.43 |

Table 2: Descriptive Statistics