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

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Abstract

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

JEL Classification numbers: C23, E44, E52, G21.

Keywords: Monetary policy pass-through, dynamic heterogeneity, bank lending channel, lending margins.

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1 Introduction

Lending conditions play a crucial role in determining the level of economic activity and of welfare. This is particularly true in the euro area, where bank loans represent more than 50% of the external financing of both small and large non-financial corporations. By way of comparison, the equivalent figure for the United States is only 25%. If firms face working capital and wage bill constraints, credit restrictions or rigidity in lending rates might constrain hiring, investment and the level of aggregate activity. Lending conditions are also important for stabilisation purposes: an impaired or time-varying pass-through of policy rate 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, 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, normalised so that the policy rate is zero in July 2007. A visual inspection shows four distinct phases.

Up to the end of 2008, the distribution of the average lending rate closely tracks the policy rate and the dispersion is small. From the beginning of 2009 to the middle of 2011, the median of the distribution of average lending rates still follows policy rate changes, but the dispersion increases. In the third phase, running from July 2011 to May 2014, the median lending rate no longer follows policy rate changes, especially for banks operating in financially stressed countries – we class Greece, Cyprus, Italy, Spain, Ireland and Portugal as "stressed", while the remaining countries are "non-stressed". 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%, but the maximum-minimum range increased by one percentage point. From May 2014 onwards, the median lending rate mirrors policy rate reductions, and the fall is large in stressed countries. In addition, the dispersion of the distribution decreases to pre-2011 levels.

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

The conventional view is that in normal times balance sheet characteristics determine how lending rates and loan volumes react to monetary policy contractions. In the United States, the pass-through to lending rates has been found to be stronger for banks that are small (Kashyap and Stein, 1995), illiquid (Stein, 1998; Kashyap and Stein, 2000) or poorly capitalised (Peek and Rosengren, 1995; Kishan and Opiela, 2000). Gambacorta (2005) and Gambacorta and Mistrulli (2008, 2014) confirm these findings using a sample of Italian banks. Larger, better capitalised, and more liquid banks are more resilient to monetary contractions because they can more easily substitute sources of external financing. In this way, contractionary policy decisions are transmitted to the real economy, because the Modigliani-Miller theorem does not hold for small, illiquid, and poorly capitalised 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, with the exception of two episodes, euro area monetary policy has been expansionary over the last ten 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) and Illes et al. (2015) find only a mild decrease. 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 sheets affects their portfolio choices, and hence may affect the pass-through to lending rates.

This paper documents the presence of a time-varying pass-through of monetary policy innovations to lending rates charged to non-financial corporations and households in the euro area during the last decade and relates its evolution to national and bank-specific characteristics. Unlike existing works, which examine 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; Illes 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 datasets 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 datasets are rich in many dimensions: the sample covers over 80% of the euro area banking system, and 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 latter's contribution to normalising lending rate conditions.

In contrast to recent studies that rely on cross-sectional differences to identify the causal effects of monetary policy (see, for example, Rodynaski and Darmouni, 2016; Carpinelli and Crosignani, 2016; and 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 existing studies fail to consider the endogeneity of policy rate changes and the feedbacks on lending rates due to macroeconomic responses to policy changes, we constructed pass-through measures that explicitly account for them. Furthermore, while the previous analyses are unable to examine the dynamic response of lending rates to monetary policy surprises because of the methodology employed, we are able to distinguish static from dynamic effects.

The analysis is divided in three parts. First, we examine how policy rate surprises affected 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. Standard "fixed effects", such as a bank's location or unconstrained access to European Central Bank (ECB) extraordinary liquidity programmes, are unable to explain the differences. Instead, banks' balance sheet characteristics, such as the level of capitalisation, exposure to domestic sovereign debt, share of non-performing loans, and stability of funding have an explanatory effect. We estimate that the difference between the top and bottom quartiles of the distribution of pass-through sorted by these characteristics could be up to 40 basis points. These conclusions are robust to the sample employed (all banks vs large banks) and the way 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 lending rates to non-financial corporations. Since June 2014, the ECB has employed credit easing measures – 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 programme (APP) – to further ease monetary policy.

We show that non-standard policies helped to normalise lending rate conditions by inducing banks, which were previously sluggishly in reacting to policy rate changes, to aggressively cut their lending rates. The programmes solidified the balance sheet of all banks, but banks located in stressed countries and with poor initial balance sheet characteristics were most responsive to the measures. In general, better and more homogeneous lending rate conditions materialised for three reasons: funding cost reliefs, which improved the liability side of banks' balance sheets; asset revaluations, which enhanced the asset side of banks' balance sheets, particularly for banks whose net worth was low prior to 2014; and signalling 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 features, due to particular customer relationships and to the widespread use of non-competitive pricing (see, for example, De Graeve et al., 2007), the dynamics of the pass-through to lending rates to households and non-financial corporations are similar throughout the sample. Because banks did not strategically use market power to differentiate their response between firms and households, the large pre-2014 cross-bank heterogeneity in the pass-through and the following return to normality cannot be attributed to changes in the riskiness of firms' projects.

While some normalisation could have 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 cost relief and asset revaluation that reduced the pre-2014 pass-through heterogeneities.

In the third part, we examine how non-standard measures affected banks' lending margins, i.e. 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, can alter the returns from maturity transformation activities, with adverse effects on banks' profitability and market value. Lending margins were significantly compressed from mid-2014 onwards, and this compression was greater for banks with initially poor balance sheet characteristics. As such, while non-standard measures contributed to normalising 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 first to measures lending rates pass-through in the

United States. More recently, Gambacorta (2008), De Graeve et al. (2007), Ciccarelli et al. (2013), Hristov et al. (2014) and Iles et al. (2015) have studied the same 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 policies 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 of monetary policy (Brunnermeier and Sannikov, 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 greater 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, different bank characteristics are associated with differences in how lending rates respond to monetary policy changes and that non-standard monetary policy changes have redistributive effects.

Our work is also linked to the literature studying the effect of non-standard policies on bank behaviour (Ongena et al., 2015; Bluwstein and Canova, 2016; Boeckx 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 organised as follows. Section 2 describes the datasets and section 3 the empirical methodology. Section 4 discusses the pass-through of standard policy measures and Section 5 the pass-through of non-standard ones. Section 6 examines the dynamics of profit margins. Section 7 concludes.

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 using $r_{i,t} = \sum_{k=1}^{K} \sum_{\tau=1}^{l} w_{i,\tau,k,t} r_{i,\tau,k,t}$ where i stands for bank, τ 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 ensure 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 variable or fixed interest rates (variable-rate loans generally have a shorter maturity τ than fixed rate loans). The distinction is not crucial for lending rates to non-financial corporations, since the vast majority of loan contracts are at variable rates. 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 and Portugal; conversely, in Belgium, Germany and France, more than 80% of mortgage agreements are at fixed rates. Similarly, while savings banks tend to prefer fixed-rate loans, commercial banks have a more balanced portfolio of fixed and variable mortgage loans. Clearly, the share of variable to fixed-rate mortgages is likely to affect the transmission of policy rate changes. We checked that no compositional biases resulted from the fact that some banks lend primarily on a long-term basis and others for the short term (about 60% of all bank loans have a maturity of less than one year), or that some lend to small and others to large corporations, which may give some banks monopolistic power. While one could work directly with the disaggregated data, the large number of rate categories (by maturity and size) that could be considered would make the empirical techniques used in this study unfeasible.

The second proprietary dataset is called the Individual Balance Sheet Indicators (IBSI). It reports asset and liability items of 325 banks resident in the euro area from July 2007 to October 2017. From here, we obtained information on banks' exposure to domestic sovereign debt, capital position, funding structure, and other relevant balance sheet information. We excluded from the sample smaller units that appear as groups or conglomerates and banks that were acquired, and we restricted our attention to head institutions and subsidiaries, such that each bank can be treated as an independent (legal) entity. This would not have been possible if branches were also considered, as head institutions must cover branch losses, with consequences for regulatory constraints, risk-taking behaviour and thus lending and deposit pricing policies.

This dataset 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 in which it is located; and whether it is publicly or privately owned; we can also 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 A.1 in the on line appendix shows, most of the banks are from Germany, France, Italy and Spain; about half are head institutions, and cross-country linkages are as important as domestic linkages. The richness of the data can be put into perspective noting that the 2014 stress-testing exercise conducted by the European Banking Authority included about 100 banks, fewer than half of which were head institutions, and balance sheet characteristics were only irregularly observed.

We also obtained information on bank bond yields (from Markit iBoxx), on regulatory capital ratios, on gross non-performing loans (from the commercial provider SNL Financial) and on credit default swaps (from Datastream). Table 1 summarises 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. There are large differences in financing costs: the average interquartile dispersion in bank bond yields is 370 basis points, and banks in the top quartile face financing costs which are four times greater than banks in the lower quartile. Since average deposit rates and average bank bond yields are correlated, the cost of financing operations could be up to five times higher for certain types of banks.

There is also significant heterogeneity in the distribution of domestic sovereign debt exposure, capital ratios, leverage, non-performing loans and credit risk. Our sample contains banks with almost no sovereign bonds and banks with over 6% of their assets in sovereign bonds; banks with a small percentage of non-performing loans and banks with up to 8.5% in this category; banks with low risk and banks with relatively high risk; and banks that are 50% more leveraged than the median bank. Finally, banks in our sample are generally medium-sized, and the interquartile range of the distribution of total assets is between €10 and €70 billion.

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, in 75% of cases it will still have this characteristic in the lowest quartile at the end of the sample. Moreover, the probability that a bank ranking in the lower (upper) quartile of the distribution at the beginning of the sample will end up in the upper (lower) quartile at the end of the sample is only 0.03 on average across characteristics. Hence, although some banks recapitalised and others decreased their shares of non-performing loans relative to the average, the ranking in the distribution for a given characteristic is fairly stable and very few banks with poor initial balance sheet conditions managed to solve their problems by the end of the sample. These facts allow us to condition on pre-sample characteristics when grouping the pass-through. Using pre-sample information allows us to bypass thorny issues regarding the endogeneity of the banks' balance sheet items in our pass-through computations. For example, banks may delay recapitalisation in response to monetary expansion, since the savings from lower financing costs may be set aside as reserves.

While for most of the analysis we use one bank characteristic at a time to sort the pass-through, for robustness, we also consider the pass-through ranked using all balance sheet characteristics together. One would imagine balance sheet characteristics to be highly correlated: a bank with low level of capital may also be more leveraged, have greater 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 each available bank characteristic which 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 bank characteristics and monetary policy shocks, the results they present are comparable with those we obtain with one characteristic at a time.

3 The econometric methodology

In this study, we use a two-step cross-sectional vector autoregressive (VAR) methodology. First, 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 bank, country-specific and euro area macroeconomic variables. We then sort the estimated distribution of pass-through using bank-specific characteristics and measure the difference between the upper and lower quartiles of the distribution. Because the pass-through might depend on country-specific factors (such as unemployment or sovereign risk) or area-wide factors (such as aggregate inflation or the state of the real business cycle), 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.

Our approach has two main advantages over single-equation pass-through regressions (see, for example, Illes et al., 2015). 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 not properly measured in single-equation dynamic setups estimated with ordinary least squares. Our methodology is also preferable to approaches that restrict the dynamics of the endogenous variables to homogeneity (e.g. Kashyap and Stein, 2000; Gambacorta, 2008; De Santis and Surico, 2013, among others). The heterogeneities documented in Figure 1 make pooling highly unpalatable. The 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 purposes.

In contrast to studies which exploit cross-sectional differences (see, for example, Rodynaski and Darmouni, 2016; Carpinelli and Crosignani, 2016; Chakraborty et al., 2016), we use the time series dimension of the panel to identify the causal effects of policy changes. In addition, since cross-sectional approaches use a difference-in-difference methodology to estimate causal links and capture aggregate effects with time dummies, they are unable to examine lending rate dynamics in response to monetary policy changes or to account for macroeconomic feedbacks. Moreover, none of these studies account for the possibility that changes in the policy rate are endogenous. As such, they provide only a rough approximation of the impulse setting the adjustments in motion and the magnitude of the static effects generated.

Finally, in contrast to most of the recent literature, we focus attention on the dynamics of banks' lending rates and lending margins rather than their loan volume, their currency denomination (see, for example, Ongena et al., 2015), the composition of banks' asset portfolios (see, for example, Jimenez et al., 2012) or their overall riskiness (see, for example, 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, see also Sa et al. (2014).

Letting the vector of variables for 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, the VAR we estimate for each bank is

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

$y_{i,j,t}$ 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 harmonised index of consumer prices (HICP) inflation rate and the unemployment rate. The area-wide inflation rate and unemployment rate serve as a proxy for euro area business cycle conditions, while country specific variables are employed to capture deviations in 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 could 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 area-wide VIX index and other measures of uncertainty. Conditioning on this variable therefore 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; and the country-specific unemployment rate, the euro area inflation and unemployment rates are from Eurostat. We use the EONIA 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 is market-determined, our choice of EONIA as the policy rate requires a few words of explanation. First, note that the three ECB rates move discontinuously in discrete jumps when the Governing Council decides on rate changes, while the EONIA evolves daily. Second, the EONIA does not have a floor at zero, which is important when measuring the impact of non-standard policies. Third, the EONIA 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 individual 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. 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 allow HICP inflation and the unemployment rate to affect the EONIA within a month, but not vice versa. For robustness, we also identify 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 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 announcement dates, as in narrative approaches to monetary policy (see, for example, Ramey, 2016). Gertler and Karadi (2015) have used information from federal funds 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 not sensitive to which euro area-wide variables are included in the VAR. In particular, omitting the euro area-wide unemployment and inflation rates or using a euro area factor does not change any of our conclusions.

The results we obtain are robust in respect of the way in which policy rate innovations are constructed, because the pass-through we compute has the form of a dynamic multiplier (see below). 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 differences in pass-through.

Given the limited size of our sample and the dynamic heterogeneities in pass-through, we derive the exact small-sample distribution of the pass-through using Bayesian methods. Let β_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 ζ is a vector of prior hyperparameters which incorporates three features: i) the empirical model for each unit is shrunk towards 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 ζ is random with a flat prior distribution. The marginal posterior of θ is obtained by integrating out ζ from the joint posterior of (θ, ζ) (see Canova, 2007). The VAR for each bank is estimated with four lags and a constant and sequences from the posterior distribution of θ are drawn with a Gibbs sampler.

Denote by β_i^m a draw from the marginal posterior of β_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 3×1 vector for each i, and v_{kt} denotes the monetary policy shock. 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 h is obtained using 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 by pooling cross-sectional information. This quantity, however, would be different to that 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 analyse 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. 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, assuming a persistent 100 basis point unexpected decline in the policy rate. The stylised evidence presented in Figure 1 hints at the fact that the average lending rates 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 location of a bank matters, we sort the cross-sectional distribution of lending rate responses and of the pass-through by type of country. 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 practically 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 highly dispersed: after 36 months, the highest posterior 68% interval goes from about 0.4 to 1.5. The location of banks bears little relation to this heterogeneity. The median pass-through in the two groups has, roughly, the same dynamic behaviour, and the highest posterior 68% intervals overlap.

How, then, does one reconcile Figures 1 and 2? The evidence in Figure 1 is unconditional; Figure 2 is constructed conditionally on a monetary policy shock. As such, 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 analysing 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 through fixed-rate full-allotment auctions. As the EONIA has adjusted accordingly, its changes reflected both standard and non-standard policy measures (see Ciccarelli et al., 2016). It emerges 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 banks' participation in the two three-year VLTROs conducted on 20 December 2011 and 28 February 2012 and checked whether those banks bidding in the operations (regardless of the amount actually taken up) displayed different pass-through to banks not participating the programme. About half of the banks 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% 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 generates an average long-run pass-through of about 0.85 for highly capitalised banks, and of about 0.45 for poorly capitalised banks. Note that the 95% 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 adjust their rates sluggishly over time. Our finding that exposure to sovereign debt is important for pricing loans is consistent with the evidence in Drechsler et al. (2014), Altavilla et al. (2016) and Peydró et al. (2016) on risk-shifting incentives at times of crisis. Van den Heuvel (2002) describes a model in which lending rates of banks with weak capital positions 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 have a binding effect 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 compare the pass-through of banks with low capital, high domestic sovereign exposure, unstable funding and a high level of non-performing loans and of banks with high capital, low domestic sovereign exposure, stable funding and a low level of non-performing loans. Figure A.1 in the on-line appendix shows that banks with weak balance sheet positions do indeed have a significantly lower pass-through, and the difference in the long run could be up to 20 basis points.

4.1 Robustness

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

First, we identified monetary policy shocks in different ways. When an IV approach is used, instrumenting policy rate residuals with high-frequency announcement information, the conclusion are unchanged (see Figures A2-A4 in the online appendix): the pass-throughs of banks located in stressed and non-stressed countries are similar; and banks with low capital, high exposure to domestic sovereign bonds, unstable funding and a high percentage of non-performing loans have a pass-through which is significantly lower than that of banks with the opposing characteristics.Quantitatively, the instantaneous pass-through with IV identification is generally lower. However, the long-run pass-through for banks with healthy characteristics is typically higher, making the long-run difference larger and more significant.

When the smaller sample of banks is considered, the results are qualitatively similar (see Figures A5-A6 in the online 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 positions. Recall that the banks in this sample are primarily large institutions. Thus, while the conclusion that balance sheet characteristics are important is robust, large banks seem less affected by exposure to domestic sovereigns and insufficient capital ratios than smaller ones when it comes to translating changes in policy rates into changes in lending rates.

5 The pass-through of non-standard measures

Although the EONIA responded to liquidity changes induced by the credit easing and the quantitative easing packages, the VARs have no variable capturing market liquidity or central bank balance sheet expansion, making it hard to characterise 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 proceeded in two steps.

First, we calculated the responses of the EONIA, 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, for example, Krishnamurthy and Vissing-Jorgensen 2011; Altavilla et al. 2015). The effects of the announcements on these three variables can be broadly associated with the signalling, portfolio rebalancing, and cost relief channels of non-standard monetary policy (Eggertsson and Woodford, 2003; Krishnamurthy and Vissing-Jorgensen, 2011; Joyce et al., 2011; and Bauer and Rudebusch, 2014). While the induced changes in the EONIA affected all banks, changes in sovereign bond yields and bank bond yields did not. We therefore expect the effects of non-standard policies to be heterogeneous across banks and different to those obtained by manipulating the EONIA alone. Second, we compared the VAR-based dynamics of individual bank lending rates in two situations: when EONIA, sovereign yields and bank bond yields take the values predicted in the first step; and when they evolve unconditionally from May 2014 onwards.

A high-frequency approach is necessary for the exercise because the financial market reaction to non-standard measures is likely to be washed out if monthly data are used (see, for example, Altavilla et al., 2016; Bluwstein and Canova, 2016; and 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 relative to the hypothetical situation under which the ECB had not taken any new measures from May 2014 onwards. While non-standard measures may have been taken, in part, in response to the heterogeneity of the pass-through distribution observed prior to 2014, the methodology is statistically valid because announcement dates can be taken as predetermined to the distribution of pass-through when daily data are used.

To the best of our knowledge we are the first to condition not only the EONIA rate– a proxy for the standard policy rate movements – but also sovereign yields and of bank bond yields. These additional variables are of crucial importance when trying to evaluate the impact of non-standard measures on lending. A counterfactual that focuses only on the changes in the EONIA rate would most likely miss the effects of the unconventional policies that go through the term premia of sovereign yields and the funding costs of the banks. Of course, to the extent that these policies are transmitted to the lending conditions through other factors not included in the conditioning set we are underestimating the impact of non-standard policy measures. In this sense, the estimated effect is to be considered a lower bound to the total effect that non-standard policies could produce.

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 falls are two such events that come to mind. To isolate the effect of policy surprises, we consider an auxiliary regression and obtained the path of the EONIA, of sovereign yields, and of bank bond yields that would have materialised if the euro area had been hit only by non-standard policy announcements. The regression 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 United States and ϵ_t a iid disturbance. D_t includes 42 announcement dates: for credit easing measures we include the Governing Council meetings 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 programme. The decisions to start the APP programme (announced on 22 January 2015), to extend the package (reinvesting the principal payments and extending the set of eligible assets to regional and local government debt; announced on 3 December 2015), to increase the monthly purchases, to launch a second TLTRO and a new corporate sector purchase programme (CSPP), where the set of eligible assets was extended to include investment-grade euro-denominated bonds issued by non-bank corporations (announced on 3 March 2016), and then to recalibrate the amounts purchased (8 December 2016 and 26 October 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 official ECB 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 Δy_t measures the daily change in either the EONIA 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 by cumulating on a monthly basis the path predicted by (4) between May 2014 and October 2017.

Figure 5 reports the median effect (solid blue line) and either the cross-country or cross-bank variations (dashed red lines). Banks located in stressed countries benefited most and the portfolio rebalancing channel appears stronger than the cost relief channel. Their median funding costs had fallen by about 40 basis points by October 2017, and median sovereign bond yields by over 125 basis points. By comparison, a typical bank in non-stressed countries saw median funding cost and sovereign bond yield reductions of 10 and 50 basis points, respectively. Note also that more than three-quarters of the decline in the EONIA rate over the period is due to the policy announcements.

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

5.2 From financial variables to lending rates

We used 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, of sovereign bond yields and of bank bond yields as set out in Figure 6; ii) letting these three variables evolve unconditionally since May 2014. Formally, we computed:

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

where Ω_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 and yield variables and ξ_{it+h} in (5) measures the response of lending rate of bank i at horizon h to non-standard policy surprises (see, for example, Canova, 2007). Expectations were computed using the distribution of parameter estimates obtained with information up to April 2014. Figure 6 presents the cross-sectional distribution of ξ_{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 United States, the median long pass-through of standard and non-standard policies is similar, and the distribution of pass-through is large. The reductions in the lending rate are significantly larger for stressed countries. For example, while the lending rate falls by over 90 basis points for the median bank in the stressed country group, the median fall in the non-stressed country group is only 35 basis points. As such, non-standard measures were transferred to borrowers to a greater extent in countries where the monetary accommodation was most needed.

Balance sheet characteristics matter when it comes to explaining the reduction in the dispersion of the distribution of lending rate responses (see Figure 7). 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 positions to aggressively cut lending rates in order to acquire market share.

5.3 Robustness

Using the sample of large banks does not changes the conclusions (see Figures A7-A8 in the online appendix).

The analysis has so far considered credit easing and quantitative easing policies jointly. However, the two types of measures act on banks' balance sheets differentently and may therefore be transmitted to the real economy though different channels. To study whether there is a differential impact, we reran the high-frequency exercise using only quantitative easing announcement dates, computed the predicted path of EONIA, bank bond yields and sovereign bond yields, and constructed responses conditioning on these new paths.

Figures A9 and A10 in the online appendix show that excluding credit easing announcements does not change the conclusions. The falls in bank bond yields and sovereign bond yields are larger for banks located in stressed countries. These changes are 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 bond yields and sovereign bond yields is smaller than in the baseline exercise but the median pass-through is about the same. Nevertheless, differences in the decrease in lending rates between banks located in the top and bottom quartiles of the distribution of banks' balance sheet characteristics are 30% smaller than in that exercise. Quantitative easing measures were therefore particularly effective in re-establishing normal lending conditions, but the importance of credit easing measures cannot be overlooked, as they interacted with quantitative easing measures to improve the health of banks' balance sheets.

What is the relative importance of interest rate declines, in particular into negative territory, versus changes in bank and sovereign bond yields in normalising lending conditions? This is an important issue because Koijen et al., 2016, and Adrian et al., 2018, have suggested that when nominal interest rates become negative, banks' incentives may change, leading them to take on higher risk and thus hampering the balance sheet improvements that ECB programmes have produced. To shed light on the issue, we conducted a counterfactual experiment, similar to the one of Section 5.2, except that we conditioned only on the path of EONIA generated by policy announcements. In other words, while bank and sovereign bond yields evolve endogenously in response to EONIA changes, they do not encode the direct effects of the announcements.

Figures A11 and A12 in the online appendix indicate that interest rate policies alone would have caused a fall in lending rates, but that the pass-through would have been smaller and similar in stressed and non-stressed countries. When we sort the distribution of lending rate responses by bank characteristics we find that, once again, sovereign exposure and stable funding are key to determining which banks decrease their lending rates more aggressively. However, the capital ratio is no longer important, and the share of non-performing loans makes only a weak difference. As such, standard policies that would have allowed interest rates to become negative could have somewhat reduced 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 lending rates to households

So far, we have been concerned with lending rates to non-financial corporations. Since we also have information about lending rates to households, we repeated the exercises with this variable and two goals in mind: we wanted to see whether the effects of non-standard measures are robust; and we were curious as to whether banks made strategic use of funding cost relief in the two markets to acquire market share. Figures A13-A16 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, the cross-sectional distribution of pass-through in response to conventional policy changes is wide: the location of the bank does not explain the dispersion of the distribution of pass-through, but indicators of banks' balance sheets do. Non-standard measures were more effective on household lending rates in stressed countries and most effective on banks with a high share of non-performing loans, low capital, high exposure to domestic sovereign debt and unstable funding. Quantitatively, the pass-through to household lending rates is generally lower than for corporate lending rates in response to both conventional and non-standard policy innovations (0.75 and 0.8 respectively). However, the cross-sectional dispersion of pass-through in response to non-standard measures is smaller than for corporate lending rates.

6 Side-effects? The dynamics of lending margins

There are several reasons to be concerned with the dynamics of lending margins – 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; Alessandri and Nelson, 2015; and Altavilla, et al., 2018) observed 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. 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' portfolios and lead to a decrease 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 households' incentive to save. When the pass-through is imperfect but deposit rates track lending rate 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 hints about the relevance of these concerns. Historically, lending margins in the euro area fell since 2009. The fall is more persistent and pronounced since non-standard measures were announced because of the fast decline in lending rates and to very sluggish changes in deposit rates.

Non-standard surprises are associated with a substantial compression of lending margins – by a median figure of about 25 basis points in the period to October 2017 (see Figure 8) – and the maximum effect occurred in January 2016. The reduction is more pronounced for banks operating in stressed countries (30 vs 20 basis points, median figures). 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 fell significantly more than the lending margin of banks with healthy balance sheet positions (see Figure 9). Thus, non-standard policy measures generate an important trade-off: mending the transmission channel of monetary policy and reducing borrowers' costs compresses 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 documents the presence of a time-varying pass-through of monetary policy innovations to lending rates to non-financial corporations and households in the euro area during the last decade and relates its dynamic evolution to country and bank-specific characteristics. The analysis makes use of novel datasets covering lending and deposit rates and balance sheet characteristics of a large number of Euro area banks. Our analysis highlights a number of facts.

The monetary pass-through for the median bank in the period from 2007 to 2014 is similar to that observed prior to 2007. However, there is considerable cross-sectional heterogeneity, not necessarily related to where a bank operates. 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. Our results support the interpretation that certain banks became more prudent, charging customers higher rates than one would have expected from the dynamics of the policy rate, because the deterioration in the asset side of their balance sheets and difficulties in securing funding threatened their long-term viability. The interaction between financial frictions and balance sheet characteristics is more important for smaller banks and is independent of the way policy shocks are identified.

Non-standard policies helped to reduce the heterogeneity of pass-through 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, had been unable to respond to policy rate changes. Lending rates to households and firms display similar behaviour supporting the idea that frictions and banks' balance sheet constraints were responsible for the pre-2014 wide distribution of pass-through and for its reduction after that date. Loan demand-driven explanations are important for the spread in the lending rate distribution, but not when it comes to explaining heterogeneities in the distribution of the pass-through.

Both credit easing 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 in heterogeneities is larger, but balance sheet imbalances would not necessarily have been resolved without credit easing policies. Reductions in the dispersion of pass-through would have been much more limited if only a standard interest rate policy had been used. Negative interest rates would have driven lending rates to non-financial corporations down, but they would perhaps not have produced substantial differential effects across groups of countries or banks.

Non-standard measures compressed lending margins, and the compression is larger for banks with poor balance sheet characteristics. Thus, while non-standard measures contributed to normalising 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 the 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 turn implies a distribution of good-specific (and average) inflation rates via a standard cost channel (see, 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 the average core CPI inflation rate in the pre-2014 period was lower than the reference value (2.0%) 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 the market power of firms (see 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%) and a negative and significant effect on the output gap (0.5%). The mechanism producing the adjustments is simple: by decreasing the lending rate, non-standard policies decrease marginal costs for firms (borrowing costs are lower). This expands the aggregate supply, with positive effects on employment. Conversely, the fall in the deposit rate increases the consumers' incentive to spend. Since aggregate demand effects are large, inflation increases and the output gap falls.

There are many issues that 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 loans matters for the pass-through. Investigating the effects of non-standard measures on the quantity and quality of loans would complement the pricing analysis of this paper. A study of the effects of monetary policy on bank profitability is relevant from a macroprudential point of view. An investigation of the bank external finance premium, the difference between the cost of issuing bonds and the cost of financing the operations in the interbank market, could be useful to understand whether models of the financial accelerator apply to banks facing collateral constraints. Such an analysis could provide a link between the analysis of the paper and the literature studying financial constraints in macroeconomic models. The dynamics of lending rates may be driven by numerous shocks. Characterising the cyclicality of lending rates 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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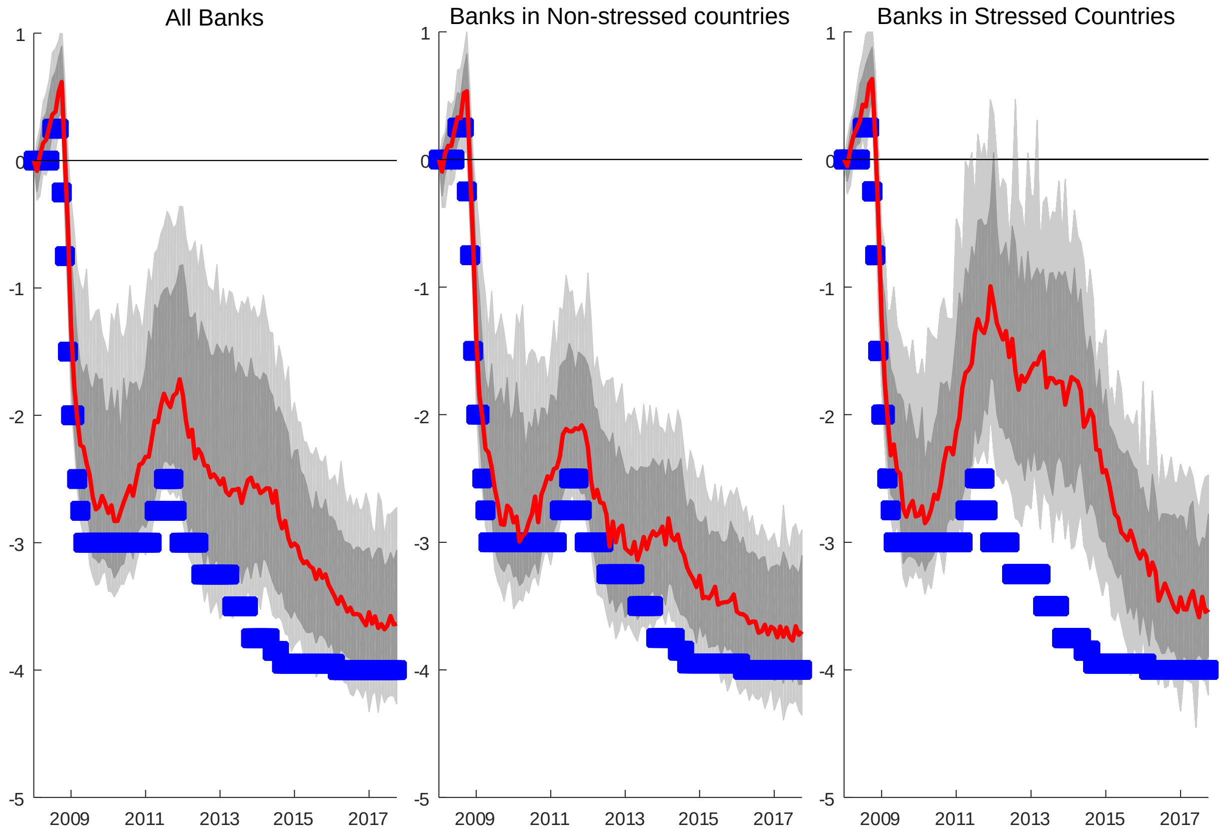
Table 1: Descriptive statistics

	N. obs	N. banks	Percentile		
			25th	50th	75th
Lending rate to NFCs	28883	325	1.94	2.79	4.29
Lending rate to HHs	28740	325	2.58	3.66	5.01
Bank bond yields	12197	114	0.79	2.34	4.42
Deposit rate	25062	325	0.60	1.42	2.63
Sovereign debt exposure (over main assets)	35613	325	0.03	1.89	5.99
Non-performing loans (gross)	3484	234	2.40	4.50	8.48
CET1 capital ratio	4428	253	8.98	11.26	13.90
Leverage ratio	35758	325	4.48	7.29	10.92
Credit default swap (CDS)	23125	204	0.74	1.12	1.82
Capital and Reserve (bn)	36073	325	0.56	1.83	5.48
Total Assets (bn)	36075	325	10.02	27.61	71.43

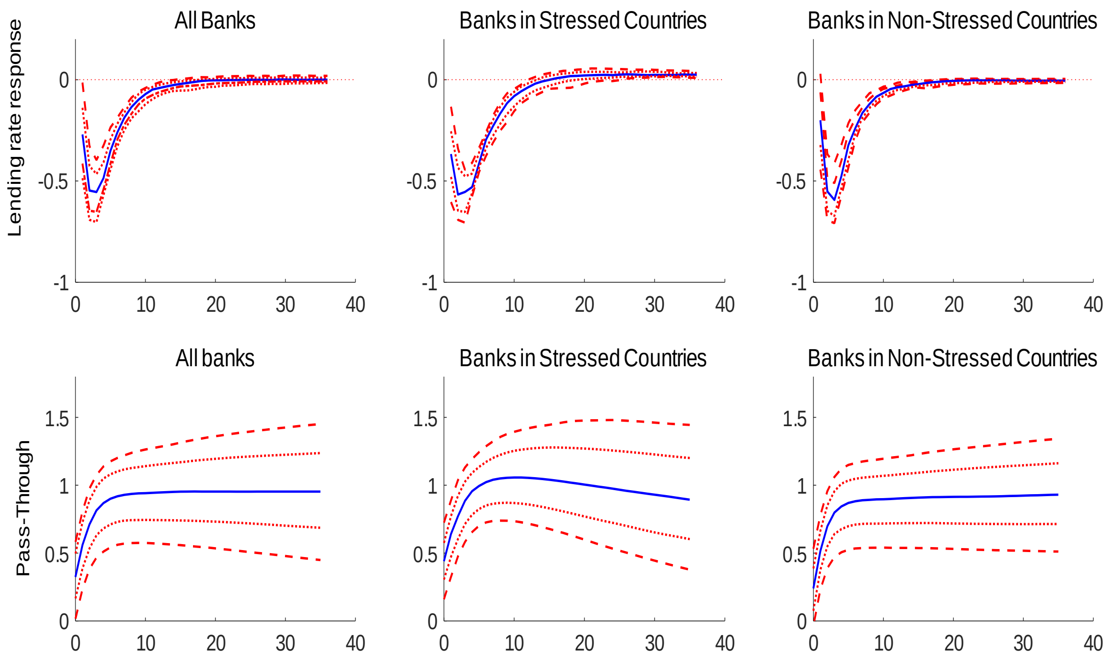
Notes: The table sets out the number of observations, the number of banks, the median and the 25th and 75th percentiles of the distribution of bank characteristics.

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



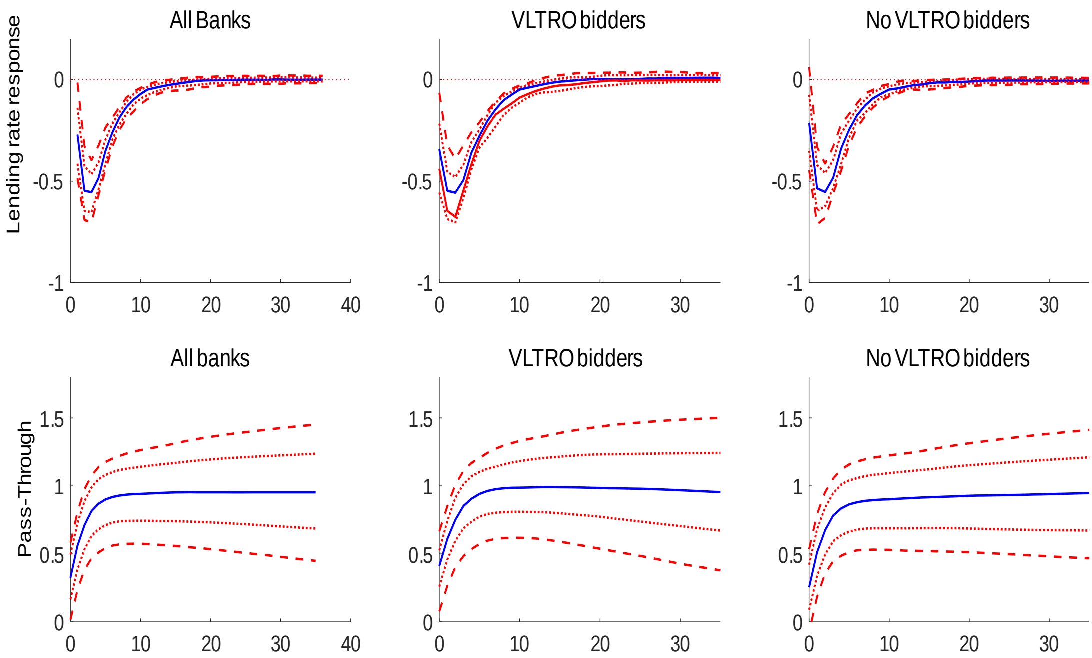
Notes: The figure presents the policy rate (segmented line), the median value (continuous line), and 68% and 95% of the distribution of lending rates to non-financial corporations (shaded areas) relative to the July 2007 value. Stressed countries: Ireland, Greece, Spain, Italy, Cyprus and Portugal.

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



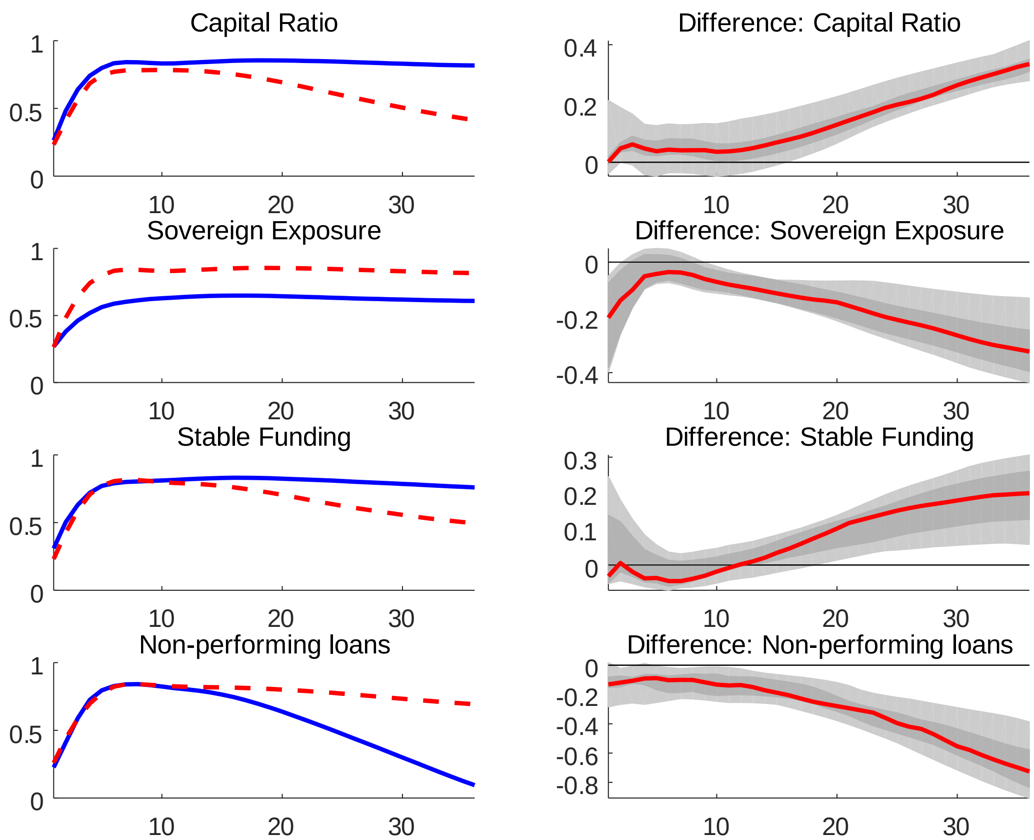
Notes: The figure presents the median value (solid line), the 16th and 84th percentiles (dotted lines) and the 2.5th and 97.5th (dashed lines) percentiles of the distribution of lending rate responses (top row) and of pass-through (bottom row) of conventional monetary policy surprises for all banks and for banks located in stressed and non-stressed countries. Non-financial corporations.

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



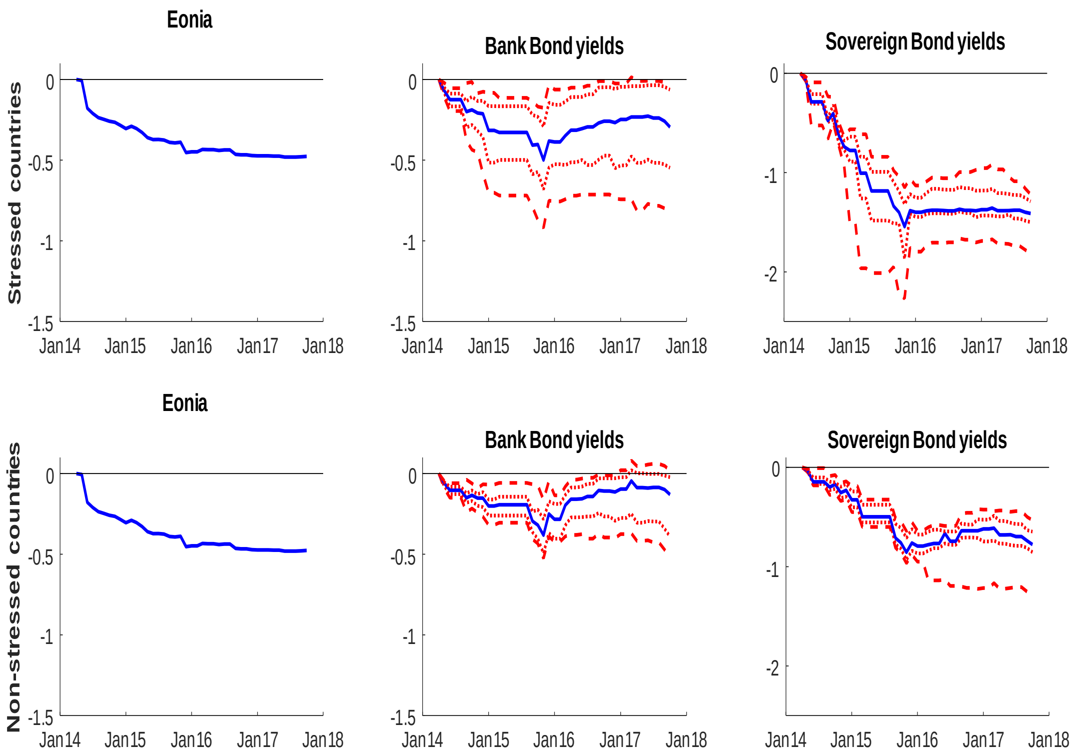
Notes: The figure presents the median value (solid line), the 16th and 84th percentiles (dotted lines) and the 2.5th and 97.5th (dashed lines) percentiles of the distribution of lending rate responses (top row) and pass-through (bottom row) of conventional monetary policy surprises for all banks and for banks banks participating and not participating in the VLTRO programme. Non-financial corporations.

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



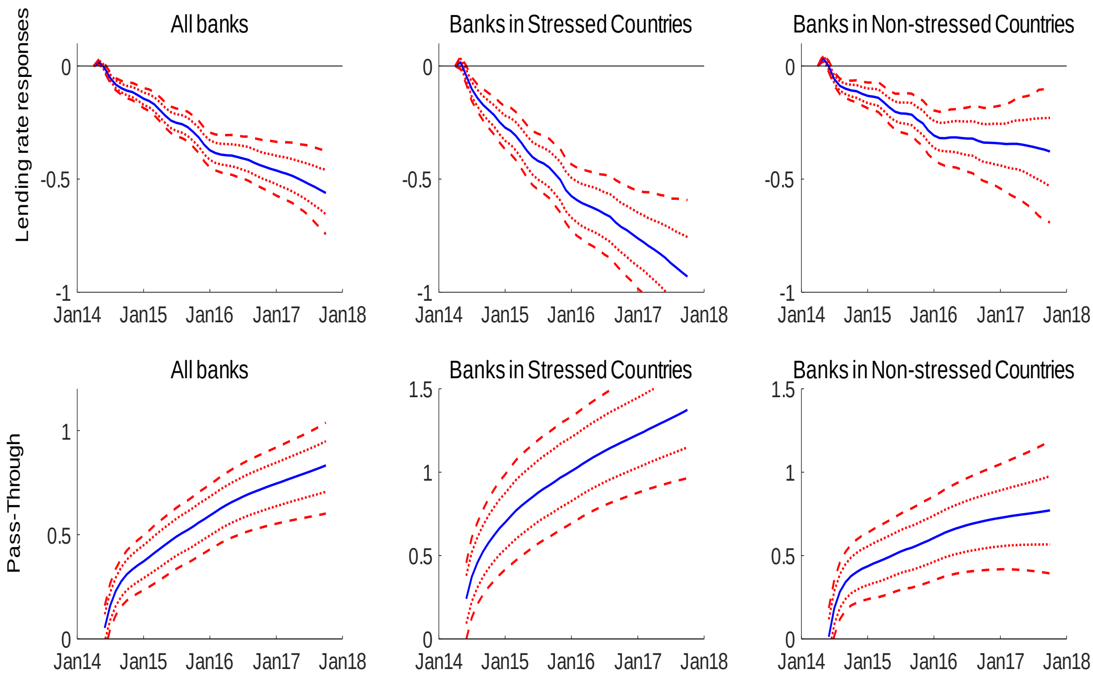
Notes: The left panel presents the mean of the top quartile (solid line) and of the bottom quartile (dashed line) of the pass-through distribution following conventional policy surprises. The right panel presents the mean differences in the two quartiles (solid line) together with 68 and 95 percentage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

Figure 5: Counterfactual path for EONIA, bank bond and sovereign bond yields due to non-standard monetary policy announcements



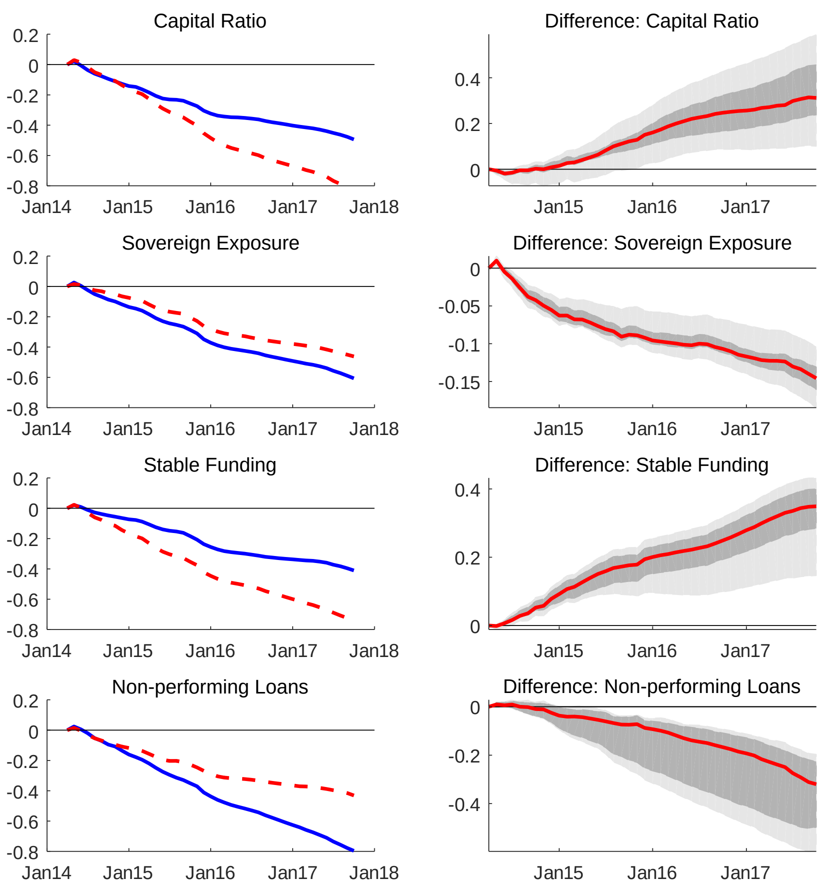
Notes: The figure presents the cumulative effects of non-standard measures on the EONIA (the same for all banks), on sovereign yields (the same for all banks operating in the same country) and on bank bond yields (different for each bank). The top row reports the paths for stressed countries, the bottom row the paths for non-stressed countries. Solid lines represent the value for the median bank, dotted lines the 16th-84th and dashed lines the 2.5th-97.5th percentiles of the values across countries or banks. Non-financial corporations.

Figure 6: Distribution of lending rates responses and pass-through. Non-standard policy surprises



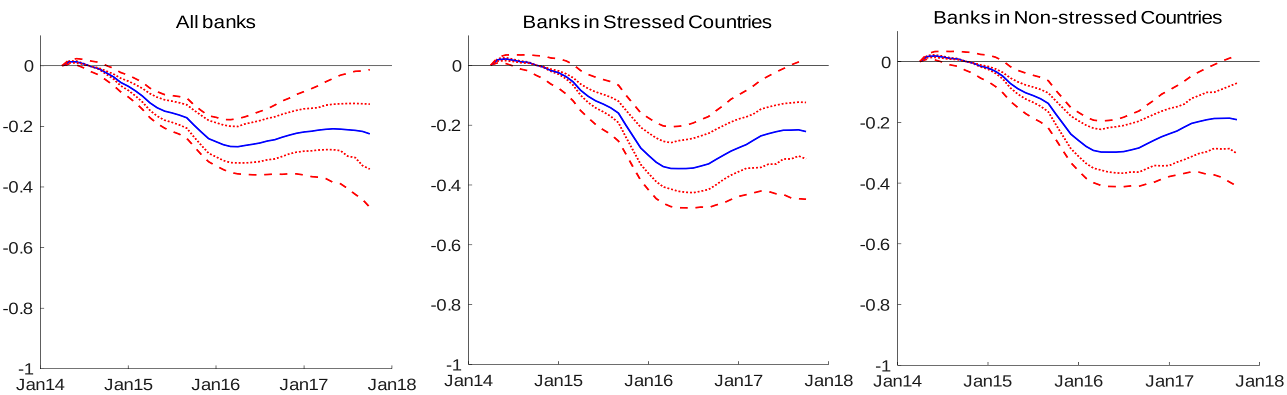
Notes: The figure presents the distribution of lending rate responses (top row) and of pass-through (bottom row) to non-standard policy surprises. The solid line is the median, the dotted lines the 16th and 84th percentiles and the dashed lines the 2.5 and 97.5 percentiles of the distribution. Non-financial corporations.

Figure 7: Lending rate responses sorted by banks' characteristics. Non-standard policy surprises



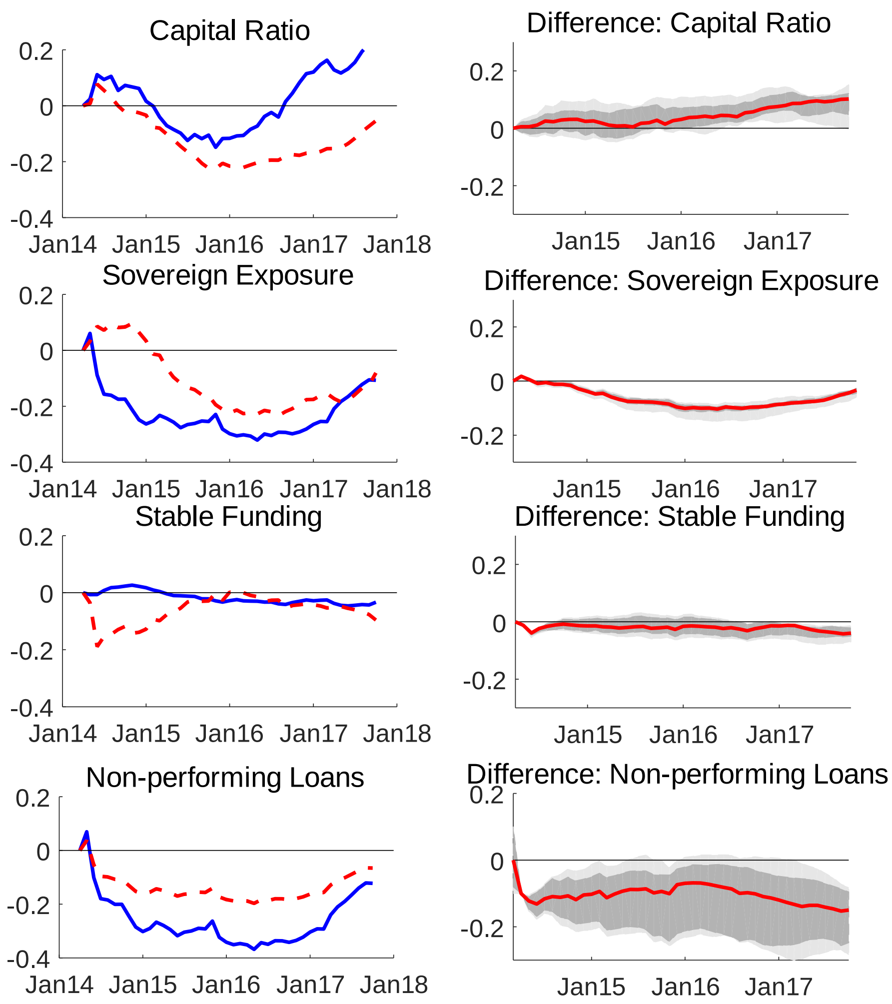
Notes: The left panel presents the mean of the top quartile (solid line) and bottom quartile (dashed line) of the distribution of the lending rate responses following non-standard policy surprises. The right panel presents the mean differences in the two quartiles (solid line) together with 68th and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

Figure 8: 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 solid line represents the median value, the dotted lines the 16th and 84th percentiles and the dashed lines the 2.5th and 97.5th percentiles of the distribution.

Figure 9: Lending margin responses to non-standard policy surprises sorted by banks' characteristics.



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