Cross-Border Effects of Regional Monetary Authorities: The Case of the ECB

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ABSTRACT

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1. Introduction

The collapse of Lehman Brothers in September 2008 marked the first phase of a liquidity crisis in the euro area that lasted for the better part of ten years, threatening the very existence of the euro. In the aftermath of the fall of Lehman Brothers, market funding for banks came to a sudden stop. In the absence of an integrated banking system that could share risks across countries, the burden of supporting banking systems fell on sovereigns to support their national banking systems, leading to negative feedback loops between national banking sectors and governments that reached crisis proportions in 2011-12, marking a second phase of the crisis. Then, at the end of 2013, the euro area faced a credit crunch as the annual rate of loans to the private sector contracted by more than 2 percent; against this background, inflation began a downward drift and, by the end of 2014, moved into negative territory, marking a third phase of the crisis. Confidence in the euro, as indicated by its exchange rate against the U.S. dollar, plummeted; the euro fell from 1.40 dollar per euro in late-2013 to 1.05 a year later. With governments having to consolidate their fiscal positions, the ECB became the "only game in town." In each phase of the crisis, it took measures to restore bank lending, eradicate redenomination risk and, by so doing, safeguard confidence in the euro as an international asset.

In this paper we assess the effects of the ECB's monetary-policy operations on (i) confidence in the euro as a reserve asset as indicated by the holdings of international reserves both within the euro area and outside the euro area, and (ii) bank lending by euro-area banks. Part of this work draws on the literature on international reserves as a buffer against aggregate shocks, recent contributions here include Aizenman (2011), Aizenman and Lee (2007), Barnichon (2009) and Obstfeld, Shambaugh and Taylor (2012). The other part of this paper is closely related to the literature on the Bank Lending Chanel

inaugurated by Bernanke and Blinder (1988), and many subsequent papers which are mentioned below.

With regard to international reserves, we first provide some stylized facts on the holding of reserves within the euro area and within other regions. Our conjecture is that the ECB's funding measures from 2011 onwards should have produced a decline in the holdings of reserves by euro-area countries relative to other regions, reflecting a positive confidence effect (on the demand for reserves within the euro area) of the ECB's non-standard operations. We then provide estimates of the impact of those operations on the demand for euros as an international reserve asset by other regions. While the proportion of foreign exchange reserves held in euros declined, we find that ECB funding policy had a positive effect, preventing the fall being larger.

To examine, the effects of the ECB's liquidity providing operations on bank lending, we apply two empirical methodologies. First, we use standard panel data estimation to examine the effects of ECB funding to banks on gross lending by euro-area banks. To do so, we use confidential data with which we constructed a series of borrowing from the ECB by euro-area banks; our sample covers the period 2007 to 2016 and comprises semi-annual data on 88 euro-area banks. We first estimate the long-run effects of the ECB's funding operations. Then we estimate the dynamic effects to show the adjustment paths. Second, we use spatial panel data estimation in order to show the spill-over effects of ECB funding on lending. In this connection, we provide what we believe is a novel approach. Specifically, whereas the spatial framework is itself a static framework, we estimate a dynamic spatial model so that we can shed light on the adjustment process.

The remainder of the paper is structured as follows. Section 2 assesses the ECB's funding operations on both the demand for international reserves within the euro area and the demand for the euro as an international reserve asset outside the euro area. Section 3 presents

the effects of ECB's funding operations on gross lending by euro-area banks, using a panel of individual banks. Section 4 concludes.

2. The ECB's Financing Operations and international holdings of euros

2.1 An Account of ECB Non Standard Financing

The collapse of Lehman Brothers in September 2008 triggered a global liquidity crisis. As in other advanced economies, euro-area banks were confronted with a sudden stop in the availability of funding in the money market. During the early stages of the crisis, the ECB changed the approach to their financing operations that provide liquidity to the banking system – the weekly main refinancing operations (MRO) and the quarterly long term refinancing operations (LTRO). Specifically, it started to provide all the liquidity asked by banks in each tender at a fixed rate at increasingly long durations and against a wider range of collateral.[2] The ECB also lowered its main refinancing rate to the then-record low of 1 percent in May 2009, and inaugurated the Covered Bonds Purchase Programmes (CBPPs) and the Securities Market Programme (SMP), aiming at improving liquidity conditions in covered bond markets and government bond markets, respectively.

The severity of the crisis was such, however, that the banking sector remained under pressure. This created the conditions for a second phase of the crisis -- namely, the sovereign-debt crisis of 2011-12 and its amplification through bank-sovereign feedback loops. During this phase, sovereign borrowing costs spiked, especially in those countries hit hardest by the crisis (Gibson et al, 2017). The result was a severe disruption of the monetary transmission process.

[2] Prior to mid-2008 each tender for financing was for a fixed amount of money. Thus, if demand was higher than the fixed amount only the banks that gave the highest bids (interest rates) obtained the financing. So, the ECB went from a fixed allotment with marginal rates to full allotments at fixed rates.

The ECB's response to the second phase of the crisis was twofold. First, to ensure that banks had access to longer-term funding, the ECB introduced two three-year longer-term refinancing operations, which were implemented in December 2011 and February 2012, respectively, amounting to € 1 trillion. Second, the announcement of the Outright Monetary Transactions (OMT) programme in the summer of 2012 prevented a further deterioration in economic conditions by removing redenomination risk, which had become a key contributor to economic instability.

By the time of the announcement of the OMT, the sovereign-debt and banking crises had left a trail of destruction of banks' balance sheets. As a result, in 2013 deflationary pressures emerged with progressive falls in inflation to levels well-below 2 percent. The concurrent reduction of output and inflation indicated that the renewed weakness of the economy was driven by a negative demand shock. Maintaining price stability in the face of weak aggregate demand and downward price pressures required a more-expansionary monetary-policy stance. Consequently, a new phase of non-standard measures was initiated. Beginning in June 2014, the ECB employed the following instruments to achieve the objective of influencing the entire constellation of interest rates: (1) negative interest rates on the deposit facility, thereby providing a floor to the interest-rate corridor; (2) forward guidance on the evolution of the corridor in the future; (3) targeted longer-term refinancing operations (TLTROs); and (4) the Asset Purchase Programmes (APPs) which included purchases of both private sector and public sector bonds. Over time, these measures boosted the growth momentum of the euro area and raised inflation from the negative rates recorded in 2014. The main transmission mechanism through which this improved performance was achieved was the bank lending channel. We investigate the effects of the non-standard measures on bank lending in what follows.

2.2 The behaviour of foreign reserves in the euro area

We begin by describing the way foreign reserves have behaved over the period 2000-2018. In general countries hold foreign exchange reserves in order to enable them to continue to import should foreign exchange be scarce and to provide a safety net in the event of international turbulence on, say, foreign exchange markets. Thus the demand for reserves is likely to depend on income and development levels, the opportunity cost of holding reserves, a country's rating as well as its exchange rate regime.

Chart 1 shows the holdings of reserves held by a number of EU countries expressed as a proportion of their GDP. Typically these countries hold very low level of reserves, even allowing for the fact that at the creation of the euro (or when joining the Euro) a proportion was transferred to the ECB.[3] There is a clear downward trend in reserves during the first part of the period, before the onset of the financial crises, as counties felt that the euro itself was providing a shield from foreign exchange shocks and so the traditional need to foreign currency reserves fell. After 2008 however this trend clearly reverses and countries show much less confidence in the ECB's willingness to step in and defend the currency. From 2011 onwards and the beginning of the ECB's refinancing programs we can see a clear reversal in the upward trend in reserves for many countries as confidence in the ECB's willingness to support banking systems and financial markets grows.

Chart 2 shows a range of smaller euro area countries. This clearly shows the large fall in reserves which occurs at the point of joining the Euro, such as for Malta and Cyprus who joined in 2008. The case of Latvia is slightly out of line with the other countries. Latvia joined the European Union in 2004 and in 2005 it pegged its currency to the

[3] Each member contributes to ECB reserves in accordance with its capital key.

Euro. During this period there was an ongoing need to defend this rate and hence the buildup of reserves. Latvia finally replaced its currency with Euro's on 1st January 2014 and we can see a steady decline in reserves from that point onwards towards a level similar to the other countries.

We now consider the levels and movements in reserves in some of the larger non-euro countries inside the European Union. The three eastern European countries have much higher levels of reserves than the euro area countries and these again start to rise after 2008. Interestingly they also show a tendency to fall with the onset of the ECB special measures from 2011, suggesting positive spillovers from the euro area and ECB measures. By contrast, the two developed non euro area European countries, the UK and Sweden, both show relatively low and stable levels of reserves although there is a clear upward trend after 2008.[4]

2.3 The behaviour of Reserves in non-EU Countries

In this section we consider the behaviour of reserves in some large non EU countries (Chart 4).

Russian reserves are dominated by developments in the political arena and world oil prices as oil is Russia's largest export and a key driver to the economy. The Ukrainian conflict and the imposition of sanctions by the US and Europe in 2014 were clearly key shocks which drove up the reserves towards the end of the period.

[4] On joining the European Union, the Treaty of Accession states that all new member states shall be part of the economic and monetary union from the date of accession but with a derogation which allows them to maintain their own currency for an indefinite period but with the ultimate aim of joining the euro area. Poland had never an explicit target date for joining the euro. Hungary and Romania however did. They were continuously pushed back creating thus significant uncertainties.

The other countries in the chart clearly cluster around a reserve ratio of about 15% of GDP, although Brazil has been slowly moving towards this value.

Chart 5 shows a range of large south-east Asian economies. As expected, given their level of development and the fact that they are not part of a strong economic block, all have much higher reserves than the EU member economies and they all show an increase in reserves from the early 2000s, reflecting an upward shift in the demand for reserves following the Asian crisis back in the late 1990s.

On balance, there is a significant level difference in reserves between developed economies and emerging markets. Moreover, the inclusion of less developed economies in a larger (and more developed) economic region facilitates a significant drop in international reserves.

2.4 Holdings of foreign exchange reserves in euro: an econometric analysis

Chart 6 shows the time series for total reserves in euro as a percentage of allocated reserves in the world as a whole. Holdings of euro as foreign exchange reserves rose from around 24% in 2003 to 28% in 2009. Thereafter they fell quite sharply to under 20% before stabilizing.

We now turn to examine what drives holdings of foreign exchange reserves in euro. In particular, what impact have the ECB's nonstandard monetary policies had on the use of the euro as a reserve currency. To this end, we construct a simple VAR analysis involving the log of real euro foreign exchange reserves (LTREALRESE) as a function of the log of real world GDP (LWGDP), representing a scale variable, interest rates (INT), reflecting the opportunity cost of holding reserves and the log of intervention activity of the ECB in the banking system (LECBTOT). Intervention activity includes both main refinancing operations as well as the non-standard measures outlined above.

We find that a VAR of order 2 is selected by the standard selection criteria and the results are presented in Table 1. The main point of interest in this VAR is the response of the system to a shock to ECB funding, and in particular the response of reserves. We will therefore not show the complete impulse response set for all variables to all shocks but simply concentrate on this one result which is shown in chart 7.

Chart 7 shows a significant positive effect of ECB funding to reserve holdings which builds up quickly and lasts for about 3 quarters and then slowly declines. This can be interpreted as a confidence effect whereby the ECB shows commitment to the stability of the Euro system and thereby engenders confidence in the world in the stability of the Euro. So despite the decline in the share of the euro in foreign exchange reserves, that decline would have been even greater without the ECB's monetary policy stance during the crisis.

We can then go on to see if this is indeed a valid relationship by testing to see if there is a cointegrating relationship underlying this VAR. Table 2 gives the standard trace test for the number of cointegrating relationships existing between these variables. The conclusion from this table is that there is indeed one cointegrating relationship. We can thus re-estimate the VAR with this rank imposed to further explore the relationship (Table 3).

Both the cointegrating vector and the corresponding shows, as expected, that there is a positive and significant effect of world GDP and ECB funding on world reserve holdings of euros and a negative effect from interest rates. This provides evidence that ECB interventions during the crisis have bolstered foreign reserve holdings of euro in non-euro area countries.The results suggest that the ECB was considered to be taking adequate measures to contain the euro

area crisis, boosting thus confidence in the economic prospects of the region. Consequently the euro increased its relative attractiveness as an international reserve currency. Moving forward, we investigate whether ECB interventions had a positive impact on the euro area economy. We focus on interventions directed to bank lending

3. ECB interventions through main refinancing operations and non-standard measures directed towards banks – the impact of bank lending in the euro area

3.1 A standard Panel Data approach

The ECB funding directed to bank lending consist of three basic parts, the standard financing operations – MRO and LTRO – as well as the non-standard TLTRO. This data are at the bank level and included as an explanatory variable in our bank lending equation.[5]

Our basic specification follows Gibson et al. (2019). It is worth emphasizing that unlike many earlier papers looking at the lending channel and the determination of bank lending (Bernanke and Blinder (1988), Angeloni, Kashyap and Mojon(2003), Ehrmann and Gambacorta, Martinez-Pages, Sevestre and Worms (2003), Ehrmann and Worms (2004), Ashcraft (2006), Ivashina and Sharfstein (2008) and Cohen-Cole et al (2008)) we do not use a log specification. There are two reasons for this; first as argued by Gibson et al (2019) the standard model in the literature is not well specified in terms of its long-run equilibrium and it mixes levels and differences in a way which is incorrect. We address this here by using a normal error correction model which correctly separates the long-run from the dynamics. Second, as many of the observations on ECB funding to individual banks are zero a log specification is inappropriate.

[5] The data measure period end funding received by each bank.

We focus on 88 banks from of the following euro area countries – Austria, Belgium, Cyprus, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain.[6] The data are either annual or semi-annual from 2007 to 2016. Annual data are interpolated to match the semi-annual data available for the majority of banks in the sample.

Following a general to specific approach our final long-run equation for gross loans is specified as:

$$GL_{i,t} = \beta_0 + \beta_1(LIAB - ECBF)_{i,t} + \beta_2(ECBF)_{i,t} + \beta_3(LIQ/A)_{i,t} + \beta_4(NPL/GL)_{i,t} + \beta_5(LR)_{i,t}$$

Where GL is gross loans, LIAB is total liabilities, ECBF is ECB funding, LIQ is liquid assets, A is total assets, NPL is non-performing loans and LR is the lending rate, *i* refers to the bank and *t* to the time period.[7]

We expect total liabilities to be positive as it is a proxy for size, while the share of liquid assets is expected to have a negative effect as liquid assets act as a substitute for loans. An increasing share of non-performing loans is anticipated to have a negative effect on gross loans. Finally we also expect rising lending rates to have a negative effect on the demand for loans.[8]

[6] The original sample was 105 banks; however some of the banks did not have data for some of the variables during this period. Thus our final sample consists of 88 banks, with semi-annual data from 2007:S1 to 2016:S2. Even though the number of banks is fairly small, considering that more than 2500 banks some funding at some point of time during our sample investigation, the total amount of ECB funding accounted for is non-negligible. Our bank sample accounts for more than 50% of total funds for most of the time.

[7] ECB funding is subtracted from the banks' total liabilities in order to avoid double counting as the ECB requires collateral in order to provide funding.

[8] Country specific variables like GDP are not significant or enter with the wrong sign and are excluded from the long run equation. Moreover, as our sample period is predominantly characterized by monetary loosening, we do not interact the interest term on loans with bank characteristics.

Our long-run equation in Table 4 indicates that an increase of total liabilities by 1 billion implies an increase of gross loans by €400 million, while an increase of 1 billion in ECB funding increases gross loans by €2.56 billion implying thus a significant multiplier to bank lending. At the same time an increase liquid to total assets by 1 percentage point decreases loans by €1.67 billions, while an increase of 1 percentage point of NPLs to gross loans (for example from 5 to 6 per cent) decreases gross loans by €440 millions. Finally, an increase in the lending rate by 1 percentage point (for example from 5 to 6 per cent) decreases gross loans by €4.12 billion.[9]

Our dynamic loan equation is estimated in an error correction form which allows us to obtain a functional long-run equilibrium. The general empirical specification is a panel error correction model of the following form:[10]

$$\Delta GL_{i,t} = \gamma_{0,i} + \sum \gamma_{1,k} \Delta (LIAB - ECBF)_{i,t-k} + \sum \gamma_{2,k} \Delta (ECBF)_{i,t-k} + \sum \gamma_{3,k} \Delta (LIQ/A)_{i,t-k} + \sum \gamma_{4,k\Delta} (NPL/GL)_{i,t-k} + \sum \gamma_{5,k} \Delta (LR)_{i,t-k} + \sum \gamma_{6,k} \Delta (RGDP)_{i,t-k} + \sum \gamma_{7,n} \Delta GL_{i,t-n} + \delta \, (GL_{i,t-1} - (\beta_0 + \beta_1 (LIAB - ECBF)_{i,t-1} + \beta_2 (ECBF)_{i,t-1} + \beta_3 (LIQ/A)_{i,t-1} + \beta_4 (NPL/GL)_{i,t-1} + \beta_5 (LR)_{i,t-1})$$

Following again a general to specific approach, the final estimated model is presented in Table 5. It seems to be well specified with the residual from the long-run equation having the correct sign and being highly significant.

The magnitude of the error-correction term coupled with the dynamic adjustment implies a half-life of about one and a half years for a permanent shock to pass through. Moreover, the fairly high point-

[9] In our long-run equation GDP comes out either insignificant or wrongly signed.

[10] In order to capture effects like management differences, differences in sectoral loan diversification and other bank specific differences which may affect loan growth we estimate our error correction model in a fixed effects setting, with the fixed effects being at the bank level.

estimate of the ECB funding on loan growth, together with the error-correction, implies that €1 increase of ECB funding leads to 1 euro increase in gross loans within 2 years.[11]

3.2 A Spatial Estimation Procedure

Despite the direct effects of the ECB funding showing a significant multiplier there may be indirect effects at play here. In particular, both banks and economic activity in the euro area is inter-connected. Thus, it may be the case that, in an expanding market, an increase in lending of one bank feeds through to increases in lending for other banks. Similarly, in a stagnant or contracting market a decrease in lending of one bank may spill over to decreases in lending by other banks. ECB funding may also create other spillover effects. That is, economic agents might gain confidence that the entire banking sector will be protected when they observe that banks are being supported. Alternatively, it may be the case that, on realizing that a particular bank needs funding from the ECB, confidence in other banks might fall.

In order to account such effects we need to estimate our bank lending equation in a spatial setting. The essence of a spatial model is the idea that banks are highly interconnected and do not work in isolation. Thus a bank will respond to what is happening to other banks in terms of their lending behaviour or the assets which they are receiving from the ECB. So one bank may receive funding from the ECB and this support may affect the confidence with which other banks can operate. Such an effect is not be captured by the usual model estimated above. Specifically, the spatial model uses a weighing matrix to impose a set of restrictions on the spillover effects so that these effects can be estimated.

[11] We should note that the full long-run impact of 2.56 is reached asymptotically

In our case we estimate a model of the following form: Consider the following models:

(1) $$y_{i,t} = \beta_0 + \beta_1 x_{k,i,t} + \gamma_1 W y_{i,t} + \varepsilon_{i,t}$$

Where $y_{i,t}$ is a vector of i endogenous variables at time t, $x_{k,i,t}$ is a matrix of k exogenous variables with i cross section observations at time t, and $\epsilon_{i,t}$ is a vector of i error terms at time t. The model is a spatial lag dependent variable model, respectively, where W is a $i \otimes T$ matrix.[12] To avoid confusion it is worth emphasizing that when we refer to a spatial lag this does not refer to a lag in time, in the conventional sense. Rather a spatial lag determines how what happens to all the other banks in the current period, weighted together by the W matrix, affects the lending of the bank which is the dependent variable in this period.

The key is how to define the weighting matrix W. Usually a measure of physical distance or the presence of joint border is used. Intuitively one has to use some measure of proximity to identify the spillovers.

The panel data set used above is an unbalanced one, but for spatial estimation we need a balanced panel. This circumstance reflects the fact that, if every member of the panel is entered into every equation, we need to have data on every member at every point in time. Our final balanced panel consists of 57 banks for the period 2008:S2 to 2016:S1 with a total of 912 observations. [13]

[12] Various features have of spatial lagged exogenous variable models and a spatial autoregressive error models, have been estimated as well. However they turn out to be either insignificant or they do not add to the analysis. As such they are excluded.

[13] It should be noted that reducing our sample does not qualitatively and quantitatively impact on the results reported in previous sections.

3.3 Identifying W through our data, some descriptive statistics.

First of all, we can see that our sample period is characterized by a significant retrenchment of the banks in our sample (see Chart 8). The gross loans for our 57 banks are reduced by almost €1 trillion from peak to trough. At the same time they account for a significant amount of ECB funding. This implies that in a spatial dependent variable setting we would expect our spatially dependent variable to be negative.[14]

Second, it is a stylized fact that the euro area crisis had a regional aspect with countries in the South (Spain, Italy, Greece, Ireland) being more affected by contagion than countries in the North (Austria, France, Netherlands, Germany and Belgium). We therefore posit that spatial contagion is more likely to be found among the South.

Third, the banking system of the euro area differs on a country by country basis. In our sample the banks in the 'Northern' countries are in many respects more Anglo-Saxon in nature, meaning that they have moved away from traditional retail banking with a significant proportion of their assets and liabilities coming from other sources than loans and deposits. By contrast, banks in the 'Southern' countries are more 'traditional'. This is evident as the share of gross loans to total assets is significantly higher for Southern banks (see Table 6).

The dependence of the Southern banks on loans made them also more vulnerable to the shock that hit the real economy of these countries. While the northern banks could retrench their balance sheets through other means (see Table 7), the southern banks had to embark in a vicious circle of retrenching their balance sheets by recalling loans,

[14] By contrast, in an expansion period we would expect, a priori, our spatial lag to be positive.

which would further exacerbate the economic downturn forcing banks to retrench their balance sheets further.

The implication here is that while Northern banks probably held ECB funding as a precautionary measure, Southern banks probably used it more actively for lending purposes.

We try to incorporate these stylized differences between the 'North' and 'South' in our weighting matrix. Specifically our weighting matrix allows for spillovers within the 'South' and within the 'North' but not between the 'South' and 'North'.

3.4 Spatial Estimations

These spillovers, within the North and within the South, are represented by two different weighting matrices W_1 and W_2. In the first weighting matrix (W_1) we allow for limited spillovers across countries (within the same group), while in the second weighting matrix (W_2) we allow for equal spillovers across countries (within each group).

For each weighting matrix we estimate a spatial dependent variable regression where we capture any spillover from a banks' lending activity to another. This estimation seems to better capture the interdependencies of our data.[15] We estimate our spatial models using maximum likelihood.[16]

[15] All spatial autoregressive error models where insignificant and are thus excluded. Spatial independent variables are also either insignificant or do not add qualitatively or quantitatively to our analysis.

[16] See Anselin (1988), Kapoor et al. (Lee (2004) , Kapoor et al. (2007) and Lee and Yu (2010).

3.5 The long run

The results for our long-run spatial estimations are presented in Table 8. The first block of results with the estimated coefficients and the estimated spatial dependent variable can be considered the direct effects. In the second block of results, we let the spatial dependent variable 'feed' through the system obtaining thus the final total economic effects implied by our spatial estimation.

For model 1 the results show that the direct effects are fairly similar to our non-spatial long-run equation. However the spatial dependent variable is negative and significant. As the period of investigation is characterized by a reasonably stagnant – or even contracting – market this is not an unreasonable result.

The direct and total effects of ECB funding in model 1 imply that if a bank receives funding from the ECB it increases its lending by 2.5 times more than the funding. At the same time it 'takes' lending away from banks that have not received funding – a crowding out effect. Specifically, in model 1, consider that we only have two banks A and B. If the ECB only funds bank A by €1 then banks A lending would go up by €2.50. However, banks B lending would decrease by €0.52. If the ECB funded both banks by €1 their lending would increase by €1.98 each. Thus even during a period of significant retrenchment of banks' balance sheets with non-negligible negative spillovers and significant negative real economy developments there is still a significant positive multiplier effect coming from central bank funding.

The main difference for model 2 which allows for stronger spillovers across countries is the magnitude of the estimated spatial dependent variable, which is larger. The larger negative spatial effects imply lower total effects of ECB funding as the 'crowding out' effect is larger. Even

so, the total effects continue to point to a non-negligible multiplier to bank lending.

3.6 The short run

We obtain the residuals from our long run spatial equation in Table 4 and use them to estimate a spatial dynamic error correction model. Given the sample difference with the error correction model presented in Table 5, we repeat our general to specific approach with the final model presented in Table 9. The dynamic specification is fairly similar, implying that the estimated economic relationships are quite stable over time and across banks.

Our spatial dependent variable is positive and significant implying positive spillovers of changes in gross loans. The results are not at odds with the negative spillovers obtained in our long run equation. In particular, the long run equation spillovers capture the general retrenching observed in our data, while the positive spillovers in our error correction model imply that if the changes in gross loans in a bank, be they either negative or positive, are reinforced and are transmitted further in economy. This implies that the positive concurrent impact of ECB funding on gross loans are further reinforced and could be thought of as having positive systemic effects over and above their direct effect on bank lending.

This is evident when comparing the direct and total effects of changes in ECB funding on gross loans.

In our spatial setting the magnitude of the error-correction term along with the dynamics implies a half-life of one and a half years for a shock to pass. Moreover, the fairly high point-estimate of the ECB funding on loan growth, together with the error-correction, implies

that €1 increase of ECB funding leads to €1 increase in gross loans within 2 years.

Lastly we can note that the total effect of our error correction term in this spatial setting (of -0.14 in model 1 and -0.15 in model 2) is somewhat higher than in our non-spatial error correction implying a faster correction towards the long-run equilibrium. This could be also interpreted as an improvement in the monetary transmission mechanism that stems from positive spillover effects.[17]

On balance our results imply that the ECB funding provided to euro area banks have a significant positive multiplier effects. Our spatial estimations indicate also that the central bank funding, apart from positive direct effects also had positive systemic effects, which are evident from the positive spillovers in our dynamic spatial error correction estimation. Finally, there are some indications that accounting for positive spillovers there seems to be an improvement of the monetary transmission mechanism as the speed of return to the long-run equilibrium is somewhat faster.

4. Conclusions

From 2011 onwards the ECB, alongside its standard operations, began intervening in a number of non-standard ways outlined above to support the banking system within the Euro area. We have looked at the effects on foreign exchange reserves held by countries within the euro area. those countries not in the euro area but in the EU and a number of large countries not in the EU. We find that ECB interventions during crisis period appear to have had a calming effect on the build up of foreign exchange reserves in the euro area. Secondly, we considered how the euro has been affected as a world reserve currency

[17] See also Table A1 and Chart A1 for a comparison of spatial and non-spatial error correction models- estimated for a common sample and the implied speed of adjustment.

by the ECB's evolving policy stance. The results suggest that ECB policy positively influenced real holdings of euros by non-euro area counties. Thus, they prevented the share of euros in foreign exchange reserves from falling further than they did. Finally, we have also argued, and presented evidence that ECB intervention has had strong and significant effects on the lending behavior of Eurozone banks. This not only works through the usual econometric channels which we are used to analyzing through the bank lending channel literature on individual banks treated in isolation. It also has strong spatial effects as one bank influences other in the banking system. These spatial effects alter our estimates of the total effect on the banking system, suggesting it is important to take them into account when examining the impact of ECB intervetions.

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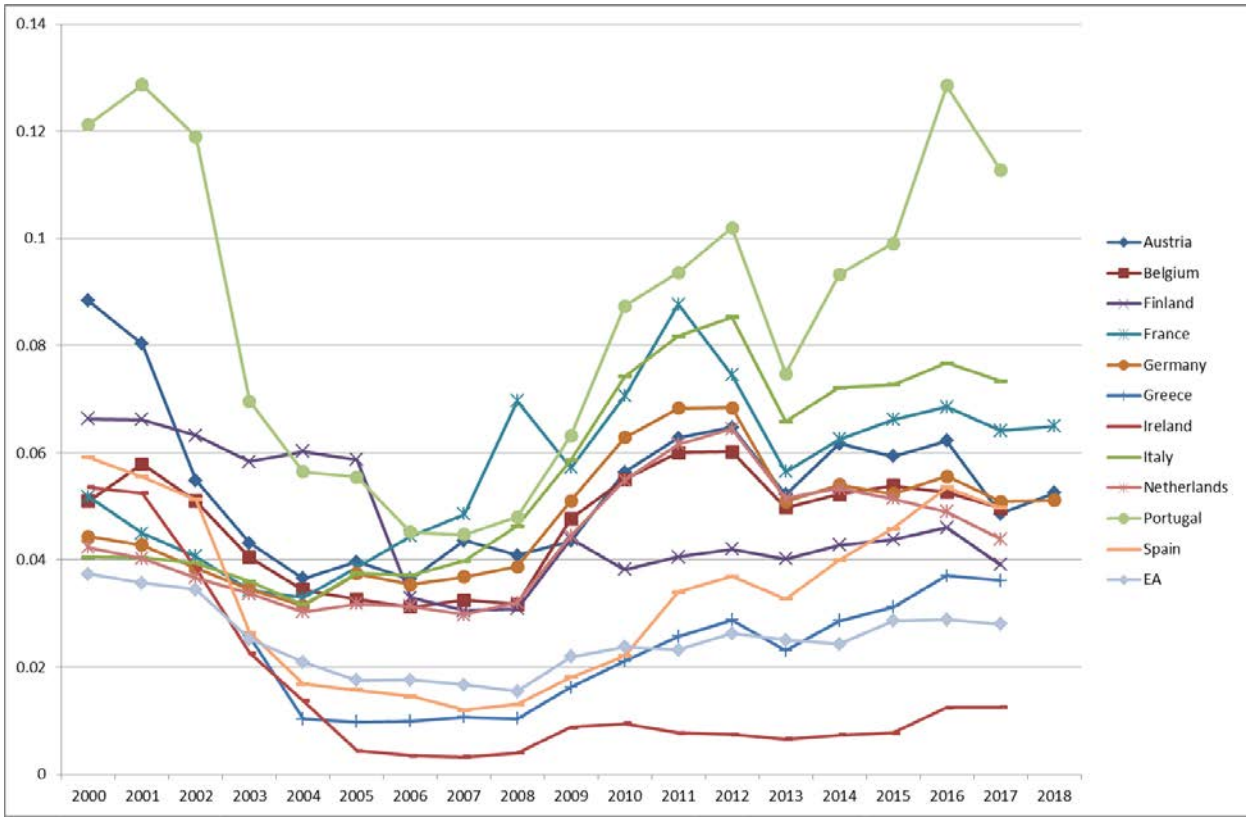
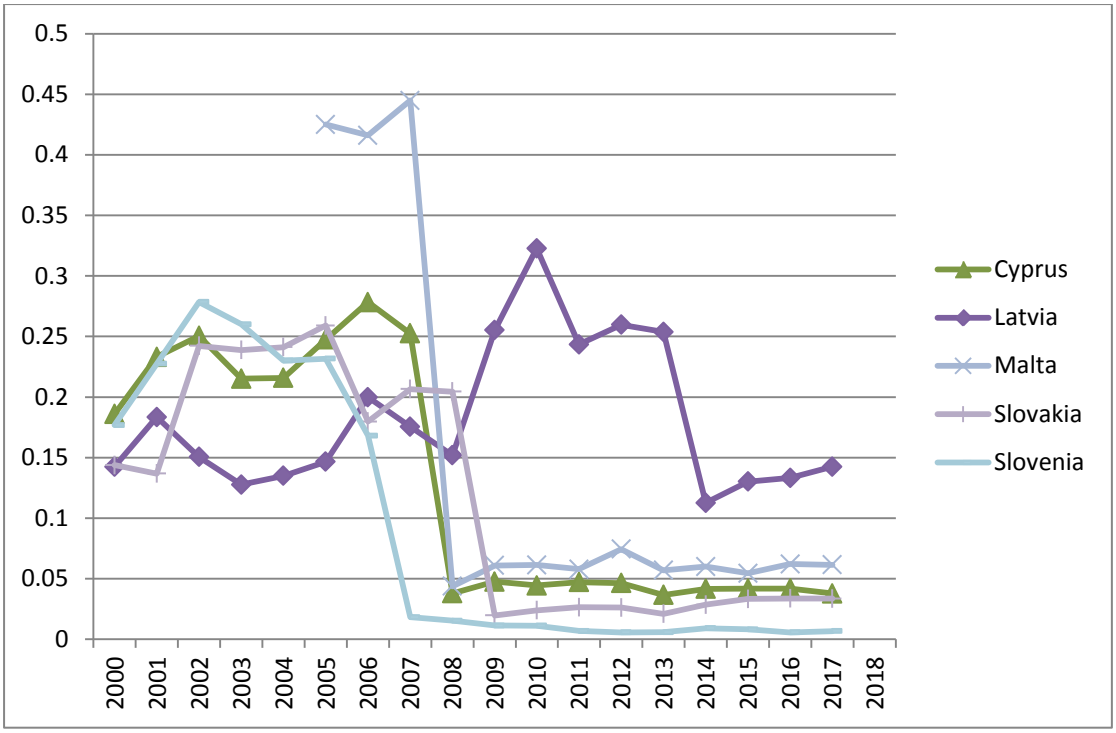
Chart 1: Reserves held by the Main EU Countries (proportion of GDP)



Source: International Financial Statistics, IMF

Chart 2: Reserves held by selected smaller EU Countries (proportion of GDP)



Source: International Financial Statistics, IMF

Chart 3: Selected EU Non-Euro Countries (proportion of GDP)

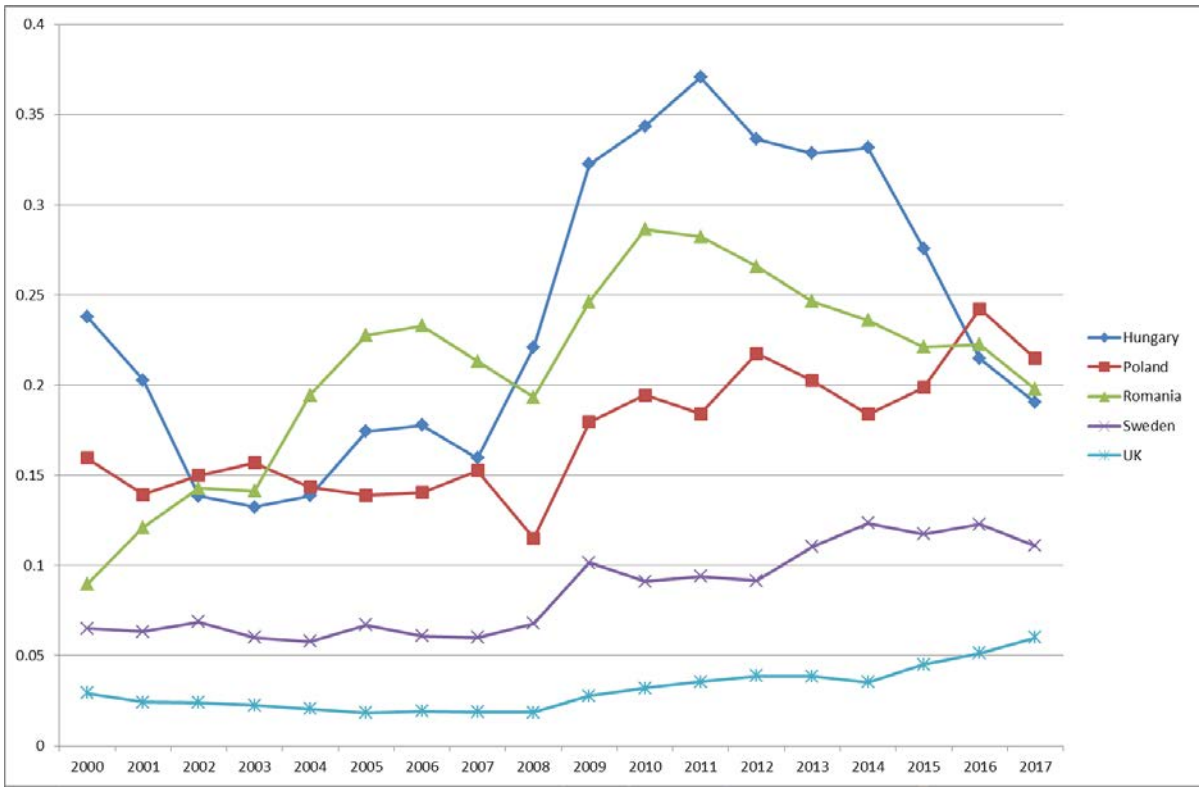
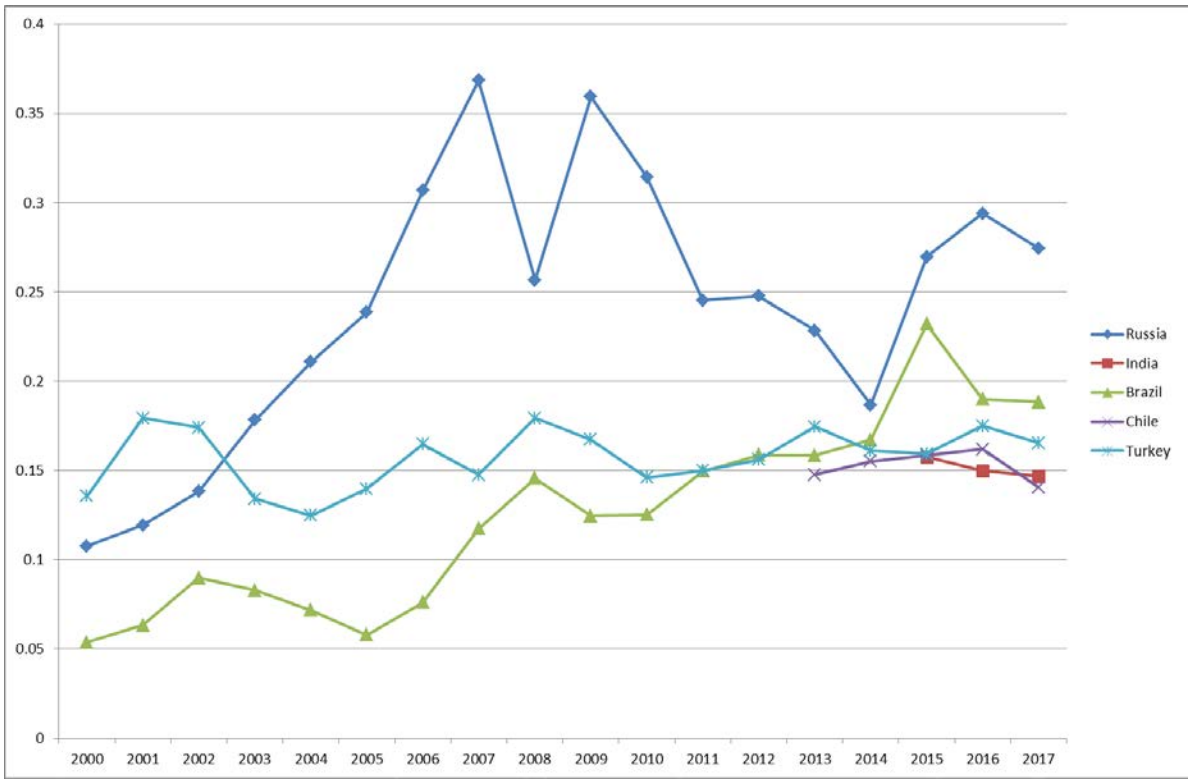
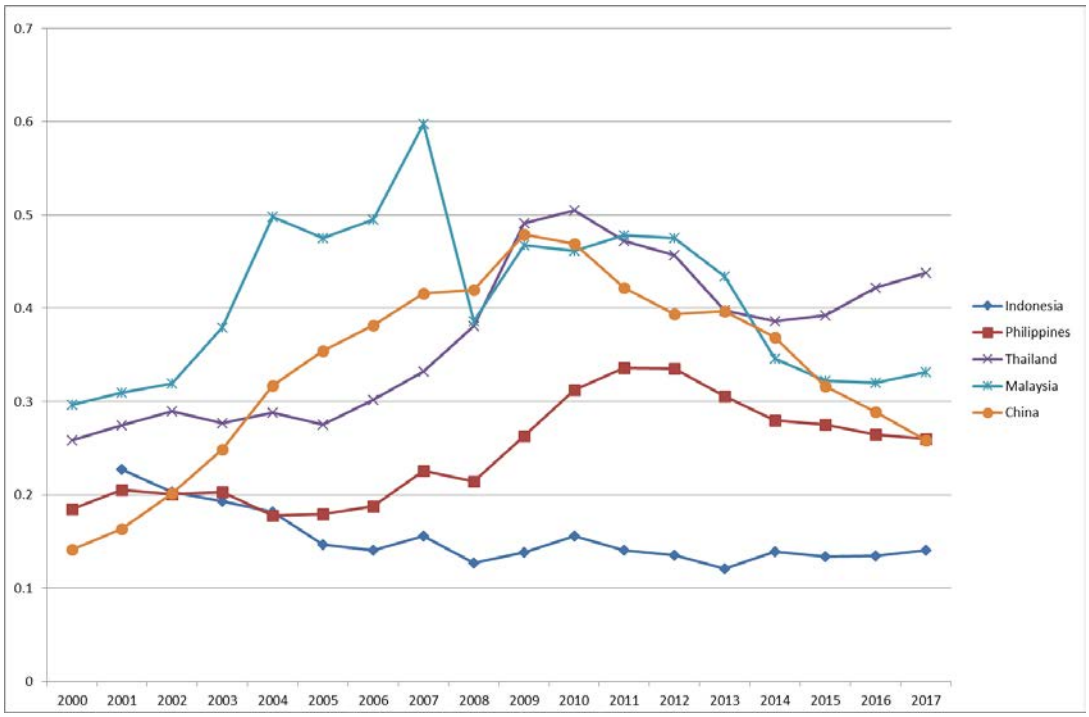


Chart 4: Reserves Held by Selected Large Non-EU Countries (proportion of GDP)



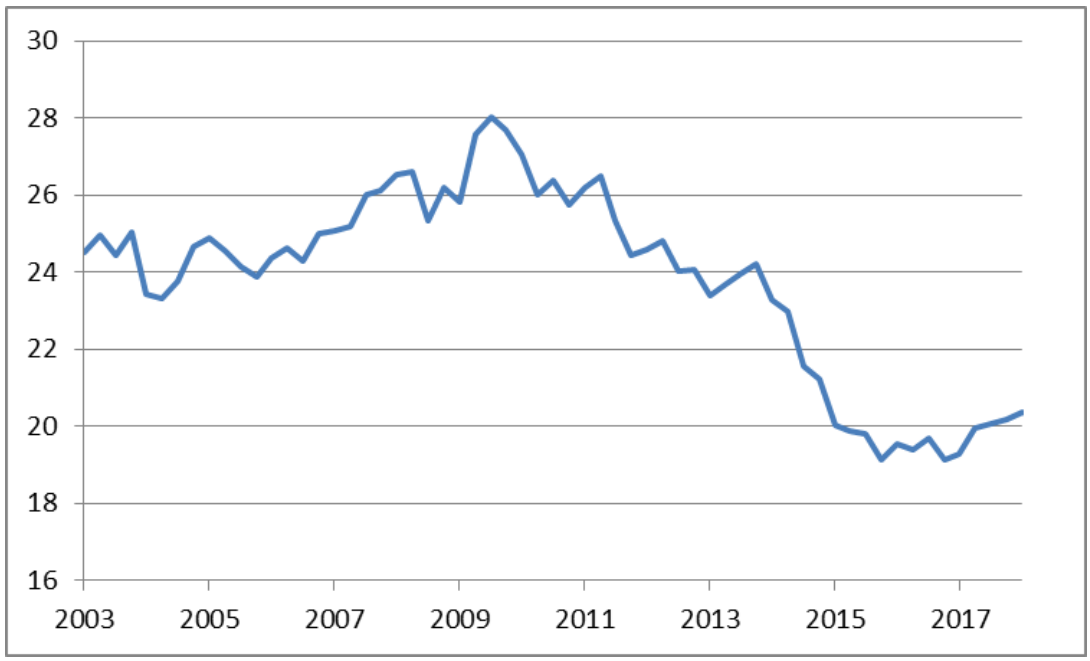
4.1 Source: International Financial Statistics, IMF

Chart 5: Selected South-East Asian Countries (proportion of GDP)



Source: International Financial Statistics, IMF

Chart 6: Percentage of allocated reserves held in euro



4.2

Source: Composition of Foreign Exchange Reserves, IMF

Chart 7: Response of total reserves to a shock to ECB funding

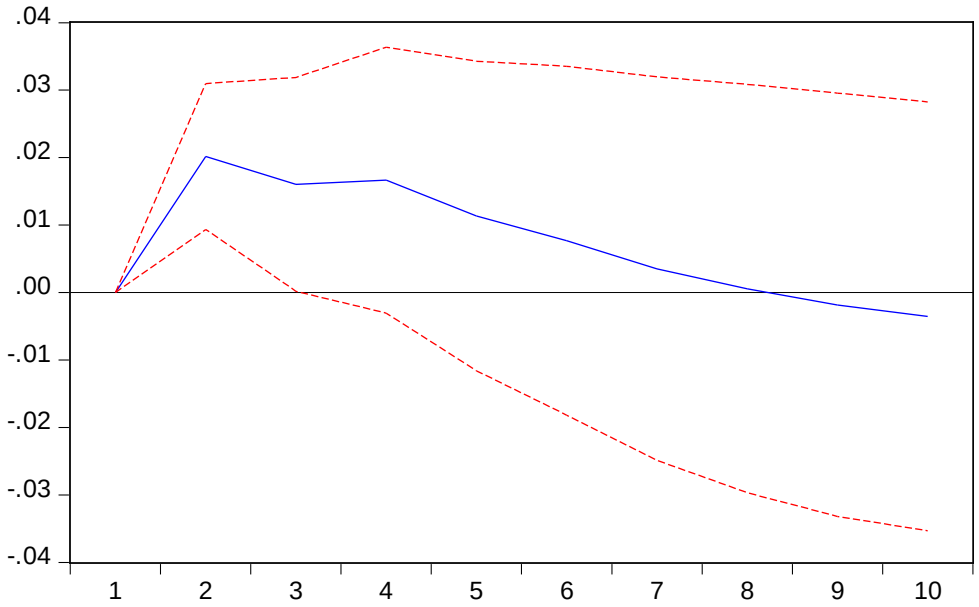


Chart 8: Descriptive totals Loans and Funding

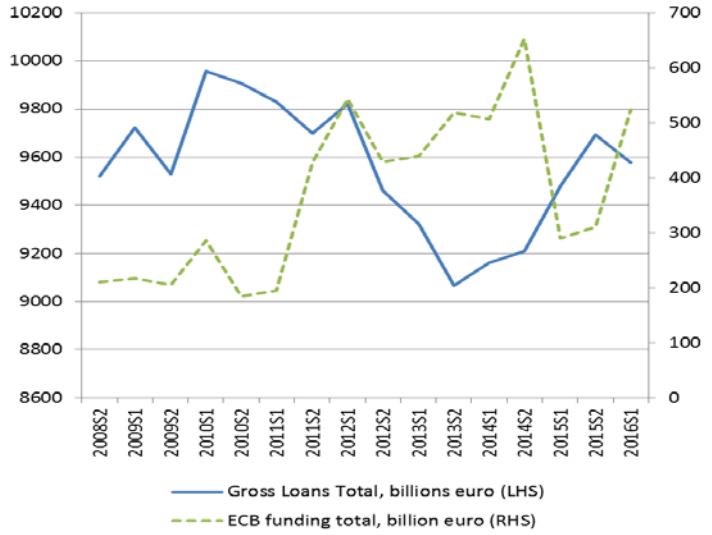


Table 1: Vector Autoregression Estimates

Sample (adjusted): 2010Q1 2018Q1
Included observations: 33 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LTREALRESE	LWGDP	INT	LECBTOT
LTREALRESE(-1)	0.657	0.010	0.038	0.897
	(0.163)	(0.005)	(0.085)	(0.795)
	[4.033]	[1.992]	[0.445]	[1.128]
LTREALRESE(-2)	0.313	0.009	0.098	-0.970664
	(0.149)	(0.005)	(0.078)	(0.72505)
	[2.106]	[1.918]	[1.27]	[-1.33875]
LWGDP(-1)	9.152	1.198	1.428	-29.402
	(4.390)	(0.139)	(2.277)	(21.404)
	[2.085]	[8.587]	[0.627]	[-1.374]
LWGDP(-2)	-9.033	-0.241	-1.732	29.875
	(4.257)	(0.135)	(2.207)	(20.75)
	[-2.122]	[-1.783]	[-0.785]	[1.439]
INT(-1)	-0.823	-0.020	1.376	3.171
	(0.263)	(0.008)	(0.136)	(1.282)
	[-3.128]	[-2.443]	[10.092]	[2.473]
INT(-2)	0.752	0.0156	-0.460	-3.069
	(0.250)	(0.008)	(0.129)	(1.218)
	[3.009]	[1.964]	[-3.553]	[-2.520]
LECBTOT(-1)	0.145	-0.000	-0.0251	1.148
	(0.035)	(0.001)	(0.018)	(0.169)
	[4.196]	[-0.319]	[-1.397]	[6.792]
LECBTOT(-2)	-0.164	-0.002	0.004	-0.228
	(0.038)	(0.001)	(0.020)	(0.184)
	[-4.356]	[-1.841]	[0.186]	[-1.240]
R-squared	0.972	1.000	0.994	0.932
Adj. R-squared	0.964	1.000	0.992	0.912
Sum sq. resids	0.023	2.28E-05	0.006	0.538

S.E. equation	0.030	0.001	0.016	0.147
F-statistic	123.9	34835.1	569.5	48.59
Log likelihood	73.38	187.21	95.06	21.10
Akaike AIC	-3.963	-10.86	-5.276	-0.794
Schwarz SC	-3.600	-10.50	-4.914	-0.431
Mean dependent	14.02	5.232	0.280	14.09
S.D. dependent	0.159	0.083	0.175	0.495

Table 2: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.763924	69.93448	40.17493	0.0000
At most 1	0.425781	22.29557	24.27596	0.0871
At most 2	0.113732	3.989016	12.32090	0.7125
At most 3	0.000143	0.004731	4.129906	0.9548

Table 3: VECM with cointegration restrictions from table 2 imposed

Cointegration Restrictions:

B(1,1)=-1

Convergence achieved after 1 iterations.

Restrictions identify all cointegrating vectors

Restrictions are not binding (LR test not available)

Cointegrating Eq:	CointEq1
LTREALRESE(-1)	-1.000
LWGDP(-1)	0.1763
	(0.257)
	[0.688]

INT(-1)	-0.501
	(0.091)
	[-5.544]
LECBTOT(-1)	0.194
	(0.012)
	[16.23]
C	10.57

Error Correction:	D(LTREALRESE)	D(LWGDP)	D(INT)	D(LECBTOT)
CointEq1	0.564	0.008	0.072	-2.307
	(0.231)	(0.005)	(0.152)	(0.729)
	[2.441]	[1.788]	[0.476]	[-3.164]
D(LTREALRESE(-1))	-0.141	0.003	0.075	-0.891
	(0.198)	(0.004)	(0.130)	(0.625)
	[-0.712]	[0.857]	[0.578]	[-1.424]
D(LTREALRESE(-2))	-0.151	0.001	-0.019	-0.215
	(0.144)	(0.003)	(0.094)	(0.453)
	[-1.051]	[0.332]	[-0.197]	[-0.475]
D(LWGDP(-1))	9.857	1.042	2.472	10.512
	(3.871)	(0.076)	(2.543)	(12.22)
	[2.546]	[13.61]	[0.972]	[0.860]
D(LWGDP(-2))	-0.899	-0.195	2.667	-79.953
	(4.773)	(0.094)	(3.135)	(15.06)
	[-0.188]	[-2.071]	[0.851]	[-5.308]
D(INT(-1))	0.238	0.006	0.597	1.214
	(0.384)	(0.008)	(0.252)	(1.212)
	[0.619]	[0.843]	[2.365]	[1.002]
D(INT(-2))	0.032	0.011	-0.0364	1.508

	(0.405)	(0.008)	(0.266)	(1.279)
	[0.0800]	[1.431]	[-0.137]	[1.179]
D(LECBTOT(-1))	0.106	-0.002	-0.023	0.170
	(0.047)	(0.001)	(0.031)	(0.149)
	[2.232]	[-1.990]	[-0.728]	[1.140]
D(LECBTOT(-2))	0.010	-0.000	-0.027	0.417
	(0.043)	(0.001)	(0.028)	(0.135)
	[0.228]	[-0.535]	[-0.946]	[3.082]
C	-0.0622	0.002	-0.051	0.707
	(0.0386)	(0.001)	(0.025)	(0.122)
	[-1.613]	[2.015]	[-2.006]	[5.809]
R-squared	0.642	0.933	0.612	0.786
Adj. R-squared	0.495	0.906	0.454	0.698
Sum sq. resids	0.017	6.72E-06	0.007	0.171
S.E. equation	0.028	0.001	0.018	0.088
F-statistic	4.382	34.16	3.860	8.953
Log likelihood	75.05	200.6	88.50	38.27
Akaike AIC	-4.066	-11.91	-4.906	-1.767
Schwarz SC	-3.608	-11.45	-4.448	-1.309
Mean dependent	0.017	0.009	-0.012	0.044
S.D. dependent	0.040	0.002	0.025	0.161

Table 4: Long-Run Equation for Gross Loans

Dependent Variable: Gross Loans	Coefficient	t-statistic
Total Liabilities	0.38	24.28
ECB funding	2.56	6.73
Liquid assets/Total Assets	-1.67	-6.29
NPL/Gross Loans	-0.44	-3.46
Lending Rate	-4.12	-2.37
constant	58.47	7.02
N. obs		1285
R-sq adj		0.83
F(5, 1279)		407

Table 5: Error correction model for changes in gross loans

Dependent variable: D(Gross Loans)	Coef.	t
D(Gross Loans(-1))	-0.12	-3.26
D(Gross Loans(-2))	0.16	4.42
D(Total Liabilities(-1))	0.04	2.74
D(Total Liabilities(-2))	-0.05	-3.33
D(ECB funding)	0.25	2.74
Real GDP		
D(Real GDP(-1))	0.10	2.74
Error Correction (-1)	-0.12	-6.21
N. obs		1093
N. Groups		77
R-sq within:		0.09

Table 6: Descriptive Statistics North vs South (average 2008:S2-2016:S1)

	Gross Loans to Assets	Total Liabilities to Gross Loans	NPL to Gross Loans	Liquid to Total Assets
South	0.64	1.47	0.10	0.06
North	0.42	2.29	0.04	0.14

Table 7: Descriptive Statistics North vs South

		% Change Peak to Trough	% Change Period Total
South	Assets	0.8%	8.2%
	Loans	-4.7%	0.0%
North	Assets	-17.4%	-11.0%
	Loans	-4.8%	1.0%

Table 8: Spatial Long-Run Equation for Gross Loans

Dependent Variable: Gross Loans	Model 1		Model 2	
	Coeficient	z-score	Coeficient	z-score
Total Liabilities	0.38	56.26	0.38	56.82
ECB funding	**2.50**	8.27	**2.27**	7.43
Liquid assets/Total Assets	-1.29	-3.97	-1.23	-3.87
NPL/gross loans	-0.93	-2.72	-0.99	-2.93
Lending Rate	-9.12	-3.14	-8.66	-3.03
Constant	123.95	7.17	140.56	7.71
	W_1		W_2	
Gross Loans	-0.28	-4.30	-0.39	-5.15
Wald test of spatial terms:				
chi2(1) = 18.53 Prob > chi2 = 0.0			chi2(1) = 26.52 Prob > chi2 = 0.0	
N. obs		912		912
R-sq adj		0.8396		0.8397
Ml est, wald Chi2		4807.67		4881.57
Delta-Method	W_1		W_2	
	dy/dx	z	dy/dx	Z
Total Effects:				
Total Liabilities	0.30	20.31	0.28	18.65
ECB funding	**1.98**	7.52	**1.65**	6.52
Liquid assets/Total Assets	-1.02	-3.71	-0.90	-3.63
NPL/Gross loans	-0.74	-2.80	-0.72	-3.00
Lending Rate	-7.21	-3.21	-6.31	-3.07

Table 9: Spatial Error Correction Models for changes in Gross Loans

Dep. Var. : D(Gross Loans)	Model. 1		Model. 2	
	Coef.	z	Coef.	z
D(Gross Loans(-1))	-0.20	-5.06	-0.19	-4.89
D(Total Liabilities)	0.20	15.70	0.21	15.88
D(Total Liabilities(-1))	0.06	4.41	0.06	4.28
D(ECB funding)	0.18	2.12	0.18	2.12
D(Real GDP)	0.09	1.89	0.09	1.93
Error Correction (-1)	-0.12	-5.67	-0.13	-5.95
	W_1		W_2	
D. Gross Loans	0.18	2.01	0.16	1.68
Wald test of spatial terms:				
chi2(1) = 4.06 Prob > chi2 = 0.04			chi2(1)=2.81 Prob >chi2 = 0.09	
N. obs		741		741
R-sq adj		0.3533		0.3569
Ml est, wald Chi2		425.74		427.61
Delta-Method	W_1		W_2	
	dy/dx	z	dy/dx	z
Total Effects:				
D(Gross Loans(-1))	-0.24	-4.48	-0.23	-4.35
D(Total Liabilities)	0.25	9.00	0.24	8.75
D(Total Liabilities(-1))	0.08	4.04	0.07	3.93
D(ECB funding)	0.22	2.08	0.21	2.07
D(Real GDP)	0.11	1.86	0.11	1.89
Error Correction (-1)	-0.14	-4.90	-0.15	-4.98

Appendix

If the 'normal' estimations were done for the same sample as the spatial estimations (i.e. for the same time periods and same banks) the results for the Error correction model would be the ones presented in Table A1. The implied reaction to a 1 euro permanent increase of ECB funding in a non-spatial and spatial setting are presented in Chart A1. We see that taking into account the spatial spillovers results in non-negligible differences in the banking systems adjustment process.

Table A1: Non-spatial Error correction model for changes in gross loans: Similar estimation periods and bank sample as Table 9 of the main results

Dependent variable: D(Gross Loans)		
	Coef.	t
D(Gross Loans(-1)	-0.20	-4.92
D(Gross Loans(-2))	0.16	4.42
D(Total Liabilities(-1))	0.21	15.46
D(Total Liabilities(-2))	0.06	4.26
D(ECB funding)	0.17	1.89
Real GDP		
D(Real GDP(-1))	0.08	1.62
Error Correction (-1)	-0.11	-5.04
N. obs		741
N. Groups		57
R-sq within:		0.31