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The Bank lending channel and sovereign risk: Effects on significant and less significant banks after the implementation of the Banking Union

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A B S T R A C T

The Banking Union (BU) has given rise to the distinction between two types of banks, significant banks and less significant ones. This distinction may have produced asymmetries in the transmission of monetary policy, which has not been analysed by the previous literature. This paper tries to fill this gap in the literature by analysing the differences that monetary policy changes have on the loan supply of significant and less significant banks. Our sample consists of banks from the euro area and spans 2014 to 2020. Our empirical model, which is based on the System Generalized Method of Moments (System-GMM) methodology, regress the loan supply growth of each bank on monetary policy and sovereign risk indicators, significant and less significant banks dummies, and a group of control variables. Our results show that, although the BU may have well contributed to a smoother transmission of the monetary policy through the bank lending channel, there are still differences in how monetary policy changes affect the loan supply of significant and less significant banks. The different behaviour of the bank lending channel is observed mainly in countries with low sovereign risk, where the bank lending channel is only effective reducing the loan supply of less significant banks. Our results indicate that greater banking integration is necessary in the euro area.

1. Introduction

The bank lending channel of the monetary policy, which has recently gained significant attention, posits that a monetary policy restriction gives rise to a reduction in banks' loan supply because, on the one hand, it limits banks' access to loanable funds such as deposits and, on the other hand, it increases the cost of market funding for banks [1–3]. The loan supply reduction proposed by the bank lending channel depends on different bank characteristics such as size, liquidity and capitalisation, which have been widely analysed [4,5]. It is also affected by sovereign risk, which became evident in the aftermath of the financial crisis and sovereign debt crisis when many countries in the eurozone suffered a large increase in their sovereign risk, which was transmitted to the bank industry, thus distorting the bank lending channel [6].

Despite the different analyses that have been carried out on the bank lending channel, one of the aspects that could affect its effectiveness within the euro area and that has not yet been studied is the distinction made by the BU between significant banks and less significant. The financial crisis and the sovereign debt crisis revealed that in the eurozone the different regulations and

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supervisions present in the banking systems of each country, in addition to the link between sovereign risk and bank risk, were negatively affecting both the health of the banking system and the transmission of monetary policy. The implementation of the Banking Union (BU), and more specifically the Single Supervision Mechanism (SSM) and the Single Resolution Mechanism (SRM),[1] was a great step in reducing the fragmentation of banking supervision and regulation in the euro area and in reducing the contagion between sovereign risk and bank risk.[2] However, despite the potential benefits of both mechanisms, the way in which the BU was designed, differentiating between significant and less significant banks, could have given rise to asymmetries in the transmission of monetary policy, jeopardizing the smooth transmission of the monetary policy in the eurozone.[3]

There is no research on the effects that these regulatory changes have on the transmission of monetary policy, so this paper tries to fill this gap in the literature by analysing the differences that may exist in the effect that monetary policy changes have on the loan supply of significant and less significant banks. The identification of these differences would help the European Central Bank (ECB) implement new regulations to achieve a smooth transmission of the monetary policy in the eurozone.

Regarding the SSM, the supervision task is divided between the ECB, which supervises significant banks, and the national supervisory authorities (NSAs), which supervise less significant ones, albeit under the oversight of the ECB. The design of the SSM, with the coexistence of centralised and decentralised supervision, could therefore give rise to potential conflicts of interest. In this regard, NSAs might well be more permissive with banks that are under their supervision and their decisions may be more affected by the economic conditions in their countries [9,10]. Regarding the SRM, the resolution task is also divided between the Single Resolution Board (SRB) and national resolution authorities (NRAs) [11]. The SRB centralises the resolution of significant banks and cross-border banking groups in financial distress, whereas NRAs are responsible for resolving the rest of the banks, which includes almost all less significant banks, following no fully harmonised national insolvency proceedings. Moreover, NRAs could be reluctant to resort to the Single Resolution Fund to avoid losing national control of the resolution.

Consequently, less significant banks could be seen as riskier because they are subject to the decisions of national authorities, as well as being more permissive and susceptible to national pressures, resulting in higher financing costs, which will affect the reaction of their loan supply to monetary policy changes. Thus, the first objective of this paper is to analyse the effect that the monetary policy shocks have on the loan supply of significant and less significant banks in the euro area after the implementation of the SSM.

The previous literature has also identified that the contagion between sovereign risk and bank risk still persists due to the connection between banks and their countries' domestic economies, in addition to the continually high exposure of banks to national sovereign debt [12–14]. However, no previous study has analysed the effects that sovereign risk can have on the transmission of monetary policy, differentiating between significant and less significant banks.

Contagion is likely to be higher in less significant banks due to the aforementioned conflict of interest of NSAs and the NRAs, and the lack of harmonisation in national banking insolvency proceedings for less significant banks [9,15]. Thus, the second objective of this paper is to analyse the effect that sovereign risk has on the relationship between monetary policy changes and the loan supply of significant and less significant banks. The identification of this relationship is very relevant because the ECB could implement more efficient actions to reduce the negative effects that sovereign risk may have on the transmission of monetary policy.

To the best of our knowledge, this is the first empirical study that directly analyses the effect that the monetary policy changes have on the loan supply of significant and less significant banks and the impact that sovereign risk has on this effect, which are the two contributions of the paper. Currently, this analysis is highly relevant because after a long period with the official interest rate set at zero per cent, the unprecedently high inflation that the euro zone has had since 2022 is giving rise to an increase in interest rates and sovereign risk. In this scenario, the configuration of the BU can generate significant asymmetries in the transmission of monetary policy through the bank lending channel, which we analyse in this paper.

Our empirical analysis comprises a sample of 675 banks from the 19 countries that were members of the eurozone from 2014 to 2020. The analysis is performed using the System Generalized Method of Moments (System-GMM) methodology for panel data. Our empirical model is based on the previous articles to the bank lending channel. These papers regress the loan supply growth of each bank on a group of control variables and a monetary policy proxy. We contribute to these models by adding significant and less significant banks dummies, and their interactions with the monetary policy and the sovereign risk indicators. We find that in countries with low sovereign risk, a restrictive monetary policy gives rise to a reduction in the loan supply of the less significant banks but not of the significant ones. However, when the sovereign risk is high, no differences are observed between both types of banks.

The paper is structured as follows. In section 2, the previous literature is reviewed. The empirical analysis is carried out in section 3. Finally, the paper's conclusions are presented in section 4.

2. Literature review

In this paper, we interconnect different branches of the literature related to the bank lending channel, sovereign risk, and the BU.

[1] A third element, a European Deposit Insurance Scheme (EDIS), has been a legislative priority, but it has not been fully implemented yet.

[2] The SSM applies common rules to supervise the banks of all countries in the euro area, whilst the SRM was created to restructure or resolve failing banks in an orderly manner and apply common rules and procedures. These two mechanisms were designed to reduce the financing premium paid by banks depending on their country of origin and contribute to a smoother transmission of the monetary policy through the bank lending channel [7,8].

[3] There was significant pressure from the governments of the member states to avoid their banks being subject to scrutinization by European authorities.

For this reason, this section has been divided into different subsections in which we present the most relevant aspects of each branch of the literature.

2.1. The bank lending channel

The bank lending channel of the monetary policy focuses on the effect that monetary policy changes have on bank loan supply. According to this channel, a monetary policy restriction gives rise to a reduction in the loans granted by banks [1,16]. This reduction can be explained by two mechanisms. First, a restrictive monetary policy reduces the access that banks have to loanable funds such as deposits. In this sense, a tightening monetary policy can change the return on deposits relative to other financial assets, which can change households' willingness to hold them [17]. Moreover, if banks are required to hold more reserves at the central bank, they will experience a reduction in their loanable funds. Second, a monetary policy contraction can also increase the difficulty and cost of obtaining market funds, which will increase banks' external financing premium. As a result, banks will decrease their lending supply [2,3].

Monetary policy restrictions' effect on bank lending depends on the strength of banks. In this sense, smaller banks are often more affected by a restrictive monetary policy because they experience more difficulties accessing alternative funding sources [18,19]. Similarly, less liquid banks also experience more problems obtaining financing after a monetary policy contraction, so they will tend to further reduce their supply of loans [20–23]. Moreover, less capitalised banks find it more expensive and difficult to access new funds, so they also tend to experience greater lending reductions after tightening monetary policies [24,25]. Finally, banks with high credit risk generally obtain worse financing conditions, which is why their loan supply suffers a greater drop during restrictive monetary policy [26].

Aside from the strengths of the banks involved, the effectiveness of the bank lending channel can also be affected by banking market characteristics. In this sense, banks in more concentrated markets tend to reduce their loan supply less in response to changes in monetary policy. Moreover, bank lending in more developed financial systems is less affected by the tightening of monetary policy [27]. Finally, sovereign risk also has a significant impact on the bank lending channel of the monetary policy, especially in the euro area [6].[4]

Previous papers have also ascertained that there is an asymmetric effect between expansionary and contractionary monetary policy. In an analysis of US banks, Sapriza and Temesvary [28] found that the bank lending channel is more effective during monetary policy tightening. Moreover, in general, less strong banks seem to be more affected by monetary policy restrictions and so they increase their loan supply less during monetary policy expansions. In this regard, Kishan and Opiela [19] and Cantero Sáiz et al. [29] established that less capitalised banks were more negatively affected by contractionary monetary policies but benefit less from expansionary monetary policies. Moreover, Naqvi and Pungalinya [30] observed that small bank lending is more sensitive to monetary policy restrictions because these banks are riskier. However, larger banks are more sensitive to monetary policy expansions.

2.2. Significant and less significant banks and the bank lending channel

The financial crisis and the sovereign debt crisis in the eurozone revealed that the contrasting regulations and supervisions of the banking system in each country negatively affected the health of the banking system and the transmission of monetary policy. The implementation of the BU, through the entry into force of its first pillar, the SSM, in 2014 was therefore a fundamental step towards solving these problems by harmonising banking supervision.

One of the objectives of SSM was to achieve a smoother transmission of monetary policy between banks. Traditionally, smaller banks were considered riskier, so their loan supply was more affected by monetary policy contractions and benefitted less from monetary policy expansions [30]. The application of a common regulation for all banks, significant and less significant, under SSM has the potential to improve the financial health of both types of banks, decreasing the differences in risk and financing costs between them. However, in the SSM the supervision of banks is divided between the ECB and the NSAs. The ECB supervises the significant banks, while the NSAs supervise the less significant ones following the same rules and under the oversight of the ECB. This division of supervisory tasks could have cancelled out the positive effects that the SSM could have had on the transmission mechanism of the monetary policy. As a result, the loan supply of significant and less significant banks will respond differently to monetary policy changes. In this regard, the coexistence of a centralised and decentralised system of supervision can give rise to the existence of conflicts of interest, since NSAs might well be more permissive with the banks that are under their supervision. In this regard, Agarwal et al. [9] found, in an analysis of the USA banking system—where state and federal supervisors coexist—that state supervisors were more concerned about the economic situation in their states than federal supervisors, which increased their leniency and encouraged them to implement identical rules inconsistently. In the euro area, Avignone et al. [10] found that banks supervised by the ECB had reduced credit risk exposure compared to banks supervised by NSAs, which reflects differences between centralised and decentralised supervision.

Moreover, the SRM, the second pillar of the BU that entered into force in 2016, was created to restructure or resolve failing banks in an orderly manner and subsequently apply common rules and procedures. The SRM requires the creation of resolution plans and the implementation of the Single Resolution Fund as a source of emergency financing for banks in financial difficulties and limits public

[4] In section 2.3, we analyse the relationship between the bank lending channel and sovereign risk in more detail.

financing through the bail-in mechanism [11]. The application of common rules and the bail-in mechanism of the SRM has the potential to reduce the risk differences between significant and less significant banks, contributing to a smoother transmission of the monetary policy, since it is more difficult for governments to bail out the former based on the negative consequences derived from their bankruptcy [31]. However, the design of the SRM could generate important differences in the effects that monetary policy changes have on significant and less significant banks. In the SRM, the ECB is in charge of detecting both failing banks under its direct supervision and failing cross-border banking groups; the national competent authorities are also in charge of detecting the rest of the banks. The SRB is in charge of resolving the former, while NRAs are responsible for resolving the latter unless these banks need funds from the Single Resolution Fund, or the SRB decides, or is required, to direct the resolution. Therefore, the vast majority of the less significant banks are subject to the decisions of NRAs, while the significant ones are subject to the SRB. NRAs apply the resolution rules based on the national implementation of the Bank Recovery and Resolution Directive, with important differences still existing between countries [11].[5] Moreover, national governments could even pressure NRAs not to use the Single Resolution Fund and thus not lose national control of the resolution of a less significant bank. As a result, less significant banks could be seen as riskier. This greater risk will make their access to funding more difficult and costly. So, we expect less significant banks to find it more difficult to insulate themselves from monetary policy restrictions and further reduce their credit supply, boosting the bank lending channel. Consequently, we propose the following hypothesis.

H1. Less significant banks will reduce their lending supply to a greater extent than significant banks after a monetary tightening.

2.3. Bank lending channel and sovereign risk

Previous literature has described different mechanisms through which sovereign risk can affect the effectiveness of the bank lending channel [6]. First, banks normally hold a large amount of domestic sovereign debt [33]. An increase in sovereign risk deteriorates their balance sheet and increases their risk, making it more difficult for them to obtain external financing [34]. Second, an increase in sovereign risk reduces the value of collateral that banks can use to obtain funds from the financial market's central bank [35,36]. Third, a downgrade in a country's sovereign rating leads to a drop in the rating of the banks in that country, which makes it more difficult for them to obtain funds and increases their financing cost [37]. Fourth, an increase in sovereign risk reduces the value of the aid that governments could offer to banks in financial distress to avoid adverse effects of a bank's bankruptcy on the economy [38].

Due to these mechanisms, previous papers have concluded that the bank lending channel could be seriously affected by sovereign risk, which is more evident in the eurozone, where countries with different sovereign risk share a single monetary policy conducted by the ECB. In this regard, Cantero-Saiz et al. [6] found that, after a monetary policy contraction, banks that operate in euro area countries with high sovereign risk reduce their loan supply more than banks that operate in countries with low sovereign risk. However, they discovered little evidence of a relationship between sovereign risk and the loan supply after expansive monetary policies. Indeed, Cantero-Saiz et al. [39] established that sovereign risk only affects the bank lending channel in developed countries, especially before the financial crisis. Moreover, during the 2008 financial crisis, the expansive monetary policies carried out did not lead to an increase in bank loans.

2.4. Sovereign risk and the BU

The sovereign debt crisis in Europe revealed, apart from the weak harmonisation in banking supervision in the euro area, the contagion that existed between sovereign risk and bank risk. The implementation of the BU was a great attempt to avoid the negative effects that sovereign risk could have on the banking sector and on the transmission of monetary policy. The existence of a common regulatory framework facilitates the reduction of contagion between sovereign risk and banks, mainly because it allows more homogeneous financing conditions throughout the euro area, reducing dependence on financing from banks' country of origin [40]. Moreover, the supervision system carried out by the SSM improves the health of the banking system, reducing the negative effects that bank crises can have on the economy of eurozone countries [8].

Despite these positive effects in reducing contagion, the previous literature has not reached a consensus about the impact that the BU has had on sovereign risk contagion in the banking sector. Some studies have revealed a reduction in contagion after the introduction of the BU. In this regard, Covi and Eydam [41] determined that, although there existed high contagion between sovereign and bank risk in the euro area before the implementation of the BU, the contagion seemed to disappear in the initial years after the implementation. Fiordelisi et al. [42] found a significant reduction between sovereign and bank risk after the introduction of bail-in mechanisms. Similarly, Cantero Sáiz et al. [8] show that the SSM seems to have had some effect on reducing the contagion between sovereign risk and bank risk. Other more recent studies analysing the effects of the BU have shown a certain persistence in contagion between sovereign and bank risk. In this regard, Soenen and Vander Venet [12] identified that, after the introduction of the new European banking regulation, the interconnection between sovereign and banking risk persists and that sovereign risk is transmitted to the banking sector in an amplified manner. Bales [13] concluded that the BU increases financial stability in the short and medium term. However, contagion between sovereign and bank risk still persists, especially in the long term. This persistence of contagion is due to the fact that banks still hold a large amount of sovereign debt.

Regarding significant and less significant banks, two major factors link both to sovereign risk. First, euro zone banks are still highly

[5] In fact, there is a precedent for the discretionary extension of the resolution rules in the case of several Italian banks [32].

interconnected to their countries through the domestic economy [13]. Thus, when the economic situation of a country deteriorates, the value of the assets of all banks that operate in the country decrease considerably. Second, both significant and less significant banks continue to maintain a high exposure to the sovereign debt of their countries, facilitating contagion between sovereign and bank risk [13,14,43].

However, in less significant banks, the contagion between sovereign risk and less significant banks could be greater than in the significant banks due to the workings of the SSM and SRM. As mentioned previously, the NSAs supervise them and the NRAs are in charge of their resolution, which could give rise to conflicts of interest [9,10] and to a stronger sovereign risk contagion. In addition, as long as Single Resolution Funds are not required, NRAs will be in charge of resolving the less significant banks, for which no fully harmonised national insolvency proceedings will be followed [15]. This can reinforce contagion because less significant bank resolution is linked to national procedures and will depend on the situation in every country.

In conclusion, as less significant banks are more likely to be affected by sovereign risk than significant banks and that sovereign risk can increase the effectiveness of the bank lending channel, as shown in the previous section, we propose the following hypothesis.

H2. Sovereign risk will affect more the loan supply of less significant banks after monetary policy shocks.

3. Empirical analysis

3.1. Selection of the sample

Our initial sample consists of all the banks from the eurozone included both in the S&P Capital IQ database between 2014 and 2020 and in the ECB's official list of significant and less significant banks (755 banks).[6] Moreover, according to Cantero-Saiz et al. [39], we remove: 1) banks with growth rates of loans and/or deposits greater than 300%; and 2) banks with loans 100 times greater than deposits. After these adjustments we end up with 736 banks. We also remove the banks with data available to calculate the variables used in the paper for less than four consecutive years, which is necessary for the estimation of the System-GMM [45].

The final sample consists of an unbalanced panel of 675 banks (4009 observations) from the 19 countries that were members of the eurozone from 2014 and 2020.[7,8] Table 1 illustrates the sample's composition.

3.2. Econometric model and data

To carry out the analysis, we propose the model of Equation (1) based on the traditional approach of the bank lending channel:

$$\Delta\ln(\text{loans})_{i,t} = \beta_0 + \beta_1\Delta\ln(\text{loans})_{i,t-1} + \beta_2\Delta\ln(\text{GDP})_{m,t} + \beta_3\Delta\text{i}_{m,t} * SIG_{i,t} + \beta_4\Delta\text{i}_{m,t} * LessSIG_{i,t} + \beta_5 SIG_{i,t} + \beta_6 SIZE_{i,t-1} + \beta_7 SIZE_{i,t-1} * \Delta\text{i}_{m,t} + \beta_8 LIQ_{i,t-1} + \beta_9 LIQ_{i,t-1} * \Delta\text{i}_{m,t} + \beta_{10} CAP_{i,t-1} + \beta_{11} CAP_{i,t-1} * \Delta\text{i}_{m,t} + \sum \pi_t \text{Year}_t + \sum \vartheta_m \text{Country}_m + \varepsilon_{i,t} \tag{1}$$

*Δ*ln*(Loans)*$_{i,t}$ is the dependent variable and captures the lending growth rate. This variable has been widely used in the bank lending channel literature [6,46].[9]

*Δ*ln*(GDP)* is the real GDP growth rate. This variable controls for the business cycle [39]. As other studies suggest, there is a causal link that runs from economic growth to bank credit supply [47,48].

Δi is the change in the short-term money market rate and represents monetary policy changes. This is the variable most frequently used in the literature to test the existence of the bank lending channel with bank-level data [39,49]. To capture the effects of significant and less significant banks on the bank lending channel, we interact Δi with the variables SIG and LessSIG (significant banks and less significant banks, respectively). SIG and LessSIG are dummy variables that take a value of 1 for a bank in a given year if the bank was included in the ECB's list of significant or less significant banks for the given year, and zero otherwise. Moreover, we include the variable SIG to control for the effect that the direct distinction between significant and less significant banks may have on bank lending.

We include the bank characteristics that have been commonly used in the literature (SIZE, LIQ, and CAP) [27,46]. *SIZE* is the logarithm of total assets, *LIQ* is the ratio of securities, cash and funds due from banks to total assets and *CAP* is the ratio of total equity to total assets. Like previous studies, we also include interactions between the monetary policy variable (*Δi*), and SIZE, LIQ and CAP. As we are interacting continuous variables, similar to previous studies, to facilitate the interpretation, we normalize in Equation (1) the banks' variables (*SIZE*, *LIQ*, and CAP) with respect to their mean across all banks in the sample as it is shown in Equations (2)–(4) [23,39].[10]

[6] The sample period starts in 2014 because that is when the BU began with the entry into force of its first pillar, the SSM. As we use consolidated data, we exclude banks that are group members of other bank to avoid double counting bias [44].

[7] The composition of our sample reflects the composition of the ECB's official list of supervised banks in which German banks represent more than 50%, Italian banks 6%, French banks 4.5%, etc.

[8] After the incorporation of Croatia in 2023, the euro area currently consists of 20 countries. However, during our sample period the euro area was made up of the 19 countries that we include in our sample.

[9] As in many other studies, we introduce this variable lagged one year.

[10] The interacting continuous variables might give rise to multicollinearity problems, this mean centring of these variables is recommended to mitigate these problems [50].

Table 1
Sample Panel A: number of banks per country.

	Total number of observations	Total number of banks		Number of significant banks			
Austria	132	22		3			
Belgium	33	6		3			
Cyprus	15	3		2			
Estonia	39	6		2			
Finland	20	3		1			
France	109	17		7			
Germany	2684	452		8			
Greece	38	6		4			
Ireland	25	5		3			
Italy	483	88		9			
Latvia	57	9		4			
Lithuania	29	5		3			
Luxembourg	24	4		1			
Malta	28	4		2			
Netherlands	46	8		2			
Portugal	49	7		2			
Slovakia	41	6		0			
Slovenia	50	8		2			
Spain	107	16		11			
Total	**4009**	**675**		**69**			
Panel B: temporary distribution of the sample							
Years	2014	2015	2016	2017	2018	2019	2020
Total number of banks	383	614	635	675	660	611	431
Number of significant banks	47	55	59	66	64	64	63

This table shows the list of the 675 banks, 19 countries and 7 years included in our analysis. For each country, we report the total number of observations, total number of banks and significant banks. For each year, we display the total number of banks and significant banks.
Source: own.

$$SIZE_{it} = log\ A_{it} - \frac{\sum_{i=1}^{N} logA_{it}}{N_t} \tag{2}$$

$$LIQ_{it} = \frac{L_{it}}{A_{it}} - \frac{\sum_{t=1}^{T}\left(\sum_{i=1}^{N}(L_{it}/A_{it})/N_t\right)}{T} \tag{3}$$

$$CAP_{it} = \frac{E_{it}}{A_{it}} - \frac{\sum_{t=1}^{T}\left(\sum_{i=1}^{N}(E_{it}/A_{it})/N_t\right)}{T} \tag{4}$$

$A_{i,t}$ is the total assets, $L_{i,t}$ is the level of treasury and temporary financial investments, $C_{i,t}$ is the total capital, N_t is the number of banks and T is the number of years.

Finally, country and year dummies are introduced.

Table 2 shows the descriptive statistics of the variables and Table 3 presents the correlations between them.[11]

3.3. Methodology

Equation (1) is estimated using a two-step System-GMM with robust errors for dynamic panel data [45]. Dynamic panel models are one of the most popular methodologies in banking literature and the System-GMM estimator has been widely employed in the analysis of the bank lending channel of monetary policy [6,29,39,51–53]. The use of this approach has several advantages. First, it provides parameter estimates which are unbiased and consistent due to the use of lagged independent variables as instruments [54]. In our case, the monetary policy indicator and the macroeconomic variables are considered exogenous, whereas bank-specific characteristics are endogenous [55]. The exogenous variables are instrumented by themselves and for the endogenous variables we use the second to the third lag as instruments. Moreover, all the instruments are collapsed [39]. Second, the use of lagged independent variables as instruments also allows controlling endogeneity concerns in the relationship between monetary policy and bank lending [6,56]. Third, System-GMM combines regressions of levels and first differences, which makes this estimator more efficient [57]. Moreover, the

[11] In Tables 2 and 3, we incorporate the descriptive statistics and correlations of other variables that we include in the robustness checks carried out in the following sections. These variables are: SR (risk premium): the ten-year sovereign bond yield spread of a country relative to Germany; SR (rating): Fitch based rating index.

Table 2
Sample statistics.

Variable	Mean	Std. Dev.	Min	Max
Δln(loans)	0.0218	0.2521	−9.7575	1.3353
Δi	−0.1075	0.0869	−0.2072	0.0160
Δln(GDP)	0.0259	0.0281	−0.1036	0.2987
SIZE	7.8637	1.7083	2.9003	14.5477
LIQ	0.0244	0.0639	0.0000	0.8055
CAP	0.0725	0.0393	0.0110	0.5956
SR (risk premium)	0.3630	0.8001	−0.2800	7.8300
SR (rating)	1.8131	3.1698	0	15

This table shows the summary statistics for the continuous variables used in Equation (1). *Δ*ln*(Loans)*: the growth rate in loan supply from bank *i* in year *t* relative to year *t-1*; *Δi*: the change in the short-term money market rate and represents monetary policy changes; *Δ*ln*(GDP)*: the real GDP growth rate*; SIZE*: the logarithm of total assets; *LIQ*: the ratio of securities, cash and funds due from banks to total assets; *CAP:* the ratio of total equity to total assets; *SR* (risk premium): the ten-year sovereign bond yield spread of a country relative to Germany; *SR* (rating): Fitch based rating index. The statistics of the variables *SIZE*, *LIQ*, *CAP*, *SR* (risk premium) and *SR* (rating) are calculated before the normalization to show more comprehensive information.
Source: own.

Table 3
Correlations.

	Δi	Δln(GDP)	SIZE	LIQ	CAP	SR (risk premium)	SR (rating)
Δi	1						
Δln(GDP)	0.1635	1					
SIZE	0.0200	−0.036	1				
LIQ	0.0087	0.0843	0.0249	1			
CAP	0.0107	−0.0191	−0.1168	0.2870	1		
SR (risk premium)	0.0186	−0.1489	0.1403	0.1438	0.3064	1	
SR (rating)	−0.0106	−0.1847	0.1590	0.2539	0.3647	0.8685	1

This table shows the correlations between the continuous independent variables used in Equation (1). *Δi*: the change in the short-term money market rate and represents monetary policy changes; *Δ*ln*(GDP)*: the real GDP growth rate*; SIZE*: the logarithm of total assets; *LIQ*: the ratio of securities, cash and funds due from banks to total assets; *CAP:* the ratio of total equity to total assets; SR (risk premium): the ten-year sovereign bond yield spread of a country relative to Germany; SR (rating): Fitch based rating index.
Source: own

System-GMM approach is more suitable when there is an unbalanced panel, the number of time periods is small and the number of individuals (or banks) is large, as it is our case [54].

For the estimations, we use Stata software (version 17), which is a program that allows analysing, managing and producing statistical data and is mostly used in the economics, biomedicine and political science areas. More specifically, we run the xtabond2 command, which provides certain advantages over Stata's xtabond. On the one hand, xtabond2 is designed for System-GMM and makes the Windmeijer [58] finite-sample correction to the reported standard errors in two-step estimation, which avoids these errors being severely downward biased. On the other hand, it provides forward orthogonal deviations, a way of differencing that protects sample size when there are gaps in the panel, and allows more precise control of the instrument matrix [57].

Finally, the consistency of the System-GMM estimator relies on two specification tests. On the one hand, the serial correlation test in the error terms [ar(2)] is used to detect if there is no second-order serial correlation in the disturbances [57]. On the other hand, a test for over-identification restrictions, which serves to check whether instruments are not correlated with the error term, so that they are valid [59]. There are two commonly used test for over-identification restrictions: the Sargan test and the Hansen test. The Sargan test is only appropriate after difference GMM and one-step estimations and under the assumption of homoskedasticity and not serial correlation because it is inconsistent with heteroskedasticity or autocorrelation. On the contrary the Hansen test is robust to heteroskedasticity or autocorrelation, which is why it is used under their presence and more specifically after System-GMM, robust estimations or two-step estimations [57]. As we indicated previously, in this paper, Equation (1) is estimated using a two-step System-GMM with robust errors and collapse instruments,[12] so in the result section we report the Hansen test because is the only robust and consistent with our estimation method.

[12] Collapsed instruments make the Hansen test more powerful by reducing instrument count and the number of moment conditions employed in this test [60].

3.4. Results significant versus less significant banks

Table 4, Model (a) shows the results.[13] As we are interacting the monetary policy indicator Δi with other continuous variables, to capture the marginal effect of Δi on the growth of loans we take the derivative of Model (1) with respect to Δi. The marginal effect for significant banks is shown in Equation (5):

$$\frac{\partial \Delta \ln(\text{loans})_{i,t}}{\partial \Delta \mathrm{i}_{m,t}} = \beta_3 + \beta_7 SIZE_{i,t-1} + \beta_9 LIQ_{i,t-1} + \beta_{11} CAP_{i,t-1} \tag{5}$$

For less significant banks, the marginal effect is shown in Equation (6):

$$\frac{\partial \Delta \ln(\text{loans})_{i,t}}{\partial \Delta \mathrm{i}_{m,t}} = \beta_4 + \beta_7 SIZE_{i,t-1} + \beta_9 LIQ_{i,t-1} + \beta_{11} CAP_{i,t-1} \tag{6}$$

SIZE, *LIQ* and *CAP* are normalized and the mean of a normalized variable is zero. So, for an average bank, the marginal effect of Δi on the growth of the supply of loans is β_3 for significant banks and β_4 for less significant banks.

In the case of significant banks, the marginal effect of Δi on the growth of the supply of loans, β_3, is not significant. However, the marginal effect for less significant banks, β_4, is significant and negative. Thus, after monetary policy contractions, less significant banks reduce their loan supply, whereas significant banks are not affected.[14]

This result supports our hypothesis 1 (H1) that proposed that less significant banks will reduce their lending supply to a greater extent than significant banks after a monetary tightening. So, the way in which the BU is designed could have given rise to asymmetries in the transmission of monetary policy as a result of national government pressures. This result is relevant for the way the ECB conducts its monetary policy in the euro area and suggests that greater supervisory integration is necessary for a smoother transmission of monetary policy among all banks. Moreover, the ECB should strengthen its oversight activity of the supervision carried out by NSAs to prevent them from being more permissive.

To analyse whether sovereign risk affects the effectiveness of this channel for both significant and less significant banks (hypothesis H2), in Equation (1) we introduce the variable sovereign risk (*SR*) and its interactions with $\Delta i * SIG$ and $\Delta i * LessSIG$. So, the model estimate is the one of Equation (7):

$$\begin{aligned}\Delta \ln(\text{loans})_{i,t} = {} & \beta_0 + \beta_1 \Delta \ln(\text{loans})_{i,t-1} + \beta_2 \Delta \ln(\text{GDP})_{m,t} + \beta_3 \Delta \mathrm{i}_{m,t} * SIG_{i,t} + \beta_4 \Delta \mathrm{i}_{m,t} * LessSIG_{i,t} + \beta_5 SIG_{i,t} + \beta_6 SIZE_{i,t-1} + \beta_7 SIZE_{i,t-1} * \Delta \mathrm{i}_{m,t} \\ & + \beta_8 LIQ_{i,t-1} + \beta_9 LIQ_{i,t-1} * \Delta \mathrm{i}_{m,t} + + \beta_{10} CAP_{i,t-1} + \beta_{11} CAP_{i,t-1} * \Delta \mathrm{i}_{m,t} + \beta_{12} SR_{m,t} + \beta_{13} SR_{m,t} * \Delta \mathrm{i}_{m,t} * SIG_{i,t} \\ & + \beta_{14} SR_{m,t} * \Delta \mathrm{i}_{m,t} * LessSIG_{i,t} + \sum \pi_t \text{Year}_t + \sum \vartheta_m \text{Country}_m + \varepsilon_{i,t}\end{aligned} \tag{7}$$

Following Cantero-Saiz et al. [6], in Model (b), *SR* is the ten-year sovereign bond yield spread of a country relative to Germany.[15,16] As we are interacting continuous variables, to avoid possible multicollinearity problems, we mean centre this variable to mitigate them [50].

Table 4, Model (b) shows the results of this estimation. Focusing on the bank lending channel, the marginal effect of Δi on the growth of loans for significant banks is shown in Equation (8):

$$\frac{\partial \Delta \ln(\text{loans})_{i,t}}{\partial \Delta \mathrm{i}_{m,t}} = \beta_3 + \beta_7 SIZE_{i,t-1} + \beta_9 LIQ_{i,t-1} + \beta_{11} CAP_{i,t-1} + \beta_{13} SR_{m,t} \tag{8}$$

For less significant banks, the marginal effect is shown in Equation (9):

$$\frac{\partial \Delta \ln(\text{loans})_{i,t}}{\partial \Delta \mathrm{i}_{m,t}} = \beta_4 + \beta_7 SIZE_{i,t-1} + \beta_9 LIQ_{i,t-1} + \beta_{11} CAP_{i,t-1} + \beta_{14} SR_{m,t} \tag{9}$$

SIZE, *LIQ* and *CAP* are normalized and the mean of a normalized variable is zero. So, for an average bank, the marginal effect of Δi on the growth of the supply of loans is:

For significant banks (Equation (10)):

$$\frac{\partial \Delta \ln(\text{loans})_{i,t}}{\partial \Delta \mathrm{i}_{m,t}} = \beta_3 + \beta_{13} SR_{m,t} \tag{10}$$

For less significant banks, the marginal effect is shown in Equation (11):

[13] For each independent variable, variance inflation factor (VIF) reaches a maximum of 7.06, which suggests that there are not significant multicollinearity problems. Multicollinearity may not be relevant if VIF is lower than 10 [61].

[14] Other significant variables are the interaction between *SIZE* and the monetary policy indicator Δi.

[15] We also use the ten-year sovereign bond yield spread of a country relative to the USA and the results are similar but not shown in this paper.

[16] Estonia is not included in the analysis because it did not issue ten-year government bonds until 2020.

Table 4
Results.

	(a) Without SR			(b) SR: risk premium			(c) SR: rating index		
	Coefficient (T-student)	P-value		Coefficient (T-student)	P-value		Coefficient (T-student)	P-value	
$\Delta\ln(\text{loans})_{t-1}$	0.0738 (1.09)	0.277		0.0429 (0.59)	0.554		0.0640 (0.96)	0.340	
$\Delta\ln(\text{GDP})_t$	−0.4246 (-0.77)	0.440		−0.6052 (-1.18)	0.238		−0.8718 (-1.94)	0.053	*
$\Delta i_t{*}SIG_t$	0.1595 (1.15)	0.252		0.0761 (0.52)	0.605		0.1598 (1.07)	0.283	
$\Delta i_t{*}LessSIG_t$	−0.1206 (-2.07)	0.038	*	−0.0863 (-1.49)	0.135		−0.0506 (-0.78)	0.437	
SIG_t	0.0051 (0.77)	0.442		0.0059 (0.91)	0.362		0.0063 (1.02)	0.310	
$SIZE_{t-1}$	−0.0054 (-0.84)	0.403		−0.0101 (-1.57)	0.118		−0.0067 (-1.09)	0.275	
$\Delta i_t{*}\ SIZE_{t-1}$	−0.0711 (-1.9)	0.057	*	−0.0791 (-2.17)	0.030	*	−0.0743 (-1.99)	0.047	*
LIQ_{t-1}	0.1549 (0.25)	0.804		0.0451 (0.07)	0.944		0.2636 (0.41)	0.685	
$\Delta i_t{*}\ LIQ_{t-1}$	−0.3547 (-0.18)	0.856		0.3825 (0.2)	0.845		−0.4296 (-0.22)	0.824	
CAP_{t-1}	−0.0443 (-0.12)	0.904		−0.2910 (-0.57)	0.565		−0.1420 (-0.36)	0.723	
$\Delta i_t{*}\ CAP_{t-1}$	−1.1477 (-0.42)	0.672		−5.0292 (-1.43)	0.154		−2.9788 (-0.97)	0.333	
SR_t				0.0334 (2.47)	0.014	*	0.0048 (1.58)	0.113	
$\Delta i_t{*}\ SIG_t{*}\ SR_t$				0.1927 (3.18)	0.001	*	0.0367 (1.78)	0.075	*
$\Delta i_t{*}\ LessSIG_t{*}\ SR_t$				0.2984 (3.08)	0.002	*	0.0553 (2.49)	0.013	*
Constant	0.0272 (1.05)	0.293		0.0353 (1.41)	0.158		0.0545 (2.49)	0.013	*
Country dummies	Yes			Yes			Yes		
Year dummies	Yes			Yes			Yes		
ar(2)	0.838			0.572			0.771		
Hansen	0.187			0.357			0.193		
Mean VIF	2.47			2.75			2.59		

The dependent variable is the credit supply growth (*Δ*ln*(Loans)*). In Model (a) the sovereign risk indicator (*SR*) is not included. In Model (b) *SR* is the ten-year sovereign bond yield spread of a country relative to Germany. In Model (c) *SR* is the Fitch sovereign rating of a country transformed into a numerical scale from 0 (AAA) to 20 (RD – Restricted default). Country and Year dummies are included in the estimations, but not reported. Constant is the regression intercept. First, the results show the coefficients associated with each variable and in brackets T-student; Second, they depict the level of significance of each variable: * indicates a level of significance of 0.1 or less. ar(2) is the p-value of the 2nd order serial correlation statistic. Hansen is the p-value of the over-identifying restriction test. Mean VIF is the mean variance inflation factor that detects the severity of multicollinearity. Source: own based on Stata results through xtabond2 command.

$$\frac{\partial \Delta \ln(\text{loans})_{i,t}}{\partial \Delta \mathrm{i}_{m,t}} = \beta_4 + \beta_{14} SR_{m,t} \tag{11}$$

As the marginal effects depend on the value of sovereign risk premium (*SR*), to facilitate the interpretations of the results, we use plots that show the marginal effect of monetary policy changes (*Δi*) in relation to *SR* premium. These plots allow us to observe the marginal effect and its significance for the entire range of *SR* premium variation, thus offering a complete view of the impact that *SR* premium has on the bank lending channel.

Figs. 1 and 2 report the marginal effect of *Δi* in relation to *SR* premium for significant and less significant banks, respectively. Confidence intervals of 90% indicates when the monetary policy variable has a statistically significant effect on the loan supply (whenever the whole blue area is either above or below zero). In the case of significant banks, the marginal effect is not significant for banks in countries with low or moderate *SR* premium (*SR* mean centred lower than 0.96; *SR* no centred 1.32) because the whole blue area is not either above or below zero. However, above this value, the marginal effect is positive and significant. In the case of less significant banks, the marginal effect is negative and significant for banks in countries with low *SR* premium (*SR* mean centred lower than −0.02; *SR* no centred 0.34) and its value decreases as *SR* increases. When *SR* premium is above 0.97 (*SR* no centred 1.33) the marginal effect for less significant banks is positive and significant. These results imply that when sovereign risk is low, the loan supply of less significant banks is affected by monetary policy restrictions, whereas the loan supply of significant banks is not affected. However, when sovereign risk is high the loan supply of both significant and less significant banks behaves differently from what the bank lending channel proposes after monetary policy contractions. This different behaviour when sovereign risk is high may be due to

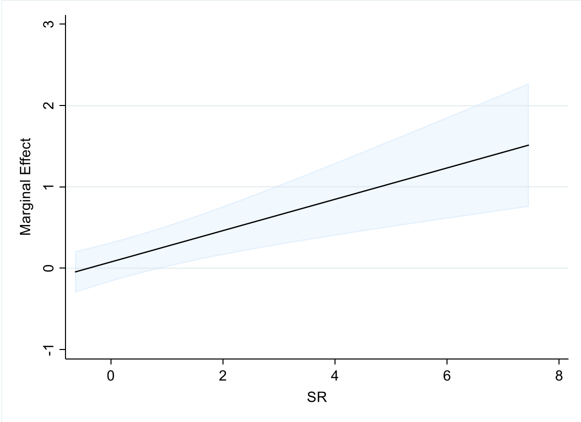

Fig. 1. The Y-axis represents the marginal effect of monetary policy on the growth of loans for an average bank belonging to the group of significant banks in relation to sovereign risk (*SR* mean centred) (X-axis). *SR* is calculated as the risk premium (the ten-year government bond yield of a country relative to Germany). 90% confidence interval in blue. Based on model (b), Table 4.

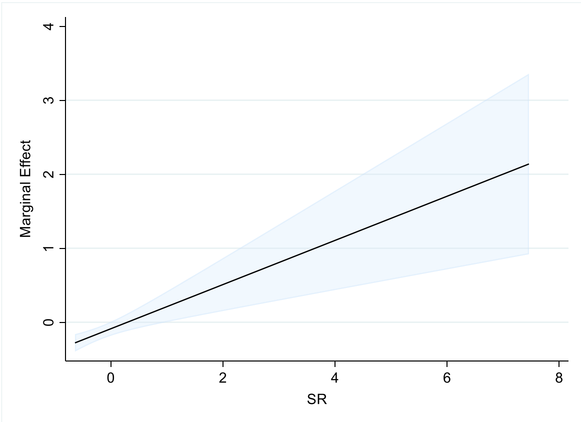

Fig. 2. The Y-axis represents the marginal effect of monetary policy on the growth of loans for an average bank belonging to the group of less significant banks in relation to sovereign risk (*SR* mean centred) (X-axis). *SR* is calculated as the risk premium (the ten-year government bond yield of a country relative to Germany). 90% confidence interval in blue. Based on model (b), Table 4.

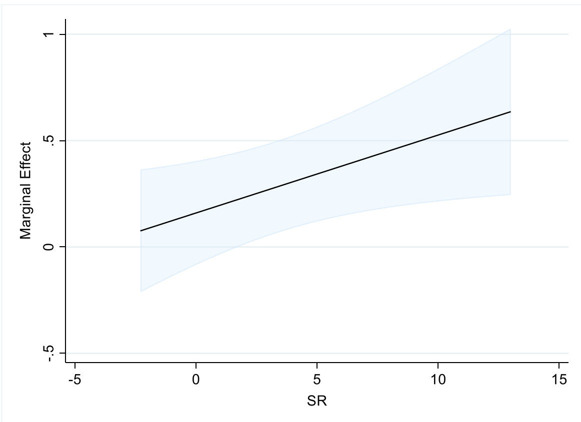

Fig. 3. The Y-axis represents the marginal effect of monetary policy on the growth of loans for an average bank belonging to the group of significant banks in relation to sovereign risk (*SR* mean centred) (X-axis). *SR* is calculated as the rating index (Fitch rating transformed into a numerical scale). 90% confidence interval in blue. Based on model (c), Table 4.

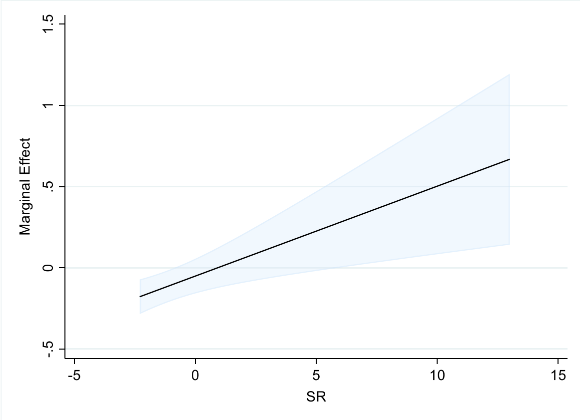

Fig. 4. The Y-axis represents the marginal effect of monetary policy on the growth of loans for an average bank belonging to the group of less significant banks in relation to sovereign risk (*SR* mean centred) (X-axis). *SR* is calculated as the rating index (Fitch rating transformed into a numerical scale). 90% confidence interval in blue. Based on model (c), Table 4.

the fact that in our sample period, the short-term money market rate decreased most years, so our results might well reflect the asymmetric effect of the bank lending channel between expansionary and contractionary monetary policy found by previous papers [19,28,30], meaning that both significant and less significant banks in countries with high sovereign risk reduce their loan supply even if interest rates decrease.

Other significant variables are the interaction between *SIZE* and the monetary policy indicator Δi, sovereign risk (*SR*) and its interactions with the monetary policy indicator Δi for both significant and less significant banks.

In conclusion, our results partially support our hypothesis H2 that states that sovereign risk will affect more the loan supply of less significant banks after monetary policy changes, because the loan supply of less significant banks are only more affected by monetary policy changes when the sovereign risk is low.

In Model (c), we carried out a robustness check using Fitch sovereign rating as proxy of sovereign risk (*SR*). Following Athari et al. [62], we transform rating data into a numerical scale. To facilitate interpretation with our previous results, our scale starts from 0 for strong sovereign stability (Fitch rating: AAA) and ends at 20 for sovereign default (Fitch rating: RD – Restricted default). Similar to the previous sovereign risk variable used, as we are interacting continuous variables, to avoid possible multicollinearity problems, we mean centre this variable to mitigate them [50]. Table 4, Model (c) shows the results and Figs. 3 and 4 illustrate the marginal effect for average significant and less significant banks, respectively. The results are similar to those obtained previously. Thus, the bank lending channel is only effective for less significant banks when they operate in countries with low sovereign risk (high sovereign rating). However, in countries with high sovereign risk (low sovereign rating), the loan supply of both significant and less significant banks tends to behave differently from what the bank lending channel proposes after monetary policy contractions, which is probably due to the fact that during our sample period interest rates decreased in most years.[17]

4. Conclusions

In this paper, we analyse the effect of monetary policy shocks on the credit supply of significant and less significant banks, as well as the impact that sovereign risk has on this effect. The sample consists of banks from the euro area between 2014 and 2020. Our results show that, although the BU may have well contributed to a smoother transmission of the monetary policy through the bank lending channel, there are still differences in how monetary policy changes affect the loan supply of significant and less significant banks. The different behaviour of the bank lending channel is observed mainly in countries with low sovereign risk, where a restrictive monetary policy affects the less significant banks but not the significant ones. However, when the sovereign risk is high, no differences are observed between both types of banks.

These results are particularly interesting for the way the ECB conducts its monetary policy in the euro area, especially in the current period of high inflation and rising sovereign risk premiums. To achieve a smoother monetary policy transmission, new regulations should be implemented to remove loopholes in the bail-in mechanism, which could reduce the financing cost gap between significant and less significant banks. Our results also suggest that greater supervisory integration is necessary for a smoother transmission of monetary policy among all banks. The ECB should strengthen its oversight activity of the supervision carried out by NSAs to prevent them from being more permissive.

[17] We have carried out further robustness checks to control for the effect of COVID-19 on the bank lending channel, by introducing the variable *Cov*. This variable is the change in the short-term money market rate (Δi) in 2020 and 0 in the rest of the years. The results of these estimations are similar to those reported previously. Due to brevity concerns, these results are not reported.

One of the main limitations of our paper is that, in the sample period, interest rates decreased most years, so our results mainly reflect the effects of monetary policy expansions. Furthermore, interest rate changes are small during the period analysed. Further analysis is thus necessary once several years have passed since the ECB launched a tight monetary policy in September 2022. Our paper suggests that sovereign contagion might well be different in significant and less significant banks. Thus, future research could analyse the link between sovereign risk and less significant bank risk because previous literature focuses only on large banks, which are the only ones with credit default swaps (CDS) to measure contagion more accurately.

Declarations

Author contribution statement

Sergio Sanfilippo-Azofra: Conceived and designed the experiments; Performed the experiments; Analysed and interpreted the data; Wrote the paper.

Begoña Torre-Olmo: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

María Cantero-Saiz: Conceived and designed the experiments; Analysed and interpreted the data; Wrote the paper.

Data availability statement

The authors do not have permission to share data.

Additional information

No additional information is available for this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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