Monetary policy transmission to bank lending and cross-country heterogeneity in the Euro area

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Abstract

Is the transmission of monetary policy to bank lending heterogeneous across Eurozone countries? This paper employs annual data on banks balance sheets and income statements to test whether the bank lending channel of conventional monetary policy was heterogeneous in the Eurozone over the period 2007-2016. To do so, we follow a simple procedure that allows direct testing of the presence of heterogeneity of monetary transmission across countries by defining a single, bank-specific criterion to select a subsample of banks that are most likely to be sensitive to the bank lending channel. We find robust evidence that the transmission of monetary policy to bank lending was heterogeneous across countries – on average the same 1% policy rate cut leads to a 4.8% increase in lending by banks located in the core and a 2.8% increase for banks located in the periphery. No evidence is instead found in favor of a bank lending channel working for the Eurozone as a whole, highlighting the extent of cross-country heterogeneity in the bank lending channel of monetary policy in the Eurozone. The findings are robust to the contemporaneous effect of unconventional monetary measures and cannot be ascribed to differences in macroeconomic and financial conditions across country groups.

Keywords: Bank lending channel, monetary policy transmission, cross-country heterogeneity, financial structures.

JEL classification: E52,E58,E42,F33

Introduction

An important measure of the effectiveness of monetary policy is the extent to which it is transmitted via the banking system to the real economy in the form of loans to households and non-financial corporations (NFCs). That such transmission is homogeneous across regions is a particularly challenging requirement in a monetary union like the euro area, where the single monetary authority – the European Central Bank – conducts policy for a group of 19 member countries whose banking systems are not yet completely integrated. As a consequence, the same monetary policy may have different effects on credit outcomes in different countries: in other words, monetary transmission to bank lending may at times be heterogeneous across countries. While diversity in banking systems is a long-standing feature of the union,[1] the impact of asymmetric financial shocks may also widen differences across countries and further prevent monetary policy to be evenly transmitted to bank lending across the euro area. This issue was particularly relevant between 2010 and 2013, when the Sovereign Crisis drove economic divergence between countries and fragmentation on financial and retail credit markets. The ensuing asymmetry between "core" and "periphery" of the euro area motivated concerns among policymakers that "[the ECB] faced severe impairments to the transmission of monetary policy across the euro area, with marked heterogeneity from country to country"(Draghi, 2014).

Using a panel of more than 3000 banks from 12 euro area countries covering 2007-2016, this paper studies whether the response of bank lending to monetary policy differed between core and peripheral countries in the euro area. The empirical strategy consists of two steps: first, the policy response of bank lending is estimated as the reaction of financially constrained banks to monetary shocks – the bank lending channel (Kashyap and Stein, 1995) ; second, the presence of cross-country heterogeneity is verified by testing for a differential bank-lending channel effect between banks located in the periphery and banks located in the core.

Results indicate that the transmission of monetary policy to bank lending was weaker for banks located in the euro area periphery as compared with banks located in the core. Specifically, on average the same 1% policy rate cut leads to a 4.8% increase in lending by core banks as opposed to a 2.8% increase for peripheral banks, everything else held constant. There is instead no evidence in favour of a bank lending channel working for the euro area as a whole, which can be taken as further indication of cross-country heterogeneity in the bank lending channel of monetary policy in the Euro area. Furthermore, the findings cannot be explained away by differences in macroeconomic or financial conditions across country groups, and are robust to the particular measure of conventional monetary policy used as well as to the introduction of measures of unconventional monetary policy alongside conventional monetary policy. The main contribution of this paper is that it devises a simple procedure that allows direct testing of cross-country heterogeneity in the bank lending channel of monetary policy. In contrast with traditional testing strategies of the bank lending channel that use multiple bank-specific characteristics *separately* (Altunbas et al., 2009; Gambacorta, 2005; Gambacorta and Marques-Ibanez, 2011; Gambacorta and Shin, 2016), in this paper bank-specific characteristics are *jointly* exploited to define a single criterion selecting a sub-sample of banks that are most likely to be sensitive to the bank lending channel. This approach has two main advantages: first, it does away with suitability issues linked to the choice of any particular measure of bank sensitivity to monetary policy; second, it is invariant to the idiosyncrasies of different banking systems which makes it particularly indicated for the study of the bank lending channel across countries.

The paper has implications for policy. Insofar heterogeneity in monetary transmission across financial systems can complicate the task of monetary policymakers (Cœuré, 2017; Guiso et al., 2000), explicit consideration to the degree of heterogeneity should inform the optimal monetary policy strategy in a monetary union. For instance, as proposed by Gambacorta (2003), if the members of a monetary union have asymmetric bank lending channels, the optimal monetary policy would be influenced not only by the magnitude of the variance of the shock, but also by its point of origin.

The remainder of the paper is organized as follows. The first section presents some stylised facts on bank lending in the euro area and discusses the main motivation behind the paper, while the second section presents a review of the literature. The empirical analysis is reported in the third section, alongside a discussion on the sample and the econometric model. The fourth section presents the main results and the fifth section concludes.

[1] See, for instance, Cecchetti (1999) and Ehrmann et al. (2002) .

1 Bank lending and heterogeneity in the Euro area

The main motivation of this paper is the observed heterogeneity in bank lending outcomes observed since 2010 in the euro area. During the euro area Sovereign Debt Crisis (2010-2012), financial and real asymmetries became evident between "core" and "peripheral" countries.[2] On the financial side, banks located in the euro area periphery were particularly exposed to the suffering of their own sovereign. With domestic government securities amounting to the lion share of their fixed income portfolio, Greek, Italian, Irish, Spanish and Portuguese banks saw their balance sheets rapidly deteriorating as the value of their bond holdings widely used as collateral started plummeting. Soon banks in the periphery and sovereigns became joined at the hip (Mody and Sandri, 2012). The financial fragmentation that ensued is regarded to have determined, for banks, different degrees of access to external finance in different countries (Durré et al., 2014). On the real side, economic conditions varied remarkably across countries, with the recession being, for some countries, more severe and enduring than for others. Such heterogeneity was reflected on retail credit markets, where a moderate and short-lived decline in bank loans in the core contrasted with a severe and persistent credit crunch in the periphery (Gilchrist and Mojon, 2014). In response, from 2010 the ECB launched a mix of conventional and unconventional measures to provide cheap liquidity to banks and sustain credit supply to the real economy. Moreover, by restoring the viability of money and sovereign markets, the ECB sought to preserve the integrity of monetary transmissions in the Eurozone Durré et al. (2014). In spite of the expansionary stance of the single monetary policy (see figure 1), bank lending remained substantially heterogeneous across countries. As depicted in the figure 2, instead, while following the outbreak of the Great Financial Crisis in 2008 bank lending plunged for all euro area countries alike, from 2010 a clear divergence emerged: while banks in the core experienced only a moderate and short-lived decline in lending, bank lending in the periphery was considerably restricted, resulting in a severe and persistent credit crunch in the periphery.[3] Such divergence remained very persistent, arising in mid-2010 and carrying through the present day: on average, between January 2010 and November 2017, bank lending in the periphery was 7.5% lower than bank lending in the core.

Moreover, the extent of cross-country heterogeneity in bank lending was economically relevant. This can be appreciated by looking at figure 3, where the dispersion of the growth rates of adjusted loans to NFCs across euro area countries is compared with the dispersion of real GDP growth rates.[4] For the whole period, cross-country heterogeneity in loan growth was constantly higher, in absolute terms, than heterogeneity in GDP growth. Furthermore, loan growth dispersion was especially high in the run up to the Great Financial Crisis, during the Sovereign Crisis (2010-2012) and during the following recovery (2014-2016).

A set of policy questions then arises: How can geographically heterogeneous credit outcomes follow homogeneous policy impulses? Does bank lending respond differently to monetary policy in different countries? The remainder of this paper seeks to shed light on these questions.

[2] Throughout the paper, the category "peripheral countries" refers to euro area countries which experienced severe sovereign stress in the period 2010-2013 as opposed to "core countries", namely those countries that did not experience similar sovereign stress in the same period and had relatively low levels of public debt (De Grauwe, 2013; Lane, 2012). In this paper, peripheral countries are Greece, Ireland, Italy, Portugal and Spain, while core countries are Austria, Belgium, France, Finland, Germany, Luxembourg and the Netherlands.

[3] It can be noted that prior to 2008 bank lending was actually growing faster for banks in the periphery, in good measure reflecting the overheating in the banking sector related to the build-up of housing bubbles in some peripheral countries such as Spain and Portugal.

[4] Adjusted loans refer to loans adjusted for sales and securitisation, as well as for the impact of notional cash pooling positions that result from cash management services provided by certain banks to corporate groups. Adjusted loans thus give a better signal of underlying credit developments for euro area borrowers and improve the comparability of country-level data

2 Literature review

The bank lending channel is the traditional mechanism through which monetary policy directly influences bank lending. In its original form proposed by Bernanke and Blinder (1988), Bernanke and Gertler (1995) and Kashyap and Stein (1995), the channel depends on the existence of financial frictions in the market for uninsured non-deposit funding whereby some banks are less able to substitute sources of finance and pay an external finance premium to raise wholesale funding. The resulting testable hypothesis is that the effect of monetary policy easing should be stronger for financially constrained banks which stand to benefit the most from easier borrowing conditions vis-á-vis other banks and which are therefore more likely to respond by expanding their lending.[5] Empirical tests of the channel typically use bank-level data and focus on a subset of banks that may be financially constrained in the wholesale funding markets. Specifically, the literature looks at bank lending variation in response to monetary stimuli conditional on observable specific characteristics such as size, capitalization, liquidity and credit-risk, taken as proxies for banks' degree of financial constraint. For instance, small banks may have difficulty accessing external funds, given greater informational-asymmetry problems vis--vis large banks stemming from their simple capital structure (Kashyap and Stein, 1995), illiquid banks usually face higher costs to offset deposit losses (Gambacorta, 2005; Kashyap and Stein, 1995, 2000; Kishan and Opiela, 2000), while poorly capitalized banks are believed to face an external finance premium as perceived riskier (Gambacorta and Shin, 2016; Peek and Rosengren, 2005). As a result, small, illiquid and poorly capitalized banks are taken to be more sensitive to policy impulses, and thus the ideal conduit of the bank lending channel. An important underlying assumption is that credit demand faced by banks is homogenous within countries, implying that loan demand is unrelated to specific bank characteristics. For example, if customer of small banks tend to increase their demand for funds more promptly in the face of a monetary loosening, it is impossible to identify the bank lending channel. However, for the sake of this research we regard this assumption as tenable given that most customers tend to have scarce short-term alternatives to bank lending in euro area bank-based financial systems. While a growing empirical literature on monetary transmission overcome this identification issue using loan-level data on a country-by-country basis (Iyer et al., 2014; Jiménez et al., 2014, 2012), we do not have access to euro area-wide loan-level data and thus we work under the assumption of homogeneity of loan demand as a reasonably good approximation.

A related literature considers the monetary policy implications of heterogeneous banking structures within a monetary area. In an optimal currency area the even transmission of monetary policy requires synchronized business cycles and similar economic structures across member states. While there is evidence that euro area economies are sufficiently synchronized as well as economically and financially integrated (Baele et al., 2004; De Grauwe and Mongelli, 2005; De Haan et al., 2008; ECB, 2016), differences across banking systems and the lack of integration in retail credit markets persist to the present day and may introduce an element of heterogeneity in the transmission of the common monetary policy to bank lending across countries (De Santis and Surico, 2013). This hypothesis was originally put forth by Cecchetti (1999) and Kashyap and Stein (2000) who argued that differences in structures of financial intermediation, legal systems, corporate finance practices and capital market development between EMU countries may give rise to differences in the way monetary policy is transmitted to bank loans across the union. The usual rejoinder to this hypothesis was that even if financial structures differ substantially across countries, economic and financial convergence in the euro area would imply that any difference in the transmission mechanism will eventually disappear over time (Ciccarelli and Rebucci, 2002; Dornbusch et al., 1998).

Motivated by these literatures, European monetary integration has prompted interest in the study of differences in the bank lending channel between euro area countries and the extent of cross-country heterogeneity therein. While methodologically all studies are essentially applications of the original test of the bank lending channel by Kashyap and Stein (1995) onto

[5]The bank lending theory further assumes that financially constrained banks will tilt their asset allocation in a particular way in response to a monetary easing. As banks face an asset choice (holding liquid bonds or earning a spread on illiquid loans) and a liability choice (deposit or non-deposit funding), the risk of future deposits shortfalls and payments mismatches prompts banks to hold extra bonds as a liquidity buffer. By lowering the external finance premium and relaxing the liquidity constraint, monetary expansions should, ceteris paribus, encourage reallocation away from bonds and towards illiquid (but more profitable) assets such as loans (Butt et al., 2015).

European data, the resulting empirical evidence is mixed. Amongst country-specific studies, using panels of, respectively, Italian, Spanish and French banks for periods between 1990 and 2001, Gambacorta (2005); Hernando and Martínez-Pagés (2001); Loupias et al. (2002) detect a bank lending channel working only for illiquid banks. Yet, cross-country studies reveal a different picture. Using balance sheet data to investigate the bank lending channel, De Bondt (1999) finds some evidence for a bank lending channel for Italian, French and German banks, while Altunbas et al. (2002) detect a bank lending channel working through size only in Italy and, partially, in Spain. In a very comprehensive study, Ehrmann et al. (2002) use annual bank balance sheet data owned by the Eurosystem to explicitly address cross-country heterogeneity in monetary transmission by estimating and comparing the bank lending channels for France, Germany, Italy and Spain. The resulting evidence shows that the effect of monetary policy on bank credit was quite homogeneous across countries both prior and after the introduction of the euro. Ten years later, in a very similar exercise De Santis and Surico (2013) find the opposite result. Drawing from a sample over the period 1999-2011, the authors report that the impact of monetary policy is heterogeneous across countries, with the bank lending channel being stronger in Germany and Italy and weaker in Spain and France. Further evidence in favor of heterogeneity of the bank lending channel in the euro area is provided by De Santis (2015) who finds that between 1999 and 2011 monetary policy easing supported relatively more the lending of French small banks and German illiquid banks with respect to Spanish and Italian banks.

Interest in cross-country heterogeneity of monetary transmission was reignited in the context of the euro area Sovereign Crisis and the resulting monetary policy response by the ECB. For instance, Ciccarelli et al. (2013) estimate a VAR model over the period 2002-2011 for a panel of 12 euro area countries and identify a bank lending channel at the macro-level. In particular, the authors find that the response of bank lending to monetary policy is stronger in countries under sovereign stress (Greece, Italy, Ireland, Portugal and Spain in their analysis) as opposed to other countries (Austria, Belgium, Finland, France, Germany, Luxembourg and the Netherlands), highlighting substantial heterogeneity across countries. However, the authors maintain that ECBs unconventional monetary policy measures appear to have partially mitigated the bank lending channel between 2010 and 2011. In a recent study, using a global VAR model that exploits panel variation among all euro area economies between 2007 and 2015 and takes into account cross-country interdependencies, Burriel and Galesi (2018) find that the Eurozone-level response of new credit operations to unconventional monetary policy is insignificant, possibly reflecting large degree of heterogeneity across country responses masked by aggregating country-specific effects.

3 Empirical analysis

Through the bank lending channel, expansionary monetary policy can boost lending by affecting banks access to external finance. However, the bank lending channel may be heterogeneous across countries. This paper addresses the following question: Was monetary transmission to bank lending different between core and peripheral banks? To answer, this paper uses balance sheet data and a novel methodology based on the bank lending channel.

3.1 Data

This paper uses annual data on euro area banks containing balance sheet and income statement information. Data are sourced through Fitchconnect, a comprehensive commercial database provided by Fitch Solutions, a provider of credit market data member of the Fitch Group. The original sample covers 3110 commercial, savings and cooperative banks from all 19 euro area member countries for the period 2007-2016, amounting to 31100 observations and covering 32% of the euro area bank population. The treatment for corrupted observations and outliers follows the approach of Gambacorta (2005) and Ehrmann et al. (2002). First, banks containing nonsense information (zero or negative entries for total assets or gross loans) are removed, as well as banks with less than 4 years of consecutive available information for gross loans and total assets. Second, all banks with values greater or less than, respectively, the 99^{th} and 1^{st} percentile for loan growth are dropped (percentiles refer to the distribution of mean values for each bank across the period and refer to country-specific distributions), as well as all banks posting loan

growth of more than 50%, since these are likely to have merged with other institutions or to have been restructured. To keep the cross-section dimension as large as possible, the analysis is restricted to unconsolidated accounts. Finally, only banks located in either core or peripheral countries are kept in the sample. The final sample is a strongly balanced panel counting 2249 banks and a total of 22490 observations over the 10 year period of interest, whose descriptive statistics are presented in table 2. Macroeconomic data are collected through the European Central Bank, Eurostat and the European Money Market Institute.

3.2 Identification

The bank lending channel requires some banks to be more sensitive to monetary policy at the margin. Therefore, the channel is traditionally tested by looking at the differential lending response to monetary policy by banks conditional on *either* their size, liquidity, capitalization or credit risk (Altunbas et al., 2009; Gambacorta, 2005; Gambacorta and Marques-Ibanez, 2011). However, if one is interested in testing and comparing the bank lending channel across countries, issues arise about the suitability of using bank financial characteristics separately to measure a banks sensitivity to monetary policy.

To begin with, some banks may be simultaneously small but liquid, or big but overcapitalized, or overcapitalized but low-risk. If such occurrences are systematic in some banking system, the bank lending channel-informational content of any individual measure per se would be confounded for that country, thus complicating cross-country comparisons. Evidence suggests this is indeed the case for some euro area countries. In Italy, for instance, small banks are often liquid and highly capitalized: banks of small size rooted in the territory are good at drawing resources from local deposit markets and are thus particularly liquid. Additionally, small Italian cooperative banks can be prevented from distributing dividends and thus tend to capitalize retained earnings (Gambacorta, 2005). By the same token, German banks tend to have low capital, but this is usually compensated by the low riskiness of their asset structure (Ehrmann et al., 2003).

There are also specific problems related to the informational content of bank-specific characteristics when they are used as standalone proxies. For instance, bank networks and relationship lending may distort the informational content of bank size. Large banks in upper tiers of the network usually serve as liquidity providers to small banks in lower tiers in case of liquidity deficits, potentially neutralizing the latters liquidity constraint (Ehrmann et al., 2003). Furthermore, banks that engage in relationship-lending – typically small banks in the euro area (Ongena and Smith, 2000) – may provide implicit guarantees to their customers that they will grant access to credit regardless of liquidity and monetary policy conditions (Rajan and Zingales, 1998). As a result, bank size may not be a good proxy to evaluate the distributional effects of monetary policy across banks.[6] Bank capital can also be an ambiguous indicator: under Basel II and Basel III risk-based capital requirements, after a monetary expansion banks close to the capital regulatory floor may be less able to increase lending - thus lowering capital-assets ratios - unless provided with additional capital. Additional liquidity may instead be allocated to assets free from capital requirements, such as government bonds. Accordingly, no differential effect of policy on lending would be captured via bank capital (Van den Heuvel, 2002).

Overall, to test for the presence of a bank lending channel across countries, a more convenient procedure is to define a necessary criterion that is more stringent than those implied in standard methods. Such approach has two main advantages: i) it allows doing away with all individual suitability issues linked to the choice of any particular measure of bank sensitivity to monetary policy used separately; ii) it is invariant to the idiosyncrasies of each banking system. This paper departs from previous literature by proposing an alternative (but complementary) identification strategy for the bank lending channel whereby a single criterion selects a sub-sample of banks that are most likely to be sensitive to the bank lending channel of monetary policy. The logic is as follows: if through the bank lending channel monetary policy has any differential effect at all on some banks, then it should definitely be observed for banks that are *simultaneously* small, illiquid and under-capitalized. If no effect is detected for these banks, then it is very unlikely there is an active bank lending channel of monetary policy at all for the period considered.

[6] Additionally, in the euro area government guarantees and deposit insurance cover banks irrespective of their size: accordingly, deposit accounts at small banks should not be considered any riskier than deposits accounts at big banks (Ehrmann et al., 2003)

Table 1: Bank lending channel thresholds

Bank-specific characteristics	Thresholds	Average number of banks	Other banks
Small	Log assets $\leq$ 95 pct	1691	564
Undercapitalised	Capital regulatory distance $\leq$25 pct	308	921
Illiquid	Liquidity ratio $\leq$75 pct	1635	544
BLC banks	Small, illiquid and undercapitalized	148	1071

Defining the criterion involves two steps. In the first step, three thresholds are defined to classify banks as small, illiquid or under-capitalized. For size, following Kashyap and Stein (2000) banks are considered small if, in any given year, they lie in the bottom 95% of the distribution of total assets for all countries. For capitalization, banks are marked as under-capitalized if, in any given year, the distance between their regulatory capital ratio from the regulatory floor is in the bottom quartile of the distribution of distances for all countries, in line with Borio and Gambacorta (2017) and Gambacorta and Shin (2016). Finally, banks are considered illiquid if, in any given year, their liquidity ratio is smaller than 20% as in Kashyap and Stein (2000). In the second step, an indicator variable (BLC banks) is defined to take value 1 for all banks that are, in any given year, simultaneously small, under-capitalized and illiquid, and zero otherwise. That is:

$$BLCbanks_{it} = \begin{cases} 1 & \textit{if a bank is small \& illiquid \& undercapitalised} \\ 0 & \textit{otherwise} \end{cases}$$

As discussed above, this approach avoids all issues linked to the choice of any particular measure of bank sensitivity to monetary policy used separately, and is also unaffected by differences across banking systems. In doing so, this approach expands previous work on the bank lending channel whose focus was on banks that were simultaneously small and illiquid (Kashyap and Stein, 2000) or small and under-capitalized (Kishan and Opiela, 2006). This approach presents however potentially serious shortcomings related to sample selection that may bias the results (a discussion in this sense is presented in section 4.1). Armed with this criterion, it is now possible to test directly the effectiveness of monetary policy through the bank lending channel.

This approach has two main advantages and one drawback. Amongst the advantages, i) it allows doing away with all individual suitability issues linked to the choice of any particular measure of bank sensitivity to monetary policy used separately; ii) it is invariant to the idiosyncrasies of each banking system. In doing so, this approach expands previous work on the bank lending channel whose focus was on banks that were simultaneously small and illiquid Kashyap and Stein (2000) or small and undercapitalised Kishan and Opiela (2000). The main drawback is instead related to sample selection. A discussion in this sense is proposed in section 4.2. Armed with this criterion, it is now possible to test directly the effectiveness of monetary policy through the bank lending channel.

3.3 Econometric specification

Building from traditional estimations of the bank lending channel,[7] model (1) is designed to detect heterogeneous bank lending channels between core and peripheral countries:

$$\Delta \log Loans_{it} = \alpha_i + \beta_1 \Delta MP_t + \beta_2 \Delta MP_t \times BLCbanks_{it-1} + \beta_3 \Delta MP_t \times BLCbanks_{it-1} \times Periphery_i + \gamma_1 \Delta \log Loans_{it-1} + \gamma_2 X_{it-1} + \gamma_3 Y_{it} + \epsilon_{ijt} \quad (1)$$

The dependent variable ($\Delta \log Loans$) is the annual growth rate of bank (gross) loans which is regressed on an indicator of conventional monetary policy (ΔMP) in first difference to avoid spurious correlation alongside two interaction terms and two vectors of control variables ($X$and Y). Specifically, the conventional monetary indicator (ΔMP) is represented by the annual change in either the 3-months EURIBOR rate or the EONIA interbank rate, according to the specification.[8] The first interaction term has the monetary policy instrument interacted with the bank lending channel selection criterion ($BLCbanks_{-1}$) as defined in the previous section and lagged one year to attenuate endogeneity concerns. The second interaction term compounds the first term with a dummy ($Periphery$) taking value 1 if the bank is located in the periphery and 0 otherwise. Finally, one lag of the dependent variable ($\Delta \log Loans_{it-1}$) is included to absorb persistence in bank lending.

X is a vector of bank-level variables controlling for characteristics such as size (log of total assets), liquidity (cash, interbank liquidity and securities divided by total assets) and capitalization (equity-assets ratio and Tier 1 regulatory capital ratio). All variables are normalized with respect to their own average across all banks, and thus sum up to zero over all observations. Thus transformed, values are entered with one lag both to attenuate endogeneity concerns and because lending decisions conditional upon bank-specific features usually take place with a lag.[9]

Y is a vector of macroeconomic control variables including real GDP growth, HCIP inflation, sovereign spread,[10] and unemployment rate at the country-level. While the main focus of this study is conventional monetary policy, from 2010 onwards the ECB launched several unconventional monetary measures that were designed to act in complementarity with conventional policy (Albertazzi et al., 2016). To assess the net effect of conventional monetary policy on bank lending, it is therefore important to absorb the concomitant impact of unconventional monetary measures on bank lending. To do so, the following variables are added to the list of macro controls. First, the ratio between total assets on the balance sheet of the National Central Bank and domestic nominal GDP is included to account for the asset expansion by central banks as part of unconventional measures relative to the size of the economy (Gambacorta and Marques-Ibanez, 2011; Peydro et al., 2017), as well as the ratio between total assets on the ECB's balance sheet and domestic nominal GDP. Second, the slope of the yield curve (measured as the difference between the 10-year government bond yield and the 3-months EURIBOR rate as in Borio and Gambacorta (2017)) stands as another proxy of unconventional measures since one of the main consequences of Quantitative Easing (QE) was the flattening of the yield curve. Finally, bank fixed effects are added to absorb unobserved time-invariant heterogeneity at the bank-level.

[7] See, for instance, Gambacorta (2005).

[8] Highly correlated with the ECBs main refinancing rate, both EURIBOR and EONIA represent benchmark interest rates for banks funding and widely used to study of the BLC channel (see, for instance, Altunbas et al. (2009); **?**.

[9] The size criterion makes exception in that it is normalized not only with respect to the average over the whole sample period but also with respect to each single period. This treatment aims at removing undesired trends in size, due for instance to the fact that size is measured in nominal terms (Gambacorta, 2005)

[10] A widely used measure of sovereign risk,we define spread as the difference between the German and the country's equivalent 10-year government bond yield, annual averages (Albertazzi et al., 2014).

Three testable hypotheses on the bank lending channel fall out of model (1) and depend on the sign and statistical significance of the beta coefficients.

$$\frac{\partial \Delta \log Loans_{it}}{\partial \Delta MP_t} = \beta_1 + \beta_2 BLCbanks_{it-1} + \beta_3 BLCbanks_{it-1} \times Periphery_i$$

H.I The interest rate channel: $\beta_1 < 0$. For economic theory, an interest rate cut is associated with higher bank lending by *all* banks.

H.II The bank lending channel: $\beta_2 < 0$. If the bank lending channel is active, an interest rate cut should have a larger effect on bank lending by banks selected by the criterion (BLC banks).

H.III Heterogeneous bank lending channel: β_3 not statistically different from zero. If the bank lending channel is heterogeneous across countries, the bank lending channel should be stronger in some country groups and weaker in others.

Model 1 is estimated with system GMM (Arellano and Bond, 1991; Blundell and Bond, 1998). This estimator is chosen to attenuate endogeneity concerns related to reverse causality between the dependent variable and bank specific characteristics, as well as to address dynamic panel bias, i.e. the fact that lagged values of the dependent variable are mathematically correlated with bank-fixed effects. System GMM estimator mitigates endogeneity issues by instrumenting suspected endogenous variables ($\Delta \log Loans_{t-1}$, size, liquidity, capitalization and all other bank-specific variables included in vector X) with their lags or differenced lags. Exogenous variables (ΔMP, real GDP growth, HCIP inflation and all other macro variables included in vector Y) are instrumented by themselves. This approach ensures consistency and efficiency provided that the instruments used are valid and the variables do not display auto-correlation of order two (Roodman, 2006). Specifically, the paper employs the system version of the estimator, because it tends to outperform the difference GMM estimator in terms of consistency and efficiency as it uses both the difference and the levels equation (Blundell and Bond, 1998).

4 Results

This section presents the results of the test on whether the bank lending channel of monetary policy worked differently between core and peripheral countries between 2007 and 2016. As discussed, the test is based on model (1) which is estimated with System GMM (two-step procedure and robust standard errors). As requested to satisfy the conditions of consistency and efficiency of the estimator, post-estimation tests carried out confirm that the instruments used are valid (Hansen test) and the variables do not display auto-correlation of order two (Arellano-Bond test). Results and post-estimation tests are shown in Table 4 on the next page.

4.1 Main results

Table 3 lists summary statistics for banks in the core and the periphery for the sample selected by the criterion. Interestingly, there are no great differences in bank characteristics between the average core and peripheral bank in the sub-sample. Specifically, bank size and capitalisation are broadly similar across country groups, the only difference being the ratio of liquid assets to total assets which was 7% lower for selected banks in the periphery. Taken at face value, this suggests that any differential bank lending response to monetary policy between the two country groups cannot be directly attributed to wide differences in observable bank characteristics.

The main results are presented in Table 4. Looking at the estimates in the first column, monetary policy has the expected negative effect on lending growth for all Eurozone banks: a 1% interest rate cut leads to an increase in bank lending of approximately 3.4%. Other estimates are also in line with standard results: bank lending appears to be cyclical and persistent Gambacorta (2005): on average, higher real GDP growth and HCIP inflation rates are associated with higher bank lending rates and past bank lending growth is positively related to current lending. Additionally, small banks tend to lend out more. Yet, there is no evidence of a bank lending channel working for the euro area as a whole, since the coefficient on the first interaction term (β_2) is not statistically different from zero.

However, once the second interaction term (MP × BLC banks ×Periphery) is introduced (second column), the bank lending channel coefficient (β_2) turns negative and statistically significant, while the coefficient on the second interaction term (β_3) is positive and statistically significant. This finding suggests the transmission of monetary policy to bank lending was weaker for banks located in the periphery of the euro area as compared with banks located in the core. Indeed, as the specification now discriminates between core and peripheral banks within the selected subsample, the coefficient on the first interaction term is to be interpreted as the policy effect on selected banks located in the core. Conversely, the coefficient of the second interaction directly suggests that the bank lending channel was much weaker for selected banks located in the periphery. As reported in table 5, the long term effect of monetary policy on lending for banks located in the periphery was almost one third of that for banks located in the core for the period 2008-2016.[11] This result contrast with the evidence on macro data found by Ciccarelli et al. (2013) while being consistent with the findings of De Santis (2015); De Santis and Surico (2013), although their bank-level evidence is based on country-by-country regressions.

The next four columns of table 4 contain a battery of robustness checks. First, model (1) is re-estimated with annual differences in the EONIA rate as the conventional monetary policy indicator: as shown in column 3, results are unchanged. Second, column 4 shows that results are also robust to the introduction of additional control variables at the country-level to control for macroeconomic (unemployment rate) and financial conditions (sovereign spread). A further concern is to check that that the effect of conventional monetary policy on bank lending survives the launch of unconventional measures. Results listed in columns 5 and 6 mitigates this concern, adding the slope of the yield curve and the ratios between balance sheet of the National Central Bank (column 3) and of the ECB (column 4) to domestic nominal GDP as additional control variables. The results on heterogeneity are unchanged, and no significant effects of unconventional measures, so measured, on bank lending are recorded.

4.2 Potential selection bias

The principal methodological contribution of this paper is the use of a single criterion to measure banks sensitivity to the bank lending channel. As discussed, choosing a single arbitrary criterion allows direct testing of cross-country heterogeneity in the bank lending channel of monetary policy while avoiding suitability issues linked to the choice of any particular measure of bank sensitivity to monetary policy. Additionally, this approach is invariant to the idiosyncrasies of each banking systems, making it particularly indicated in for cross-country studies of the bank lending channel.

This approach may incur, however, in selection bias. Being based on thresholds unrelated to any specific national banking system, by construction the criterion may prove too stringent for some banking system and too lax for others. As a result, the criterion may select few banks in big, highly capitalized and liquid banking systems, and many in small, over-capitalized and illiquid systems. The selected sub-sample could therefore be endogenously skewed towards some countries, misrepresenting the original sample and thus impairing the validity of the results. Tables 6 and 7 allow to compare the representation of national banking systems in the sample and the selected sub-sample, both in terms of average total assets and number of observations over the 2007-2016 period.

Looking at tables 6 and 7 the cost of the approach appears clearly. The selection criterion over-selects Austrian, Italian, German and Portuguese banks, while under-selecting Belgian, Dutch, French and Spanish banks. This is the case whether the selection bias is measured in terms of total assets or number of observations.[12] Moreover, it appears that the sample is now skewed toward Italian, German and Austrian banks. However, since the focus of this research is not to account for Eurozone-wide macroeconomic effects of monetary policy, but rather to compare the bank lending response of similar banks across-countries, it can be argued that our exercise is still meaningful, provided the proportions of selected banks in the core and in the

[11] As in Borio and Gambacorta (2017), the long-run impact of monetary policy on bank lending for core banks is calculated as $\frac{\partial \Delta \log Loans_{core}}{\partial \Delta MP} = \frac{\beta_1+\beta_2}{1-\gamma_1}$, while the long-run impact of monetary policy on bank lending for peripheral banks is calculated as $\frac{\partial \Delta \log Loans_{periphery}}{\partial \Delta MP} = \frac{\beta_1+\beta_2+\beta_3}{1-\gamma_1}$.

[12] This effect is mainly due to the threshold for size, which tends to leave out most banks especially in the French and Spanish banking systems whose banks are historically composed of relatively few large banks.

periphery are similar, which is indeed the case (ranging between 45 to 55 percent both in terms of total assets or number of observations).

Conclusion

This paper asked whether conventional monetary policy may affect bank lending heterogeneously across the Euro area through the bank lending channel. Results indicate that between 2007 and 2016 the bank lending channel was stronger for core countries, i.e. the transmission of monetary policy to bank lending was heterogeneous across countries. The finding cannot be easily explained away by differences in macroeconomic or financial conditions across country groups and is robust to the particular measure of conventional monetary policy used. Furthermore, the presence of unconventional monetary measures does not to wash away the effect of conventional policy on bank lending.

The presence heterogeneity across financial systems may significantly complicate optimal policy strategy in a common currency area, and targeted measures aimed at lowering the degree of monetary policy heterogeneity across countries are therefore crucial. To help individuating the most suitable policy tools, further research should investigate which particular factors are driving heterogeneity in monetary transmission across the euro area.

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Table 2: Descriptive statistics

	Core			Periphery		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Whole sample						
Δ ln (loans)	11502	4.072	10.145	5005	3.679	10.349
Total assets (EUR Millions)	11502	4763	70714	5005	1703	4826
Equity/assets ratio (%)	11502	8.875	7.097	5005	11.018	6.224
Liquidity ratio (%)	11106	25.337	14.523	4941	21.301	14.893
Real GDP (growth rate, %)	11502	0.914	2.485	5005	-0.817	2.421
HCIP inflation (%)	11502	1.447	1.010	5005	1.545	1.350
Euribor rate (%)	11502	1.300	1.370	5005	1.300	1.373
Eonia rate (%)	11502	0.973	1.173	5005	0.973	1.175
2006-2010						
Δ ln (loans)	3875	3.706	10.906	1697	7.853	10.452
Total assets (EUR Millions)	3875	5232	79791	1697	1869	5530
Equity/assets ratio (%)	3875	7.541	5.856	1697	11.254	5.365
Liquidity ratio (%)	3769	25.073	13.535	1673	17.211	12.018
Real GDP (growth rate, %)	3875	-0.172	3.742	1697	-1.587	2.937
HCIP inflation (%)	3875	1.506	1.146	1697	1.940	1.261
Euribor rate (%)	3875	2.735	1.709	1697	2.735	1.702
Eonia rate (%)	3875	2.220	1.555	1697	2.220	1.548
2011-2016						
Δ ln (loans)	7627	4.258	9.731	3308	1.537	9.617
Total assets (EUR Millions)	7627	4525	65628	3308	1617	4420
Equity/assets ratio (%)	7627	9.553	7.561	3308	10.897	6.619
Liquidity ratio (%)	7337	25.473	15.005	3268	23.395	15.764
Real GDP (growth rate, %)	7627	1.465	1.141	3308	-0.422	1.996
HCIP inflation (%)	7627	1.417	0.933	3308	1.341	1.349
Euribor rate (%)	7627	0.344	0.509	3308	0.344	0.518
Eonia rate (%)	7627	0.142	0.348	3308	0.142	0.357

Table 3: Bank Lending Channel banks

	Core			Periphery		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Whole sample						
Δ ln (loans)	11502	4.072	10.145	5005	3.679	10.349
Total assets (EUR Millions)	11502	4763	70714	5005	1703	4826
Equity/assets ratio (%)	11502	8.875	7.097	5005	11.018	6.224
Liquidity ratio (%)	11106	25.337	14.523	4941	21.301	14.893
Selected sample						
Δ ln (loans)	1090	5.630	6.987	637	3.582	10.039
Total assets (EUR Millions)	1090	1836	3726	637	2904	4489
Equity/assets ratio (%)	1090	7.109	1.723	637	6.751	3.097
Liquidity ratio (%)	1090	20.909	8.482	637	13.294	10.293

Table 4: Main results

Δ Log Loans	(1) Bank lending channel	(2) Bank lending channel + Heterogeneity	(3) Δ MP =EONIA	(4) Extra Macro controls	(5) Unconventional policy (1)	(6) Unconventional policy (2)
ΔMP	-3.429***	-3.428***	-3.774***	-2.029***	-1.878***	-1.950***
	(0.380)	(0.392)	(0.433)	(0.366)	(0.352)	(0.349)
ΔMP × BLC banks	0.216	-1.249**	-1.612***	-1.212**	-1.026**	-1.111**
	(0.338)	(0.500)	(0.595)	(0.478)	(0.471)	(0.469)
ΔMP × BLC banks × Periphery		2.105***	2.412***	2.160***	1.981***	2.086***
		(0.589)	(0.667)	(0.559)	(0.554)	(0.553)
Real GDP growth	1.466***	1.475***	1.440***	0.723***	0.621***	0.636***
	(0.163)	(0.168)	(0.165)	(0.152)	(0.146)	(0.141)
HCIP Inflation rate	0.699***	0.610**	0.776***	0.910***	0.910***	0.980***
	(0.221)	(0.245)	(0.258)	(0.311)	(0.347)	(0.352)
Size_{t-1}	-0.144***	-0.131***	-0.152***	-0.162***	-0.160***	-0.173***
	(0.0314)	(0.0287)	(0.0289)	(0.0295)	(0.0323)	(0.0328)
Capital_{t-1}	0.0299	0.0243	0.0196	0.0306	0.0257	0.0244
	(0.0307)	(0.0315)	(0.0331)	(0.0331)	(0.0337)	(0.0339)
Liquidity_{t-1}	-0.00667	-0.00995	-0.00709	0.00262	0.00233	0.00220
	(0.00873)	(0.00959)	(0.00951)	(0.00995)	(0.0107)	(0.0109)
Δ Log Loans_{t-1}	0.109**	0.0947***	0.0747**	0.0799**	0.0809**	0.0671*
	(0.0472)	(0.0349)	(0.0368)	(0.0356)	(0.0384)	(0.0364)
Unemployment rate				-0.327***	-0.338***	-0.332***
				(0.113)	(0.126)	(0.128)
Sovereign spread				-1.010***	-1.170*	-0.870**
				(0.317)	(0.636)	(0.409)
Slope of the yield curve					0.0510	-0.285
					(0.621)	(0.402)
Total assets National Central Bank / domestic NGDP					0.0300	
					(0.0365)	
Total assets ECB / domestic NGDP						0.000880
						(0.00140)
Constant	-0.0267***	-0.0240***	-0.0274***	0.0115	0.00373	0.0120
	(0.00779)	(0.00828)	(0.00830)	(0.0109)	(0.0185)	(0.0118)
Bank-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of instruments	47	56	56	58	60	60
A-B test for AR(1) in 1st diff. (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
A-B test for AR(2) in 1st diff. (p-value)	0.676	0.725	0.797	0.452	0.452	0.472
Hansen test (p-value)	0.280	0.296	0.350	0.794	0.699	0.802
Observations	7,922	7,835	7,835	7,835	7,835	7,835
Number of banks	1,816	1,793	1,793	1,793	1,793	1,793

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Long-term effect of monetary policy on lending, core vs periphery calculated on the estimates of model 1, specified as in column 2 of table 5.

Long-term coefficients	
Core	Periphery
-4,807***	-2,804***
(0,703)	(0,545)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Assessing selection bias - full sample

Mean values 2007-2016	Total assets		N of observations	
Country	EUR million	Share of full sample (%)	Observations	Share of full sample (%)
Austria	1048405	2,8	217	5
Belgium	1485590	4	390	9
Finland	454457.5	1,2	240	5,6
France	137E+07	36,6	276	6,4
Germany	8891067	23,8	1077	25
Luxembourg	461948.4	1,2	650	15,1
Netherlands	3853733	10,3	370	8,6
Core	**29895201**	**79,9**	**3220**	**74,6**
Greece	52296.07	0,1	140	3,2
Ireland	535916	1,4	160	3,7
Italy	3407622	9,1	577	13,4
Portugal	352480.9	0,9	108	2,5
Spain	3156480	8,4	109	2,5
Periphery	**7504795**	**20,1**	**1094**	**25,4**
Full sample	***3.7E+07***	***100***	***4314***	***100***

Table 7: Assessing selection bias - selected sample

Mean values 2007-2016	Total assets		N of observations	
Country	EUR million	Share of selected sample (%)	Observations	Share of selected sample (%)
Austria	97144	10,7	166	7,8
Belgium	3948	0,4	7	0,3
Finland	4259	0,5	10	0,5
France	30400	3,3	27	1,3
Germany	249154	27,4	1005	47,3
Luxembourg	24219	2,7	1	0
Netherlands	22117	2,4	12	0,6
Core	**431276**	**47,4**	**1228**	**57,8**
Greece	27447	3	20	0,9
Ireland	19774	2,2	7	0,3
Italy	329556	36,2	728	34,3
Portugal	45441	5	97	4,6
Spain	56924	6,3	44	2,1
Periphery	**479143**	**52,6**	**896**	**42,2**
Selected sample	***910419***	***100***	***2124***	***100***

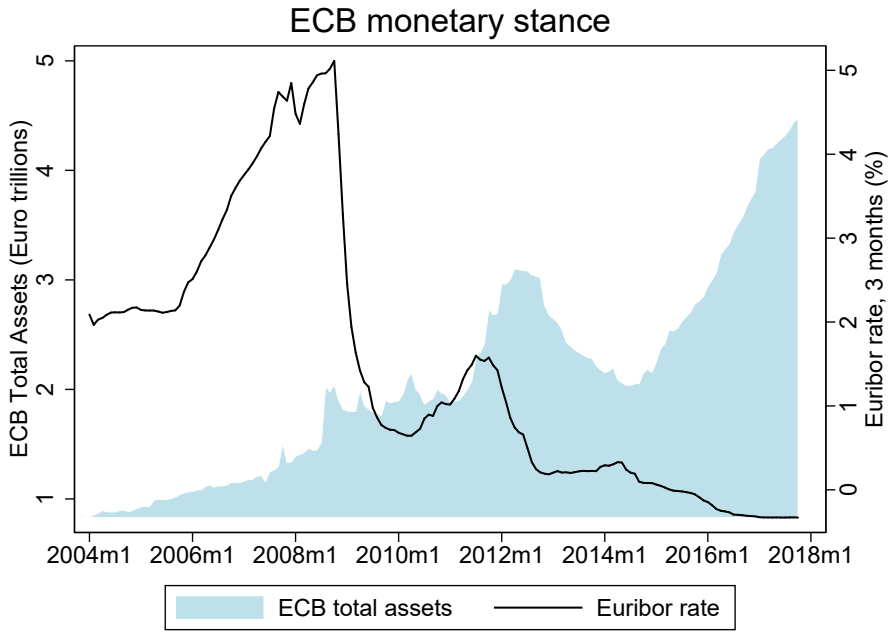

Figure 1: ECB monetary stance
Eurosystem total assets, monthly average, EUR trillions (left-hand side scale); Euribor rate, 3-months, monthly average, percentage points (right-hand side scale).
Source: ECB (2017).

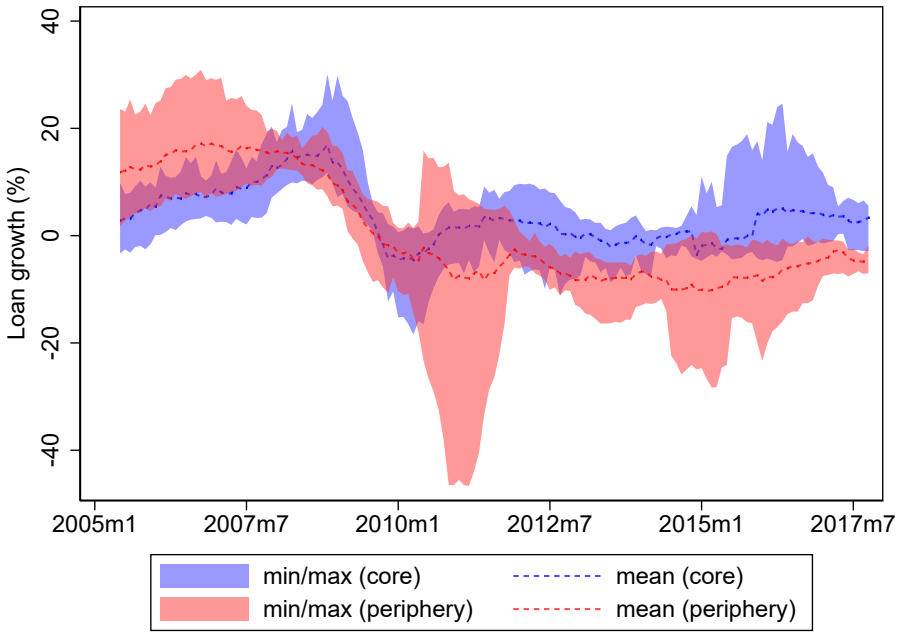

Figure 2: Bank lending growth, core vs periphery.
Growth rate of adjusted loans to euro area Non-financial Corporations (NFCs) by banks located in the core and by banks located in the periphery, year-on-year growth, monthly frequency, percentage points. Dashed lines represent mean values, while the shaded coloured area represent the min/max spread for, respectively, core and peripheral countries.
Source: ECB (2017).

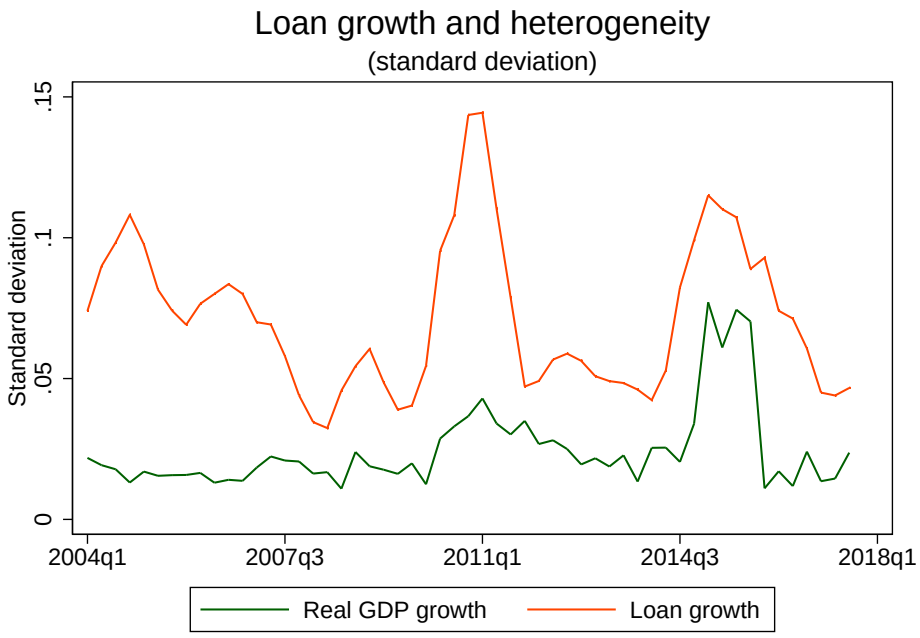

Figure 3: Loan growth and heterogeneity

The graph plots the standard deviation across countries of the year-on-year loan growth rate of adjusted loans by Eurozone Main Financial Institutions (MFIs) to domestic Non Financial Corporations (NFCs) against the standard deviation across countries of real GDP growth, year-on-year. Source: ECB (2017) and Eurostat (2017)