Money and Credit dynamics in the Euro Area

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Jingyang Liu

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Chapter 1.
Introduction

The 2008 Global Finance Crisis (GFC) and the subsequent 2010 Euro crisis reinvigorated the long-standing debate on the role of money and credit in the economy. Directly after the crisis, a number of agents involved with the financial system were blamed in the media as well as academic circles for having significantly contributed to the initial boom and final bust. A quick consensus emerged that the banking sector typically took too many risks, facilitated by perverse incentives. Procyclical credit feedback loops led to an extreme rise of private –household – credit in many countries, accompanied by asset and real estate booms and increased financial fragility. Regulators and supervisors accommodated risk-seeking bank behavior to a large extent.

Central bankers concentrated on macroeconomic stability as reflected in low inflation and stable economic growth, ignoring the risks of financial instability. The low interest policy coincided with a substantial growth of bank credit as well money. For example, in the euro area M3 growth averaged almost 8 percent per year from 2001 to 2008, while inflation was stable with an average slightly above 2 percent. (see Setzer and Wolff, 2013). Central banks defended the low interest rate policy despite the relatively high money and credit growth by pointing at the instability of money demand and the corresponding short-run disconnect between money growth and inflation. In this thesis, I contribute to the analysis of money and credit in modern economies, particularly the euro area.

1.1 Background

1.1.1 Credit

It has been recognized for a long time that private – bank – credit plays a crucial role in the economy, both because of its intermediating function to allocate funds as efficiently as possible and to allow for the smoothing of consumption. Levine (2005) provides supportive evidence for the consensus existing just prior to the GFC, that financial development in general and a high credit-to-GDP ratio in particular is beneficial for economic growth. However, more recently new evidence has suggested that the link between financial development and economic growth may be less robust than previously thought, see for example Arcand et al. (2012) and Bijlsma et al. (2018). It shows that financial development is likely to have diminishing returns, so that there may be a threshold above which increasing credit may decrease growth. Similarly, Cecchetti and Kharroubi (2012, 2015) investigate the connection between financial development and economic growth in emerging countries and advanced countries. Their work shows that financial development is good for productivity growth under a certain level, after which it becomes a drag on growth. A fast financial-sector development is detrimental to advanced economies in particular in their view.

A related stream of research investigates the importance of the allocation of credit. During the period 1990-2010, Jorda, Schularick and Taylor (2016) observe a 78 percent increase of credit to GDP ratio in 17 advanced economies. More than two thirds of the growth is due to the expansion of credit to households, see also Admati and Hellwig (2014). Similar to Jorda et al. (2016), Bezemer et al. (2014), and Samarina and Bezemer (2016) empirically demonstrate that bank credit in the past decades has been reallocated away from lending to the non-financial corporate sector towards household – mortgage – credit. In their view, the switch from productive corporate credit to non-productive financial mortgage credit and credit within the financial sector exerts a negative effect on economic growth and a positive effect on the probability of future economic busts and credit crunches see also Cecchetti, King and Yetman (2011) and Beck, Degryse and Kneer (2014). If a crisis happens, economies with a large private debt burden typically have a longer and deeper recession. Moreover, Lane and Milesi-Ferretti (2011) and Büyükkarabacak and Krause (2009) find that economies with increasing household credit tend to have larger external imbalances and net capital inflows.

More generally, credit is found to be an important early warning indicator of financial crises. Schularick and Taylor (2012) identify run-ups of private-debt for OECD countries and point out that high credit growth is a crucial variable in the financial boom-bust cycle and one of the most reliable indicators of financial crisis. Borio and Shim (2007) document that industrialized and developed countries often experience economic busts after a strong credit expansion. In addition, Aikman et al. (2015) provide empirical evidence that credit dominates broad money as an indicator of financial distress. IMF (2009) also shows that private – domestic – credit dominates other variables in predicting financial busts. Mian and Sufi (2010) show that household leverage is a powerful indicator of the severity of the 2007-2009 recession in the U.S. In particular, increasing leverage and dependence on credit explains a large fraction of housing defaults and the subsequent recession. The important role of bank credit in the boom-bust cycle is strongly related to the pro-cyclical feedback loops between (mortgage) credit and real estate prices, and credit and financial market prices, respectively, see for example Adrian and Shin (2008, 2010). Reinhart and Rogoff (2009) observe that across many advanced economies recessions are preceded by large run-ups of real estate prices and large increases of current account deficits, essentially foreign credit.

The empirically observed negative consequences of excessive credit growth are in line with an older strand of literature — associated with Minsky (1982) and Kindleberger (2010) — that focuses on financial fragility and suggests that financial crises can be seen as "credit booms gone wrong." An example is the transition from the Great Moderation period—with low and stable inflation level and stable growth of GDP—to the GFC. Kiyotaki and Moore (1997) provide a theoretical basis for financial cycles. This approach also echoes Joseph Schumpeter's

diagnosis that "reckless lending" and financial speculation are closely linked to credit creation as the "monetary complement of innovation" over the business cycle (Schumpeter, 1939).

Since the recent crisis, the literature on measuring the financial cycle and using it as an early warning indicator has surged, see for instance Borio (2014). The most parsimonious description of the financial cycle is the combination of bank credit and property prices, especially housing prices (Drehmann, Borio, Tsatsaronis, 2012). This literature typically has a strong policy focus. Aikman et al. (2015), and Schularick and Taylor (2012) argue that officials could exclusively focus on credit cycle. On the other hand, Ng (2011) argues that officials could focus on property prices via the interaction between real estate prices and certain key variables, like inflation and the interest rate. To regulate and constrain – too – fast financial development and avoid another GFC, Borio and Shim (2007) propose to use macro-prudential tools to accompany standard monetary policy. Similar instruments are now implemented in the recent Basel IV regulation.

1.1.2 Money and credit

For monetary policy, three issues play a major role in the current debate. First, there is the use and effectiveness of unconventional monetary policy under zero lower bound conditions. This is strongly tied to the aftermath of the crisis. In the thesis this will only be touched upon marginally.

Second, there is the reflection on the appropriateness of solely concentrating on the final macroeconomic objectives of low and stable inflation and stable economic growth in normal times. This relates to the stability of money demand and the influence of real estate and equity prices. Increased financial development and substitution possibilities between different financial assets may destabilize money demand and make standard central bank policy more difficult. The current consensus is that central banks should not use their standard policy rate as an instrument for financial stability. Macroprudential policy instruments are seen as superior in this respect. It leaves open to what extent central banks can and should ignore the development of money and credit aggregates. If not, they may need to incorporate these indicators in their policy framework more explicitly.

Third, there is the discussion on the relation between money and credit in the real economy. Again, the debate can be traced far back in history. Here, I conveniently start with Bernanke and Blinder (1988) (B&B, hereafter). They document that the standard theoretical money demand model treats money and credit asymmetrically. In their view, money leads and constrains credit. In particular, B&B compare the traditional “money view” that money plays a central role in the transmission of monetary policy to the real economy and the “credit view” emphasizing

the dominant role of the modern financial system. However, as Blinder and Stiglitz (1983) argue, data analysis may have difficulty distinguishing between money and credit because the two normally are highly collinear.

An alternative view— the "endogenous money view"—provides a more fundamental departure point, which is rooted in post-Keynesian monetary theory (Lavoie, 1984). The starting point of the theory is that loans create deposits, not the other way around (Palley, 1994; Fontana 2003; Bofinger, 2001; and Werner 2014, 2016). Underlying this view is the assumption that banks are triggered by the demand for (new) bank loans, not by the demand for money (deposits). In its simplest form, the demand for money (deposits) then is determined by and equal to the demand for credit. The equilibrium obtained by the interaction of credit supply – optimizing bank behavior – and credit demand results in an equilibrium amount of credit, which is equal to the amount of money. This money supply is generated by the central bank, which passively fulfils any demand for bank reserves. In recent years, the endogenous money view has become more popular, helped by two stylized facts. First, central banks typically do not target base money or other monetary aggregates anymore. Second, it is well-known that commercial banks account for almost all money creation through the creation of credit, see for example McLeay et al. (2014).

Both B&B and the endogenous money supply view imply a strong positive relation between money and credit. However, Schularick and Taylor (2012) (S&T hereafter), Baeriswyl and Ganarin (2011) and Baeriswyl (2017) argue that the connectedness between monetary aggregates and credit regularly is weak in a modern economy. In particular, S&T investigate the development of money and credit since World War II. They show that there is a close link between the two before the war, while clearly divergent patterns appear afterwards.

From a policy perspective, the money-credit link has received increasing attention lately as well. A major driver has been the decreasing trust in the banking sector due to the GFC by the public at large. Governments have been forced to save major banks in many countries at the taxpayers' expense. The broad recognition that banks have not acted in the public interest, leading to private gains and public losses has caused a serious backlash. Moreover, many people feel their bank deposits are less safe than they thought and less safe than they think they should be. In support of this public view, academic research clearly documents the implicit and explicit subsidies banks receive through the deposit guarantee system and TBTF problems.

If private banks indeed can determine the amount of money and credit created and central banks have insufficient instruments to control this, it calls for other solutions. Public initiatives call for the possibility to have a public – risk free – substitute for private bank deposits. It has led to the suggestion to separate money and credit. One

option is to create 100 percent reserve banking. Recently, the idea has been floated again by Benes and Kumhof (2012). However, it actually dates back to the 1930s when it became known as the Chicago Plan. Alternatively, there is the option to allow individuals to directly bank with the central bank, using central-bank-issued-digital currencies (CBDC), see Kumhof and Noone (2018).[1] While interesting, little is known yet about the costs and benefits of the different solutions. Moreover, empirical evidence on the causality between money and credit is quite limited still.

1.1.3 The euro area

The money and credit issues discussed have a global nature and play in all – developed – countries. In this thesis, we focus on the Euro Area for three reasons. First, the euro area financial system is predominantly bank-based. As a consequence, its economic development is to a much larger extent depending on bank credit than is the case in Anglo-Saxon countries. Second, the common currency imposes a common monetary policy despite strongly heterogeneous credit and real estate market developments across countries (see Deutsche Bundesbank, 2013). As a result, monetary policy instruments to prevent or fight national boom-bust cycles are absent. Third, the internal market for financial services leads to almost perfect capital mobility in the euro area. As a result, cross-country capital flows – strongly related to cross-country bank credit – within the euro area have increased substantially since the start of the euro in 1999 and have contributed to the observed heterogeneity. The heterogeneity is shown to have a significant North-South pattern by Holinski, Kool and Muysken (2012), who document the development of current account imbalances of euro area members in the run-up to the GFC. They identify a divergent patterns between northern and southern countries, in particular a significant deficit position for the south and a significant surplus position for the north. However, they do not observe a corresponding productivity growth in southern countries. A similar pattern is observed in cross-border capital flows.

In addition, Borio and Lowe (2002, 2004) document that the build-up of external financial imbalances is the most common source of distress. Obstfeld (2012) observe that numerous crises have been preceded by large current-account deficits—Chile in 1981, Finland in 1991, Mexico in 1994, Thailand in 1997, the United States in 2007, Iceland in 2008, and Greece in 2010. He uses stylized facts to show that policymakers should pay attention to current-account imbalances since it captures economic fundamentals and can signal macroeconomic and financial stress.

[1] The increased popularity of private digital currencies – as for example Bitcoin – and the decrease in the use of cash are other arguments in the debate.

Nevertheless, the debate on the importance of macroeconomic external imbalances is not settled yet. Lane and McQuade (2014) argue that domestic macroeconomic imbalances are to a large extent financed by foreign bank credit. However, Gourinchas and Obstfeld (2012) empirically show that larger current-account deficits generally do not play a statistically significant role in helping predict crises. Moreover, Borio and Disyatat (2011) criticize the traditional view that countries with large current account surpluses are those with "excess saving". Unger (2017) provides evidence that external imbalances emerge from domestic pull (demand) rather than from foreign push (supply). Even though the general verdict on the role of current account imbalances is still out, a general consensus exists that current account imbalances in a currency union as the euro area do play a role in domestic boom-bust cycles. On the policy side, the EU has responded by implementing the Macroeconomic Imbalance Procedure (MIP) to at least monitor external imbalances better than before the GFC.

1.2 Setup of the thesis

The research conducted during my PhD has resulted in four papers which aim to contribute to a better understand of the dynamics of money and private credit, respectively and the complex relation between the two. The empirical analysis in all papers uses macroeconomic data from selected euro area countries.

In chapter 2, I start with the analysis of private credit dynamics in euro area countries to explore their connectedness both with the real economy and financial markets. It is an extension of Cecchetti and Kharroubi (2012,2015) on the one hand. In particular, it shows to what extent financial development, in particular private credit, is negatively or positively related to economic growth. On the other hand, I extend Reinhart and Rogoff (2009) by including housing prices, equity prices and net foreign credits. This strand's analysis also provides empirical support for the discussion of Ng (2011) that policy makers should focus on the interaction between credit, real estate prices and some key economic variables. Moreover, our analysis also solidifies Kool et al. (2013) and Lane and McQuade(2014) by discussing the connection between domestic credit growth and external debt accumulation—foreign borrowing in the euro area

In chapter 3, I focus on money and investigate the connection between monetary aggregates and the real economy. I incorporate real estate prices and equity prices in the monetary analysis to understand the effect from financial markets on the stability of money demand. It sheds light on the potential role of monetary aggregates and the appropriateness of interest rate targeting in monetary policy. From this perspective, my work is an extension of Nautz and Rondorf (2011).

The next two papers in my thesis concentrate on the relation between money and credit in the real economy, which now is at the heart of an ongoing macroeconomic debate. Chapter 4 builds on the two previous chapters and investigates to what extent money and credit deviations from trend – labeled money overhang and credit overhang, respectively –are related. It allows an assessment of the hypothesis that money and credit move symmetrically, as argued by Bernanke and Blinder (1988), for instance. However, in this chapter there is no strict causality test.

Subsequently, I directly address the causality between money and credit in chapter 5 to discriminate between the exogenous and endogenous money supply theory, respectively. This is particularly important for the euro area that is predominantly depending on bank credit, but has a unified monetary policy. At the same time, this causality research sheds light on the issue of the separation of money and credit and produces evidence on the casual inference debate of the two to some extent.

1.2.1 Credit

In chapter 2, I focus on the problem of the association between private credit and the real economy and financial markets in the euro area in the long-run as well as the short-run. Additionally, I take into account the potential GFC effect on the long-run relation. Thus, I construct a panel sample containing 10 original euro area members excluding Greece and Luxembourg, with quarterly data from 1999 to 2013. Following the basic specification built by Calza, Gartner and Sousa (2003) and Calza, Manrique and Sousa (2006), I employ income, which is denoted by GDP, as a transaction variable and the real interest rate to capture the opportunity cost as the core control variables. In addition, I incorporate two asset prices—housing price and equity price—to investigate the interaction between credit and financial markets, as well as net foreign credit positions —an approximate mirror image of the current account — to represent cross-border credit flows and macroeconomic imbalances in the analysis. All data are from ECB and Eurostat.

Chapter 2 contributes to the existing empirical research on macroeconomic credit dynamics by using a panel approach—dynamics OLS (DOLS)—which is proposed by Kao and Chiang (2001). So far, the literature on euro area credit is scarce. Existing research mostly uses a VAR/VECM model, see Calza, Gartner and Sousa (2003) and Calza, Manrique and Sousa (2006) for the euro area as a whole, which neglects information of individual countries. Hofmann (2004) and Goodhart and Hofmann (2008) investigate credit country by country, which does not allow results for a larger area as a whole. The DOLS method allows for heterogeneity of individual members. It produces a homogenous long run relation for the whole area and provides heterogeneous dynamics in the short run (Kao, 1999; Kao and Chiang, 2001).

Estimation results confirm that breaks occur in interest rate and housing price coefficients around the third quarter of 2008. For the period before 2008, the research identifies that private credit is positively related to income (GDP) with a unitary elasticity. It is negatively related to both the real interest rate and net foreign credit, and is positively connected to housing prices. The results are in line with previous literature like Calza et al. (2006), Lane and McQuade (2014) and Hofmann (2004). Credit creation is negatively linked to equity prices, which partly confirms Frömmel and Schmidt (2006) who investigate the dynamics between credit and stock prices using a VECM model for nine euro area countries over the period before 2004.

After 2008, my results show that the negative relation between credit and the interest rate turns positive, while it becomes negative for the relation between credit and housing prices. For income and net foreign credit, the results remain qualitatively similar. I use a time dummy to capture the break and incorporate corresponding interaction terms to build a long-run stable credit demand function.

The significantly negative link between net foreign credit and domestic credit is of particular importance in the euro area and the debate of cross-country imbalances. Our results show that countries that receive foreign credit tend to have high domestic credit creation and vice versa. Without a causality test, it is not possible to decide whether pull or push factors are dominant, see Unger (2017). However, the results strongly suggest that the combination of high capital mobility and large country heterogeneities should be a concern for monetary policymakers. More generally, there is also some broader evidence of a North-South divide, which requires further research.

1.2.2 Money

In chapter 3, I turn to an analysis of the development of monetary aggregates in the real euro area economy. From its start, the ECB has used a two-pillar approach to monetary policy, with one pillar being exclusively devoted to the development of the main monetary aggregate M3. In practice, the ECB appears to have reduced its focus on the monetary pillar in actual policymaking already quite early, partly due to overshooting of the assumed reference growth rate. Additionally, stylized facts show strong cross-country heterogeneity in money growth. Investigating the extent to which a stable and cross-country homogeneous long-run money demand equation can be obtained, therefore, may provide valuable information to policymakers.

Based on Coenen and Vega (2001), Calza, Gerdesmeyer and Levy (2001), and Brand and Cassola (2004), who specify a standard money demand function, I use real GDP to represent the transaction motive and the nominal interest rate—the 10 year government bond yield—to capture the opportunity cost of holding money in the long

run. Analogous to the chapter 2 credit analysis, I extend the money demand function by including housing prices, equity prices and net foreign credit, in turn. There is an extensive literature on the relation between money and financial markets, motivated amongst other by the theoretical portfolio framework of Friedman (1988). So far, the theoretical basis for the link between money and net foreign credit is not well developed yet. However, I include net foreign credit to parallel the credit specification in chapter 2.

The chosen setup allows us to discuss the relation between money, financial markets and macroeconomic imbalances. In this chapter, I use the same 10 original euro area countries panel data as in chapter 2, with quarterly data from 1999 to 2013 as well. I use M3 to represent monetary aggregates, which is provided at ECB statistics.

For the empirical approach, we follow Nautz and Rondorf (2011), Setzer et al. (2011) and Setzer and Wolff (2013), who all perform a money demand panel analysis where all variables are defined in deviation of the euro area mean. Compared to previous empirical money demand research, our sample includes the GFC period, allowing the investigation of potential structural breaks in the relation. Similar to chapter 2, I use the dynamic OLS model built by Kao and Chiang (2001) to estimate the long run money demand function. The method imposes identical long-run coefficients across countries but allows for heterogeneous short-run dynamics.

The estimation results show a positive income effect with a coefficient close to one, a negative interest effect and a significant positive housing prices coefficient for the period prior to 2008. The relation between equity prices and money demand in the euro area is weak. Complementary to results on the link between net foreign credit and domestic credit, I find a significantly negative link between net foreign credit and domestic money. However, the size of the effect is smaller for money than for credit. When I extend the period till 2013, I observe sign shifts happen in the interest rate coefficient, the housing price coefficient, and the coefficient of net foreign credit. To obtain a stable long run money demand function, I need to use a time dummy and interaction terms to capture the breaks.

Overall, the results are ambiguous. On the one hand, the results show a stable unitary coefficient between money and real income across countries, which is consistent with the transaction motive of money demand. Moreover, the results for the period before 2008 show plausible coefficients and are somewhat supportive of a stable money demand function. On the other hand, I document changes in the sign and size of most of the other coefficients around the GFC. Clearly, the financial crisis and its aftermath with interest rates reaching the zero lower bound and the introduction of unconventional monetary policies have changed transmission channels and monetary

relations. It is unclear if and when monetary policy can be normalized and whether the pre-crisis relation will be restored.

1.2.3 Money overhang and credit overhang

In chapter 4, I focus on the identification and analysis of (possible) excessive money and credit in euro area countries. In the analysis, I also explore the (possible) determining role of net foreign credit in the excessive creation of money and credit. The paper is based on chapters 2 and 3, where money and credit long-run theoretical equilibrium relations are identified and estimated. The chapter is closely related to Kool et al. (2013) and Schularick and Talylor (2012).

From chapters 2 and 3, I observe that the estimated long-run relations for money and credit have similar patterns in terms of the relation with real economy and financial markets. In particular, both money and credit are related about one-to-one to real GDP. Subsequently, I calculate money overhang and credit overhang by computing the time paths of country-specific deviations from the respective long run equilibrium values of money and credit. I compute overhang measures from specifications with and without net foreign credit. First, comparing the two overhang measures may shed light on the potential role of net foreign credit in determining excessive money and credit. Second, I test the correlation between money overhang and credit overhang, which sheds light on the money-credit relation.

Two findings stand out. First, the evidence confirms that overhang of both money and credit occurs in most periods. In particular, countries with current account deficits – and corresponding inflow of net foreign credit - exhibit a substantial build-up of credit overhang. Put differently, net foreign credit is strongly related to the development of credit overhang. The size of the estimated credit overhang is significantly reduced once net foreign credit is included in the specification used to calculate the overhang. In contrast, the relation between money overhang and net foreign credit is rather weak.

Second, with respect to the association between money overhang and credit overhang, the interaction is limited across the 10 original countries. It throws doubt on the hypothesis that it is primarily the money–creating potential of commercial banks that drives credit booms. Instead, countries can experience a substantial amount of credit overhang without the build-up of money and vice versa. As shown in our analysis, net foreign credit is one channel that can create a wedge between money and bank credit. But also other, market-based, funding options available to commercial banks for additional loan supply may need to be taken into consideration. Our findings suggest a broader approach of bank credit is required, encompassing more items on the banking sysems' balance sheet.

1.2.4 Causality between money and credit

Following up chapter 4, in this chapter I focus on the causality between money and credit to further explore the phenomenon identified that "countries can experience a substantial amount of credit overhang without the build-up of money and vice versa". The evidence in chapter 4 suggested a potentially loose relation between money and credit creation. Simultaneously, this causality research contributes to the debate on the exogenous versus endogenous money supply theory.

In chapter 5, I use deposits and private loans. In addition, four other bank balance sheets items, i.e. debt, net securities, net interbank borrowing and net external position are included in the deposit-loans analysis. I use six euro area countries, three from the North—Austria, Germany and the Netherlands – and three from the South (or periphery)—Spain, Italy and Ireland. Monthly data from 1997 to 2018 are available from ECB statistics. Chapter 5 is an extension of work by Badarudin, Ariff and Khalid (2013) amongst others.

To investigate the causality, I employ an innovative method named VAR-LiNGAM which is developed by Moneta et al. (2013). The standard methodology—either a restricted or unrestricted VAR/VECM—is sensitive to the lag choice in the model (Granger 1988). Moreover, in a (sign) restricted VECM, results are also conditional on the imposed restrictions which are based on prior economic knowledge. This type of empirical literature yields mixed results. For instance, Howells and Hussein (1998) and Caporale and Howells (2001) both find that loans causally drive deposits in G-7 countries, but with some caveats. Badarudin, Ariff and Khalid (2013) find strong supportive evidence for the endogenous view for Germany and Canada, while they cannot exclude the exogenous view for France, Italy, US and the UK. In contrast, the VAR-LiNGAM method does not require the use of prior economic theory to impose restrictions but depends on data characteristics, in particular the presence of non-normality.

Using this method, I find a strong positive relation between bank deposits and bank loans in five countries out of the six. However, the direction of causality varies across countries. That is—for Austria and Germany, bank deposits drive loan creation, while for Spain, Ireland and the Netherlands, loans drive deposits. For Italy, no significant causality is observed. Furthermore, there is no clear North-South divide in exogenous versus endogenous money according to our results.

The results do show more complex dynamics in bank balance sheet items than a simple one-to-one relation between loans and deposits. First, I find a significantly negative relation between the net external asset position and net interbank lending for all countries. It means that more net foreign lending may either reduce interbank lending or attracts more interbank borrowing. Moreover, a few patterns are only found in a smaller set of countries.

For Germany, Ireland and the Netherlands, I find bank deposits may causally drive interbank lending, while banks loans may causally drive interbank borrowing. For Spain, Italy, and the Netherlands, I find that bank debt leads bank loans. None of these findings – though admittedly only found in a few countries – appear supportive of the endogenous money supply theory.

1.3 Concluding remarks and directions for future research

Based on the analyses from chapters 2 to 5, three strands of conclusions stand out. The first one is the relation between money and credit respectively with the real economy and financial markets; the second one concerns the bivariate relation between money and credit; the third strand is the role of net foreign credit in money and credit creation, respectively.

Evidence on the stability of the relation between money and credit respectively with the real economy and financial markets is mixed. In particular, money and credit both have a consistently positive and close to unitary coefficient with income before and after GFC. Moreover, the negative link between net foreign credit and domestic credit is quite stable as well. However, breaks occur in long run money and credit relations, which mainly happens in interest rate and housing price coefficients. This provides a challenge to policy makers in using the development of money and credit aggregates as indicators for monetary policy. In particular, they need to consider whether the pre-crisis patterns will return or not. Therefore, a further analysis on the post-crisis period may shed additional light on this issue.

The next point I would like to emphasize concerns the relation between money and credit. On the one hand, my evidence in chapters 2 and 3 shows that money and credit have similar patterns in terms of their relations with the real economy and financial markets, particularly before the GFC. Especially, they share the almost proportional trend co-movement with real GDP. In addition, chapter 5 shows that loans and deposits have a strong positive relation in the six euro area countries that I have investigated. On the other hand, the overhang analysis in chapter 4 provides some contradictory evidence. It shows that countries with a build-up of credit overhang may not be the ones that experience money overhang, and vice versa. This suggests a rather loose relation between money and credit in the short-run. Finally, the causality analysis in chapter 5 is inconclusive, as the direction of causality across countries is heterogeneous. In addition, chapter 5 shows a complex transmission of monetary policy through the bank balance sheet in excess of the loan-deposit relation. Also other bank assets and liabilities play an important role. Their role deserves further analysis. The same holds for additional research on the causality between money and credit in general.

The third issue I would like to point out is the role of net foreign credit. In particular chapter 2 illustrates that countries who lend more to other countries will have less space to create credit in their domestic market. I estimate a significantly negative stable long-run relation between net foreign credit and domestic credit. In addition, chapter 4 shows that net foreign credit is a significant factor behind the estimated credit overhang in a number of countries. The empirical relation between net foreign credit and money (chapter 3) is found to be much weaker and less stable. Moreover, a theoretical framework for this relation is still lacking and needs attention.

My findings of the relation between domestic and foreign credit are consistent with the often- mentioned North-South divide in the euro area. Overall, this provides supportive evidence for the hypothesis that in a monetary union with full capital mobility macro-economic imbalances, as reflected in sizable current account surpluses or deficits, are related to imbalances in domestic credit conditions and potentially to the emergence of national boom-bust cycles in real estate and equity markets. My results do not allow drawing conclusions about the direction of causality. However, the existence of this relation should be a point of attention for policymakers. It emphasizes the need for future research on this topic.

In addition to the above three general points, improvements are also possible with respect to the data and methodology for future research. This thesis focuses on the euro area, which limits the time span for which data are available. In most cases, data for the euro area start around 1997 or even later. The quarterly data I use in chapters 2 to 4 are from the ECB and Eurostat and cover the period 1999-2013. For the empirical estimation with housing prices, it is limited from 2000. Moreover, the GFC is shown to cause breaks in the estimated relations in 2008. The limited time span, particularly for the estimation after 2008, may exert bias effects on the estimation. The analyses in chapter 2 to 4 now end with data in 2013. They would benefit from the inclusion of more recent data. More recent data could shed light on the robustness of our results – in particular the post-2008 period – and reduce the weight of the GFC event in the data.

With respect to the methodology aspect, I use DOLS (Kao and Chiang, 2001) to estimate the long run equilibrium. That is because DOLS is preferred to FMOLS when the time span and cross section number is relatively small. If it would we possible to expand the times series length and countries in our sample, FMOLS could be used as a robustness at least. With respect to the VAR-LiNGAM method in Chapter 5, it is a very innovative causality estimation method, for which no proper robustness tests are available yet.

Furthermore, I only use a small set of all euro area countries in the analysis. In chapters 2-4, I use 10 original countries from the euro area, excluding Greece and Luxemburg, due to issues of data availability. In chapter 5,

only six euro area countries are used. On the one hand, the 10 initial countries account for more than 90% of the whole area in terms of economic activity. Therefore, my results are economically significant and provide reliable policy implications in my view. On the other hand, intuitively, it would be more persuasive if to include all original countries or even all countries to capture the whole area.

Chapter 2.
Credit dynamics in the euro area: a disaggregate panel approach

2.1 Introduction

It has been known for a long time that private – bank – credit plays an important role in the economy, both as a driver of economic growth and as a leading indicator of asset market booms and subsequent busts and financial crises. Understanding the determinants and dynamics of credit is particularly important for the euro area for two reasons. First, the euro area financial system is predominantly bank-based. As a consequence, its economic development is to a much larger extent depending on bank credit than is the case in Anglo-Saxon countries. Second, the common currency and the internal market for financial services lead to almost perfect capital mobility in the euro area. As a result, cross-country capital flows within the euro area have increased substantially since the start of the euro in 1999 with strongly heterogeneous credit developments and potential imbalances as a consequence. The heterogeneous development of private credit as well as real estate markets across euro area countries prior to 2008 is clearly documented in Deutsche Bundesbank (2013). The heterogeneity is shown to have a significant North-South pattern. A similar pattern is observed in cross-border capital flows.

Despite these considerations, empirical evidence on credit dynamics in the euro area is relatively scarce so far. The literature that exists mostly focuses on the aggregate euro area or on one or more individual euro area countries.[2] In this paper, we contribute to the literature with a simultaneous – panel – analysis of private credit dynamics in ten euro area countries with quarterly data over the period 1999-2013.[3] The panel setup allows for a better understanding of the common drivers as well as the heterogeneity of private credit dynamics across euro area member countries. Moreover, it alleviates the obvious limitation of short time series for single euro area countries. Our specification facilitates an analysis of credit developments in individual euro area countries in relation to standard determinants such as income and real interest rates. In addition, we in turn include stock prices and real estate prices to investigate the link between credit and asset markets, and cross border credit flows – proxied by net foreign bank lending – to account for the link between external imbalances and domestic credit growth.

We apply a panel co-integration approach—DOLS—assuming homogenous long run relation across ten countries, but still allowing for heterogeneity in the short run dynamics. Since the 2008 financial crisis had considerable influence on economic and financial conditions in the whole area, we allow for a structural break in the relations

[2] An exception is De Bandt et al. (2009), who take an approach that is related to ours.
[3] See Nautz and Rondorf (2011), Setzer and Wolff (2013) and Setzer et al. (2011) for a similar approach to money demand and De Bandt et al. (2009) for credit demand.

in 2008. Acknowledging that, we estimate the credit relation for two separate sub periods, i.e. 1999-2008 and 2008-2013, as well as over the whole period using a break dummy and corresponding interaction terms.

Overall, when considering the first sub period, we document a significantly positive income elasticity, a negative interest effect, a positive house price effect, a negative equity price effect and a negative link to the net foreign credit position. Our results are consistent with those in previous empirical studies, but have more stability and precision because of the exploitation of the cross-country heterogeneity to determine common drivers.

When we extend our sample period and include the post-crisis period we find a structural break in the long run credit relation. We show that it is necessary to explicitly account for a structural break in 2008 to identify a stable relation between private credit and a set of standard macroeconomic variables. The break is particularly important for real interest rate and real house price effects. The interest effect changes sign from negative to positive after 2008, while the housing effect changes from positive to negative.

Finally, we analyze the South-North divide in the euro area from the perspective of the relation between credit, the real economy and asset markets. The most pronounced difference between the North and the South appears in the real interest rate and house price effects after the crisis. A more in-depth analysis into this phenomenon is left to future research.

The paper is set up as follows. In section 2.2, we briefly review the literature about private credit in the euro area. In section 2.3, we formulate our hypotheses, introduce the empirical model that we will use for the analysis, and briefly discuss the preferred econometric methodology. Section 2.4 contains an overview of the sources of our panel data and corresponding stylized characteristics. Section 2.5 presents and discusses the empirical results. Section 6 concludes.

2.2 Literature review

In this review, we start with a short review of the main strands in the literature on credit. Then, we turn to the available empirical evidence for the euro area.

2.2.1 A broad overview

It has been recognized for a long time that private – bank – credit plays a crucial role in the economy, both because of its intermediating function to allocate funds as efficiently as possible and to allow for the smoothing of consumption. Simultaneously, it has been clear that there is a dark side to credit.

Levine (2005) provides supportive evidence for the consensus existing at that time, that financial development in general and a high credit-to-GDP ratio in particular is beneficial for economic growth. The 2008 Great Financial Crisis and its aftermath have caused a surge in credit-related literature and reassessment of its benefits and costs. First, new evidence suggests that the link between financial development and economic growth may be less robust than previously thought, see for example Arcand et al. (2015) and Bijlsma et al. (2018). It shows that financial development is likely to have diminishing returns, so that there may be a threshold above which increasing credit may decrease growth. Second, there is strong evidence that high credit growth is a crucial variable in the financial boom-bust cycle and one of the most reliable indicators of financial crisis, see for example Reinhart and Rogoff (2009), Schularick and Taylor (2012), and IMF (2009). The concept of credit cycles and financial instability dates back to Schumpeter and Minsky. Kiyotaki and Moore (1997) provide a theoretical basis for such cycles. Since the recent crisis, the literature on measuring the financial cycle and using it as an early warning indicator has surged. See Borio (2014) for an overview.

Schularick and Taylor (2012) and Aikman et al. (2015) provide empirical evidence that credit dominates broad money as an indicator of financial distress. IMF (2009) also shows that private – domestic – credit dominates other variables in predicting financial busts. Aikman et al. (2015) establish a conceptual framework to discuss three mechanisms that could explain swings in the credit cycle relative to the real business cycle. They propose to implement macro-prudential policy to curb the credit cycle. In addition, their work shows that the synchronization of credit cycles across countries has increased, due to the interaction between multi-national banks.

In general, the above literature takes domestic credit developments as given and subsequently analysis its role as determinant of future GDP growth or as an indicator of financial crises. Little attention is given to the underlying determinants of credit demand and credit supply and the interaction between the two. Bernanke and Blinder (1988) (hereafter, the BB model) firstly model credit from the supply side as well as the demand side, incorporating standard economic variables like the real interest rate and income. Their work provides a theoretical basis for an analysis of the relation between private credit, the real economy and financial markets. Chiades and Gambacorta (2004) extend the BB model into an open economy with a quasi-fixed exchange rate regime. The work demonstrated empirically the importance of credit in implementing effective monetary policy as well.

2.2.2 Empirical evidence for the euro area

The empirical literature on credit dynamics and the relation between credit, asset markets and cross border flows is rather limited for the euro area. Most research ignores the supply side of the market for bank credit and focuses

on the demand side. In this approach, banks are supposed to set the lending rate and to provide an almost infinitely elastic supply of credit, facilitated by central bank policy. This may have been a plausible assumption prior to the 2008 crisis. After that, stricter regulation and the need to clean up banks' balance sheets because of too high amounts of non-performing loans and other toxic assets and too low levels of capital are likely to have made credit supply less elastic.

Early private credit studies for the euro area as a whole by Calza, Gartner and Sousa (2003) and Calza, Manrique and Sousa (2006) relate credit to economic activity (GDP) and the real interest rate. Note that these studies mostly focus on the period prior to the start of the euro, so that aggregate euro area variables had to be constructed from national data. While these two studies have a somewhat different research design, they both find a stable long-run relation between credit demand, income and the real interest rate. Subsequent studies typically incorporate additional variables in the credit specification, such as house prices, stock prices and cross-country capital flow to retain the stability of private credit demand.

The literature relating private credit growth to house prices for euro area countries is relatively extensive. Boom and bust cycle in credit market have historically been strongly associated with cycles in property markets (Borio and Lowe, 2002). Several contributions show that credit developments tend to be positively related to asset prices particularly the house price. Examples are Detken and Smets (2004) and Gerdesmeier et al. (2010). Kaufmann and Valderrama (2007) document that house prices and private credit may reinforce each other. That is, the increase of house prices indicates the growth of collateral value, which permits a further extension of private credit. At the same time, credit stimulates investment which leads to the increase of house prices. Hofmann (2004) and Goodhart and Hofmann (2008) investigate countries outside of the euro area and support the positive relation between house prices on credit growth. Overall, the literature concludes there is a positive relation between house prices and credit, particularly during the boom phase.

Studies that focus on the relation between credit and equity price are relatively limited. Krainer (2014) documents that stock markets play a key role in lending decisions and allocation of resources in Europe. Frömmel and Schmidt (2006) run a Markov switching error correction model for 9 euro area member countries before 2004, but find diverse relations. They detect a strong positive co-movement of the credit volume with the development of stock markets for 6 member countries like Belgium, Germany and Portugal, but not for the remaining ones. Bernanke and Gertler (1995) argue there might be a negative relation between equity prices and credit demand. In times of an economic upswing, indicated by the increase of stock prices, the cash-flow position of firms is

likely to improve, so that firms may switch from external to internal financing and thus reduce their borrowing. That is, firms may prefer to increase saving to smooth consumption particularly under a transitory economic environment.

Several studies discuss the relation between credit growth and external imbalances in the euro area. Quite some evidence shows that current account deficits were financed to a large extent by foreign bank credit. Seminal references in this strand are Borio and Disyatat (2011) and Lane and McQuade (2014). In general, both give suggestive evidence of a positive relation between domestic credit growth and net foreign credit[4]. However, the direction of causality is unclear. Unger (2017) relates current account imbalances in euro area countries to domestic credit growth and argues that the evidence suggests that domestic lending drives borrowing from abroad. Some other studies try to identify the underlying channel how cross border capital flows interact with domestic credits. Gómez et al. (2014) argue that capital flows, through their effect on asset prices, negatively affect the external financing premium, augmenting the borrowing capacity of firms. Aoki et al. (2009) draw a similar conclusion using a theoretical model in which asset prices and credit limits are shown to have a strong interaction that works as a propagation mechanism; the effects of higher capital inflows towards the real sector are amplified by the increase in asset prices, which further loosens borrowing constraints.

A general criticism with regard to the estimation of credit functions in the euro area is that cross-country heterogeneity is not considered. An analysis of aggregate credit development for the euro area implicitly assumes that member countries have a similar economic environment and development path under the unified monetary policy. This is a rather heroic assumption, which is unlikely to hold in practice. Hristov, Hulsewig and Wollmershauser (2012) and Darracq-Paries, Maurin and Moccero (2014) employ individual country data. Both contributions build a panel-VAR and consider cross country heterogeneity to some extent but do not treat the euro area a whole. De Bandt et al. (2009) investigate household (HH thereafter) credit in the euro area. They adopt an ARDL approach using eight countries and find a positive a relation between the HH credit and housing price in the long run. The advantage of this study is that it considers the cross-country heterogeneity, but the disadvantage is that the ARDL framework does not provide a test for cointegration taking advantage of the panel dimension.

So far, panel-analyses of credit dynamics for a group of euro area countries to exploit heterogeneity with the purpose to find common drivers do not exist. This stands in sharp contrast to the money demand literature for the euro area. Nautz and Rondorf (2011), Setzer van den Noord and Wolff (2011) and Setzer and Wolff (2013) all

[4] See Kool et al.(2013) for a detailed discussion.

take this approach to analyze euro area money demand. In this paper, we take the same route for a credit market analysis

2.3 Hypothesis and model

The primary aim of this paper is to analyze credit dynamics in the euro area for the period 1999-2013, using a disaggregate panel approach. The heterogeneity of credit dynamics across euro area member countries may help identify the relation between private credit, income, the real interest rate, real estate and equity prices and cross border capital flows, with particular focus on the last three variables. Our ultimate purpose is to obtain a common and stable long-run equilibrium relation between credit and some key economic variables by exploiting the cross-country heterogeneity in the data. This may provide useful insights into both aggregate and disaggregate credit developments in the long-run. In addition, a better understanding of the long run relation between domestic credit and asset market prices and cross-border credit respectively may be helpful for policy makers in designing and operationalizing financial and macro-prudential policies. In this respect, Bernanke and Blinder (1988) document that monetary policy actions affect the real economy not only through the money market but also through the credit market. Friedman (1981) and Blinder and Stiglitz (1983) propose to use aggregate credit as an intermediate target for monetary policy. The stability of the credit function thus is of great importance in implementing monetary policy as well.

2.3.1 Hypotheses

First, we focus on the relation between domestic credit creation and house prices. Over the past decades, individual euro area countries have experienced – unsynchronized – episodes of booms and busts in credit markets. These credit cycles have often coincided with cycles in economic activity and property markets. Theoretically, there is a positive and potentially bi-causal link between credit and real estate prices. Higher house prices lead to wealth increases which induce consumers to spend and borrow more, and simultaneously allow banks to supply credit more because of increased collateral value.[5] Higher availability of credit in turn may cause extra demand in the real estate market, leading to rising prices.[6] The available empirical literature generally supports the positive relation between credit and house prices. Based on the above, our first hypothesis is that house prices are positively related to domestic credit creation.

[5] In addition, the construction sector may boom and investment in new houses will increase because Tobin's q, the ratio between market value and replacement cost, rises. Part of this investment will be financed by bank credit. See also Goodhart and Hofmann (2008).
[6] See also Kaufmann and Valderrama(2007).

Second, we address the relation between equity prices and the volume of private credit in euro area countries. To a large extent, for equity prices the same arguments hold as for real estate prices, suggesting a positive relation between credit and equity prices. Price increases increase wealth and collateral value for consumers and firms, allowing both to borrow more. Higher credit availability may also drive up equity prices if investors use borrowed funds to buy stocks. On the other hand, higher stock prices may cause firms to fund new investments by new equity issuance or internal finance, reducing the demand for credit. This would lead to a negative relation between credit and equity prices (see Bernanke and Gertler, 1995). The empirical literature provides mixed evidence as documented in the previous section. Overall, we leave the sign of the relation between domestic credit creation and equity prices to be determined in the empirical analysis.

Third, we investigate the relation between domestic credit and cross border credit flows. The link between domestic credit growth and external imbalances has recently received extra attention. Stimulated by the emergence of large and persistent current account deficits of some euro area countries prior to 2008, the question has arisen to which extent large foreign capital flows can be a determinant of domestic credit creation. Literature suggests that it is not the current account per se, but cross-country bank credit that may accommodate credit booms in individual countries, see for instance Lane and McQuade (2014) and Borio and Disyatat (2011). The latter also claim that it is not 'excessive saving' (push factor) that drive cross border capital flows, but the 'excessive elasticity' (pull factor) of the global monetary and financial system that fails to constrain the unsustainable build-up of credit and asset price booms.[7] Unger (2017) gives suggestive evidence for the dominating role of the pull factor using a panel analysis. Therefore, we hypothesize a negative relation between domestic credit and net foreign lending. Countries who borrow more from abroad, generate more credit domestically.[8]

Lastly, we account for potential instability of the credit function, in particular because of the 2008 financial crisis which may have had serious effects on the relation between credit and some of its determinants. Both households, firms and banks in many countries suffered from excessive indebtedness and consequent balance sheet problems after the crisis. Balance sheet repair depressed both credit demand and credit supply for a considerable period. Interest rates went to zero, reaching their natural lower bound and central banks increasingly resorted to unconventional monetary policies. Whether banks were still willing and able to supply credit at a given interest rate under such conditions is unclear a priori. It makes sense to at least allow for a structural break in the credit

[7] To support their view, they also point to the fact that gross cross-border capital (credit) flows are a multiple of net capital flows and their mirror image, the current account.
[8] Our study abstracts from the causality issue in the relation between cross country bank credit flows and domestic credit growth. Kool et al. (2013) suggest bidirectional causality between the two.

relation. Therefore, we do the panel estimation both for the whole period 1999-2013, the two sub periods 1999-2008 and 2008-2013 and the whole period while adding a structural break dummy and corresponding interaction effects.

2.3.2 Model

In this part, we introduce the specification of the private credit relation to be estimated. To model the credit market, we refer to Bernanke and Blinder (1988) and express a simplified credit demand function as:

(2.1) $CR^d/P = L(Y, RR, Z_1)$

Where CR is nominal private credit, P is the GDP deflator, Y is income which is usually represented by GDP, RR is the real interest rate on bonds, which we use as a proxy for the loan rate, and Z_1 comprises additional factors. Theoretically, credit demand depends positively on income and negatively on the loan rate. A simplified credit supply function can be written as:

(2.2) $CR^s/P = S(Y, RR, (1-t)D, Z_2)$

Here, D is bank deposits, t is the bank reserve ratio and Z_2 represents other factors. Credit supply depends positively on income Y and the amount of available funds - deposits corrected for reserve requirements – and positively on the loan rate RR. The interaction of credit demand and credit supply results in realized values of the volume of credit and the loan rate. Empirically, the sign of the relation between credit and loan rate is undetermined without further identification and depends on the actual demand and supply shocks hitting the credit market. In addition, we need to point out that the role of the deposit level has become subject of considerable debate recently. In traditional credit market analysis, bank deposits are assumed to be exogenous and to constrain credit expansion. More recently, it is increasingly acknowledged that this constraint is looser than previously thought. Partly because banks increasingly use market funding in addition to deposit funding, partly because they tend to increase loans and deposits simultaneously, facilitated by central bank liquidity policy, see for instance McLeay et al. (2014). For this reason, we do not use a proxy for the level of deposits as an explanatory variable in our credit market specification.

With these caveats in mind, we assume a semi-log linear equation for the relation between private credit and a relevant set of scale and opportunity cost variables. Then we add house prices, equity prices and net foreign credit in turn as an additional variable in the credit function. This gives

(2.3) $c_{it} - p_{it} = \alpha_{it} + \beta_{it} y_{it} + \gamma_{it} RR_{it} + \theta_{it} Z_{it} + \varepsilon_{it}$

Where (*c-p)* is real private credit taken in logs, y is real GDP in logs and *RR* represents real borrowing costs. In our analysis, we take the nominal bond yield corrected for inflation as proxy for *RR*.[9] The parameter β_{it} denotes the elasticity of credit with respect to the income variable. We expect it to be positive and close to unity. The impact of the cost of credit is captured by the semi-elasticity γ_{it}. Most research using some variant of equation (2.3) assumes it can be interpreted as a credit demand function.[10] In that case, γ_{it} is expected to be negative. However, when supply effects are also important, the sign of γ_{it} becomes indeterminate. θ_{it} is expected to be negative when Z is net foreign credit. Net foreign credit is the net amount of one country's cross border lending to the rest of the world. The higher the stocks of outstanding net foreign credit, the lower domestic credit and vice versa. θ_{it} is expected to be positive when Z represents house prices, its sign is ambiguous when Z represents equity prices.

2.3.3 Econometric method

Since the variables entering equations (2.3) are typically nonstationary, the appropriate empirical design is based on panel co-integration methods. Co-integration estimation yields estimates of the common cross-country long-term equilibrium relation between dependent and independent variables.

To do so, we adopt a parametric panel co-integration approach – DOLS – proposed by Kao and Chiang (1999). It assumes homogeneous long-run equations across the countries in the panel, while allowing for heterogeneity through country-specific short-run dynamics and fixed effects.[11] The FMOLS method proposed by Pedroni (2000, 2001, 2004) focuses more on long-term heterogeneity across countries. We adopt DOLS in this paper to estimate a long run co-integrating vector for two reasons. First, we think it is more plausible to assume homogeneity across euro area countries in the long run due to their strong similarities and common monetary framework. Second, Kao and Chiang (1999) and Mark and Sul (2003) convincingly show that DOLS is preferable to FMOLS in samples with modest number N and large T. To minimize the impact of omitted variables and cross-sectional dependence, we use time-demeaned variables in the analysis.[12]

2.4 Data

Our sample contains ten original Euro area members, Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain. The 11th initial euro country Luxemburg is excluded due to lack of data.

[9] We would prefer to use a forward-looking, expected, real interest rate. However, such data are not consistently available for most countries in our sample. Therefore, we have to resort to a backward-looking real interest rate using realized inflation.
[10] See Calza et al. (2003), Calza et al. (2006) and Hofmann (2004).
[11] See also Stock and Watson (1993) and Kao (1999).
[12] This is similar to the approach taken by Nautz and Rondorf (2011), Setzer, van den Noord and Wolff (2011) and Setzer and Wolff (2013) in the case of euro area money demand.

The same holds for Greece that entered shortly after the introduction of the euro. The time span is from 1999Q1 to 2013Q3.

Quarterly private credit is defined as credit to the non-financial sector. The data is collected from BIS statistics[13], and is seasonally adjusted by X-13-ARIMA for each country. Nominal and real quarterly GDP, as a proxy for income, are taken from Eurostat statistics, the latter being defined as chain-linked volumes with 2005 as the reference year. The GDP deflator (2005=100) is constructed to be the ratio of nominal to real GDP multiplied by 100. Real private credit is nominal credit deflated by the GDP deflator. In the subsequent empirical analysis, real private credit and real GDP are expressed in logarithms. The monthly 10-year government bond yields per country come from the ECB.[14] Quarterly interest rates are constructed as period averages and expressed as annual percentages. Real interest rates are defined as the nominal long-term interest rate deflated by contemporaneous inflation as measured by the annual percentage change in the GDP deflator.

In addition, proxies for two wealth factors, i.e. house prices and equity prices are used in the analysis. Quarterly data for the nominal housing price index are collected from the OECD[15] with 2010=100. Note that the data are accessible from 2000Q1. For equity prices, we employ a Datastream index with 1985 as base year. Real housing prices are defined as nominal prices deflated by the GDP deflator. The same holds for real equity prices. The two real prices are expressed in logarithms in our subsequent analysis as well. As explained in the previous section, we also want to incorporate a measure of cross-border credit in our data. The raw data is taken from BIS locational banking statistics by residence and denoted in US dollars. We take cross-border bank asset and liability positions which represent the outstanding end-of-month amount of claims and debts that the reporting country's banking system holds to parties outside the country. For instance, the gross foreign asset position of the Netherlands at a point in time equals the amount that banks residing in the Netherlands have lent to the rest of the world including other EA members.[16] The gross liability position is defined similarly as the amount that banks residing in the Netherlands have borrowed from the rest of the world including other EA members. We define net foreign credit as the difference between cross-border assets and liabilities.[17] The data are converted to euros, using the

[13] Since its establishment, the euro area has been expanding and now contains 19 countries. Most new countries are relatively small. A comparison of the aggregate amount of credit in our 10 country sample with the official ECB data for the changing euro area as a whole show a very close relation, providing suggestive evidence that our data capture most of the euro area wide developments.
[14] Over the sample period, the use of the long rate does also have the advantage of not facing the zero lower bound problem.
[15] House prices refer to residential property prices.
[16] Ideally, we would like to split up net foreign credit in the country's net position relative to the rest of the euro area and its net position to the rest of the world excluding the euro area. Unfortunately, the data do not allow such break-up.
[17] Net foreign credit is a narrower measure than a country's net foreign asset position which includes all cross-border assets and liabilities, like for instance FDI. The net foreign asset position theoretically is the mirror image of the cumulated current account.

dollar/euro exchange rate provided by the ECB reference exchange rate statistics. Finally, net foreign credit is scaled by nominal GDP and expressed in percentage points.

Table 2.1 provides stylized statistics for all variables in our analysis. We distinguish between levels and first differences and between the full period 1999-2013 (panel A) and two sub-periods, 1999-2008 (panel B) and 2008-2013 (panel C) respectively. It is important to note that the statistics are a mix of cross-country variation (between) and time-variation (within). Both can be substantial but the degree to which this is the case depends on the specific variable. We start with the full period. The log levels of credit and GDP display large structural and persistent differences across countries due to differences in size (population) and level of economic development (per capita income). Housing prices and equity prices show less variation across countries. Net foreign credit is already scaled by GDP so that country size is not an obvious determinant of cross-country variation. However, some countries tend to be persistent debtors (borrowers), while others are persistent creditors (savers) due to underlying characteristics. Net foreign credit shows the most variation of all variables. The relatively high real interest rate variation is mainly caused by the cross-sectional divergence in the second half of the sample. The first difference statistics in panel A show that over the full sample period, the growth of real GDP was about 1.4 percentage per year, while the growth of real credit was close to 4 percent. On average, the change in the real interest rate was zero. House prices rose with about 1.5 percentage annually and equity prices decreased with slightly more than 2 percent per year. Net foreign credit increased slightly too. Variation in equity prices changes was quite large as could be expected. Variation in house price changes is much more subdued and comparable to credit growth variation.

With regard to the statistics across the two sub periods, most variables in level show quite stable patterns in terms of means and variations. The exception is the long-term real interest rate which shows a doubling of the standard deviation from the first sub period to the second sub period. Due to the financial crisis, there is substantial cross-country variation as well as cross time variation in the real rate. In particular, the rate fell after the 2008 financial crisis in the Northern European countries and showed a strong increase in the Southern members. With respect to variables in first differences, the sub-period distinction shows that the average growth rate of credit, real GDP, house prices and equity prices experienced a substantial decrease from 1999-2008 to 2008-2013. Annual real credit growth declined on average from close to 7 to -1 percent, while real GDP growth amounted to about 2.4 percent per year before 2008 and became negative (-0.6) thereafter. Housing prices increased by almost 4 percent per year before 2008 and declined by 2.5 per year after. For equity prices, corresponding percentage rate changes

are +1.2 and -8. Changes in the real interest rate and net foreign credit appear less dramatic, though for the two overall variation increases comparably.

To bring out in more detail the relative contribution of cross-country variation and time variation and focus on country heterogeneity, we provide some graphical evidence in figures 2.1 to 2.5 for the central variables in our analysis. In figure 2.1, we graphically show the average annual growth rate of real credit over time and additionally plot the minimum and maximum growth rate across countries for each quarter to indicate the range of variation. For comparison, we also include the average growth rate of GDP. A first observation standing out from figure 2.1 is that there is indeed substantial variation across countries and time. The band width reaches a maximum difference of about 30 percent in 2005-2007, preceding the crisis. After the financial crisis, it first declines but then again reaches a 30 percent difference in 2010Q3. In the first sub-period, the minimum growth rate is plausibly stable, while maximum growth rate moves around quite a lot. In that period, euro area credit growth is rather stable as well. In the second sub-period, the minimum and average growth rate fall, and the minimum rates become much less stable. Average growth reaches a peak of 10% in 2006Q1, with the maximum growth rate across members above 30% and the minimum growth rate around zero. Note that average real credit growth moves roughly in line with real GDP growth.

Figure 2.2 illustrates the development of real interest rates across the full period and across the 10 countries. Note that the overall variation comes both from nominal interest rate and inflation rate heterogeneity cross-time and cross-country. We observe relatively little variation across countries prior to the financial crisis. Variation comes mainly from trend changes over time. For the period after 2008, time variation persists but cross-country variation becomes a dominant factor. Weak countries are perceived to be very risky, leading to strongly rising rates until 2012. At the same time, other countries become more attractive to investors as they are seen as a safe haven, leading to decreases in real interest rates. At the end of the sample, the band width between maximum and minimum rates gets back to the level of the beginning phase.

Figure 2.3 illustrates developments of house prices over the period 2000-2013, with considerable variation across euro area states and time. Due to the index character of this variable with base year 2005, cross country variation in that year is minimal. From 1999 till about 2008, there is an upward house price trend on average, which is predominantly driven by the countries who initially have relatively low prices. In this period, house prices are quite stable in Austria, Belgium and Germany. Booms occur in Spain, France, Italy and Ireland before 2006 and

in the Netherlands already before 2002. From 2008 housing prices fall on average due to the hit from the financial crisis, though there is substantial variation across countries as seen by the fanning out.

Figure 2.4 shows the movement of equity prices across country and time. The picture looks somewhat similar to figure 2.3 for housing prices. Naturally, there is little cross-country variation in the base year 2005. Interestingly, this lack of cross-country variation is observed for the whole boom period 2003-2008. All countries experience roughly the same upward trend in equity prices, reflecting strong financial integration. Cross-country variation in the bear markets before 2003 and after 2008 is much greater. The impact of the financial crisis in 2008-09 is clearly visible, as is the stabilization from 2010 onward.

Finally, figure 2.5 provides evidence on the net foreign credit position across countries and time. The average remains relatively stable, but variation around that is larger than for credit growth. In the early years, it is especially Ireland that has a large and increasing positive net foreign credit position, while Portugal has a substantial negative position. Italy and Spain have more moderate negative positions in this period. Between 2004 and 2009, the Irish positive position deteriorates quickly and becomes substantially negative – most likely partly due to its banking crisis – bringing it in the same class as Portugal. After 2009, both Portugal and Ireland are forced to adjust. Finland then becomes the country with the most negative net foreign credit position.

As a next step, we apply panel unit root tests to investigate the degree of non-stationarity of the different (time-demeaned) variables in our sample. This serves as a pre-test before we proceed to panel co-integration tests. Three methods are adopted to test for panel unit roots, i.e. IPS (Im, Pesaran and Shin, 2003), LLC (Levin-Lin-Chu, 2002) and two Fisher-type tests, ADP and PP (Choi, 2001). Specifically, the IPS test and the Fisher test assume different unit root processes across panel members; the LLC test posits an identical unit root process. The IPS test allows for heterogeneity of intercepts across members of the panel while the LLC allows for heterogeneity in intercepts as well as in the slope coefficients. All three panel unit root tests have the null hypothesis of a unit root. We apply the Akaike Information Criteria (AIC) to select the optimal lag length with a maximum lag of four periods. In the LLC unit root test, we specify a Bartlett kernel to control for homogeneous long run covariance across sections. Regarding the (log of) real credit and the (log of) real GDP, a time trend is included in the test auxiliary regression based on the observation of significant trend in the two variables. For the real long-term interest rate, house price, equity price and net foreign credit the time trend is excluded. Table 2.2 contains the results for all variables both in levels and first differences for the total period 1999-2013. We test the demeaned variables. In general, it can be concluded that real credit, real income and long-term interest rates and net foreign credit are non-stationary and

integrated at one order, i.e. I(1). According to the IPS and Fisher tests, house prices and equity prices are I(1), while the LLC results marginally lead to the conclusion that the two are I(0). For the first differences, I(1) is rejected in all cases. In the subsequent co-integration analysis, we assume all level variables to be I(1).

2.5 Empirical analysis

In this section, we first test for the existence of a co-integration relation between private credit and a set of explanatory variables, based on equation (2.3). Then, we proceed to estimate and discuss the corresponding long-run relations using DOLS.

2.5.1 Co-integration test

First, we apply the panel co-integration test proposed by Pedroni (1999), which according to among others Gutierrez (2003), is more powerful than that of Kao (1999) for large T panels. We report both the PP and ADF statistics. Table 2.3 provides the results for four sets of specifications. The standard credit equation includes real GDP and the real long-term bond yield. Subsequently, real house prices, real stock prices and net foreign credit are added in turn. We do the co-integration test for the full period 1999-2013 and the two sub-periods. The null hypothesis of no co-integration is always strongly rejected when the full period is considered, regardless of the inclusion of any of the three extra variables.[18] For the first sub-period, the null of no co-integration relation cannot be rejected for the standard specification. However, it is rejected when either the house price, the equity price or net foreign credit is included as an additional explanatory variable. This is consistent with Hofmann (2004) who concludes that the credit equation is stable when house prices are included. More generally, it supports the intuition that house prices, stock prices and net foreign credit are important elements in the credit function. In the second sub-period, the null of no co-integration cannot be rejected in most cases. The exception is the equation with house prices. Note though that the number of observations in the second period is quite limited. Given the support for co-integration in the full period and the first sub period, we continue with the estimation of the equilibrium relations. Especially the results for the second sub period should be interpreted with caution.

2.5.2 Results and discussion

We use the Kao and Chang (1999) DOLS approach to estimate the following panel equation, both for the whole period and the two sub periods:[19]

[18] The Pedroni co-integration test is based on the Engle-Granger approach. The method cannot show how many co-integrating relationships exist among dependent and independent variables. In the paper, we mainly focus on the existence of co-integration between credit and its determinants. A discussion on other possible underlying relations in the system is beyond the scope of this paper.
[19] For details on the properties of the DOLS estimator we refer to Kao and Chiang (1999) and Phillips and Moon (1999).

(2.4) $\overline{Cr_{it}} = \alpha_i + \beta \bar{x}_{it} + \sum_{j=-q_1}^{q_2} \gamma_{it} \Delta \bar{x}_{it+j} + v_{it}$

where *Cr* is real credit and *x* is the vector of other variables (real GDP (*gdp*), the real interest rate (i^{rl}), and – depending on the specification – one of the other variables: the real house price (*hpi*), the real stock price (*eqi*) and net foreign credit (*nfc*). The upper bar indicates that we use time-demeaned variables. Our preferred co-integrating regression typically includes one lag and one lead, i.e. DOLS (1, -1).[20] Table 2.4 contains the results for the benchmark relation, including only real GDP and the real interest rate. We only report the long-run coefficients. Standard errors are reported in brackets.

The income elasticity is close to one and very significant. It is quite stable across two sub periods. This is consistent with previous empirical research and implies that credit growth moves roughly proportionally to real income. The real interest coefficient is significantly positive for the full period. This effect is an average effect. It combines a significantly negative interest effect in the first sub period with a significantly positive interest effect in the second one. The sign shift in the coefficient of the real interest rate indicates a structural break which is influenced by the 2008 financial crisis. To capture the break, we introduce a time dummy which is equal to one before the third quarter of 2008, and zero upwards. We then include the dummy and its interaction with the real interest rate in our panel estimation for the whole period. The results are shown in the last column of table 2.4. It gives us consistent results, and provides further evidence on the break in the long run relation between private credit and the real economy.

In the subsequent analysis, we introduce house prices, equity prices and net foreign credit in turn. We start with the real house price. The results are reported in table 2.5 in a format similar to table 2.4. Note that the estimated income elasticity and interest rate coefficients remain qualitatively similar to the benchmark results in table 2.4. The income coefficient estimation appears robust to changes in the specification. It is significant and close to one. The interest coefficient shows the same pattern as before. There is a significantly positive effect over the full period and the second sub period, but a significantly negative one in the first sub period. For the full period and the first sub period, we find a significant positive housing price coefficient. This confirms our conjecture that increasing house prices is positively related to domestic credit. The house price coefficient is significantly negative in the second sub period. A possible explanation is that in the boom phase of the cycle, credit and house prices go up together, while in the bust phase the house price tends to go down much faster than the stock of credit. The latter is much more persistent as balance sheet adjustment in a debt-driven recession takes a relatively long time.

[20] The estimation results change little when using default DOLS (2,1) as a robustness check.

The full period results in the final column of Table 2.5 where we include the time dummy and its interaction effects provide evidence that is consistent with the sub period results.

We report the results for specification with equity prices in table 2.6. Again, we obtain robust coefficients for real income and the real interest rate. The coefficient of equity prices is negative in each period, though significantly so only for the full period and the first sub period. This is consistent with the hypothesis that firms prefer internal finance and (direct) stock market finance to bank credit. It provides support for the conclusion by Krainer (2014) that stock prices do play a role in bank lending decision. The dummy specification in the final column is consistent with the other results.

Table 2.7 illustrates the long run relation with net foreign credit. We find that the net foreign credit coefficient is significantly negative in the full period and two sub periods. This is in line with Lane and McQuade (2014) and Unger (2017) that domestic credit growth is structurally related to cross border capital flows. Our hypothesis that countries who borrow more from abroad have larger capability of granting credit in their domestic market is confirmed. The other results are qualitatively similar to the ones observed before. When we incorporate the time dummy and its interaction with the real interest rate, we obtain consistent results.

Other research on private credit dynamics in the euro area typically focuses either on euro area aggregates or on individual countries. Moreover, most of these use data prior to 2008 when the Great Financial Crisis started. Calza et al. (2003), Calza et al. (2006), and Hofmann (2004) use aggregate data. They report significant income elasticities in a range from 0.6 to 2.1. Frömmel and Schmidt (2006) employ individual country data and identify income elasticities from 0.4 (Finland) to 3.2 (Portugal). Our income elasticities close to one are in the middle of this range. Calza et al. (2003) and Calza et al.(2006) both employ the real long term interest rate to represent the opportunity cost variable and find significantly negative coefficients over the period, which is consistent with our first period results. Frömmel and Schmidt (2006) use the nominal long-term government bond yield and find mixed results across countries. For Austria, German, they find a significant negative coefficient, while for France and Portugal the coefficient is positive. For other member countries, they do not find significant results at all. This comparative analysis shows that exploiting country heterogeneity to extract common patterns indeed succeeds in obtaining stable and plausible results.

With regarding to house price coefficients, Hofmann (2004) and Goodhart and Hofmann (2008) take a VEC approach for individual countries before 2008 and find significantly positive house price coefficients, consistent with our results. With respect to equity price coefficients, our first period results support the research by Frömmel

and Schmidt (2006) to some extent. Regarding net foreign credit, Lane and McQuade (2014) and Unger (2017) provide evidence in line with ours that cross border credit flows and domestic growth are structurally negatively related. In short, our first period results are in line with the empirical time series literature.

Looking at the total period, our results suggest a stable long-run relation cannot be found without accounting for the effect of 2008 financial crisis, even when including either house prices, equity prices or net foreign credit. This is in contrast with the stable long-run relation Hofmann (2004) reported. Our second period results show significant sign changes in the coefficients of house prices and the real interest rate in particular. We don't find these changes in equity prices and net foreign credit at the time point of the financial crisis. The sign of the interest rate effect depends ultimately on the shocks hitting the credit market. This suggests the global financial crisis has led to different financial conditions in general and credit supply constraints on the banking system in particular, providing an explanation of the structural break in the interest rate coefficient. A full analysis of the underlying determinants of the changes is beyond the scope this paper. However, the fragility of bank loans, the divergence in sovereign bond yields due to default risk premiums and the adoption of unconventional policy by ECB may have played a role.

2.5.3 The North versus the South

The North-South divide in the euro area is a well-known phenomenon, both institutionally and economically. For instance, the North has a substantially higher per capita income than the South. Prior to 2008, most Southern – and peripheral – countries built up large and increasing current account deficits and became net debtors in international financial markets, while Northern countries showed the opposite patterns.[21] In addition, Allen et al. (2008) document that housing systems are different between Southern and Northern European countries due to the welfare mechanism. In this respect, it is important to keep in mind that two of the four countries in the Southern group – Spain and Ireland – experienced an extreme boom-bust cycle in the real estate market over the sample period.

To investigate whether the North-South divide has an impact on credit dynamics, we re-estimate the credit function for the two groups as a robustness check to our approach. In particular, we define the group of Northern countries to include Austria, Belgium, Germany, France, Finland and the Netherlands, while we define Southern as Ireland, Italy, Spain and Portugal. The results are in tables 2.8 and 2.9, for the North and the South respectively. Several points stand out.

[21] For a detailed discussion about the North-South divide we refer to Holinski et al. (2012)

Overall, our estimated income elasticities are close to one. For the North the magnitudes tend to be slightly above one, while they are below unity for the South. Nonetheless, the difference is insignificant based on the standard errors. The interest rates for the North show a consistent and stable – in most cases significant – negative effect across two sub periods. For the South, the interest rate effect is roughly the same as reported in table 2.4 to 2.7. That is, we find a significantly negative coefficient for the first sub period and a positive one for the second period. Possibly, the divergence in real interest rate effects is related to the increasingly important role of risk prima after 2008, which affected the North and the South quite differently. A further analysis of the divergent interest rate patterns is left for future research.

The house price pattern shows a significant North-South divide as well. For the North, house price effects are positive for the full period and the first sub period and negative for the second sub period. This is qualitatively similar to the full sample estimation. For the South, the coefficient is consistently negative in each period. Equity price effects are roughly similar for the South and the North. For net foreign credit the same conclusion holds. Results for the North and the South are quantitatively and qualitatively similar. The pattern is also comparable to the full sample results, consistently showing a negative coefficient in each period.

Overall, splitting up the sample in a Northern and Southern group leaves the main results for real GDP, equity prices and net foreign credit qualitatively unchanged. However, for the real interest rate and the house price the results show considerable heterogeneity across the Northern and the Southern countries.

2.5.4 Robustness checks

To check the sensitivity of our results, we perform three more robustness check. First, we exclude Germany, the dominant economy in the euro area, from the sample. In the second, we exclude the two countries with the highest average credit growth—Ireland and Spain—and the two with the lowest —Austria and Belgium. In the third, we loosen our assumption about independent member countries in the sample and adopt a GLS estimation which allows for cross-sectional dependence. The estimation results are displayed in the Appendix tables 2A.1 to 2A.3. Overall, the results from the three strands estimations are consistent with the main results. That is, we find consistently: i) a robust income elasticity close to one; ii) an interest coefficient that is negative in the first sub period and positive in the second one ; iii) a positive relation between housing prices and domestic credit creation; iv) a negative link between credit growth and equity prices ; v) a negative relation between net foreign credit and domestic credit growth; vi) a structural break in the long run credit relation around the 2008 financial crisis which shows up not only in the interest rate coefficient but also in the sign of the house price coefficient. The three robustness checks do not show the sensitivity as was displayed by the North-South divide. The divergent pattern

between the South and the North particularly on the relation between credit, the real interest rate and house prices needs further research.

2.6 Conclusion

The 2008 financial crisis has revived the interest of credit dynamics and its interaction with the macro economy. Credit analysis for the euro area countries is particularly important, both because of the bank-based character of the financial system in most countries and because of the heterogeneous credit development across countries, driven by the unified monetary policy and almost perfect capital mobility. Our paper contributes to understanding credit dynamics in the euro area, using a panel framework and incorporating housing prices, equity prices and cross border lending. We jointly investigate 10 original euro area countries (except Luxembourg and Greece) over the period 1999Q1 to 2013Q3. Since the financial crisis had a structural impact on many economies, we allow for a break in the relation between private credit and its determinants in 2008. So we estimate the period 1999Q1-2008Q3, 2008Q4-2013Q3 and 1999Q1-2013Q3, respectively. Considering the heterogeneity across countries, we adopt a panel co-integration approach—DOLS—to identify a long run private credit relation. In the estimation, we assume the long run relation is homogeneous. All variables are time de-meaned to reduce cross-sectional dependence.

First, for the period 1999Q1-2008Q3 the results are consistent with those in previous empirical studies. We obtain a significantly positive income elasticity which is close to unity. The estimated negative interest effect is consistent with the theory of credit demand. The positive housing coefficient confirms the collateral effect, while the negative equity coefficient suggests internal funding effects play a role. With regard to cross border credit, our results are supportive of the work by Lane and McQuade (2014) that high domestic credit growth corresponds with a high net foreign liability position.

Second, we extend our sample and include the post-crisis period, using a time dummy and its corresponding interactions to capture the occurring breaks. The evidence suggests a structural break in the long run credit relation. The changes are significant in interest effect and housing prices. The interest effect shifts to positive, while the housing coefficient changes to negative. We don't find strong evidence of a break in the relation between credit and equity prices. The negative relation between domestic credit and cross border credit is stable across the two sub periods. The income elasticity is robust and significantly closes one regardless of the change of the sample period and the inclusion of housing prices, equity prices and net foreign credit.

Lastly, acknowledging the potential importance of the North-South divide, we estimate credit relations for northern and southern European countries separately. While income and net foreign credit coefficients are similar across the two groups, a pronounced difference exists for the interest rate and housing price coefficients. For equity prices, the evidence supporting the divide between North and South is limited. A further analysis of the underlying drivers of the difference between North and South is left for future research.

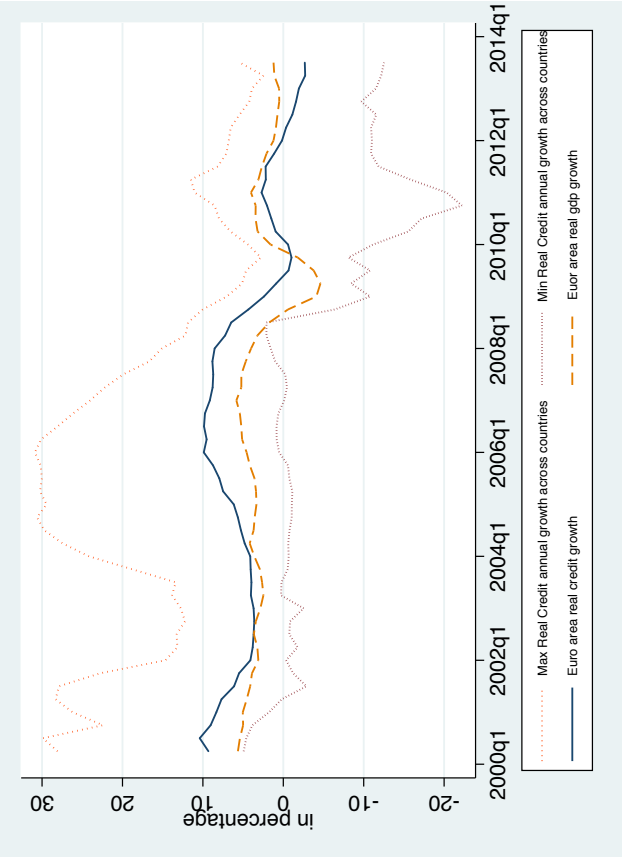

Figure 2.1. Credit growth rate.

Data source: ECB statistics, growth rates are own calculation
Sample period: 1999q1-2013q3

Figure 2.2. Real interest rate

Data source: nominal interest rate from ECB statistics, real rate based on own calculation
Sample period: 1999Q1-2013Q3

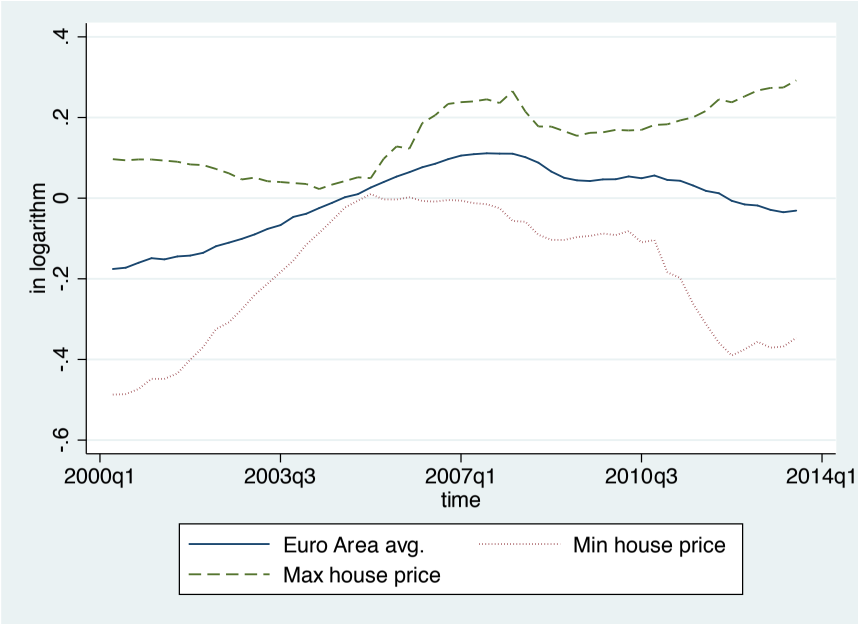

Figure 2.3. Real house price index (adjusted to base year 2005Q1)

Data source: OECD statistics
Sample period: 2000q1-2013q3

Figure 2.4. Real equity price, adjusted to base year 2005

Data source: Datastream
Sample period: 1999q1-2013q3

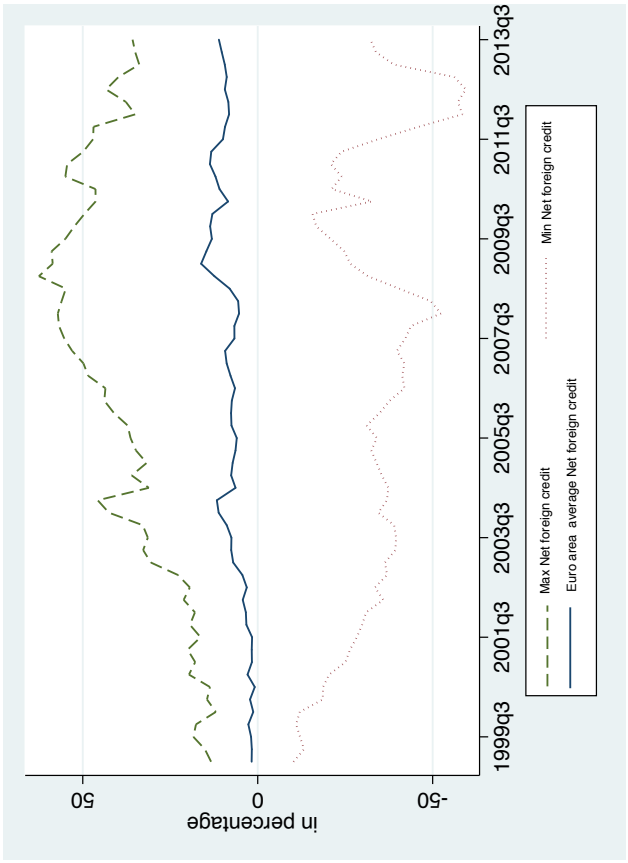

Figure 2.5. Net foreign credit

Data source: BIS locational bank statistics, net position is own calculation
Sample period: 1999q1-2013q3

Table 2.1. Summary statistics

Panel A 1999Q1-2013Q3												
Var.	Level						First differenced					
	unit	Obs.	Mean	Std.	Min	Max	unit	Obs.	Mean	Std.	Min	Max
Cr	Real private credit, logarithm	590	8.41	1.03	6.34	10.05	% per quarter	580	0.97	2.28	-8.43	14.17
gdp	Real GDP, logarithm	590	11.71	1.00	10.29	13.35	% per quarter	580	0.35	1.11	-5.46	6.00
i^{rl}	Real long term interest rate, %	590	2.47	2.10	-2.98	14.96	Percentage points	580	0.00	1.11	-5.54	6.61
hpi	Real house price index, logarithm	586	-0.14	0.20	-0.71	0.43	% per quarter	576	0.37	1.89	-8.89	6.83
eqi	Real equity price, logarithm	590	2.11	0.82	0.03	3.76	% per quarter	580	-0.55	11.20	-42.00	49.27
nfc	Net foreign credit, % GDP	590	7.45	22.84	-59.49	62.55	Percentage points	580	0.16	5.61	-57.22	49.74
Panel B 1999Q1-2008Q2												
Var.	Level						First differenced					
	unit	Obs.	Mean	Std.	Min	Max	unit	Obs.	Mean	Std.	Min	Max
Cr	Real private credit, logarithm	380	8.31	1.05	6.34	10.05	% per quarter	370	1.71	2.11	-3.85	14.17
gdp	Real GDP, logarithm	380	11.68	1.01	10.29	13.32	% per quarter	370	0.63	0.92	-5.10	6.00
i^{rl}	Real long term interest rate, %	380	2.13	1.49	-2.98	9.53	Percentage points	370	0.04	0.99	-3.66	6.61
hpi	Real house price index, logarithm	376	-0.17	0.23	-0.71	0.43	% per quarter	366	0.95	1.63	-8.89	6.83
eqi	Real equity price, logarithm	380	2.22	0.84	0.18	3.76	% per quarter	370	0.29	9.90	-10.19	49.27
nfc	Net foreign credit, % GDP	380	5.40	20.88	-52.36	57.14	Percentage points	370	0.10	4.46	-57.22	23.93
Panel C 2008Q2-2013Q3												
Var.	Level						First differenced					
	unit	Obs.	Mean	Std.	Min	Max	unit	Obs.	Mean	Std.	Min	Max
Cr	Real private credit, logarithm	210	8.59	0.98	7.26	9.98	% per quarter	210	-0.33	1.97	-8.43	5.71
gdp	Real GDP, logarithm	210	11.76	1.00	10.51	13.35	% per quarter	210	-0.15	1.23	-5.46	3.89
i^{rl}	Real long term interest rate, %	210	3.08	2.81	-1.89	14.96	Percentage points	210	-0.06	1.30	-5.54	4.95
hpi	Real house price index, logarithm	210	-0.09	0.10	-0.45	0.33	% per quarter	576	-0.63	1.89	-7.98	3.88
eqi	Real stock price, logarithm	210	1.90	0.74	0.03	3.15	% per quarter	580	-2.02	13.08	-42.22	24.39
nfc	Net foreign credit, % GDP	210	11.15	26.65	-59.49	62.55	Percentage points	210	0.26	7.21	-41.45	49.74

Table 2.2. Panel unit root test

Level						
	$\overline{Cr}$	$\overline{gdp}$	$\overline{\text{ir}}$	$\overline{\text{hpi}}$	$\overline{\text{eqi}}$	$\overline{\text{nfc}}$
IPS	4.72(1.00)	2.10(0.98)	0.25(0.60)	1.79(0.96)	-0.84(0.20)	-1.31(0.10)
ADF	-2.22(0.99)	-1.84(0.97)	-1.81(0.96)	-0.07(0.53)	-0.57(0.72)	0.61(0.27)
PP	2.49(0.99)	-1.69(0.95)	1.19(0.11)	-2.18(0.99)	1.28(0.10)	0.52(0.30)
LLC	0.84(0.80)	-0.41(0.34)	2.31(0.99)	-1.62(0.05)	-1.34(0.09)	-1.30(0.10)
First differenced						
IPS	-10.28(0.00)	-4.82(0.00)	-21.41(0.00)	-4.38(0.00)	-18.84(0.00)	-18.26(0.00)
ADF	2.66(0.00)	8.03(0.00)	21.64(0.00)	2.42(0.01)	19.12(0.00)	9.77(0.00)
PP	49.42(0.00)	31.42(0.00)	101.32(0.00)	34.97(0.00)	68.65(0.00)	74.96(0.00)
LLC	-7.56(0.00)	-14.75(0.00)	2.05(0.99)	-5.01(0.00)	-15.59(0.00)	-19.17(0.00)

NOTE: Upper bar variables are time-demeaned. For the unit root test on Credit and GDP, a time trend is included. IPS refers to the approach proposed by Im, Pesaran and Shin (2013). ADF and PP refer to the test proposed by Choi (2001). LLC is the method by Levin Lin and Chu (2002). The null hypothesis of IPS, FISHER (ADF and PP) and LLC is that all panels contain a unit root, the alternative hypothesis is that some panels are stationary. Numbers in parentheses are p-values of the four tests.

Table 2.3. Panel co-integration test

Time span	1999-2013		1999-2008		2008-2013	
	Group PP	Group ADF	Group PP	Group ADF	Group PP	Group ADF
$\overline{gdp}, \bar{\imath}^{rl}$	-1.71(0.04)	-1.50(0.07)	-0.94(0.17)	-0.02(0.49)	0.54(0.71)	-0.82(0.21)
$\overline{gdp}, \bar{\imath}^{rl}, \overline{HPI}$	-3.23(0.00)	-3.58(0.00)	-1.77(0.04)	-1.74(0.04)	-4.79(0.00)	-4.47(0.00)
$\overline{gdp}, \bar{\imath}^{rl}, \overline{EQI}$	-1.56(0.06)	-1.14(0.13)	-1.67(0.05)	-1.57(0.06)	-0.15(0.44)	-0.34(0.37)
$\overline{gdp}, \bar{\imath}^{rl}, \overline{NFC}$	-2.40(0.01)	-2.09(0.02)	-2.91(0.00)	-2.76(0.00)	-0.08(0.47)	-0.24(0.41)

Note: Pedroni (1999) group tests for the null of no co-integration amongst a multivariate vector. Tests are performed with the automatic lag selection SIC. Numbers in parentheses are p-values of the two tests' results.

Table 2.4. DOLS results for the benchmark equation

Model	$\overline{gdp}, \bar{\imath}^{rl}$			
Period	1999-2013	1999-2008	2008-2013	1999-2013
$\overline{gdp}$	0.978**	1.000**	0.998	0.995**
	[0.423]	[0.443]	[0.695]	[0.418]
$\bar{\imath}^{rl}$	0.039***	-0.035***	0.066***	-0.031***
	[0.005]	[0.007]	[0.006]	[0.008]
$\bar{\imath}^{rl}$ *DUM				0.101***
				[0.009]

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

Table 2.5. DOLS results for the equation including house prices

Model	$\overline{gdp}, \bar{\imath}^{rl}, \overline{hpi}$			
Period	2000-2013	2000-2008	2008-2013	2000-2013
$\overline{gdp}$	0.996**	1.026**	0.992**	1.027**
	[0.459]	[0.492]	[0.510]	[0.468]
$\bar{\imath}^{rl}$	0.031***	-0.038***	0.045***	-0.043***
	[0.005]	[0.006]	[0.004]	[0.008]
$\bar{\imath}^{rl}$ *DUM				0.106***
				[0.009]
$\overline{hpi}$	0.636***	0.768***	-0.294***	0.687***
	[0.128]	[0.156]	[0.122]	[0.158]
$\overline{hpi}$*DUM				-0.880***
				[0.175]

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

Table 2.6. DOLS results for the equation including equity prices

Model	$\overline{gdp}, \bar{\imath}^{rl}, \overline{eqi}$			
Period	1999-2013	1999-2008	2008-2013	1999-2013
$\overline{gdp}$	1.007**	1.032**	1.026	1.025***
	[0.400]	[0.422]	[0.728]	[0.399]
$\bar{\imath}^{rl}$	0.037***	-0.039***	0.064***	-0.036***
	[0.005]	[0.006]	[0.005]	[0.007]
$\bar{\imath}^{rl}$ *DUM				0.104***
				[0.009]
$\overline{eqi}$	-0.119**	-0.129**	-0.114	-0.123***
	[0.053]	[0.052]	[0.126]	[0.052]

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

Table 2.7. DOLS results for the equation including net foreign credit

Model	$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$			
Period	1999-2013	1999-2008	2008-2013	1999-2013
$\overline{gdp}$	1.008***	1.029***	1.014*	1.021***
	[0.315]	[0.348]	[0.525]	[0.312]
$\bar{\imath}^{rl}$	0.045***	-0.015***	0.068***	-0.013***
	[0.004]	[0.005]	[0.004]	[0.006]
$\bar{\imath}^{rl}$ *DUM				0.085***
				[0.007]
$\overline{nfc}$	-0.004***	-0.006***	-0.004***	-0.004***
	[0.000]	[0.000]	[0.000]	[0.000]

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

Table 2.8. DOLS results for Northern European countries

AUT BEL DEU FIN FRA NLD

Panel A												
Model	$\overline{gdp}, \bar{\imath}^{rl}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{hpi}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{eqi}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$		
Period	99-13	99-08	08-13	00-13	00-08	08-13	99-13	99-08	08-13	99-13	99-08	08-13
$\overline{gdp}$	1.076	1.099*	1.038***	1.072	1.086*	1.049***	1.094	1.131**	1.034***	1.094**	1.114**	1.065***
	[0.767]	[0.629]	[0.375]	[0.850]	[0.662]	[0.355]	[0.700]	[0.561]	[0.292]	[0.501]	[0.452]	[0.382]
$\bar{\imath}^{rl}$	-0.012	-0.010	-	-	-	-0.035***	-	-	-	-0.005	-0.005	-0.004
	[0.010]	[0.007]	0.017***	0.035***	0.027***	[0.005]	0.024***	0.054***	0.012***	[0.006]	[0.005]	[0.005]
			[0.005]	[0.011]	[0.007]		[0.009]	[0.006]	[0.004]			
$\bar{Z}^{b}$				0.680***	0.908***	-0.480***	-0.085	-	0.030	-0.004***	-0.005***	-0.004***
				[0.205]	[0.131]	[0.098]	[0.055]	0.173***	[0.051]	[0.000]	[0.000]	[0.000]
								[0.033]				

Panel B				
Model	$\overline{gdp}, \bar{\imath}^{rl}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{hpi}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{eqi}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
$\overline{gdp}$	1.077	1.044	1.094	1.094*
	[0.755]	[0.730]	[0.744]	[0.504]
$\bar{\imath}^{rl}$	-0.007	-0.024***	-0.034***	-0.002
	[0.012]	[0.009]	[0.009]	[0.008]
$\bar{\imath}^{rl}$	-0.028			-0.015
*DUM	[0.020]			[0.014]
$\bar{Z}^{b}$		0.942***	-0.118**	-0.004***
		[0.190]	[0.056]	[0.000]
$\bar{Z}^{b}$*dum		-1.448***	0.091	
		[0.311]	[0.070]	

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively

Table 2.9. DOLS results for Southern European countries

ESP ITA IRL PRT

Panel A												
Model	$\overline{gdp}, \bar{\imath}^{rl}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{hp\imath}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{eq\imath}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$		
Period	99-13	99-08	08-13	00-13	00-08	08-13	99-13	99-08	08-13	99-13	99-08	08-13
$\overline{gdp}$	0.860***	0.860***	0.918	0.801**	0.789**	0.882*	0.899***	0.904***	0.991	0.869***	0.910***	0.897
	[0.333]	[0.316]	[1.115]	[0.398]	[0.312]	[0.537]	[0.317]	[0.316]	[1.136]	[0.270]	[0.287]	[0.789]
$\bar{\imath}^{rl}$	0.005	-	0.026***	-	-	0.024***	0.013***	-	0.041***	0.007**	-	0.032***
	[0.004]	0.020***	[0.007]	0.016***	0.027***	[0.003]	[0.004]	0.018***	[0.006]	[0.003]	0.065***	[0.005]
		[0.005]		[0.005]	[0.004]			[0.005]			[0.005]	
$\bar{Z}^{b}$				-0.363**	-	-	-0.116*	-0.123	-0.140	-	-	-
				[0.163]	0.320***	1.379***	[0.067]	[0.095]	[0.160]	0.004***	0.005***	0.004***
					[0.119]	[0.141]				[0.000]	[0.000]	[0.000]

Panel B				
Model	$\overline{gdp}, \bar{\imath}^{rl}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{hp\imath}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{eq\imath}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
$\overline{gdp}$	0.868***	0.844***	0.904***	0.896***
	[0.334]	[0.310]	[0.318]	[0.260]
$\bar{\imath}^{rl}$	-0.017***	-0.030***	-0.001	-0.051***
	[0.006]	[0.005]	[0.006]	[0.005]
$\bar{\imath}^{rl}$	0.034***	0.039***	0.022***	0.093***
*DUM	[0.007]	[0.006]	[0.007]	[0.006]
$\bar{Z}^{b}$		-0.271***	-0.115*	-0.006***
		[0.102]	[0.070]	[0.000]
$\bar{Z}^{b}$*dum				

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively

2.7 **Appendix:**

Table 2A.1. Robustness check 1: Excluding Germany

Panel A												
Model	$\overline{gdp}, \bar{\imath}^{rl}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{hpi}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{eqi}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$		
Period	99-13	99-08	08-13	00-13	00-08	08-13	99-13	99-08	08-13	99-13	99-08	08-13
$\overline{gdp}$	0.967**	0.956**	1.007	1.028**	1.020**	0.982*	1.015**	1.000**	1.059	0.974***	0.973***	1.000*
	[0.428]	[0.448]	[0.785]	[0.481]	[0.498]	[0.550]	[0.406]	[0.419]	[0.807]	[0.331]	[0.371]	[0.583]
$\bar{\imath}^{rl}$	0.033***	-0.062***	0.065***	0.031***	-0.042***	0.043***	0.033***	-0.059***	0.063**	0.040***	-0.043***	0.069***
	[0.005]	[0.007]	[0.006]	[0.005]	[0.006]	[0.004]	[0.005]	[0.006]	*	[0.004]	[0.006]	[0.005]
									[0.006]			
$\bar{Z}^{b}$				0.724***	0.742***	-0.422***	-0.124**	-0.110**	-0.137	-0.006***	-0.007***	-0.004***
				[0.155]	[0.167]	[0.130]	[0.052]	[0.051]	[0.135]	[0.000]	[0.000]	[0.000]

Panel B				
Model	$\overline{gdp}, \bar{\imath}^{rl}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{hpi}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{eqi}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
$\overline{gdp}$	0.970**	1.026**	1.015**	0.977***
	[0.423]	[0.476]	[0.397]	[0.327]
$\bar{\imath}^{rl}$	-0.053***	-0.046***	-0.048***	-0.039***
	[0.008]	[0.008]	[0.007]	[0.006]
$\bar{\imath}^{rl}$ *DUM	0.121***	0.107***	0.113***	0.111***
	[0.009]	[0.009]	[0.008]	[0.007]
$\bar{Z}^{b}$		0.594***	-0.115**	-0.006***
		[0.154]	[0.051]	[0.000]

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively

Table 2A.2. Robustness Check 2: Drop the two lowest and two highest credit growth countries

Panel A												
Model		$\overline{gdp}, \bar{\imath}^{rl}$		$\overline{gdp}, \bar{\imath}^{rl}, \overline{hpi}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{eqi}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$		
Period	99-13	99-08	08-13	00-13	00-08	08-13	99-13	99-08	08-13	99-13	99-08	08-13
$\overline{gdp}$	0.949	0.981	0.909**	0.955	0.994	0.913**	1.080**	1.158	0.946*	0.978**	1.015**	0.858**
	[0.623]	[0.749]	[0.407]	[0.621]	[0.760]	[0.426]	[0.528]	[0.752]	[0.511]	[0.423]	[0.419]	[0.415]
$\bar{\imath}^{rl}$	0.020***	-	0.041***	0.034***	-	0.034***	-0.001	-	0.034***	0.026***	-	0.033***
	[0.006]	0.040***	[0.003]	[0.005]	0.027***	[0.003]	[0.005]	0.085***	[0.003]	[0.004]	0.023***	[0.003]
		[0.009]			[0.009]			[0.009]			[0.005]	
$\bar{Z}^{b}$				0.889***	0.923***	0.035	-0.243***	-	-0.069	-	-	0.003***
				[0.175]	[0.181]	[0.151]	[0.068]	0.298***	[0.112]	0.002***	0.004***	[0.000]
								[0.072]		[0.000]	[0.000]	

Panel B				
Model	$\overline{gdp}, \bar{\imath}^{rl}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{hpi}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{eqi}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
$\overline{gdp}$	0.962	0.967*	1.160*	0.985**
	[0.608]	[0.599]	[0.743]	[0.391]
$\bar{\imath}^{rl}$	-0.035***	-0.015	-0.087***	-0.017**
	[0.011]	[0.010]	[0.009]	[0.007]
$\bar{\imath}^{rl}$ *DUM	0.075***	0.064***	0.269***	0.060***
	[0.013]	[0.012]	[0.070]	[0.008]
$\bar{Z}^{b}$		0.860***	-0.051***	-0.003***
		[0.019]	[0.028]	[0.000]
$\bar{Z}^{b}$ *dum				0.002***
				[0.000]

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively

Table 2A.3. Robustness check 3: Use GLS estimation

Panel A												
Model	$\overline{gdp}, \bar{\imath}^{rl}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{hpi}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{eqi}$			$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$		
Period	99-13	99-08	08-13	00-13	00-08	08-13	99-13	99-08	08-13	99-13	99-08	08-13
$\overline{gdp}$	0.983***	1.003***	0.995***	0.995***	1.023***	0.996***	1.009***	1.034***	1.022***	1.007***	1.024***	1.011***
	[0.001]	[0.001]	[0.002]	[0.002]	[0.001]	[0.003]	[0.002]	[0.002]	[0.003]	[0.002]	[0.002]	[0.004]
$\bar{\imath}^{rl}$	0.027***	-	0.050***	0.034***	-	0.048***	0.024***	-	0.042***	0.037***	-	0.058***
	[0.001]	0.012***	[0.003]	[0.002]	0.013***	[0.003]	[0.001]	0.015***	[0.003]	[0.001]	0.006***	[0.002]
		[0.002]			[0.001]			[0.002]			[0.002]	
$\bar{Z}^{b}$				0.654***	0.792***	-	-	-	-	-	-	-
				[0.016]	[0.011]	0.220***	0.119***	0.131***	0.113***	0.004***	0.006***	0.004***
						[0.056]	[0.002]	[0.003]	[0.005]	[0.000]	[0.000]	[0.000]
Cons												

Panel B				
Model	$\overline{gdp}, \bar{\imath}^{rl}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{hpi}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{eqi}$	$\overline{gdp}, \bar{\imath}^{rl}, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
$\overline{gdp}$	1.000***	1.011***	1.039***	1.022***
	[0.001]	[0.002]	[0.004]	[0.002]
$\bar{\imath}^{rl}$	-0.008***	-0.003	-0.009***	-0.002
	[0.003]	[0.004]	[0.003]	[0.003]
$\bar{\imath}^{rl}$	0.055***	0.048***	0.051***	0.060***
*DUM	[0.004]	[0.005]	[0.004]	[0.003]
$\bar{Z}^{b}$		0.598***	-0.129***	-0.005***
		[0.024]	[0.003]	[0.000]
Cons				

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively

Chapter 3.
Monetary dynamics in the euro area：a disaggregate panel approach

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3.1 Introduction

In a recent speech, ECB president Mario Draghi stated that "*the decision to grant central banks price stability objectives, and to give them independence to deliver those objectives, was based on the understanding that inflation is always, ultimately, a monetary phenomenon. It could thus always be controlled in the medium-term by a committed monetary authority*".[22] From that perspective, the development of monetary aggregates should be a key component of the ECB's monetary policy framework. In practice, the role of monetary aggregates has been considerably reduced over time. Like many other central banks, the ECB increasingly relied on interest rate targeting to maintain price stability up till the start of the 2008 financial crisis.

Over the past years, interest in the dynamics of monetary aggregates has increased again for two reasons. On the one hand, persistently low inflation and economic growth in combination with a policy rate virtually equal to zero has led to the use of unconventional monetary policy in which size and composition of the central bank's balance sheet play an important role. On the other, the search for causes of the financial crisis and subsequent euro debt crisis has brought to light strongly divergent patterns in money and credit growth across euro area countries. This has also raised the question how and to what extent money and credit developments are related to booms in real estate and equity markets.

Monetary aggregates have developed heterogeneously across euro area countries from the introduction of the euro (Bosker, 2004), despite the ECB's common monetary policy. For instance, over the period of 1999 to 2013 M3 increased 35% in Germany in comparison with 60% in Spain. The highest growth rate (170%) over that period was recorded in Ireland. These cumulative growth rates diverge considerably from the 4.5% per year ECB reference rate of money growth. During the same time, housing prices developed in a diverse way across euro area member states as well. Some countries experienced extremely high growth rates in real estate prices. Particularly in Spain and Ireland average annual growth rates were in the double digits till 2008. Stock market returns showed some heterogeneity too over the past decades. Similar patterns show up in cross border capital flows. The data on international bank lending and current account imbalances show that most Northern European countries had an external surplus and were net lenders in the international market, whilst Southern European countries mostly ran external deficits and became debtors, particularly prior to the financial crisis.

[22] Marjolin Lecture, February 4, 2016.

Monetary dynamics in the euro area: a disaggregate panel approach

This paper contributes to the literature through the analysis of the heterogeneity of monetary dynamics across euro area member countries and their possible relation with housing market and equity market developments and cross border credit flows. Our analysis extends Nautz and Rondorf (2011) by using cross border credit flows as an additional factor in money holdings and by using a sample that includes the recent great Financial Crisis. This is important for three reasons. First, it sheds light on the stability of an extended money demand function during one of the most severe recessions in history and facilitates understanding of the monetary pillar of the ECB policy framework. Second, the analysis helps to understand how the divergence across euro area member countries in economic conditions – including housing market and stock market heterogeneity – may endanger financial stability related to country-specific monetary developments. Third, it provides new evidence on the link between credit flows between euro area countries and money growth across countries. Note that the introduction of the euro as a common currency has facilitated large capital flows between countries, accommodating larger and more persistent current account imbalances as well as credit growth divergences across countries, which in turn have been blamed for contributing to financial fragility.

To shed more light on the relation between money and housing prices, equity prices and cross border financial (credit) flows, we start from a standard money demand framework in which real money demand depends on income and an opportunity cost variable, the nominal interest rate. In turn, we add housing prices, equity prices and net foreign bank lending as an additional variable in the analysis. Since we are interested in the information that a disaggregate perspective may provide, we use a panel set up for 10 original euro area countries using quarterly data for the period 1999-2013. Greece and Luxembourg are excluded for lack of data. In this approach, we impose a homogeneous long-run relation across countries, but allow for heterogeneous short-run dynamics. We acknowledge that the 2008 financial crisis may have had a structural impact on the relation between the variables in our analysis. For this reason, we also investigate two separate sub periods 1999-2008 and 2008-2013.

We find a significantly positive income effect, a significantly negative interest rate effect and a significantly positive housing price effect for the first period, similar to previous research. For equity prices, support is limited. If anything the effect in the first sub period is negative. Complementary to research on the link between net foreign credit and domestic credit, we find a significantly negative link between net foreign credit and domestic money. However, when we extend our sample to include the financial crisis and its aftermath, structural breaks are observed in the long run money demand function. Especially the interest rate effect changes sign and is positive in the second sub period. There is also some evidence of sign reversals for equity prices and net foreign credit.

The paper is set up as follows. In section 3.2, we briefly review the literature on money demand analysis in the euro area. In section 3.3, we introduce the model and the econometric estimation approach. Data sources and stylized facts of the data are shown in section 3.4. We present and discuss the empirical results in section 3.5. Conclusions and suggestions for future research are provided in section 3.6.

3.2 Literature review

Money demand theory provides a suitable framework to analyze the relation between money aggregates, the real economy and financial markets. There is a substantial empirical literature using such framework. For the euro area, almost all research focuses on euro area wide aggregates and does not pay attention to the information in country-specific developments.

The stability of money demand function plays a dominant role in making appropriate monetary policy. Early demand studies for the euro area as a whole by Coenen and Vega (2001), Calza, Gerdesmeyer and Levy (2001), and Brand and Cassola (2004) employ standard specifications of money demand to provide suggestive evidence of the stability of a long run euro area money demand function[23]. When extended samples are employed, stability of the money demand function receives less support. Later studies typically need to include additional variables such as stock prices, stock price volatility, housing price or cross-country capital flows, to retain money demand stability. Examples are Boone, Mikol and van den Noord (2004), Carstensen (2006), Dreger and Wolters (2009) and De Santis, Favero and Roffia (2013)[24]. Joseph, Larrain and Ottoo (2012) extend the standard money model and provide a theoretical base for the inclusion of domestic and foreign wealth. Friedman (1970, 1988) already suggested that if the demand for money was viewed in a portfolio framework, wealth may be a determinant. Friedman (1988) proposes a wealth effect, a transaction effect and a substitution effect to explain the relationship between money and asset prices.

Adalid and Detken (2007) investigate the relation from another perspective. They identify liquidity shocks using broad monetary aggregates as proxy for 18 OECD countries with historical data, and illustrate that liquidity shocks are a driving factor for real estate prices during boom episodes but not during normal times. More generally, boom and bust cycles in asset markets have historically been strongly associated with large movements in monetary

[23] These studies are typically based on the pre-euro period with samples ending in the late nineties. As a consequence, the euro area aggregate is constructed from national series, using specific assumptions with respect to the conversion of currencies.
[24] Boone et al. (2004), Carstensen (2006) and Dreger and Wolters (2010) identified a structural break at the beginning period of the establishment of the euro area. De Santis et al. (2013) discuss the impact of sovereign debt crisis on the money demand function, but did not find break pressure. Note that most of the literature uses sample periods before 2008 or 2009 and neglects the potential impact of the 2008 Financial Crisis on the money demand function.

aggregates. Most empirical literature provides evidence on the positive relation between money and house prices. Greiber and Setzer (2007) investigate the relation between money and property prices in the euro area. They show that causality runs in both directions, i.e. a reinforcement mechanism between broad money increases and housing price growth. Other examples are Boone and van den Noord (2008) and Setzer, van den Noord and Wolff (2011). They provide empirical evidence that the housing price is positively related to money growth due to its wealth and transaction effect.

The research on the relation between equity prices and money is relatively scarce compared with that on housing prices. Carstensen (2006) incorporates the equity price spread and volatility in a money demand system using aggregate euro area data. The study explicitly explains the substitution relation between equity and money holdings: the higher return on stocks, the less preference on holding money aggregates. Later studies extend the data sample and provide more consistent evidence on a negative relation between money growth and equity prices. Examples are Boone, van den Noord (2008) and Dreger and Wolters (2009).

Recently, the relation between money and foreign credit has attracted attention. Research provides increasing evidence that persistent current account deficits – and more precisely cross-border bank credit funding these imbalances – in some euro area countries correspond to excessive asset and real estate booms, see van Ewijk (2013). Kool, de Regt and van Veen (2013) perform panel analysis on individual euro area member countries. They provide empirical evidence that net foreign debts do play a significant role in money growth since the early 2000s. In line with this perspective, De Santis et al. (2013) empirically show that net sales of foreign assets by euro area residents result in an increase of broad monetary aggregates in the euro area.

Only a few studies analyze euro area money demand using the information on country-specific developments of euro area members. Dedola, Gaiotti and Silipo (2001) compare aggregate and national money demand estimations in the pre-euro area. Carstensen, Hagen, Hossfeld and Neaves (2009) compare money demand dynamics for the euro area (EMU) as a whole with that of its four largest member countries, Germany, France, Italy and Spain. Nautz and Rondorf (2011), Setzer et al. (2011) and Setzer and Wolff (2013) perform a panel analysis where variables are defined in deviation of the euro area mean, similar to our approach.[25] While Setzer and Wolff (2013) employ a standard money demand specification, Setzer et al. (2011) include housing wealth proxies and Nautz and Rondorf (2011) use both equity and real estate prices. The panel approach in these studies provides more

[25] Note that this is virtually the same as doing a panel analysis with time fixed effects. With time fixed effects the unweighted average across countries is used, where individual countries are included with a different weight in the euro area average.

scope for finding a stable money demand function than does an analysis for the euro area as a whole because possibly disturbing effects of common omitted variables are eliminated from the analysis. In theory, the approach allows for an analysis of heterogeneous monetary developments in euro area member countries. In practice, none of these three studies pay much attention to the consequences of the estimated money demand function for national monetary developments in comparison to the euro area as a whole.

3.3 Modeling strategy

The aim of this paper is to analyze monetary dynamics in the euro area in the period 1999-2013, using a disaggregate panel approach. The heterogeneity of monetary dynamics across euro area member countries may shed light on the relation between money, cross border credit flows and financial asset markets. This is important for three reasons. First, extending the money demand analysis by including a broad set of determinants and covering a longer period that includes the Great Financial crisis will shed light on the stability of the relation and its role in the ECB policy framework. Second, the analysis helps to understand how the divergence across euro area member countries in economic conditions – including housing market and stock market heterogeneity – that may endanger financial stability is related to country-specific monetary developments. Third, it provides new evidence on the link between credit flows between euro area countries and domestic money growth.

First, we address the potential (in-) stability of the money demand function. This is of great importance in the implementation of monetary policy and the role of monetary aggregates in this policy. Already before 2008, there were indications of instability of the money demand function as documented earlier. In empirical studies that contain data beyond 2001, frequently additional explanatory variables like real estate prices, equity prices or equity volatility are required to find a stable money demand function. On the policy side, the ECB over time lowered the weight of monetary aggregates in its decision-making process due to the perceived unreliability of the standard relation between money growth and inflation. Most of these studies do not use data covering the 2008 financial crisis. Including this disruptive period would be another argument for a structural break in money demand. For this reason, we will analyze monetary dynamics both for the whole period 1999-2013 and the sub periods 1999-2008 and 2008-2013. Note that most empirical studies documenting breaks use aggregate euro area data. For disaggregate data, money demand instability appears to be less of a problem, see Nautz and Rondorf (2011), Setzer, van den Noord and Wolff (2011) and Setzer and Wolff (2013).

When investigating the stability of money demand, we explicitly want to take the role of asset prices into account. In our specification, we exclude foreign asset prices and only consider a direct link between domestic money and domestic asset markets.[26] The development of monetary aggregates – measured by national contributions to euro area wide M3 – shows considerable heterogeneity across euro area member states since the introduction of the euro (Setzer et al. 2011; Bosker, 2004).[27] House price developments display diversity across euro area countries too. Several countries, like Ireland and Spain, experienced strong growth in house prices. In other countries more moderate increases are observed. Equity prices also show a certain degree of variation in terms of annual growth across member states.

Asset prices could affect money growth through three channels, i.e. the wealth effect, substitution effect and transaction effect (Friedman, 1988; Stein, 1995; Setzer et al. 2011; Goodhart and Hofmann, 2008). Rises in house and stock prices imply an increase in nominal wealth, which may result in differences between the actual and desired portfolio composition. In turn, the desired portfolio adjustment could lead to a growing demand for money. This is called the wealth effect, through which asset prices have a positive effect on money growth. The substitution effect, also called risk-spreading effect, suggests a negative relation between asset prices and money creation. Lower asset risk or higher expected future revenue makes assets more attractive. It implies a reduced demand for money, a shift from money to assets and rising asset prices (Friedman, 1988). On the other hand, a rise in asset prices implies an increase in the demand for financial transactions, which may increase the demand for money. This is called the transaction effect, which indicates a positive relation between asset prices and money creation. The overall effect of asset prices on monetary aggregates depends on the relative strength of the three effects.[28] Previous empirical evidence overall suggests a positive sign for housing prices and a negative effect for equity prices.

Finally, we analyze the role of net foreign credit in money creation. During the past decades, cross border capital flows have significantly increased and display substantial differences across member countries.[29] Empirical evidence supports the idea that these capital flows have been used to finance current account imbalances, though the causality of the relation is ambiguous (see Unger, 2017). Borio and Disyatat (2015) and Lane and McQuade

[26] Joseph et al. (2012) provide a theoretical discussion about the connection between domestic money demand and foreign asset prices. De Santis et al. (2013) document a stable domestic money demand function by including foreign asset prices for the euro area.
[27] Fig. 3.1 also shows the heterogeneity in monetary aggregates. Note the potential issue of measurement errors in domestic money demand as the national contribution to monetary aggregates includes cross-border money holdings.
[28] Since we focus on a disaggregate analysis of money demand, we do not explicitly take into account the possible link from money to asset prices. See Blot et al. (2017) for a discussion of this link.
[29] See figure 3.4.

(2014) among others focus on cross-border credit flows and link these to divergent credit growth across countries. Countries with current account deficits in general receive net foreign credit and experience strong domestic credit growth. Here, we hypothesize that net foreign credit may be related to money growth as well. Starting from the stylized balance sheet of a country's banking system, we note that on the asset side foreign credit is a substitute for domestic credit, while on the liability side foreign borrowing is a substitute for domestic deposits. To formulate hypotheses about the sign and direction of the relation between the different balance sheet items, a theoretical framework is required that appropriately models demand and supply of these variables. To our knowledge, such a framework is missing at this point. Its development is beyond the scope of this paper. We, therefore, confine ourselves to an empirical examination.

Most theoretical and empirical money demand research (See Ericsson, 1999; Coenen and Vega, 2001, Dreger and Wolters, 2010) starts from a long-run money demand function of the form:

(3.1) $M^d/P = f(Y, R, Z)$

Where M^d is some nominal money aggregate, P represents the price level, Y is a scale variable and R is the nominal opportunity cost of holding money. Z is a vector of additional determinants; see Ericsson (1999). Real GDP is the most common scale variable and is expected to exert a positive effect on money demand. In the literature, opportunity cost measures vary from the 3-month money market rate to the 10-year government bond yield and are assumed to have a negative effect on money. Some studies also include a proxy for the "own" rate on money, for which inflation may be used (Dreger and Wolters 2010, 2014; Coenen and Vega, 2001). Additional variables used in the literature comprise proxies for uncertainty or wealth effects, particularly real estate and equity prices.

In our analysis, we start from a standard specification and then include the housing price and the equity price to capture wealth factors, and net foreign credit to account for cross-border dynamics in money market as additional variables. Net foreign credit is defined as the net level of foreign assets (loans) of the domestic banking sector. Overall, it leads to the following equation (3.2):

(3.2) $m_{it} - p_{it} = a_{it} + \beta_{it} y_{it} + \gamma_{it} R_{it} + \theta_{it} Z_{it} + \varepsilon_{it}$

Where m equals the log of M3, p is the log of the GDP deflator, y is the log of real income (GDP), R the nominal interest rate. Z represents the log of the real housing price, the log of the real equity price, and net foreign credit

as a percentage of GDP, respectively. We choose the nominal 10-year government bond rate as the appropriate opportunity costs of money in our analysis. The subscript *i* refers to individual euro area countries, while *t* is the time index. The parameters $\beta_{it} > 0$, $\gamma_{it}<0$ denote the hypothesized income elasticity and semi- interest rate elasticity, respectively. In general, we are agnostic with respect to the sign of θ_{it} . The existing empirical literature provides evidence that the combined wealth and transaction effect dominate the substitution effect in the case of real estate, implying θ_{it} will be positive when Z represents the real house price. Similarly, the literature suggests θ_{it} will be negative when Z denotes the real equity price, due to the fact that in this case the substitution effect dominates.

In line with Setzer et al. (2011), Boone and van den Noord (2008) and Nautz and Rondorf (2011), we estimate equation (3.2) by panel co-integration –DOLS— as developed by Kao and Chiang (2001) and Kao (1999). The method assumes common long-run vectors across countries and cross-sectional independence, and allows for heterogeneity in the short run dynamics. Alternatively, we could use FMOLS. However, we prefer DOLS as it has a relatively small bias for samples with modest N. We perform the estimation using one lag and one lead, i.e. DOLS (-1,1). In eq. (3.2), $\varepsilon_{it} = u_i + \epsilon_{it}$ with u_i being the country fixed effects, ϵ_{it} is an error term. Since ϵ_{it} is auto-correlated according to Kao and Chiang (2001), we use the Newey and West (1994) correction. The inclusion of lags and leads improves the efficiency in estimating the panel co-integration vector. All variables are defined in deviations from the cross-sectional mean. The demeaning deletes the common shocks which are the main sources of dependence across the member countries and minimizes the impact of omitted variables. The approach is similar to a specification including time fixed effects. Pesaran and Smith (1995) show that a pooled panel estimation provides unbiased estimates of coefficient means when the coefficients differ randomly. The estimated coefficients in our paper then should be interpreted as the average reaction to the variables.

We use panel estimation for a number of reasons. First, it allows the use of short-run heterogeneity across member countries to bring out the underlying long-term determinants of money demand. Second, at the level of the euro area, it is hard to identify a money demand function since monetary aggregates in the euro area may be partly supply driven (Bosker, 2004). However, this is less of an issue at a disaggregate level. Setzer et al. (2011) illustrate that in a common currency union with perfect capital mobility, money can flow wherever it is needed. Therefore, at sub-union levels of aggregation, we do not expect large money supply effects and variations in money aggregates (relative to the monetary union as a whole) should reflect variations in money demand rather than money supply (again relative to the euro area as a whole). Also, in this approach there is less risk of reverse

causality from money aggregates onto its determinants in money demand function such as real GDP and financial market prices.

3.4 Data

Our sample contains 10 original member countries in the euro area with a time span from 1999Q1 to 2013Q3. Regarding monetary aggregates, we use the national contribution to overall M3. End of month M3 data are obtained from Datastream and ultimately from national banks' statistics. Quarterly data is constructed by taking averages of monthly data. Real and nominal GDP are provided by Eurostat, where the former is defined as chain-linked volumes with 2005 as bench year. We construct the GDP deflator (2005=100) as the ratio of nominal to real GDP multiplied by 100. Real money balances are obtained through dividing nominal M3 by the GDP deflator. In our analysis, real money aggregates and real GDP are expressed in logarithms. The data of opportunity cost, i.e. 10-year government bond yield are from ECB. Quarterly interest rates are period averages and expressed in annual percentages.

With regard to the housing price, quarterly nominal house price data (base year 2010) are obtained from the OECD. The data starts from 2000Q1 to keep panel balance because the data of Austria are not accessible before that. Euro area countries do not provide a consistently defined equity price index. Thus, to keep consistency, we employ a Datastream index (base year 1985). We deflate nominal house prices and equity prices by the GDP deflator and express the resulting series in logarithms in the subsequent analysis. Finally, net foreign credit is used. The net foreign credit variable is constructed as the difference of a country's gross cross border asset position and gross cross border liability position. The data are collected from BIS locational banking statistics by residence and denoted in US dollars. For instance, a country's gross foreign asset position represents the amount of claims that that country's banking sector holds to its counterparties outside the region, while the gross liability position is defined as the amount the country's banking sector has borrowed from its counterparts in the rest of the world, including other EA members. Thus, the net foreign credit is a narrower measure than country's net foreign asset position which includes all cross-border items like FDI. Note that the data are converted to be expressed in euros by the contemporaneous dollar/euro exchange rate which is accessible in ECB statistics. In the following analysis the net foreign credit is expressed as a percentage of nominal GDP.

We first illustrate the statistical stylized facts of all variables which are displayed in table 3.1. All variables are summarized in levels and first differences over the full period 1999-2013 (see Panel A) and two sub-periods, i.e. 1999Q1-2008Q2 (in panel B) and 2008Q3-2013Q3 (in panel C). The stylized facts are a mix of cross-sectional

variation and time variation. We first focus on the overall period in panel A. Both money and GDP levels show large and persistent differences across member countries mainly due to differences in size. For net foreign credit, cross country variation is also large, though country size is not an obvious determinant of cross-country variation. However, some countries tend to be persistent debtors (borrowers), while others are persistent creditors (savers) due to underlying characteristics, which leads to substantial cross-sectional variation. The two (indexed) asset price variables show relatively low variation. The relatively high variation of the nominal interest rate is mainly caused by the cross-sectional divergence in the second half of the sample. The first difference statistics in panel A show that over the whole period, real GDP growth was about 1.4 percent per year, while real money growth equaled 3.4 percent. On average interest rates remained stable, house prices rose with about 1.5 percent annually and equity prices declined with slightly more than 2 percent per year. Net foreign credit increased slightly too. Variation in equity prices changes was quite large as could be expected. Variation in house price changes is much more subdued and comparable to money growth variation.

Looking at the stylized statistics across the two sub periods in panels B and C, we note quite stable patterns in terms of means and standard deviations for most level variables. The most noteworthy exception is the nominal interest rate which shows a tripling of the standard deviation from the first to the second sub period. Due to the crisis, there is substantial variation across time and countries in interest rate levels after 2008 with overall declines in the Northern European countries and strong rises in the Southern ones. For the first differenced variables, we note average money, real GDP, housing prices and equity prices experienced a substantial decrease in growth rates from 1999-2008 to 2008-2013. Average annual real money growth dropped from 5 percent to approximately zero. Meantime, real GDP growth fell from an average annual growth of 2.5 percent per year before 2008 to -0.6 percent thereafter. Housing prices on average increased by almost 4 percent per year before the crisis and declined by 2.5 percent after. For equity prices the corresponding percentages are +1.2 and -8 percent. For the nominal long-term interest rate and net foreign credit, the mean change is comparable across the two periods, but variation increases substantially.

To shed more light on the relative contribution of cross-section and time variation, we provide some graphic evidence in figures 3.1 to 3.5.[30] Figure 3.1 shows real M3 growth across euro area countries as well as the euro area average real GDP growth rate. The band width is quite small at the early stage of the establishment of the euro area and then widens to a difference about 30 percent over the time 2007-2008. In the second sub-period it

[30] For presentational purposes, the real house price and the real equity price are rescaled to base year 2005.

declines somewhat to around 15 percent. The euro area average real M3 growth ranges between zero and fifteen percent over the full sample period, and reached a peak of 12 percent in 2007Q4. The minimum money growth is relatively stable in the first sub-period. While the maximum growth rate across countries changes quite a lot and reaches 27 percent in 2007Q2. In the second sub-period, both the minimum and maximum growth rate decline. Note that average real money growth rate moves roughly with real GDP growth.

In figure 3.2, we observe strong homogeneity of long-term nominal interest rates prior to the financial crisis. Virtually all variation until 2008 comes from trend changes over time. After 2008, time variation persists but cross-country variation becomes a dominant factor. Weak countries are perceived to be very risky, leading to strongly rising rates until mid-2012. At the same time, other countries become more attractive as they are seen as a safe haven, leading to lower nominal interest rates. In 2012-13, spreads narrow again though they remain substantially higher than in the early years.

Figure 3.3 illustrates developments of house prices over the period 2000-2013, with considerable variation across euro area countries and time. Due to the index character of this variable with base year 2005, cross country variation in that year is minimal. From 1999 till about 2008, there is an upward house price trend on average, which is predominantly driven by the countries that initially have relatively low prices. In this period, house prices are quite stable in Austria, Belgium and Germany over the sample period. Booms occur in Spain, France, Italy and Ireland before 2006 and in the Netherlands already before 2002. From 2008 housing prices fall on average due to the hit from the financial crisis, though there is substantial variation across countries as seen by the fanning out.

Figure 3.4 shows the movement of equity price across country and time. The picture looks somewhat similar to figure 3.3 for housing prices. Naturally, there is little cross-country variation in the base year 2005. Interestingly, this lack of cross-country variation is observed for the whole boom period 2003-2008. All countries experience roughly the same upward trend in equity prices, reflecting strong financial integration. Cross-country variation in the bear markets before 2003 and after 2008 is much greater. The impact of the financial crisis in 2008-09 is clearly visible, as is the stabilization from 2010 onward.

Finally, figure 3.5 provides evidence on the net foreign credit position across countries and time. The average remains relatively stable, but variation around that is larger than for money growth. In the early years, it is especially Ireland that has a large and increasing positive net foreign credit position, while Portugal has a substantial negative position. Italy and Spain have more moderate negative positions in this period. Between 2004

and 2009, the Irish positive position deteriorates quickly and becomes substantially negative – most likely partly due to its banking crisis – bringing it in the same class as Portugal. After 2009, both Portugal and Ireland are forced to adjust. Finland then becomes the country with the most negative net foreign credit position.

In the next step, we apply unit root tests to check the stationary of the variables which are going to be used in the analysis. This is also a preparation for the panel co-integration analysis. We employ three approaches to test for unit roots. In particular, IPS (Im, Pesaran and Shin, 2003) and two Fisher type—ADF and PP (Choi,2006) assume different unit root process across panel sections, while LLC (Levin, Lin and Chu, 2002) propose an identical unit root process. All three methods have the null hypothesis of a unit root. A time trend is included in the real GDP and M3 test, while for others it is not. Table 3.2 illustrates the test results for each variable both in levels and first differences. We used the demeaned variables, which are indicated by an upper bar. In general, it can be concluded that real money, real income, nominal interest rates and net foreign credit are non-stationary and integrated at order one, i.e. I (1). According to the IPS and ADF Fisher tests, house prices and equity prices are I (1), while the LLC results marginally lead to the conclusion that the two are I(0). For the first differences, I (1) is rejected in all cases. In the subsequent co-integration analysis, we assume all level variables to be I (1).

3.5 Empirical analysis

In section 3.5.1, we investigate the existence of a long run relation for monetary aggregates. We start with the standard money demand equation and then add the housing price, the equity price and net foreign credit in turn, as formulated in equation (3.2). We estimate the equation with quarterly data for the whole period 1999-2013 and two sub periods 1999-2008 and 2008-2013, using the default time of Lehmann Brothers at October 2008 as break point in section 3.5.2.

3.5.1 Co-integration test

This section first applies a panel co-integration test using the approach proposed by Pedroni (1999). Table 3.3 provides the statistics of the Phillips Perron group test and ADF test for estimations over the full period and two sub-periods for four sets of specifications. The equation always includes real GDP and the nominal interest rate. In addition, the real housing price, the real equity price and net foreign credit are included in turn. The null hypothesis on no co-integration is rejected for the full period, regardless of the inclusion of one of the three additional variables. In the first sub period, the null hypothesis is strongly rejected when equity prices and net foreign credit are included, but not when housing prices are incorporated. This is consistent with the results of Nautz and Rondorf (2011). In the second sub period, the null hypothesis can be rejected in the ADF test, but it

cannot be rejected in the PP test. This may be resulting from the limited observations in this sub period. Given the support for co-integration in the full period and the first sub period, we continue with the estimation of the long run money relationship.

In the following, we apply DOLS to estimate the long run monetary relation using panel co-integration, see Kao and Chiang (2001). We specify a DOLS (-1,1) model, which leads to the equation:

(3.3) $\overline{m_{it}} = \alpha_i + \beta\overline{x_{it}} + \sum_{j=-1}^{1} \gamma_{it} \overline{\Delta x_{it+j}} + v_{it}$

Where *m* is real money demand and x is the vector of explanatory variables (real GDP (*gdp*) and nominal interest rate (i^l), while housing price (*hpi*), equity price (*eqi*) and net foreign credit (*nfc*) enter one by one). The upper bar indicates that we are using demeaned variables.

3.5.2 Panel estimation results

Table 3.4 contains the results for the standard specification of the money demand equation including real GDP and the nominal interest rate. We only report the long-run coefficient vector β. Standard errors are reported in brackets. The income elasticity is slightly below one and very significant. It is quite stable across sub periods. The estimation result is consistent with monetary theory that the demand for real transactions balances roughly moves proportionally to real income. The interest rate coefficient is significantly positive over the full period. However, the sub period results show that this overall effect is an average of a significantly negative interest effect in the first sub period and a larger positive effect in the second period. We hypothesize that this sign change is primarily due to the financial crisis. Increased sovereign risk in the Southern European countries caused a flight to safety – including an increased demand for money – as well as strongly rising long-term nominal interest rates. To capture this effect, we introduce a time dummy that is one from 2008Q4 onward, and zero before and include both the dummy and the interaction effect of the dummy with the interest rate in the specification. The last column of table 4 shows the results. It confirms the sign change, though the individual coefficients fail to become significant.

In table 3.5, we add real house prices to the specification. The results for income and interest rate are qualitatively similar to the standard specification in table 3.4. The estimate of the income elasticity appears very robust to the change in specification and remains close to one and significant. The pattern of interest rate coefficients also is the same as before, though with reduced significance. Consistent with the literature, we find a significantly positive house price elasticity both for the full period and the first sub period. In the second sub period, no significant effect is found, most likely due to the heterogeneous housing market developments with only some

countries experiencing a severe bust. The last column shows the results for the full period including the dummy and interaction terms. The direct income and house price effects are significant and qualitatively similar to the benchmark specification in the first column. The interest rate coefficients change sign between periods but are insignificant. Also the house price interaction term is insignificant.

In table 3.6, we report the results when the equity price is included in the specification. We again obtain roughly the same results for the income and interest rate effects. The equity coefficients are insignificant both for the full period and the two sub periods. However, using the dummy and interaction terms for the interest rate and the equity price shows a significantly negative equity price effect before 2008 and a slightly larger positive effect thereafter. Similar to the interest rate effect, there appears to be a structural break in the relation between money and equity prices that is related to the financial crisis period. Our pre-2008 result is consistent with Nautz and Rondorf (2011).

Finally, we turn to the case of net foreign credit as a determinant of money demand. Results are summarized in table 3.7. The evidence on income and interest rate effects is similar to previous specifications. With respect to net foreign credit, we find a small significantly negative coefficient both for the whole sample and the first sub period and a small significantly positive effect for the second one. Using the dummy and interaction effects yields the same result. This evidence complements earlier evidence by Lane and McQuade (2014) and Unger (2017), who report a negative relation between cross border credit flows and domestic credit growth. The null hypothesis that debtor countries have more room for domestic money and credit creation while creditor countries have less is confirmed.

Earlier research on euro area money demand using panel estimation –Nautz and Rondorf (2011), Setzer et al. (2011) and Setzer and Wolff (2013)—typically employs data up till mid-2008. All of these three studies report strongly significant income elasticities in a range from 1 to 1.5. Our income elasticities are on the bottom of this range. With respect to interest rate coefficients, both Nautz and Rondorf (2011), and Setzer and Wolff (2013) use long term rates and report significantly negative interest rate coefficients, similar to ours. Setzer et al. (2011) use the short term interest rate and only find insignificant effects. Overall, our first period results are in line with other research using a disaggregate panel approach. Our finding for the first sub period that housing prices are positively related to real money, while for equity prices the link is negative is consistent with the empirical time series literature.

Obviously, the second period results show sign changes in the nominal interest rate, housing prices, equity prices and net foreign credit. This suggests a change in the relation around the time of global financial crisis. Given the impact of the crisis on the operation of the monetary and financial system, such change is not implausible. A full analysis of the underlying determinants of this change is beyond the scope of this paper. However, both the divergence in sovereign bond yields due to default risk premiums, new rules for micro-prudential and macro-prudential regulations and the start of unconventional monetary policies by the ECB may have played a role.

3.5.3 Robustness checks

To check the sensitivity of our results, we perform four robustness checks. First, we exclude the biggest economy—Germany—in the euro area which may be seen as an anchor country in monetary policy. Second, we reduce the number of countries in our sample by excluding the two countries with the highest real money growth rate during the whole period—Ireland and France—and the two countries —Belgium and Portugal – with the lowest average money growth to check whether these extremes have a dominant influence on the results. Third, we apply GLS instead of DOLS to check for the importance of cross-sectional dependence. Fourth, we estimate long run money relations for Southern countries and Northern countries separately. The corresponding results are displayed in tables 3A.1-3A.4 in the Appendix.[31]

With one exception, we find results that are consistent with our main estimation. That is, we still find i) a robust income elasticity close to unity; ii) an interest rate effect that tends to be negative in the first sub period and positive in the second one; iii) a positive relation between housing prices and money growth; iv) a weakly negative link between equity prices and money growth; v) a negative relation between the net foreign asset position and real money growth; and vi) a structural break in the long run money relation around 2008 which shows up not only in the interest rate coefficient, but also in the sign of the housing price, equity price, and net foreign credit coefficients. Using the North-South distinction, the income and net foreign credit remain qualitatively similar. However, the estimated interest rate coefficients for the first sub period are much larger in either block and have opposite signs. For the Southern countries a negative coefficient is found, similar to the main estimation in tables 3.4 through 3.7, but for the Northern ones a positive coefficient. While the house price effect is positive in both groups, it is large and significant for North only. The equity price coefficients are positive now. Future research is needed to go into this finding deeper.

[31] Note that the results of the robustness tests need to be interpreted cautiously as the number of countries is reduced considerably in some of them. DOLS is sensitive to the number of cross-sections in a panel sample.

3.6 Conclusion

In the wake of the recent financial crisis, the development of money and credit aggregates has received increasing attention academically and in monetary policy. For the euro area, interest in monetary dynamics has an extra dimension as strong cross-country heterogeneity in money and credit growth as well as real estate markets has been observed since the start of the euro, regardless of the common monetary policy implemented by the ECB.

In this paper we intend to contribute to the understanding of the relation between real economic developments and monetary aggregates. We employ panel data of 10 member countries of the euro area over the period 1999-2013 to exploit the heterogeneity across the member countries. More in particular, we investigate to what extent wealth effects, proxied by real house prices and real equity prices, play a role in money demand, whether cross border bank credit flows play a role in the development of domestic money and whether the financial crisis has affected the stability of money demand reported in the literature prior to the crisis. For the analysis, we start with a standard framework where money demand depends on income and the nominal interest rate. In turn, we add three extra determinants, housing prices, equity prices and net foreign credit respectively.

We employ a panel co-integration methodology which is proposed by Kao and Chiang (2001) to analyze the determinants of monetary dynamics in the euro area member countries. It allows us to exploit a homogenous long run money relation while considering the heterogeneity across countries as well. During the empirical analysis, all variables are measured in deviation from their euro area average to reduce cross-sectional dependence and omitted variable bias. We estimate for the whole period from 1999-2013 as well as two sub periods, namely 1999-2008 and 2008-2013. As an alternative to the sub period estimation, we introduce a crisis dummy and interaction effects for a full sample analysis.

For the period up till 2008 our evidence is similar to earlier research. That is, we find a significantly positive income effect, a significantly negative interest rate effect and a significantly positive housing price effect. For equity prices, support is limited. If anything, the effect in the first sub period is negative. Complementary to research on the link between net foreign credit and domestic credit, we find a significantly negative link between net foreign credit and domestic money.

However, when we extend our sample to include the financial crisis and its aftermath, structural breaks are observed in the long run money demand function. Especially the interest rate effect changes sign and is positive in the second sub period. There is also some evidence of sign reversals for equity prices and net foreign credit. The estimated income elasticity is stable and robust and remains close to one – consistent with transactions

theories of money demand – independent of the inclusion of wealth variables, the choice of sample period or the set of countries in the sample. Our research also provides some suggestive evidence on the North-South divide in Europe. It calls for future research.

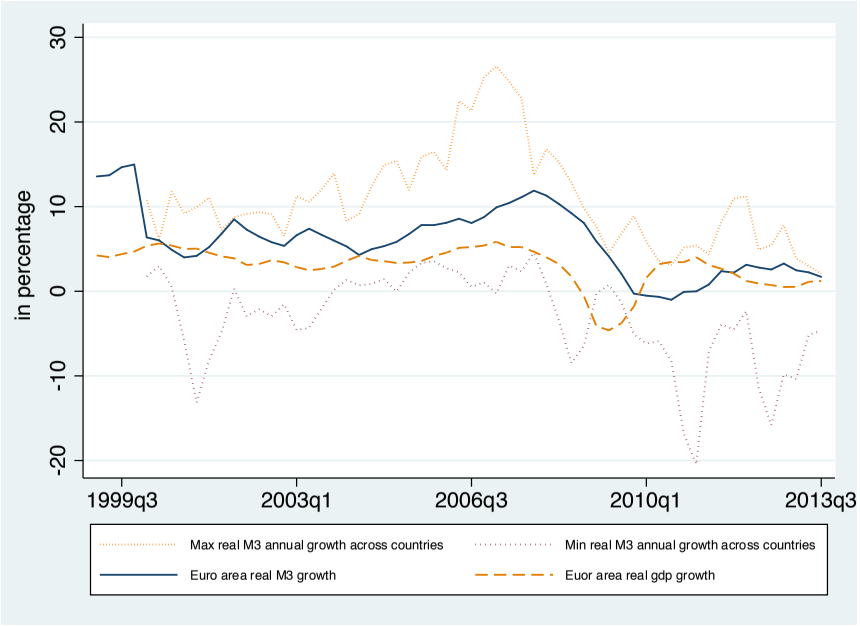


Figure 3.1. Real Monetary annual growth rate.

Data source: ECB statistics, growth rates are own calculation
Sample period: 1999q1-2013q3

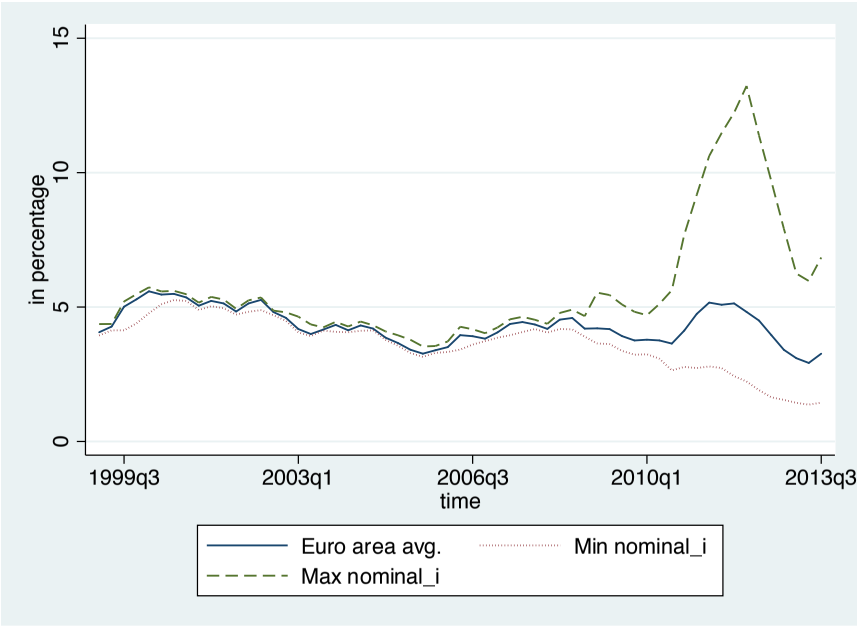


Figure 3.2. Nominal interest rate

Date source: ECB statistics, max, min and average rate are own calculation
Sample period: 1999q1-2013q3

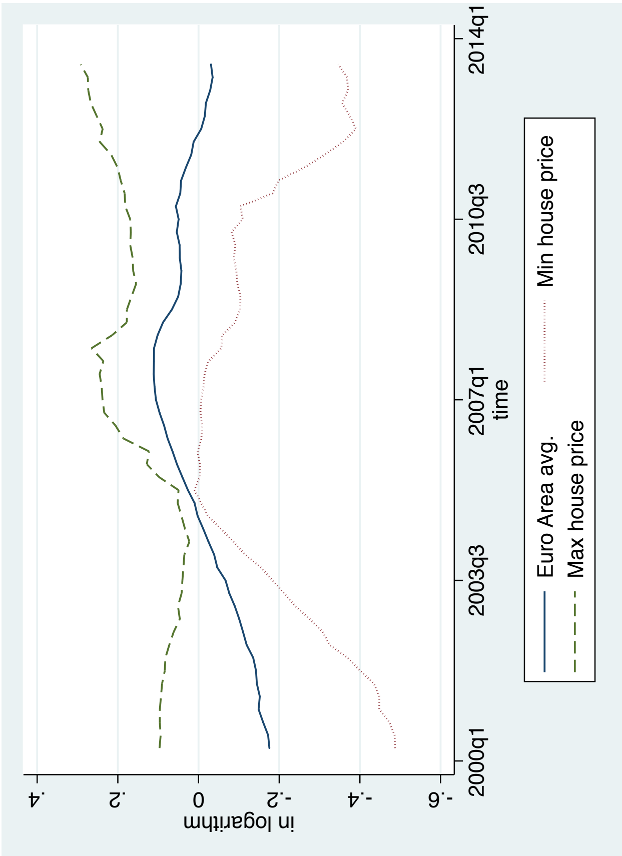


Figure 3.3. Real house price index (base year 2005)

Data source: OECD statistics
Sample period: 2000q1-2013q3

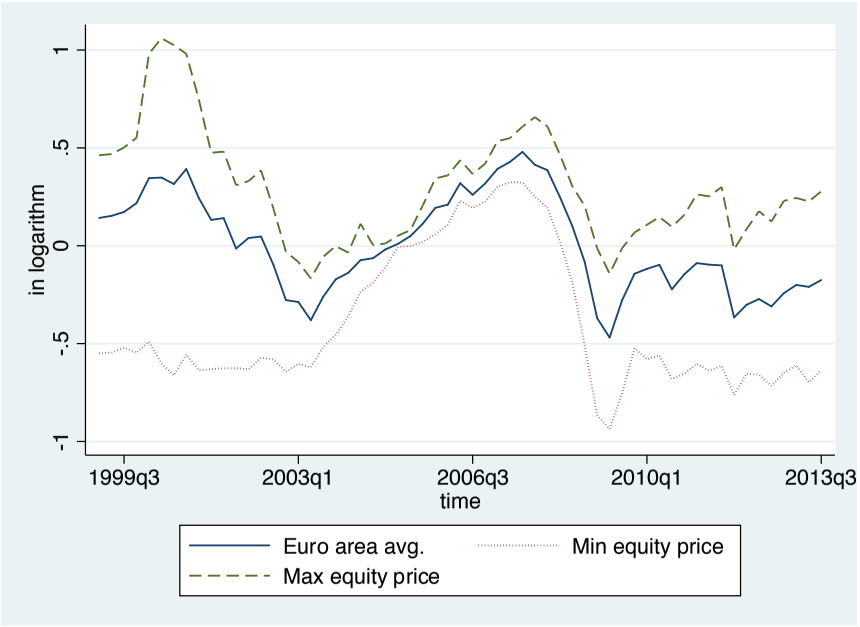


Figure 3.4. Real equity price (base year 2005)

Data source: Datastream
Sample period: 1999q1-2013q3

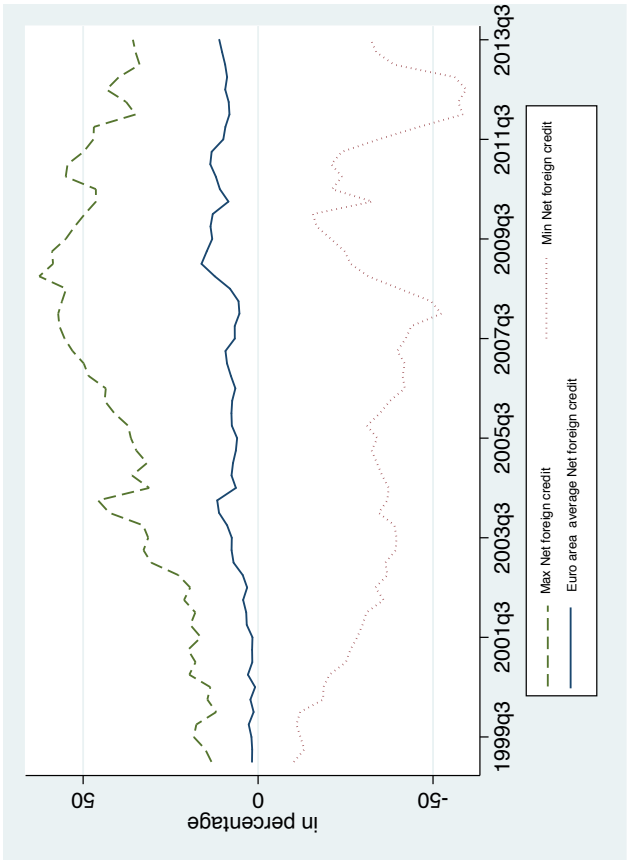


Figure 3.5. Net foreign credit

Data source: BIS locational bank statistics; net position own calculations
Sample period: 1999q1-2013q3

Table 3.1. Stylized statistics

Panel A 1999Q1-2013Q3												
Var.		Level						First differenced				
	unit	Obs.	Mean	Std.	Min	Max	unit	Obs.	Mean	Std.	Min	Max
m	Real money aggregates, logarithm	590	8.32	1.01	6.53	9.94	% per quarter	580	0.88	2.04	-7.30	15.37
gdp	Real GDP, logarithm	590	11.71	1.00	10.29	13.35	% per quarter	580	0.35	1.11	-5.46	6.00
i^l	Nominal long term interest rate, %	590	4.32	1.29	1.37	13.22	Percentage points	580	-0.01	0.40	-1.84	2.53
hpi	Real house price index, logarithm	586	-0.14	0.20	-0.71	0.43	% per quarter	576	0.37	1.89	-8.89	6.83
eqi	Real equity price, logarithm	590	2.11	0.82	0.03	3.76	% per quarter	580	-0.55	11.20	-42.00	49.27
nfc	Net foreign credit, % GDP	590	7.45	22.84	-59.49	62.55	Percentage points	580	0.16	5.61	-57.22	49.74
Panel B 1999Q1-2008Q2												
Var.		Level						First differenced				
	unit	Obs.	Mean	Std.	Min	Max	unit	Obs.	Mean	Std.	Min	Max
m	Real money aggregates, logarithm	380	8.21	1.01	6.53	9.85	% per quarter	370	1.38	1.80	-5.81	9.18
gdp	Real GDP, logarithm	380	11.68	1.01	10.29	13.32	% per quarter	370	0.63	0.92	-5.10	6.00
i^l	Nominal long term interest rate, %	380	4.44	0.65	3.15	5.73	Percentage points	370	0.01	0.28	-0.51	0.91
hpi	Real house price index, logarithm	376	-0.17	0.23	-0.71	0.43	% per quarter	366	0.95	1.63	-8.89	6.83
eqi	Real equity price, logarithm	380	2.22	0.84	0.18	3.76	% per quarter	370	0.29	9.90	-10.19	49.27
nfc	Net foreign credit, % GDP	380	5.40	20.88	-52.36	57.14	Percentage points	370	0.10	4.46	-57.22	23.93
Panel C 2008Q2-2013Q3												
Var.		Level						First differenced				
	unit	Obs.	Mean	Std.	Min	Max	unit	Obs.	Mean	Std.	Min	Max
m	Real money aggregates, logarithm	210	8.52	0.98	7.06	9.94	% per quarter	210	0.00	2.15	-7.30	15.37
gdp	Real GDP, logarithm	210	11.76	1.00	10.51	13.35	% per quarter	210	-0.15	1.23	-5.46	3.89
i^l	Nominal long term interest rate,%	210	4.11	1.97	1.37	13.22	Percentage points	210	-0.06	0.55	-1.84	2.53
hpi	Real house price index, logarithm	210	-0.09	0.10	-0.45	0.33	% per quarter	576	-0.63	1.89	-7.98	3.88
eqi	Real stock price, logarithm	210	1.90	0.74	0.03	3.15	% per quarter	580	-2.02	13.08	-42.22	24.39
nfc	Net foreign credit, % GDP	210	11.15	26.65	-59.49	62.55	Percentage points	210	0.26	7.21	-41.45	49.74

Table 3.2. Unit root test

level						
	$\overline{m}$	$\overline{gdp}$	$\overline{\text{l}}$	$\overline{\text{hpi}}$	$\overline{\text{eqi}}$	$\overline{\text{nfc}}$
IPS	3.86(0.99)	2.10(0.98)	1.95(0.97)	1.79(0.96)	-0.84(0.20)	-1.31(0.10)
ADF	-2.45(0.99)	-1.84(0.97)	-0.83(0.80)	-0.07(0.53)	-0.57(0.72)	0.61(0.27)
PP	-2.86(0.99)	-1.69(0.95)	-1.64(0.95)	-2.18(0.99)	1.28(0.10)	0.52(0.30)
LLC	1.85(0.97)	-0.41(0.34)	2.03(0.98)	-1.62(0.05)	-1.34(0.09)	-1.30(0.10)
First differenced						
IPS	-11.00(0.00)	-4.82(0.00)	-9.90(0.00)	-4.38(0.00)	-18.84(0.00)	-18.26(0.00)
ADF	2.96(0.01)	8.03(0.00)	9.30(0.00)	2.42(0.01)	19.12(0.00)	9.77(0.00)
PP	38.30(0.00)	31.42(0.00)	31.44(0.00)	34.97(0.00)	68.65(0.00)	74.96(0.00)
LLC	-6.90(0.00)	-14.75(0.00)	-6.47(0.00)	-5.01(0.00)	-15.59(0.00)	-19.17(0.00)

NOTE:

a. For the unit root test on M3 and GDP, a time trend is included.

b. The null hypothesis of IPS, FISHER (ADF and PP) and LLC is that all panels contain a unit root, the alternative hypothesis is that some panels are stationary. p-values are in parentheses.

Table 3.3. Panel co-integration test

Time span	1999-2013		1999-2008		2008-2013	
	Group PP	Group ADF	Group PP	Group ADF	Group PP	Group ADF
$\overline{gdp}, \vec{\imath}^{l}$	-2.91(0.00)	-2.57(0.01)	-3.28(0.00)	-2.29(0.01)	0.79(0.79)	-2.70(0.00)
$\overline{gdp}, \vec{\imath}^{l}, \overline{HPI}$	-1.10(0.13)	-1.66(0.05)	-0.75(0.23)	-1.03(0.15)	0.85(0.80)	-3.29(0.00)
$\overline{gdp}, \vec{\imath}^{l}, \overline{EQI}$	-1.94(0.03)	-1.54(0.06)	-2.54(0.00)	-2.11(0.03)	1.13(0.87)	-3.26(0.00)
$\overline{gdp}, \vec{\imath}^{l}, \overline{NFC}$	-2.55(0.01)	-2.00(0.02)	-3.95(0.00)	-2.48(0.01)	0.42(0.66)	-1.92(0.03)

Note: p-values are in parentheses.

Table 3.4. Long-run money demand: standard specification

Model	$\overline{gdp}, \vec{\imath}^{l}$			
Period	1999-2013	1999-2008	2008-2013	1999-2013
$\overline{gdp}$	0.985***	0.984***	0.981***	0.985***
	[0.273]	[0.361]	[0.321]	[0.273]
$\vec{\imath}^{l}$	0.018***	-0.042	0.019***	-0.013
	[0.006]	[0.038]	[0.004]	[0.035]
$\vec{\imath}^{l}$ *DUM				0.031
				[0.035]

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

Table 3.5. Long-run money demand: including house prices

Model	$\overline{gdp}, \vec{\imath}^{l}, \overline{hpi}$			
Period	2000-2013	2000-2008	2008-2013	2000-2013
$\overline{gdp}$	0.988***	0.984**	0.971***	0.987***
	[0.278]	[0.385]	[0.305]	[0.278]
$\vec{\imath}^{l}$	0.017***	-0.045	-0.008**	-0.010
	[0.005]	[0.049]	[0.004]	[0.043]
$\vec{\imath}^{l}$ *DUM				0.025
				[0.043]
$\overline{hpi}$	0.153**	0.226*	-0.007	0.170**
	[0.078]	[0.120]	[0.076]	[0.085]
$\overline{hpi}$ *DUM				-0.025
				[-0.090]

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

Table 3.6. Long-run money demand: including equity prices

Model	$\overline{gdp}$, $\bar{\imath}^l$, $\overline{eqi}$			
Period	1999-2013	1999-2008	2008-2013	1999-2013
$\overline{gdp}$	0.991***	0.998**	0.972***	0.990***
	[0.266]	[0.361]	[0.351]	[0.243]
$\bar{\imath}^l$	0.017***	-0.032	0.023***	-0.018
	[0.006]	[0.039]	[0.004]	[0.030]
$\bar{\imath}^l$ *DUM				0.042
				[0.031]
$\overline{eqi}$	-0.027	-0.057	0.049	-0.057*
	[0.035]	[0.045]	[0.063]	[0.032]
$\overline{eqi}$ *DUM				0.097***
				[0.020]

Note: standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

Table 3.7. Long-run money demand: including net foreign credit

Model	$\overline{gdp}$, $\bar{\imath}^l$, $\overline{nfc}$			
Period	1999-2013	1999-2008	2008-2013	1999-2013
$\overline{gdp}$	0.989***	0.997***	0.972***	0.991***
	[0.265]	[0.340]	[0.314]	[0.263]
$\bar{\imath}^l$	0.018***	-0.167***	0.014***	-0.172***
	[0.006]	[0.036]	[0.004]	[0.033]
$\bar{\imath}^l$ *DUM				0.191***
				[0.033]
$\overline{nfc}$	-0.001**	-0.003***	0.002***	-0.003***
	[0.000]	[0.000]	[0.000]	[0.000]
$\overline{nfc}$ *DUM				0.004***
				[0.000]

Note: Standard errors are in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

3.7 Appendix

Table 3A.1. Robustness dropping DEU

Panel A													
Model		$\overline{gdp}, \bar{\imath}^l$			$\overline{gdp}, \bar{\imath}^l, \overline{hpi}$			$\overline{gdp}, \bar{\imath}^l, \overline{eqi}$			$\overline{gdp}, \bar{\imath}^l, \overline{nfc}$		
Period	99-13	99-08	08-13	00-13	00-08	08-13	99-13	99-08	08-13	99-13	99-08	08-13
$\overline{gdp}$	1.008***	1.006***	1.010***	1.020***	1.027**	0.992***	1.027***	1.041***	1.005***	1.008***	1.012***	1.012***
	[0.299]	[0.376]	[0.351]	[0.326]	[0.426]	[0.330]	[0.292]	[0.371]	[0.383]	[0.290]	[0.348]	[0.341]
$\bar{\imath}^l$	0.015**	-0.342**	0.019***	0.005	-0.470***	-0.005	0.012*	-0.471***	0.020***	0.014**	-0.602***	0.011***
	[0.006]	[0.142]	[0.004]	[0.006]	[0.150]	[0.004]	[0.006]	[0.151]	[0.004]	[0.006]	[0.131]	[0.004]
$\bar{Z}^b$				0.193*	0.225	0.100	-0.051	-0.088*	0.023	-0.000	-0.003***	0.003***
				[0.108]	[0.158]	[0.080]	[0.038]	[0.047]	[0.066]	[0.000]	[0.000]	[0.000]

Panel B				
Model	$\overline{gdp}, \bar{\imath}^l$	$\overline{gdp}, \bar{\imath}^l, \overline{hpi}$	$\overline{gdp}, \bar{\imath}^l, \overline{eqi}$	$\overline{gdp}, \bar{\imath}^l, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
gdp	1.009***	1.022***	1.027***	1.014***
	[0.294]	[0.321]	[0.263]	[0.281]
$\bar{\imath}^l$	-0.265**	-0.414***	-0.346***	-0.563***
	[0.114]	[0.116]	[0.076]	[0.109]
$\bar{\imath}^l$ *DUM	0.281**	0.420***	0.367***	-0.573***
	[0.113]	[0.116]	[0.076]	[0.108]
$\bar{Z}^b$		0.206*	-0.083**	-0.003***
		[0.106]	[0.034]	[0.000]
$\bar{Z}^b$ *dum			0.097***	0.006***
			[0.021]	[0.000]

Table 3A.2. Robustness excluding IE FR BE PT

Panel A												
Model	$\overline{gdp}, \bar{\imath}^l$			$\overline{gdp}, \bar{\imath}^l, \overline{hpi}$			$\overline{gdp}, \bar{\imath}^l, \overline{eqi}$			$\overline{gdp}, \bar{\imath}^l, \overline{nfc}$		
Period	99-13	99-08	08-13	00-13	00-08	08-13	99-13	99-08	08-13	99-13	99-08	08-13
$\overline{gdp}$	1.041***	1.054***	1.021***	1.035***	1.036**	1.023***	1.046***	1.056***	1.022***	1.043***	1.044***	1.004***
	[0.229]	[0.376]	[0.298]	[0.242]	[0.411]	[0.314]	[0.231]	[0.371]	[0.240]	[0.223]	[0.336]	[0.306]
$\bar{\imath}^l$	-0.003	-0.179***	-0.006	-0.013*	-0.088***	-0.085***	-0.003	-0.150***	-0.004	-0.011	-0.325***	-0.001
	[0.008]	[0.023]	[0.007]	[0.007]	[0.022]	[0.007]	[0.008]	[0.023]	[0.006]	[0.008]	[0.021]	[0.008]
$\bar{Z}^b$				0.055	0.359***	-0.505***	-0.040*	-0.025	-0.027	-0.002**	-0.003***	0.001**
				[0.061]	[0.102]	[0.070]	[0.023]	[0.030]	[0.048]	[0.000]	[0.000]	[0.000]

Panel B				
Model	$\overline{gdp}, \bar{\imath}^l$	$\overline{gdp}, \bar{\imath}^l, \overline{hpi}$	$\overline{gdp}, \bar{\imath}^l, \overline{eqi}$	$\overline{gdp}, \bar{\imath}^l, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
$\overline{gdp}$	1.040***	1.042***	1.044***	1.032***
	[0.229]	[0.274]	[0.243]	[0.223]
$\bar{\imath}^l$	-0.172***	-0.106***	-0.148***	-0.344***
	[0.018]	[0.020]	[0.020]	[0.018]
$\bar{\imath}^l$ *DUM	0.173***	0.068***	0.146***	0.343***
	[0.020]	[0.021]	[0.021]	[0.000]
$\bar{Z}^b$		0.242***	-0.032	-0.004***
		[0.083]	[0.024]	[0.000]
$\bar{Z}^b$ *dum		-0.870***		0.004***
		[0.119]		[0.000]

Table 3A.3. GLS with deviation variables, 10 country sample

Panel A												
Model	$\overline{gdp}, \bar{\imath}^l$			$\overline{gdp}, \bar{\imath}^l, \overline{hpi}$			$\overline{gdp}, \bar{\imath}^l, \overline{eqi}$			$\overline{gdp}, \bar{\imath}^l, \overline{nfc}$		
Period	99-13	99-08	08-13	00-13	00-08	08-13	99-13	99-08	08-13	99-13	99-08	08-13
$\overline{gdp}$	0.987***	0.986***	0.983***	0.981***	0.981***	0.982***	1.013***	1.018***	0.943***	1.001***	1.021***	0.966***
	[0.005]	[0.007]	[0.008]	[0.006]	[0.008]	[0.008]	[0.007]	[0.009]	[0.008]	[0.005]	[0.005]	[0.008]
$\bar{\imath}^l$	0.008*	-0.103**	0.010***	0.012**	-0.080	0.009**	0.001	-0.095*	0.013***	0.014***	0.004	0.003
	[0.005]	[0.041]	[0.004]	[0.005]	[0.068]	[0.004]	[0.005]	[0.051]	[0.004]	[0.004]	[0.030]	[0.004]
$\bar{Z}^b$				0.026	0.025	-0.056	-	-0.087***	0.057***	-	-	0.000
				[0.033]	[0.040]	[0.093]	0.062***	[0.007]	[0.010]	0.002***	0.004***	[0.000]
							[0.007]			[0.000]	[0.000]	

Panel B				
Model	$\overline{gdp}, \bar{\imath}^l$	$\overline{gdp}, \bar{\imath}^l, \overline{hpi}$	$\overline{gdp}, \bar{\imath}^l, \overline{eqi}$	$\overline{gdp}, \bar{\imath}^l, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
$\overline{gdp}$	0.986***	0.986***	1.005***	1.008***
	[0.005]	[0.006]	[0.007]	[0.005]
$\bar{\imath}^l$	-0.038	-0.018	-0.027	0.019***
	[0.046]	[0.050]	[0.052]	[0.005]
$\bar{\imath}^l$ *DUM	0.046	0.027	0.038	
	[0.045]	[0.050]	[0.052]	
$\bar{Z}^b$		-0.008	-0.074***	-0.003***
		[0.029]	[0.008]	[0.000]
$\bar{Z}^b$ *dum			0.048***	0.002***
			[0.013]	[0.000]

Table 3A.4. Panel co-integration for Northern-Southern European countries

Panel A: Northern European countries				
Model	$\overline{gdp}, \bar{\imath}^l$	$\overline{gdp}, \bar{\imath}^l, \overline{hpi}$	$\overline{gdp}, \bar{\imath}^l, \overline{eqi}$	$\overline{gdp}, \bar{\imath}^l, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
$\overline{gdp}$	1.027***	1.043***	1.020***	1.027***
	[0.280]	[0.294]	[0.287]	[0.285]
$\bar{\imath}^l$	0.303***	0.091***	0.232***	0.221***
	[0.031]	[0.031]	[0.022]	[0.021]
$\bar{\imath}^l$ *DUM	-0.283***	-0.064**	-0.178***	-0.193***
	[0.032]	[0.031]	[0.023]	[0.023]
$\bar{Z}^b$		0.471***	0.292***	-0.001***
		[0.071]	[0.049]	[0.000]
$\bar{Z}^b$ *dum				0.002***
				[0.000]
Panel B: Southern European countries				
Model	$\overline{gdp}, \bar{\imath}^l$	$\overline{gdp}, \bar{\imath}^l, \overline{hpi}$	$\overline{gdp}, \bar{\imath}^l, \overline{eqi}$	$\overline{gdp}, \bar{\imath}^l, \overline{nfc}$
Period	99-13	00-13	99-13	99-13
$\overline{gdp}$	0.930**	0.932**	0.931***	0.962**
	[0.432]	[0.464]	[0.315]	[0.401]
$\bar{\imath}^l$	-0.476***	-0.449***	-	-0.770***
	[0.141]	[0.142]	0.483***	[0.133]
			[0.099]	
$\bar{\imath}^l$ *DUM	0.472***	0.442***	0.485***	0.791***
	[0.141]	[0.142]	[0.098]	[0.133]
$\bar{Z}^b$		0.083	0.147**	-0.004***
		[0.145]	[0.068]	[0.000]
$\bar{Z}^b$ *dum				0.005***
				[0.000]

Chapter 4.
Money and Credit Overhang in the Euro Area[32]

[32] Another version of this chapter has been published as "Liu, J., & Kool, C. J. M. (2018). Money and credit overhang in the euro area. *Economic Modelling*, *68*, 622-633."

4.1 Introduction

From the mid-1980s to 2007 – the so-called Great Moderation – interest in the dynamics of money and credit aggregates steadily declined, both in policy debates and in academic research. The empirical break-down of money demand equations in many countries caused central banks to switch to inflation targeting strategies, with the interest rate as prime policy instrument. Even the European Central Bank (ECB) in 2003 modified its earlier two-pillar strategy and downplayed the relevance of the development of its key monetary aggregate M3 when it consistently outgrew its reference growth rate of 4.5 percent.

The 2008 Global Financial Crisis (GFC) has revived interest in the role of money and bank credit as determinants of macroeconomic developments and in the relation between money and credit.[33] This is particularly relevant for the euro area for a number of reasons. First, the euro area traditionally depends to a much larger extent than Anglo-Saxon countries on bank-based credit. Note that a substantial increase of credit—excessive credit in the economy—may negatively affect the stability of the whole area. Second, the completion of the internal market and the introduction of the euro as a common currency have enormously increased the level of financial integration and have facilitated large capital flows between countries, which have larger and more persistent current account imbalances. During the GFC and the subsequent euro crisis, we have seen that this also leads to increased fragility of the financial system. Capital flight within the euro area has caused destabilizing effects in financial markets and on government finances. The underlying relation between cross-country capital flows and domestic credit may aggravate the instability. In addition, the interconnectedness of large banks operating throughout the euro area has caused contagion effects and has shown the need for supranational macro-prudential regulation, resolution frameworks and rescue mechanisms. An improved understanding of money and credit dynamics—identifying money overhang and credit overhang per se—can contribute to further insights into adequate monetary and financial policy.

In this paper, we focus on the question to what extent and in which countries there has been excessive money and credit growth in the period prior to 2008. In addition, we would like to analyze their bilateral relation. We use empirical results on the long run money and credit relation from chapter 2 and chapter 3. In this chapter, we limit the analysis to the full period, whereby we account for GFC structural breaks. Given the current debate on the potential role of cross-country imbalances in causing excess credit, we explicitly incorporate net foreign bank

[33] We refer to Schularick and Taylor (2012) for an overview of the different perspectives on money and credit over the past century.

credit in our analysis. Based on our earlier estimations, we compute money and credit overhang for each country and show the degree to which they are related to each other and to net foreign credit.

Overall, we document evidence of common long-run relations for money and credit respectively across euro area countries, whereby we need to account for a break around the 2008 crisis. Money and credit are seen to follow similar trends as they are roughly driven by the same variables, in particular with respect to their relations to GDP. We show that especially the weaker, current account deficit countries in our sample – Ireland, Spain and Portugal – exhibit a substantial build-up over credit overhang prior to the crisis. The Northern countries on the other hand see declining and negative credit overhang in this period. Net foreign credit is shown to be strongly related to the size of the credit overhang: including it into the analysis considerably reduces the estimated overhang for most countries. The relation between net foreign credit and estimated money overhang is weaker. The short and intermediate relation between money and credit overhang is limited. This throws doubt on the hypothesis that it is the virtually unlimited money-creating potential of commercial banks that lies behind the emergence of credit booms. Countries can have a substantial credit build-up without strong money overhang and vice versa.

The paper is set up as follows. In section 4.2, we will give a review on the literature about the relation between money and credit in the euro area. In section 4.3, we formulate some hypotheses, introduce the empirical model we want to use for the analysis and briefly discuss the appropriate econometric methodology. Section 4.4 presents and discusses the empirical results. Section 4.5 concludes.

4.2 Literature review

First, we turn to the issue of "excess money" or money overhang. Money overhang can best be defined as the (log) difference between the observed monetary aggregate and some equilibrium money stock. Credit overhang can be defined correspondingly, but has not been the focus of research previously.

A theoretical motivation of "dis-equilibrium money" can be found in the buffer stock approach (see Laidler, 1984). Empirically, the most common approach is to derive the equilibrium level of the monetary aggregate from a co-integration analysis. Excess money then equals the error correction term, computed using actual values of the variables in the co-integrating relation, such as income and interest. Alternatively, HP filtered values of these

variables can be inputted in the error correction term. We refer to Avouyi-Dovi et al. (2012) and Dreger and Wolters (2010, 2014) for examples of this strategy.[34]

A general criticism with respect to any of the above approaches to measure excess money when applied to a single country is that the co-integration analysis aims to find those in-sample coefficients which minimize the size and persistence of the error correction term. In practice, therefore, most money demand studies on the euro area level document limited monetary overhang. Dreger and Wolters (2010, 2014) for example argue that there is no evidence of excess money in the euro area in the early 2000s on the basis of such analysis. But in stark contrast to this finding, De Santis et al. (2013) document excessive euro area money growth after 2001 when using the coefficients from Calza et al. (2001) out of sample. Another signal of the inadequacy of this approach is that in euro area money demand research, the estimated income elasticity is strongly sample-dependent, suggesting it may serve as an absorption buffer for excess money empirically. Note that the panel co-integration analysis that we use is much less subject to this critique.

Second, we review the research on the relation between money and credit. Chapter 2 and chapter 3 present the literature review and analysis of separate money and credit dynamics in the euro area, respectively. Previous literature typically approaches the relation between money and credit from a balance sheet perspective. The standard theoretical money demand model treats money and credit asymmetrically, where the latter follows the former and is constrained by it (Bernanke and Blinder, 1988). Blinder and Stiglitz (1983) argue that data analysis may have difficulty distinguishing between money and credit because the two normally are highly collinear.

Schularick and Taylor (2012) document the relation between money and credit from a historical view. They identify two distinct behaviors in terms of the relation. For the period before the Great Depression, money and credit were volatile but maintained a roughly stable relationship to each other over a long time. This is also in line with the argument by Bernanke and Blinder (1988). Afterwards, starting from 1945, Schularick and Taylor (2012) identify a decoupling with credit growing faster than money and GDP. Baeriswyl and Ganarin (2011) investigate the case for the US and Switzerland. They also find the weakening connection between monetary aggregates and credit growth. These contributions challenge the reliability of traditional monetary theory of credit growth.

A separate research strand approaches the relation between money and credit from the perspective of the business cycle, see for example Musso (2009), Borio (2014) and Drehmann, Borio and Tsatsaronis (2012). Musso (2009)

[34] For alternative approaches, we refer to Masuch et al. (2001), De Santis et al. (2013) and Setzer and Wolters (2013). Kool et al. (2013) posit a long run relation for money and credit respectively based on the literature to compute equilibrium paths for these variables.

finds empirical evidence that broad monetary aggregates have a slightly higher degree of volatility than the business cycle, and that the volatility of private loans tends to be twice as large as that of the cycle. Their evidence also shows that the relation between money and business cycle has tended to be fairly stable over time, while the relation for credit has been more volatile. Borio (2014) and Drehmann et al. (2012) show that the credit cycle is significantly longer and has a much greater amplitude than the standard business cycle. In contrast, Jorda et al. (2016) find that the average duration of a credit cycle is similar to the average duration of a traditional business cycle.

Since the 2008 GFC, an old money and credit debate has resurfaced. The debate takes as a starting point the stylized fact that high private credit growth is one of the best early warning signals of financial fragility and increasing chances of a financial bust, see for example Schularick and Taylor (2012). Second, it is recognized that in modern economies most money – deposit – creation is actually done by private banks through lending operations as explained by McLeay et al. (2014). This suggests that credit creates money – as opposed to the traditional view that money creates credit – and that private bank credit creation is virtually unbounded. It raises the issue whether it would be preferable to separate money and credit creation as proposed in Benes and Kumhof (2012). Both McLeay et al. (2014) and Bacchetta (2017) contest the view that credit can create money without bounds and instead argue that the amount of money creation ultimately depends on monetary policy.

While recent empirical work increasingly provides evidence of a decoupling in the long run, the debate on the relation between money and credit is undecided as yet in our view. In this paper we plan to focus on money and credit "overhang" to contribute to the debate on the relation between money and credit. A general criticism with regard to previous estimation on money/credit overhang for the euro area is that when the euro area is treated as a whole the individual country information is neglected. On the other hand, when individual countries are the focus, the euro area dimension typically is ignored. In this paper, we adopt long run money and credit functions using panel co-integration to compute corresponding overhang measures. This takes into account country heterogeneity as well as the euro area as a whole. In the previous literature, the underlying factors that drive the (possible) decoupling are not discussed either. We aim to shed light on these issues.

4.3 Hypothesis

The existence of stable long-run relations for money and credit is an important issue in its own right, for instance because of the implications for policy. However, in our analysis we focus on a number of issues conditional on

the existence and estimation of long-run relations for money and credit.[35] More in particular, we compute the time paths of country-specific deviations from the long run equilibrium and use these deviations to shed light on three issues. We label such deviations "overhang" to indicate their disequilibrium character. As a caveat, we note that estimated deviations from long run equilibrium could result from an incomplete specification and omitted variables bias. Since we use time demeaned variables in the empirical analysis to take out common trends, we feel confident this problem is limited in our case.

The first issue we address is whether there is a run-up in credit overhang in the years prior to the start of the Great Financial Crisis. This is related to a substantial amount of research that addresses the issue whether excessive domestic credit creation is a – procyclical – determinant of boom-bust cycles in real estate and a predictor of financial crisis. Goodhart and Hofmann (2008) and Bezemer and Zhang (2014) for example provide supportive evidence of such hypothesis. Jorda, Schularick and Taylor (2016) investigate the link between credit and real estate prices from a historical perspective. While most of the literature focuses on credit booms, Setzer et al. (2011) among others show a positive link between money growth and real estate prices in the euro area between 1999 and 2008. In general, we hypothesize that the euro area countries that had the largest current account deficits and were hit hardest by the 2008 Financial Crisis and the subsequent euro debt crisis – particularly Ireland, Spain and Portugal – are the countries with the strongest credit overhang around 2007.

Second, we want to investigate the potential impact of cross border credit flows on creating money and credit overhang in individual countries in the euro area. The link between domestic credit growth and external imbalances has recently received extra attention. Stimulated by the emergence of large and persistent current account deficits of some euro area countries prior to 2008, the question has arisen to which extent large foreign capital flows can be a determinant of excessive domestic credit creation. Increasingly, the literature suggests it is not current account imbalances per se, but cross country (net) bank credit flows that may accommodate credit booms in individual countries, see for instance Lane and McQuade (2014). This leaves the causality issue in the relation between cross country bank credit flows and domestic credit growth. Kool et al. (2013) show there is bidirectional causality employing a VAR methodology. Using an accounting framework, Borio and Disyatat (2011) claim that it is not "excess saving" (push factor) that drives cross country credit flows, but the "excess elasticity" (pull factor) of the global monetary and financial system that fails to constrain the unsustainable build-

[35] Chapters 2 and 3 of this thesis contain a more detailed investigation of the long-run relations for money and credit, respectively. Here we use the results obtained in these chapters as starting point for the overhang analysis.

up of credit and asset price booms. Unger (2016) provides supportive evidence for the dominance of a pull factor in a panel analysis.

In this paper, we contribute to the debate by adopting estimated long run relations for money and credit in the euro area, with and without (outstanding) net foreign credit as an additional explanatory variable.[36,37] A comparison of the estimated overhang for the two specifications allows an assessment of the statistical and economic importance of net credit flows. Theoretically, we expect the net foreign credit variable to have a negative coefficient in the long-run credit relation. That is, under the assumption that credit supply faces constraints, a country whose banking sector borrows from the rest of the world has more room for domestic credit growth, while a country whose banking sector is a net lender has less room for domestic credit growth. For the long run money equation, we expect the coefficient on net foreign credit to be smaller than in the credit equation and possibly insignificant, since both the overall amount of money in circulation and its allocation across countries is fully demand determined.

Our third objective is to provide new evidence on the relation between money and credit. This has recently become an independent topic of research again. In the standard theoretical treatment of money and credit creation, the latter follows the former and is constrained by it. Recently, it has become widely recognized that money creation nowadays is mainly done by banks through credit creation, making money and credit growth two sides of one coin that are jointly determined (see McLeay et al., 2014 for example).[38] On the other hand, non-deposit market funding has become an increasing part of the liability side of the money creating banks' balance sheet, loosening the link between money and credit. In this paper, we distinguish between the trend – long run –dynamics between money and credit and the relation between deviations from the trend. With respect to the former, we estimated common long-run relation across all euro area countries for money and credit respectively and discuss their (dis)similarity. With respect to the latter, we contribute to the debate by investigating the link between money overhang and credit overhang in the individual euro are countries. To the extent that money and credit are indeed interchangeable sides of the same coin, one would expect a close correspondence between money overhang and credit overhang for each country.

[36] A country with positive outstanding net foreign credit has net claims on the rest of the world.
[37] We also investigate the impact of housing prices and equity prices on money and credit overhang. It turns out the influence is rather small. Therefore, in this paper we focus on the impact of net foreign credit and delegate these results to the appendix.
[38] Schularick and Taylor (2012) provide a historical analysis of the empirical links between money and credit. For a small sample of industrialized countries, they show a disconnect between money and credit growth relative to GDP from the 1950 to the 1990s and more similar pattern since.

4.4 Empirical analysis

We first briefly present and discuss the long-run equilibrium relations for money and credit respectively, based on results in chapter 2 (for credit) and chapter 3 (for money aggregates). Our estimations use quarterly data containing ten original Euro area members, Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain for the period from 1999Q1 to 2013Q3[39], accounting for a structural break in 2008.[40] Subsequently, we use the results to address three core issues. First, is there a build-up of credit overhang prior to 2008 which is especially pronounced in the weaker - current account deficit – countries of the euro area? Second, does net foreign credit play an important role in money and credit overhang? Third, do money and credit overhang move together and to what extent?

4.4.1 Recap: long-run equilibrium relations for money and credit

Table 4.1 contains the DOLS results for money and credit for the full period 1999Q1-2013Q3 with net foreign credit either included or excluded.[41] A number of points stand out. First, with respect to money estimation, the income elasticity is close to and slightly below one and very significant. Second, the interest coefficient is significantly positive for the full period, but the interest rate effect is about zero in the second period as the two interest rate coefficients roughly cancel out. Third, the effect of net foreign credit is significantly negative the first sub period, but about zero in the second one. Again, the two coefficients approximately cancel.

Our results of the first period estimation confirm our hypotheses based on monetary theory. That the demand for real transactions balances should roughly move proportionally to real income, implying an income elasticity close to one. Estimated elasticities above one may result from omitted wealth effects. Long term interest rates can be interpreted as opportunity cost proxies of holding money, suggesting a negative sign. Finally, to the extent that the domestic banking system provides cross-border loans – in return for foreign deposits – this may reduce domestic deposit (money) creation, implying a negative coefficient on net foreign credit.

The right columns in table 4.1 contain the co-integration results for real credit. Again, we find income elasticities close to one, tending to be slightly higher than for money. For net foreign credit, we find a small but significant negative coefficient for the whole sample period. It supports earlier evidence by Lane and McQuade (2014) and

[39] The data is a combination of data sample in chapter 2 and chapter 3. We already discussed characteristics of these variables in the two chapters.
[40] Evidence in chapters 2 and 3 shows evidence of a break in the long run relations of money and credit. Therefore, we use a time dummy that is one from 2008Q4 onward and zero before to capture the break. We also include interaction effects between the dummy and other explanatory variables when appropriate.
[41] This replicates evidence from tables 3.7 (for monetary aggregates) and 2.7 (for private credit), respectively.

Unger (2017) that cross border credit flows and domestic credit growth are structurally related. The null hypothesis that debtor countries have more room for domestic credit creation while creditor countries have less is confirmed. Note that our approach does not allow inferences on the direction of causality. Finally, we find a significantly negative interest coefficient, but a significantly positive interaction coefficient providing evidence of a sign reversal after 2008. Our discussion in chapter 2 showed that the sign of the interest rate effect ultimately depends on the shocks hitting the credit market. The great financial crisis has led to different financial conditions in general and credit supply constraints on the banking system in particular, providing a suggestive explanation of the structural break in the interest rate coefficient. The Wald test in table 4.1 rejects the presence of non-linearities in the money and credit long run relations.

Overall, it is important to point out the close correspondence between the trend dynamics of money and credit in the euro area as a whole. Both are close to proportionally related to the development of real GDP. In addition, both respond in a similar way to interest rate development and net foreign credit, though with differing sensitivities. In that sense, our estimation supports a common trend movement of money and credit.

4.4.2 Money and credit overhang

Based on the estimated relations, we proceed to compute money and credit overhang series to evaluate the degree of excess money and credit in the economy over the sample. Overhang is computed as the difference between actual money (credit) and the long-run equilibrium value as given by the panel estimation, consistent with our definition in section 4.3. Subsequently, we normalize the computed overhang making the mean equal to zero for each country series.[42] To highlight the cross-country trends in overhang, we then do a principal components analysis.

We are particularly interested in three issues. First, the degree to which excess money and credit was visible in specific countries in the advent of the 2008 financial crisis. Second, the degree to which net foreign credit is important in the size of excess money and credit. Third, the degree to which excess money and credit move together.

The results for credit overhang are shown in figure 4.1 in which we also incorporate the first two principal components. Here, credit overhang has been computed from the specification that excludes net foreign credit. The first two principal components account for 84 percent of total variation. As hypothesized, credit overhang rises

[42] The original series are available upon request.

and reaches sustantial levels in the years directly preceding the 2008 financial crisis for Spain, Portugal, and Ireland. For the Northern European countries – Austria, Belgium, Germany, Finland, France and the Netherlands, we observe marginally negative overhang in the years prior to 2008 indicating relatively low credit levels compared to the equilibrium.[43] For Italy, credit overhang is close to zero in this period. This pattern broadly supports the well-known divergence between Northern and Southern European countries prior to the crisis. While the former experienced current account surpluses, the latter typically had large and increasing current account deficits. The dichotomy between North and South is also demonstrated in table 4.2, which provides bilateral correlations of credit overhang (excluding net foreign credit) for each pair of countries. Broadly speaking, correlations are mostly positive and often significant for pairs of Northern countries and pairs of Southern countries respectively, and negative across groups. This holds especially true for Germany, Belgium, and Austria in the North, and Spain and Ireland in the South (perifery).

The first two principal components capture the most important common trends across the countries in our sample and may shed light on the underlying dynamics. In particular, the first component strongly decreases from 1999 to 2008 and then increases somewhat. The corresponding loadings in table 4.3, show a distinct North-South divide. Germany, Austria and Belgium – and to a lesser extent France and the Netherlands – load positively on this first principal component. On the other hand, Spain and Ireland – and to a lesser extent Italy and Portugal – display a negative loading. Finland is the only northern country with a negative loading. Overall, the first principal component appears to mainly reflect the pre-2008 credit divergence between North and South. The second component is more or less stable up till the 2008 crisis and then rises steeply. Finland, France, Italy and the Netherlands load strongly positively on it, while Portugal has a large negative loading. The grouping does not allow for an easy economic interpretation.

A similar analysis is carried out for money overhang. The results are shown in figure 4.2. Compared to credit overhang, money overhang shows more heterogeneity across countries and displays more variation during the whole period. For Belgium, and Portugal we observe a negative trend for the whole period. In Spain and Germany, a similar downward is present from the start with some stabilization and upturn in the second half of the sample. Ireland moves roughly inversely to Spain and Germany. The remaining countries display considerable variation without clear trends. The first two principal components account for 73 percent of total variation. The first one shows a decreasing trend over the whole period. It is most strongly correlated with the movements in like Austria,

[43] Note that Finland differs from the other Northern countries as its overhang is on a rising rather than declining trend from 1999 onward.

Belgium, Germany, Portugal and Spain, as confirmed by the loadings in table 4.3. The second one has a U-pattern. Positive loadings are seen for Austria, Finaland and France and a negative one for Italy. Bilateral correlation coefficients for money overhang in pairs of countries show less of a North-South pattern than credit correlations.[44]

We now turn to the potential role of net foreign credit in money and credit overhang. To this purpose, we regress the computed money and credit overhang on net foreign credit. Table 4.4 displays the results. The semi-elasticity of NFC for credit overhang is minus 0.173 and the adjusted R^2 is 0.55. For money, both the explanatory effect (-0.058) and the adjusted R^2 (0.11) are much smaller. It supports our hypothesis that net foreign credit is relativly important in credit overhang, but not so much in money overhang.[45]

Finally, we turn to the relation between money and credit overhang to investigate to what extent these are driven by the same factors. Table 4.5 shows the correlation between first two princpal components of money and credit overhang. The correlation between the first principal components of money and credit overhang is very high (0.83) and significant. Also the second principal components are strongly positively correlated (0.65). It suggests that the drivers of variation in money and credit overhang are quite similar on the level of the euro area. However, that does not directly imply a strong correlation between money and credit overhang at the country level. Actually, the loadings in table 4.3 suggest a mixed picture. Belgium, Germany and Ireland respectively load qualitatively similarly on the first money and credit principal component, but Spain does not. The latter country loads significantly negative on credit, but positive on money. Austria only has a strong positive loading on credit but an insginificant loading on money, for Portugal it is the other way around. A similar picture emerges for the second component. Finland, France and the Netherlands each have consistent loadings on money and credit, but Italy loads significantly positive on credit and negative on money. Austria has a strong positive loading on money, but not on credit. Overall, the evidence on strongly positive related money and credit dynamics on a country level is weak.

We present further graphical evidence in figure 4.3. For the comparison, we use the normalized computed overhang from the specification including a dummy but excluding net foreign credit. Apart from Ireland and to some extent the Netherlands, the estimated level of money overhang is substantially smaller and evolves smoother than is the case for credit overhang. Visual inspection does not show a strong correlation in changes in money and

[44] To save space, we do not report the money overhang correlation table. It is available from the authors on request.
[45] Kool and Liu (2018) graphically compare computed overhang including and excluding net foreign credit. They document that the difference is strongest in Ireland and Portugal, but clearly visibly in most other countries.

credit overhang. Table 4.6 contains additional evidence in the form of bilateral correlations between the two.[46] We report three sets of correlations. In the first column, we present the correlations between overhang levels. The evidence is mixed. For Spain and Italy, the correlation is significantly negative. For Finland and Austria it is insignificantly different from zero, and for the other countries it is significantly positive ranging from 0.33 (Portugal) to 0.94 (Germany). In the second column, we report the correlation for quarterly changes. Typically, correlations are low and insignificant. Significant correlation of moderate size are found for Belgium, France, the Netherlands and Portugal. Because of the possible existence of leads and lags in the interaction of money and credit, we also report correlations for 5-year changes in overhang. Now, correlations are large and positive for Germany, France, Ireland and the Netherlands.

Overall, the evidence suggests a limited amount of co-movement of money and credit overhang in the short and intermediate run. Substantial and persistent credit overhang can emerge without the simultaenous increase in monetary overhang. It throws doubt on the hypothesis that it is primarily the money–creating potential of commercial banks that drives credit booms. As shown in our analysis, net foreign credit is one channel that can create a wedge between money and bank credit. But also other, market-based, funding options available to commercial banks for additional loan supply may need to be taken into consideration. Our findings suggests a broader approach of bank credit is required, encompassing more items on the banking sysems' balance sheet.

4.5 Summary

In this paper we intend to contribute to the understanding of money and credit growth in the euro area both before and after the Global Financial Crisis. For the analysis, we use quarterly data for ten euro area countries over the period 1999Q1 to 2013Q3. In chapter 2 and 3, we employ a panel co-integration approach to estimate equilibrium relation for money and credit respectively allowing us to exploit heterogeneity across countries. In this chapter, we adopt the estimated long-run relation of money and credit to compute corresponding overhangs in euro area countries, so as to analyze the effect of cross-border credit on excess money and credit creation.

Our analysis sheds light on three questions. First, has there been a substantial build-up of private sector credit overhang in the euro area in the run-up to the Great financial crisis in 2008 and was that build-up especially pronounced in weaker countries with large current account deficits? Second, is there a relation between credit overhang and net foreign credit dynamics, as suggested by the literature? That is, are countries with positive domestic credit overhang net borrowers internationally, while countries with negative credit overhang are net

[46] Computing overhang correlations from specifications which include net foreign credit leads to qualitatively similar results.

lenders. Third, is there a strong relation between money and credit overhang, supporting the idea that it is the virtually unlimited money creating capacity of commercial banks that is at the heart of credit booms?

Using the computed overhang measures, we indeed find that the weaker euro area countries with large and rising current account deficits in our sample – viz. Spain, Ireland and Portugal – are the countries with the most pronounced build-up of credit overhang prior to 2008. Most of the Northern euro area countries on the other hand show a declining credit overhang between 1999 and 2008, which turns negative prior to the crisis. It supports earlier evidence of a clear distinction between Northern current account surplus countries and Southern current account deficit countries.

Second, we find that net foreign credit is significantly negative related to our credit overhang measure. It implies that net foreign credit has an important role to play in the cross-country dynamics of credit overhang, though our analysis does not allow to make causal inferences. It does suggest that large positive credit overhang corresponds with international borrowing, while negative overhang corresponds with international lending. For money overhang, we find less strong evidence. In general, money overhang is limited in size and evolves quite smoothly for all countries over the period 1999-2013, except Ireland. The role of net foreign credit in money overhang estimates is substantially smaller than for credit overhang.

Third, we turn to the relation between money and credit overhang. There is weak evidence of a positive correlation between money and credit overhang, but it differs substantially across countries. Quarterly changes as well as overlapping 5-year changes in money and credit overhang are only weakly correlated in most countries. The evidence suggests a limited amount of co-movement of money and credit overhang in the short and intermediate run. Substantial and persistent credit overhang can emerge without the simultaneous increase in monetary overhang. It throws doubt on the hypothesis that it is primarily the money–creating potential of commercial banks that drives credit booms. Our findings suggests a broader approach of bank credit is required, encompassing more items on the banking sysems' balance sheet. This issue is left to future research.

Table 4.1. Panel cointegration (DOLS (1, -1)) results

Dependent variable: log of real *monetary aggregates*	1999Q1-2013Q3		Dependent variable: Log of real *private credit*	1999Q1-2013Q3	
Real GDP ($\bar{y}$)	0.985***	0.991***	Real GDP ($\bar{y}$)	0.995**	1.021***
	[0.273]	[0.263]		[0.418]	[0.312]
Nominal interest rate ($\bar{R}$)	-0.013	-0.172***	Real interest rate ($\overline{RR}$)	-0.031***	-0.013***
	[0.035]	[0.033]		[0.008]	[0.006]
Nominal interest rate ($\bar{R}$)*DUM	0.031	0.191***	Real interest rate	0.101***	0.085***
	[0.035]	[0.033]	($\overline{RR}$)*DUM	[0.009]	[0.007]
Net foreign credit ($\overline{NFC}$)		-0.003***	Net foreign credit ($\overline{NFC}$)		-0.004***
		[0.000]			[0.000]
Net foreign credit $\overline{NFC}$*DUM		0.004***			
		[0.000]			
Country#	10		Country#	10	
Obs.	590		Obs.	590	
WaldChi2	19.65	160.06	WaldChi2	169.46	321.38
Prob.	(0.000)	(0.000)	Prob.	(0.000)	(0.000)

Note: All variables are measured in difference to euro area average.
Standard errors are in shown in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

Table 4.2. Correlation of credit overhang (without NFC)

	AUT	BEL	DEU	ESP	FIN	FRA	IRL	ITA	NLD	PRT
AUT	1.00									
BEL	0.68**	1.00								
DEU	0.80**	0.89**	1.00							
ESP	-0.78**	-0.78**	-0.91**	1.00						
FIN	-0.31**	-0.83**	-0.67**	0.46**	1.00					
FRA	0.69**	0.25	0.28**	-0.39**	0.23	1.00				
IRL	-0.84**	-0.43**	-0.59**	0.60**	-0.02	-0.79**	1.00			
ITA	-0.21	-0.66**	-0.60**	0.58**	0.74**	0.28**	-0.13	1.00		
NLD	0.44**	-0.01	0.17	-0.41**	0.47**	0.69**	-0.59**	0.19	1.00	
PRT	-0.32**	0.10	0.04	0.08	-0.50**	-0.69**	0.33**	-0.41**	-0.73**	1.00

Note: ** indicate the significance at 5% level.

Table 4.3. Eigenvector for money overhang (ohc) and credit overhang (ohc)

Country	ohc		ohm	
	1st PC*	2nd PC	1st PC	2nd PC
AUT	0.416	0.114	-0.087	0.447
BEL	0.389	-0.222	0.448	-0.092
DEU	0.421	-0.149	0.413	0.171
ESP	-0.419	0.054	0.355	0.229
FIN	-0.227	0.430	0.055	0.415
FRA	0.260	0.386	-0.045	0.501
IRL	-0.342	-0.256	-0.437	-0.190
ITA	-0.210	0.388	0.118	-0.432
NLD	0.186	0.411	-0.272	0.238
PRT	-0.089	-0.439	0.459	-0.085

* PC means principal component

Table 4.4. Net foreign credit (NFC) explanatory power in money and credit overhang

	Credit overhang	Money overhang
NFC	-0.173	-0.0581
	(-24.42)***	(-9.02)***
Constant	24.24	1.732
	(7.86)***	(3.92)***
Observations	586	590
R^2	0.559	0.123
Adjusted R^2	0.550	0.108

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.5. Correlation between first two principal components

correlation	PC1_ohc	PC2_ohc
PC1_ohm	0.83*	-0.47*
PC2_ohm	0.26*	0.65*

a. PC1_ohm represents first principal component for money overhang, PC2_ohm is the second principal component
b. ohc represents credit overhang, PC is principal components

Table 4.6. Correlation between money and credit overhang (without NFC)

	$\rho(ohm, ohc)$	$\rho(\Delta ohm, \Delta ohc)$	$\rho(\Delta 5 ohm, \Delta 5 ohc)$
Period		1999-2013	
	Level overhang	One quarter	Five-year change
AUT	-0.03	0.07	0.23
BEL	0.94**	0.35**	0.21
DEU	0.90**	0.10	0.84**
ESP	-0.43**	0.19	-0.03
FIN	0.13	0.01	0.15
FRA	0.70**	0.32**	0.83**
IRL	0.62**	0.20	0.82**
ITA	-0.37**	0.15	-0.37**
NLD	0.77**	0.37**	0.89**
PRT	0.33**	0.35**	-0.12

Note: ohm = money overhang; ohc = credit overhang; Δ = quarterly change; Δ5 = 5 year change;
** indicate the significance at 5% level.

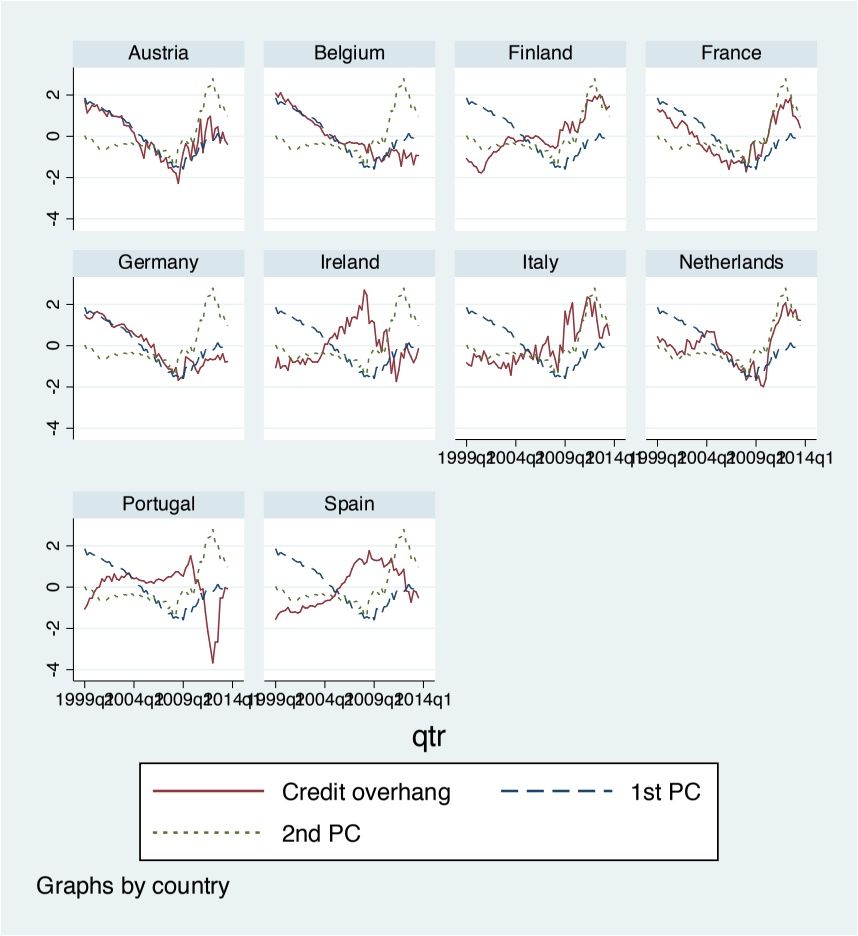


Figure 4.1. Normalized credit overhang, 1st and 2nd principal components
Source: Based on own computation

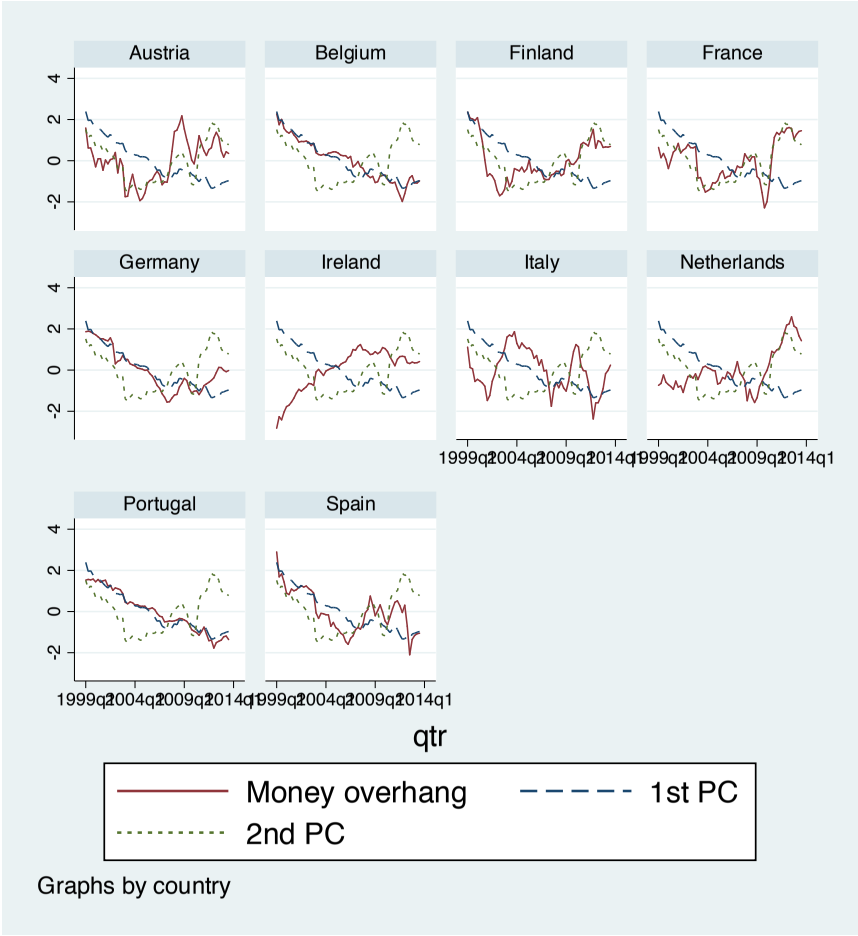


Figure 4.2. Normalized money overhang, 1st and 2nd principal components
Source: based on own calculation

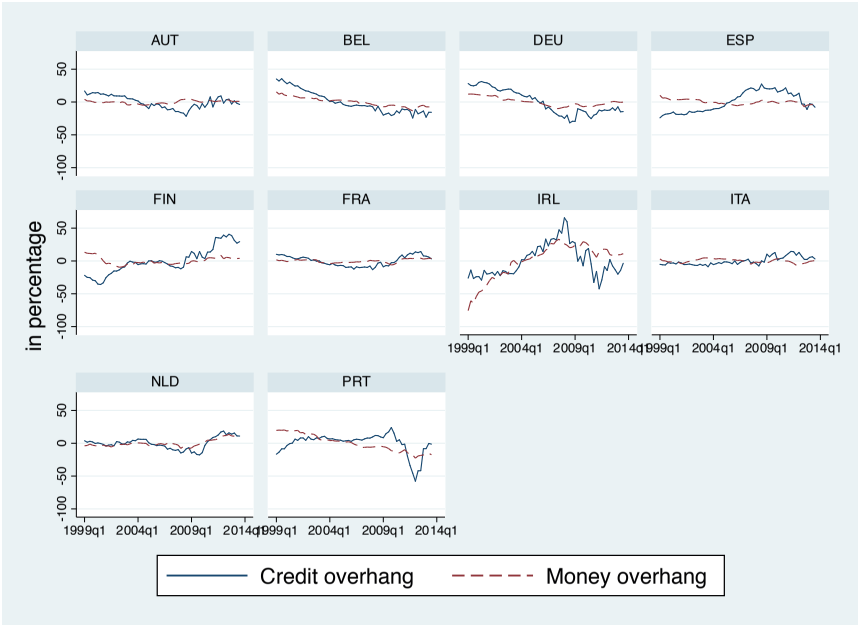


Figure 4.3. Credit and monetary overhang with dummy excluding NFC.

Note:The overhang(s) are re-scaled to average zero over the sample period.

4.6 Appendix:

In the main text, we used net foreign credit as an additional explanatory variable in the panel cointegration analysis, as it was one of the focus points of the analysis. In the empirical literature, housing and equity prices are frequenty included as well. Here, we follow that line to test for the sensitivity of our results, following the same procedure as in the main text.

First, we summarize the estimated long-run equations, accounting for a break in 2008 like before. Also, interaction terms are considered. The results are given in table 4A.1. The housing price shows a positive effect before 2008 and shifts to negative after that, while the equity price displays a negative coefficient in the first sub period which becomes positive in the second. The combined effect in the whole period is positive for the two prices, indicating the joint wealth effect and transaction effect dominates the substitution effect (see Friedman, 1988). With respect to private credit, a break shows up in the real interest rate and housing price coefficients. The housing price coefficient is positive prior to 2008, which is consistent with previous literature. In the second period, it shows a strong negative sign which may be caused by the sharp decrease of the price due to financial crisis. Equity prices have a significantly negative link with private credit in the whole period, without sign shift.

Using the cointegration results, we compute the overhang for money and credit. Graphically, we cannot observe significant changes in money overhang and credit overhang when housing prices and equity prices are incorporated.[47] For further evidence, we regress normalized money overhang and credit overhang – computed while excluding asset prices from the cointegration specification – on normalized housing prices and equity prices. The two prices do show significant coefficients in the credit overhang specification, indicating they capture some information of the overhang. However, the adjusted R^2 is very small, implying limited explanatory power. For money overhang, the coefficient of housing prices is significant, but that of equity prices is not. The corresponding adjusted R^2 are small as well. Overall, there is little evidence that asset price dynamics are significantly related to money or credit overhang.

[47] Graphs are available on request.

Table 4A.1. DOLS with housing prices, equity prices

Dependent variable: *log of real monetary aggregates*	1999Q1-2013Q3			Dependent variable: *Log of real private credit*	1999Q1-2013Q3		
Real GDP ($\bar{y}$)	0.985***	0.987***	0.990***	Real GDP ($\bar{y}$)	0.995**	1.027**	1.025***
	[0.273]	[0.278]	[0.243]		[0.418]	[0.468]	[0.399]
Nominal interest rate ($\bar{R}$)	-0.013	-0.010	-0.018	Real interest rate ($\overline{RR}$)	-0.031***	-0.043***	-0.036***
	[0.035]	[0.043]	[0.030]		[0.008]	[0.008]	[0.007]
Nominal interest rate ($\bar{R}$)*DUM	0.031	0.025	0.042	Real interest rate ($\overline{RR}$)*DUM	0.101***	0.106***	0.104***
	[0.035]	[0.043]	[0.031]		[0.009]	[0.009]	[0.009]
Real housing price ($\overline{HPI}$)		0.170**		Real housing price ($\overline{HPI}$)		0.687***	
		[0.085]				[0.158]	
Real housing prices $\overline{HPI}$*DUM		-0.025		Real housing prices $\overline{HPI}$*DUM		-0.880***	
		[-0.090]				[0.175]	
Real equity price ($\overline{EQI}$)			-0.057*	Real equity price ($\overline{EQI}$)			-0.123***
			[0.032]				[0.052]
Real equity price $\overline{EQI}$*DUM			0.097***	Real equity price $\overline{EQI}$*DUM			
			[0.020]				
Country#		10		Country#		10	
Obs.		590		Obs.		590	
WaldChi2	19.65			WaldChi2	169.46		
Prob.	(0.000)			Prob.	(0.000)		

Note: All variables are measured in difference to euro area average.

Standard errors are in shown in brackets. ***, **, * indicate significance at 1, 5, 10% level, respectively.

Table 4A.2. Housing price and equity price explanatory power

	ohc	ohc	ohm	ohm
lrhpi	29.16		11.35	
	(7.47)***		(4.23)***	
lreq		-5.929		-1.806
		(-2.80)**		(-1.28)
Constant	3.997	12.50	1.579	3.807
	(4.87)***	(2.77)**	(2.79)**	(1.26)
Observations	586	590	586	590
R^2	0.088	0.013	0.030	0.003
Adjusted R^2	0.073	-0.004	0.013	-0.014

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Chapter 5.

The causality between bank deposits and bank loans: an investigation on euro area countries

5.1 Introduction

The 2007-2008 great financial crisis (GFC) has strongly revived interest with both academics and policymakers in the role and importance of (bank) credit for macroeconomic developments. A substantial literature has emerged that focuses on credit as an early warning indicator and/or a causal factor of macroeconomic instability, as exemplified by, amongst others, Borio and Drehmann (2009), Reinhart and Rogoff (2009), Jorda, Schularick and Taylor (2011), Schularick and Taylor (2012), and Gourinchas and Obstfeld (2012).

Other research strands that have (re-) emerged focus on the analysis of the financial cycle, see for instance Drehmann, Borio, and Tsatsaronis (2012), Aikman, Haldane and Nelson (2015), and Borio (2014), the design and implementation of macro-prudential regulation and supervision, see Borio (2011) and Galati and Moessner (2013) for instance, and the – causal – relation between money and credit. This latter issue is the new round in a long-time debate.

In an accounting sense, money and credit are strongly related by construction as they are on opposite sides of the bank balance sheet. Bank deposits, which can be found on the liability side of the bank balance sheet, account for a major part of monetary aggregates. Bank loans are on the asset side of the bank balance sheet. Moreover, the creation of bank loans automatically implies the creation of an equal amount of bank deposits. Despite this accounting relation, the joint dynamics of money and credit and their role in the macroeconomic transmission process is still subject of academic debate. No consensus exists on the causality structure, either theoretically or empirically. On the one hand, proponents of the "money view" emphasize the exogenous nature of the money supply with monetary policy driving credit. On the other, proponents of the "endogenous money view" see bank credit as the driving force behind money supply dynamics.

In this chapter, our primary aim is to empirically identify the causality between bank deposits and bank loans. We contribute to the literature in two respect. First, we use a novel non-linear identification VAR-LiNGAM approach as developed in Moneta et al. (2013) instead of the standard restricted VAR/VECM approach (Engle and Granger 1987; Granger, 1988). We use prior economic knowledge to impose restrictions in the latter approach. In contrast, the VAR-LiNGAM approach is a data-driven method, which does not depend on theoretical assumptions. Second, we incorporate the most important bank balance sheet items in the analysis. The literature typically focuses on the bilateral relation between bank loans and bank deposits. In addition, we include four other major balance sheet components: bank debt, net interbank lending, net foreign lending, and net securities. In our view, this is the correct approach as

banks optimize over the whole of their balance sheet, not just loans and deposits. We apply the method to six euro area countries, three of which are from the South and periphery – Italy, Spain and Ireland – and three from the North – Germany, Austria and the Netherlands. This allows us to see to what extent causality relations are country-dependent.

First, we find a strong and significantly positive relation between deposits and loans in five out of six countries. However, the direction of causality varies. In particular, in Austria and Germany, deposits drives loans—supporting the exogenous supply theory, while in Spain, Ireland and the Netherlands bank loans causally lead bank deposits, supporting the endogenous supply theory. The relation is insignificant for Italy. Second, we observe a significantly negative relation between net foreign asset positions and net interbank lending across all countries. It implies that higher net foreign lending may either reduce interbank lending or stimulate interbank borrowing. Third, a few patterns are only found in a smaller set of countries. For Germany, Ireland and the Netherlands, we find bank deposits may casually drives interbank lending, while banks loans may causally drives interbank borrowing. For Spain, Italy, and the Netherlands, we find that bank debt leads bank loans. None of these findings – though admittedly only found in a few countries – appears supportive of the endogenous money supply theory. More research in this field is certainly recommended.

The chapter is set up as follows. In section 5.2, we provide theoretical literature to explain the development of exogenous and endogenous monetary theories. In addition, we also review some empirical work on the – causal – relations between bank deposits and bank loans. Section 5.3 illustrates how we set up our research and the model we use. Section 5.4 provides data we use and a preview based on stylized statistics of the relation between deposits, loans and other balance sheet items in each country. In section 5.5, we present and interpret the results from the VAR-LiNGAM analysis. Section 5.6 concludes.

5.2 Literature review

In this section, we review the theoretical and empirical literature on the money and credit relation. In section 5.2.1, we summarize the theoretical literature, while section 5.2.2 contains an overview of the empirical evidence.

5.2.1 The theory of money and credit

In the narrow "money view", money is the most important financial aggregate in the economy and plays a central role in the transmission of monetary policy to the real economy, see the seminal contribution by Friedman and Schwartz (1963). In this view, the central bank can directly control the money supply using either interest rate or reserve

instruments to influence output and inflation through interest rate effects. Then, the intermediating role of the banking sector is a black box with little relevance. Note that this view is consistent with the traditional IS/LM model where credit is absent. Under the assumption that the money supply is exogenous and used by the central bank as its operating target, Cecchetti (2000) states that "*all theories of how interest rate changes affect the real economy share a common starting point. A monetary policy action begins with a change in the level of bank reserves.*"

In the 1970s and 1980s, attempts were made to give banks and bank credit a more prominent place in the theoretical framework. Brunner and Meltzer (1990) extend the range of assets in the standard IS/LM model to include bank credit in a stock-flow consistent model. Making credit and money imperfect substitutes allows for interaction and a joint analysis of their dynamics. In a different strand of the literature, the narrow "credit view" is developed, see for instance Bernanke and Blinder (1988), Bernanke (1993) and Bernanke and Gertler (1995). This view argues that information problems in credit markets influence the impact of monetary policy through the bank lending channel and the balance sheet channel. Both channels directly impact on the supply of credit. Note that neither the Brunner and Meltzer approach nor this narrow "credit view" question the dominance of monetary policy and the money supply in influencing the real economy. They just open up extra channels from money to the real economy using bank intermediation.

The "endogenous money view" which is rooted in Post-Keynesian economics, provides a more fundamental departure from the money view. Contributions to this line of literature include Palley (1994), Fontana (2003), Bofinger (2001), and Werner (2014, 2016).[48] The starting point of the theory is that loans create deposits, not the other way around. Underlying this view is the assumption that banks are triggered by the demand for (new) bank loans, not by the demand for money (deposits). In its simplest form, the demand for money (deposits) then is determined by and equal to the demand for credit. The equilibrium obtained by the interaction of credit supply – optimizing bank behavior – and credit demand results in an equilibrium amount of credit, which is equal to the amount of money. This money supply is generated by the central bank, which passively fulfils any demand for bank reserves. In recent years, the endogenous money view has become more popular, helped by two stylized facts. First, central banks typically do not target base

[48] Bofinger (2001) develops a relatively simply and intuitive formal framework. Minsky (1977) provides an alternative and more radical approach to credit and financial fragility.

money or other monetary aggregates anymore. Second, it is well-known that commercial banks account for almost all money creation through the creation of credit, see for example McLeay et al. (2014). [49]

5.2.2 Empirical evidence

After 2008 GFC, a stream of literature stresses the importance of credit and documents the essence of the endogenous money supply theory (Fontana, 2004a, 2004b; Basilio and Oreiro, 2011; Spahn, 2014). A representative empirical example in this literature is Schularick and Taylor (2012). Their work investigates 14 OECD countries and provides evidence that credit is more important than money, particularly in predicting financial crises. However, Albuquerque, Baumann and Seitz (2016) find that money comprises similar forecasting power as credit in the US if money aggregates are narrowed to M1 and M2. Baker et al. (2018) also contest the conclusion obtained in Schularick and Taylor (2012).

A general acknowledgement from previous literature is that money demand and credit demand have similar patterns in relation to economic activity and financial markets. Both the growth of monetary aggregates and credit creation depend positively on income, and negatively on interest rates. Examples are Coenen and Vega (2001), Ahking (2002) and Calza et al. (2003, 2006). Goodhart and Hofmann (2008), who investigate 17 industrialized countries from 1970-2016, and Ryczkowski (2019), who test 12 developed countries since 1945, both emphasize that money and credit growth are closely linked to the development of housing prices. The similar relation between money and credit and a number of macroeconomic factors is theoretically supported by their opposite position on the bank balance sheet (Bernanke and Blinder, 1988; Bernanke and Gertler, 1995).

Nonetheless, the association is not a perfect one. Liu and Kool (2018) show that on the one hand money and credit are driven by the same determinants, but on the other that money overhang and credit overhang do not necessarily coincide. They find limited relation between money overhang and credit overhang in a medium-run and short run. In addition, Schularick and Taylor (2012), Baeriswyl and Ganarin (2012) and Baeriswyl (2017) argue that the connectedness between monetary aggregates and credit regularly is weak in a modern economy.

Some research tries to investigate the decoupling behavior of money and credit in the perspective of their interaction with the business cycle. Musso (2009) shows that monetary aggregates have a slightly higher degree of volatility than

[49] According to Spahn (2014), U.S. text books tend to support the exogenous money theory, while European ones tend to focus on endogenous money supply.

the business cycle, while loans tend to be twice as volatile as the business cycle. Borio (2014) and Drehmann et al. (2012) provide empirical evidence that the credit cycle is significantly longer than the business cycle as well. In contrast, Jorda et al. (2016) find that the average duration of a credit cycle is similar to the average duration of a traditional business cycle.

So far, very few studies focus on the identification of the causality between money and credit, and to the empirically testing of the exogenous monetary theory versus the endogenous money supply theory. Typically, research uses restricted or unrestricted VAR/VECM methods to test for causality Granger (1998). However, results are sensitive to the choice of lags and – in the case of restricted VARs – by the imposed restrictions. The later usually are derived from prior economic theory. A typical example is Howell and Hussein (1998), who investigate money-credit causality for the G-7 with a co-integrated VAR. They find evidence, which supports causality from credit to money. Caporale and Howells (2001) extend the analysis by including a third – transaction – variable in the analysis to form a tri-VAR. They also conclude that loans causally drive deposits, with some caveats.

Corradi et al. (1990) investigate this issue in Italy for the period 1965-1987 with a VECM model, and find that deposits causally drives loans in the short run. Badarudin, Ariff and Khalid (2013) extend the tri-VAR by incorporating a money multiplier variable and monetary base from a historical view to identify monetary transmission. They find strong money endogeneity for Germany and Canada, while for France, Italy, US and the UK they cannot reject the existence of exogenous money. Nell (2000) finds evidence in favor of endogenous money for South Africa. Other examples are Holtemöller (2003) for German only and Cifter and Ozun (2007) for Turkey.

It becomes more difficult to identify the causal direction nowadays, due to the increased complexity of banks' balance sheets. On the liability side, deposits are not the single source for financing credit. Alternatives are bonds, interbank borrowing or money market funds. On the asset side, loans compete with external lending and securities, for example. These innovations may break the close link between deposits and loans (Schularick and Taylor, 2012; Goodhart and Hofmann, 2006; Liu and Kool, 2018).

5.3 Setup

The issue of the causality between money and credit has been debated for decades. It is a chicken-egg problem. In this paper, we contribute to the literature in two ways. First, we use a data-driven method—VAR-LiNGAM—which does not require a priori theoretical constraints. Second, we include the main bank balance sheet items next to loans

(LOANS) and deposits (DEPO). Although the debate has mostly focused on bank loans on the asset side of the balance sheet and bank deposits on the liability side, a bank has many other assets and liabilities it can use to optimize its balance sheet composition in response to shocks and which may influence the relation between bank loans and bank deposits.[50]

Therefore, we incorporate four other balance sheet items in the analysis to look at the causality as well as the whole balance sheet operation. First, a bank can use the interbank market to lend out excess funds and to borrow in case of shortages. In general, a bank simultaneously has asset and liability positions in the interbank market. In the analysis, we use net interbank lending which is defined as the difference between gross interbank lending and gross interbank borrowing (INTER). Second, a bank can engage in cross-border lending and borrowing, leading to balance sheet positions for external assets and liabilities. In the analysis, we define net foreign credit as the difference between these two balance sheet items (NEA). Third, many banks issue marketable debt as an alternative to deposits for funding their asset side, which we therefore also use in the analysis (DEBT). Lastly, some banks purchase marketable securities, such as stocks, bonds, and money market fund shares. Simultaneously, they also receive money market funds to finance their assets. We label the difference of the two as net securities banks (SEC).

In short, banks create loans and deposits jointly. At the same time, they optimize their balance sheets in a more general way, using interbank borrowing and lending, securities etc. If deposits move away, new debt issues can be used to support the loan base, for example. From this perspective, we expect a substitution effect between deposits and debt. The same type of substitution may work on the asset side. Including these six balance sheet items jointly may shed more light on causal relation between loans and deposits.

5.3.1 Methodology

In this section we introduce the statistical approach to investigate the causal relations between bank loans, bank deposits and four other components of bank balance sheets. Previous research has used – among others – SVAR estimation to shed more light on the causality issue. Here, we apply a novel statistical approach - VAR-LiNGAM – to estimate the casual relation. This method that is proposed by Moneta et al. (2013) exploits the statistical information in the (non-gaussian) distributions of macro variables to infer the direction of causality.

[50] See Granger (1980) for the issue of omitted variable bias.

The basic model is written in equation (5.1) as follows:

$$\boldsymbol{y_t} = \mathbf{B}\boldsymbol{y_t} + \boldsymbol{\Gamma_1 y_{t-1}} + \boldsymbol{\Gamma_2 y_{t-2}} + \cdots + \boldsymbol{\Gamma_p y_{t-p}} + \boldsymbol{\varepsilon_t} \qquad \textbf{(5.1)}$$

Where $\boldsymbol{y_t}$ is a 6X1 vector, $(\boldsymbol{y_{1t}},\ \boldsymbol{y_{2t}}, \ldots \boldsymbol{y_{6t}})^T$, representing the six endogenous variables in our analysis, which all are items on the bank balance sheet. The vector $\boldsymbol{y_t}$ includes bank loans, bank deposits, marketable debt, net holdings of securities, net interbank lending and the bank's net foreign asset position. In VAR-LiNGAM, we assume the causality is acyclic. B is then a lower-triangular matrix, with a zero diagonal, once all variables are arranged in a proper order. $\boldsymbol{\Gamma_j}$ are 6X6 matrices denoting the lagged effects, to represent the system's dynamics. In equation (5.1) $\boldsymbol{\varepsilon_t}$ is a 6 x 1 vector of independently distributed structural error terms. If we define $\boldsymbol{\Gamma_0 = I - B,}$ then we can rewrite equation (5.1) in a more common structural VAR form as follows:

$$\boldsymbol{\Gamma_0 y_t} = \boldsymbol{\Gamma_1 y_{t-1}} + \boldsymbol{\Gamma_2 y_{t-2}} + \cdots + \boldsymbol{\Gamma_p y_{t-p}} + \boldsymbol{\varepsilon_t} \qquad \textbf{(5.2)}$$

$\boldsymbol{\Gamma_0}$ is lower triangular as well then with a unity diagonal. An important assumption in the chosen methodology is that we assume the error vector $(\boldsymbol{\varepsilon_{1t}}, \boldsymbol{\varepsilon_{2t}} \ldots \boldsymbol{\varepsilon_{6t}})$ to be non-normally distributed, which allows for an innovative way of identifying causality. To identify causality, we first need to identify the independent shocks $\boldsymbol{\varepsilon_t}$. It asks for the aid of the estimation of a reduced-VAR system as formulated in equation (5.3):

$$\begin{aligned}\boldsymbol{y_t} &= \boldsymbol{\Gamma_0^{-1}\Gamma_1 y_{t-1}} + \boldsymbol{\Gamma_0^{-1}\Gamma_2 y_{t-2}} + \cdots + \boldsymbol{\Gamma_0^{-1}\Gamma_p y_{t-p}} + \boldsymbol{\Gamma_0^{-1}\varepsilon_t} \\ &= \boldsymbol{A_1 y_{t-1}} + \mathbf{A_2}\boldsymbol{y_{t-2}} + \cdots + \mathbf{A_p}\boldsymbol{y_{t-p}} + \boldsymbol{u_t} \qquad \textbf{(5.3)}\end{aligned}$$

Here, the error term $\boldsymbol{u_t}$ typically has a non-diagonal covariance matrix, indicating $\boldsymbol{u_t}$ is a mixture of the underlying structural shocks $\boldsymbol{\varepsilon_t}$**.** For the VAR-LiNGAM approach to improve on a regular VAR analysis, $\boldsymbol{u_t}$ should be non-Gaussian; otherwise the standard VAR can be efficiently estimated.

Overall, we start from three important assumptions in the model: i) the six shocks $\boldsymbol{\varepsilon_{1t}}, \boldsymbol{\varepsilon_{2t}}, \ldots \boldsymbol{\varepsilon_{6t}}$ are non-normally distributed; ii) the structural shocks are statistically independent; iii) the contemporaneous structure among the six endogenous variables is acyclic, that is $\boldsymbol{\Gamma_0}$ and B are lower triangular, conditional on the ordering of our six variables.

In the analysis, we first estimate equation (5.3) to obtain error term $\boldsymbol{u_t}$ and estimates of A. We use the AIC to determine the order of the VAR. Before proceeding to the next step, we apply Shapiro-Wilk (Shapiro and Wilk, 1965) and

Shapiro-Francia (Shapiro and Francia, 1972) to test the normality of the reduced VAR error terms. If $\boldsymbol{u_t}$ is non-Gaussian (non-normality), we adopt an independent component analysis (hereafter ICA) approach to estimate $\boldsymbol{\Gamma_0^{-1}}$ conditional on the estimated $\boldsymbol{u_t}$ and the identifying condition that $\boldsymbol{\varepsilon_t}$ is independently distributed. This also allows to extract $\boldsymbol{\varepsilon_t}$ as $\boldsymbol{u_t = \Gamma_0^{-1}\varepsilon_t}$. ICA is similar to principal component analysis (PCA). PCA gives a transformation of original statistics and provides linearly uncorrelated components, while dependencies of computed components by ICA are minimized as well. In this paper, we use FastICA proposed by Hyvärinen et al. (2001). $\boldsymbol{\Gamma_0^{-1}}$ and then $\boldsymbol{\Gamma_0}$ are unique when $\boldsymbol{u_t}$ is non-Gaussian and shocks $\boldsymbol{\varepsilon_t}$ are statistically independent (Comon, 1994). To obtain the lagged effects in equation (5.1), we use the relation $\boldsymbol{\Gamma_j = \Gamma_0 A_j}$.

$\boldsymbol{\Gamma_0}$ is strictly lower triangular in theory conditional on the identification of the true causal ordering. Empirically, $\boldsymbol{\Gamma_0}$ will not be directly lower triangular because the variables have not been ordered yet. However, based on a number of row and column permutations, we can obtain a lower triangular $\boldsymbol{\Gamma_0}$. This results in the optimal causal ordering of the six variables. Finally, we divide each row of $\boldsymbol{\Gamma_0}$ with its diagonal and obtain $\mathbf{B}$ via $\boldsymbol{\Gamma_0 = I - B}$. The diagonal of $\mathbf{B}$ is zero.[51]

In practice, some of the upper-diagonal elements of B may not be exactly equal to zero due to mismeasurement and imperfect identification. Shimizu et al. (2006) propose to minimize the sum of squares of the permutated upper-triangular elements to get a strict lower triangular. Moneta et al. (2013) propose to use a bootstrap procedure to prune out small elements in the upper triangular. In our analysis, we follow Moneta et al. (2013) using 1000 draws.

Overall, this procedure leads to estimates of $\boldsymbol{\Gamma_0}$ (and $\mathbf{B}$), which are consistent with the restriction of an acyclic relation between the endogenous variables.

5.4 Data

Our data consists of 6 countries from the euro area, for the period September 1997 to March 2018. These six comprise three countries from what is typically labeled the south and periphery of the euro zone – Italy, Ireland and Spain – and three countries from what is often referred to as the north and core – Austria, Germany and the Netherlands. We use six bank balance sheet variables in our research, which are 'LOAN' (domestic loans), 'DEPO' (domestic deposits),

[51] Alternatively, we could have first computed B and then apply permutations to make B lower diagonal.

'INTER' (net interbank lending), 'SEC' (securities), 'DEBT' (debt) and 'NEA' (net foreign lending). All data are freely accessible at monthly frequency from ECB statistics. We express all variables as a fraction of total assets.

Table 5.1 shows some descriptive statistics for the six variables under consideration. We report the data characteristics country by country[52]. In the discussion, we focus on the country averages.[53] The average deposit share is around 35 percent for most countries, but significantly higher for Spain and lower for Ireland. The private loan share tends to be somewhat higher than the deposit share in all countries, except for Germany. The Loan-Deposit ratio is particularly large in Italy and the Netherlands. The mean Debt share is about 20 percent in four countries, but significantly lower in Spain and Ireland. Also, net securities in Ireland are lower on average (7 percent) than in the other countries where the share varies between 10 and 16 percent. Net foreign credit and net interbank lending are typically small for all countries. The largest average net foreign credit share is observed in Austria (8 percent), while the largest average net interbank position is seen in Ireland (-6 percent).[54]

Overall, we find considerable heterogeneity in balance sheet composition across the six euro area countries. This heterogeneity cannot be simply framed as a North-South divide. While Germany and Austria have very similar bank balance sheets, the Netherlands in some respects is closer to especially Italy. Differences between the three Southern – peripheral – countries are considerable as well, with Ireland having relatively low loan and deposit shares and Spain and Italy having quite high shares.

We plot loans and deposits as a fraction of total assets for each of the six countries separately in figure 5.1. A first observation is that the degree of co-movement between loans and deposits varies substantially across countries. Second, the level of loans and deposits is relatively low in Ireland and relatively high in Spain. This is in line with our observation in table 5.1. More in detail, we see a slight decrease of loans and deposits in Austria and Germany before the great financial crisis. After the crisis, loans and deposits strongly increase again, moving closely together. In Germany, loans grow slowly compared to deposits in the second half of the sample. In comparison with Austria and Germany, Spanish deposits and loans, particularly loans, increase significantly before the crisis. Then a drop occurs. In Spain, domestic loans are much bigger than deposits before the European debt crisis, while currently deposits

[52] We also have a summary of the whole dataset as a panel. However, we observe significant variations in terms of the six variables especially on loans and deposits. Therefore, we report the data country by country. The summary information for the panel is also available on request.
[53] Standard deviations per country are relatively small and comparable in size.
[54] Note that gross positions foreign credit and interbank lending and borrowing are considerably larger for all countries. Especially in Ireland the foreign credit position is large.

surpass their counterpart loans. We can see deposits and loans drop during the whole sample period in Ireland. In both Italy and the Netherlands, loans considerably exceed deposits almost across the whole sample; moreover, their co-movement appears less strong than for other countries.[55]

Table 5.2 shows the correlation matrix between the four asset shares and two liabilities shares per country.[56] We start with a discussion of the loan-deposit correlation as it is the core of the analysis. Both proponents of the view that loan creation automatically results in deposit creation and proponents of the view that deposits are needed to create loans would hypothesize a positive correlation between the two. Surprisingly, we only observe a significantly positive correlation for Austria and Ireland. For Spain and the Netherlands it is insignificant and for Germany and Italy even significantly negative.

Secondly, we look at the correlation between loans and debt. If banks are assumed to always be able to create jointly loans and deposits, debt is not a constraint on loans and their bilateral correlation may be insignificant. However, if more funding is required for loan creation, a positive correlation between loans and debt would be expected. Again, the evidence is diverse. There is a significantly positive correlation for Germany and Spain, a significantly negative one for Austria and the Netherlands and an insignificant one for Ireland and Italy.

Negative bilateral correlations between loans and other assets point to the existence of substitution effects on the asset side.[57] The strongest evidence is for the correlation between loans and net external assets. In five countries, this correlation is significantly negative, with the Netherlands as an exception. The correlation between loans and securities is negatively significant for Spain, Italy, Netherlands and Germany but significantly positive for Austria and Ireland. Finally, the correlation between loans and net interbank lending is positive for Italy and Spain, negative for Germany, the Netherlands and Ireland, and insignificant for Austria.

Similarly, negative correlation between deposits and debt would provide evidence of substitutions effects on the liability side. Here, correlations are significantly negative in Austria, Germany, Ireland and Italy and positive for Spain. The correlation is insignificant in the Netherlands.

[55] We don't give plots of the other four variables in this paper. All additional plots are available upon request.
[56] We define INTER as net interbank lending, which makes it an asset term. The same holds for net foreign credit (NEA) and net securities holdings (SEC).
[57] It is important to recognize that a negative correlation between loans and another net asset item may indicate substitution effects on the asset side as well as funding effects on the liability side.

Correlations between deposits and a range of asset shares vary considerably as well. Four countries – Germany, Spain, Italy and the Netherlands – have a significantly positive correlation between deposits and net external assets. For Austria, it is significantly negative, while for Ireland it is insignificant. All correlations between deposits and securities are significantly positive. For interbank lending, again four correlations – Austria, Germany, Ireland and the Netherlands – are significantly positive while they are significantly negative for Spain and Italy. Overall, most – though definitely not all – of the correlation between deposits and different types of non-loan assets are positive, suggesting deposits received by banks are initially transformed in relatively liquid assets.

Finally, we pay attention to the correlation between debt and non-loan asset positions. Here, four countries – Austria, Spain, Ireland and the Netherlands – have a significantly positive correlation between debt and net external assets, while for Italy and Germany it is significantly negative. For both securities and interbank lending, the bilateral correlation with debt is significantly positive for the Netherlands and negative for all other countries.

In sum, the bilateral correlations give a first overview of the relation between the bank assets and liabilities. Obviously, these correlations cannot be given a causal interpretation. However, it is clear that considerable cross-country variation exists in balance sheet composition as well as dynamics. In the next section, we will use the results from the VAR-LINGAM approach to shed more light on the issue.

5.5 Results

In section 5.5, we discuss the results from the VAR-LiNGAM estimation. In particular, we provide empirical evidence on the causal relation between deposit and loans, and illustrate the relations between deposits, loans and four other balance sheet terms.

Following the procedure of the VAR-LiNGAM model, we first test the normality of the six variables. We follow Moneta et al. (2013) and adopt two normality test approaches—Shapiro-Wilk (Shapiro and Wilk, 1965) and Shapiro-Francia (Shapiro and Francia, 1972)—in this paper. The two test results with corresponding quantile-quantile plots and histograms confirm that all variables are statistically significantly non-Gaussian[58]. This permits us to carry out further investigation on the causal issue based on the VAR-LiNGAM model.

[58] The normality test results are available on request. We show q-q plots and histograms in the Appendix figure 5A.1 to figure 5A.6at the end.

The results are summarized in Tables 5.3 through 5.9. Table 5.3 contains a qualitative overview of the estimated acyclic causal structure for the six countries.[59] Tables 5.4 to table 5.9 present the estimates of instantaneous effects B_0 and lagged effects Γ_j in equation (1) for each of the six countries, respectively.[60] For each country, matrix B_0 – after transformation – is lower-triangular, reflecting the estimated causal ordering between the six variables.[61] Off-diagonal elements indicate the contemporaneous shock responses. For instance, in the case of Austria matrix B_0 in Table 5.4 shows a coefficient of 0.74 for the impact response of loans to deposits. Therefore, interpretation is similar to that of structural shocks in an SVAR. Tables 5.4 to 5.9 show that most off-diagonal elements of B_0 are insignificant. In the discussion, we will focus on the most dominant patterns.

For the lagged matrices Γ_j a few points stand out. First, the one period lagged matrix typically has relatively large and significant diagonal elements. This indicates substantial persistence in the dynamics. The diagonal elements of the two-period lagged matrix are generally close to zero. Overall, it suggests that an AR (1) is a reasonable approximation of the system for each country. Most off-diagonal elements in the two Γ_j matrices are close to zero and insignificant. The significant elements in the one-period lagged matrix Γ_1 tend to be of similar size and opposite sign as the contemporaneous effects in B_0. This provides a compensation for the earlier shocks and suggests most of the lagged effects work through the own AR (1) dynamics.

Table 5.3 contains the estimated causal ordering for each country. For instance, in Austria shocks to net interbank lending (INTER) directly impact on the other five variables. Deposits (DEPO) which are ranked secondly do not have a contemporaneous effect on net interbank lending but do affect the remaining for variables etc. Note that table 3 does not contain evidence on either the sign, the size or the significance of each of these links. A few points stand out. First, we observe DEBT holds an important role in the causal chain, as in five of the six countries it stands at the first (leading) position. It implies that shocks to debt influence all other balance sheet items, while debt is insensitive to other shocks. Intuitively, the unresponsiveness of debt to other shocks to the balance sheet appears plausible, as debt is a relatively low liquidity liability that takes time to adjust. Second, interbank bank lending has least power on affecting other variables since it is at the end of the chain in most cases. Again, it is quite plausible that interbank

[59] In graph theory, acyclic implies unidirectional linkages between different variables in the system without feedback loops.
[60] We only report lagged matrices of the structural VAR (Γ_j) here. The corresponding A_j of the reduced-form VAR are given in the Appendix at the end of this paper.
[61] We follow the suggested approach from Moneta et al. (2013) and use 1000 bootstrap simulations to prune out small elements in the upper-triangular of B_0. However, we cannot ensure all upper-elements are strictly zero.

activities serve as short-term adjustment mechanism to any sudden imbalance of the banks' balance sheet. The exception is Austria where INTER is the head in its order chain. Third, the bilateral ordering of loans and deposits is not uniform across countries. For Germany and Austria, deposits lead loans, providing support for the exogenous money supply theory. For the other four countries it is the reverse, which is in accordance with the endogenous money supply theory. Since the Netherlands is in the same category as Spain, Italy, and Ireland there is no clear-cut North-South divide in this respect.

For a more detailed view on the dominant patterns in the data, we now turn to the evidence in matrices B_0 in tables 5.4 to 5.9.[62] Across countries, two bilateral linkages stand out. The first one is that between deposits (DEPO) and loans (LOANS), the second between net external assets (NEA) and net interbank lending (INTER). The former provides direct evidence on the exogenous versus endogenous money supply theories. In addition to the ordering provided in Table 5.3, Tables 5.4 to 5.9 show that the link between DEPO and LOANS is strongly positive and significant for five countries – with estimated responses varying between 0.57 and 0.86 – but positive and insignificant for Italy. Overall, this implies DEPO significantly leads LOANS in two countries, while the opposite is true for three. Based on this evidence, we cannot discriminate between the two competing hypotheses.

The second dominant pattern is the – sometimes marginally – significantly negative relation between NEA and INTER. It shows a higher amount of net external assets coincides with less interbank lending or more interbank borrowing. Our use of net balance sheet positions prevents a more precise assessment. Again, there is some heterogeneity in the causal direction of the link. For Germany, the Netherlands, Spain and Italy NEA leads INTER, while the opposite holds for Austria and Ireland.

In addition, to the above two strong bilateral linkages, there are three more clear patterns which involve either DEPO or LOANS. On the deposit side, we find a significantly positive relation between DEPO and INTER for four countries. Moreover, for three of these – Germany, the Netherlands, and Ireland –, DEPO leads INTER. It suggests that a positive shock to deposits causes either less interbank borrowing (substitution on the liability side of the balance sheet) or more interbank lending (short-run use of unexpected funding on the asset side). Although LOANS are not explicitly

[62] There are a few significant effects, which are idiosyncratic to one or two countries. Sometimes these are hard to interpret. An example is the strong positive link from DEBT to DEPO in Germany. In the current discussion, we forego such findings and leave them to future research.

involved in this bilateral link, the evidence for these three countries appears hard to reconcile with the endogenous money theory.

For LOANS, we find a significantly positive link with DEBT in three countries – Spain, Italy and the Netherlands – with in each case DEBT leading LOANS. Again, this is more in line with the exogenous money supply theory than with the endogenous theory. It suggests, more funding is used to provide more loans in these countries, possibly alleviating an existing constraint. Similarly, we find a significantly negative link between LOANS and INTER for three countries, the Netherlands, Germany and Ireland with causality running from LOANS to INTER. The most straightforward explanation would be that more loan supply is funded by more interbank borrowing or by freeing up means on the asset side through less interbank lending.

5.6 Conclusion

In this paper, we address the issue of causality between money and credit, using bank deposits and bank loans as proxy variables. We use a data-driven methodology, VAR-LiNGAM. In contrast to the normal SVAR approach this method does not use constraints derived from prior economic knowledge to identify causality. Instead, it uses non-normality of the variables in the analysis for identification. The analysis intends to shed new light on the debate between exogenous money supply theory and endogenous money supply theory. To some extent, our paper is an extension of empirical work by Corradi et al. (1990) and Badarudin et al. (2013).

We use monthly data of six euro area countries—Austria, Germany, Spain, Italy, Ireland and the Netherlands—from 1997 to 2018. Most related empirical research exclusively focuses on loans and deposits. While these are the key variables, in our view it is important to also include other main bank balance sheet items in the analysis. This allows us to better capture optimizing bank behavior. Banks issue bonds as an alternative source of funding for their assets. Moreover, net interbank lending, net foreign lending and securities positions can be easily adjusted to obtain a better portfolio. Next to the two key variables, i.e. bank deposits and bank loans, we therefore also include four other balance sheet items, namely bonds, securities, net interbank lending and net external asset positions in the analysis. All country balance sheet are for monetary financial institutes (MFIs) excluding the Eurosystem.

In sum, we find a sizable amount of heterogeneity across countries, and no clear North-South divide. At the same time, a few patterns exist which are quite consistent (in sign and significance) across countries, most notably that between loans and deposits and between net external assets and net interbank lending. Nevertheless, even then the direction of

causality varies. Overall, the evidence on the endogenous versus exogenous money supply theory is mixed. This holds both for the direct LOAN-DEPO link and for the dynamics between loans and deposits individually with other balance sheet items. Future research is needed to shed more light on this. Possibly, extending the number and detail of balance sheet components in the analysis will lead to less ambiguous results. In addition, more experimentation with the relatively new VAR-Lingam methodology can bring out more precisely its strengths and weaknesses.

Table 5.1. Descriptive statistics

Variables	Unit	Obs	Mean	Std.Dev.	Min	Max
Panel_Austria						
LOAN	Private loans, ratio to the total balance	247	0.36	0.03	0.30	0.43
DEPO	Deposits, ratio to the total balance	247	0.34	0.04	0.28	0.45
NEA	Net foreign credit, ratio to the total balance	247	0.08	0.03	0.01	0.12
INTER	Net Interbank lending, ratio to the total balance	247	-0.004	0.01	-0.03	0.03
DEBT	Debt securities issued, ratio to the total balance	247	0.21	0.03	0.15	0.25
SEC	Net securities holding, ratio to the total balance	247	0.11	.010	0.08	0.14
Panel_Germany						
LOAN	Private loans, ratio to the total balance	246	0.34	0.024	0.29	0.41
DEPO	Deposits, ratio to the total balance	246	0.37	0.04	0.32	0.45
NEA	Net foreign credit, ratio to the total balance	246	0.03	0.02	-0.01	0.08
INTER	Net Interbank lending, ratio to the total balance	246	0.01	0.03	-0.03	0.08
DEBT	Debt securities issued, ratio to the total balance	246	0.20	0.04	0.13	0.24
SEC	Net securities holding, ratio to the total balance	246	0.10	0.01	0.08	0.12
Panel_Spain						
LOAN	Private loans, ratio to the total balance	246	0.50	0.05	0.40	0.61
DEPO	Deposits, ratio to the total balance	246	0.46	0.03	0.41	0.53
NEA	Net foreign credit, ratio to the total balance	246	-0.02	0.03	-0.07	0.03
INTER	Net Interbank lending, ratio to the total balance	246	-0.05	0.03	-0.12	-0.00
DEBT	Debt securities issued, ratio to the total balance	246	0.09	0.03	0.03	0.15
SEC	Net securities holding, ratio to the total balance	246	0.16	0.04	0.10	0.24

Panel_Ireland						
LOAN	Private loans, ratio to the total balance	247	0.23	0.05	0.15	0.39
DEPO	Deposits, ratio to the total balance	247	0.18	0.05	0.12	0.32
NEA	Net foreign credit, ratio to the total balance	247	-0.01	0.04	-0.08	0.07
INTER	Net Interbank lending, ratio to the total balance	247	-0.06	0.05	-0.16	0.06
DEBT	Debt securities issued, ratio to the total balance	247	0.07	0.02	0.04	0.12
SEC	Net securities holding, ratio to the total balance	247	0.07	0.02	0.02	0.11
Panel_Italy						
LOAN	Private loans, ratio to the total balance	246	0.44	0.03	0.40	0.50
DEPO	Deposits, ratio to the total balance	246	0.35	0.04	0.27	0.46
NEA	Net foreign credit, ratio to the total balance	246	-0.02	0.01	-0.05	0.01
INTER	Net Interbank lending, ratio to the total balance	246	-0.04	0.02	-0.09	-0.00
DEBT	Debt securities issued, ratio to the total balance	246	0.18	0.03	0.09	0.23
SEC	Net securities holding, ratio to the total balance	246	0.14	0.03	0.10	0.19
Panel_the Netherlands						
LOAN	Private loans, ratio to the total balance	246	0.45	0.02	0.41	0.49
DEPO	Deposits, ratio to the total balance	246	0.36	0.03	0.29	0.45
NEA	Net foreign credit, ratio to the total balance	246	-0.02	0.02	-0.07	0.02
INTER	Net Interbank lending, ratio to the total balance	246	0.01	0.02	-0.03	0.07
DEBT	Debt securities issued, ratio to the total balance	246	0.17	0.02	0.12	0.21
SEC	Net securities holding, ratio to the total balance	246	0.12	0.02	0.09	0.18

Data source: ECB and national central banks' statistics, national contribution to the aggregated balance sheet of euro area MFIs (excluding the Eurosystem). NEA, INTER and SEC are based on own calculation.

Table 5.2. Correlation description （1997Sept.-2018Mar.）

Correlation matrix													
Panel_AUT							Panel_DEU						
Var.	LOAN	DEPO	NEA	INTER	DEBT	SEC	Var.	LOAN	DEPO	NEA	INTER	DEBT	SEC
LOAN	1.00						LOAN	1.00					
DEPO	0.95*	1.00					DEPO	-0.23*	1.00				
NEA	-0.38*	-0.21*	1.00				NEA	-0.65*	0.29*	1.00			
INTER	0.08	0.24*	0.49*	1.00			INTER	-0.48*	0.84*	0.15*	1.00		
DEBT	-0.82*	-0.89*	0.35*	-0.11	1.00		DEBT	0.49*	-0.91*	-0.27*	-0.91*	1.00	
SEC	0.79*	0.77*	-0.28*	-0.06	-0.67*	1.00	SEC	-0.52*	0.41*	0.64*	0.30*	-0.33*	1.00
Panel_ESP							Panel_IRL						
Var.	LOAN	DEPO	NEA	INTER	DEBT	SEC	Var.	LOAN	DEPO	NEA	INTER	DEBT	SEC
LOAN	1.00						LOAN	1.00					
DEPO	0.08	1.00					DEPO	0.65*	1.00				
NEA	-0.14*	0.74*	1.00				NEA	-0.27*	-0.10	1.00			
INTER	0.29*	-0.23*	-0.73*	1.00			INTER	-0.32*	0.33*	-0.22*	1.00		
DEBT	0.77*	0.35*	0.42*	-0.25*	1.00		DEBT	0.03	-0.49*	0.13*	-0.37*	1.00	
SEC	-0.49*	0.53*	0.78*	-0.83*	0.06	1.00	SEC	0.44*	0.36*	-0.03	-0.31*	-0.11	1.00
Panel_ITA							Panel_NLD						
Var.	LOAN	DEPO	NEA	INTER	DEBT	SEC	Var.	LOAN	DEPO	NEA	INTER	DEBT	SEC
LOAN	1.00						LOAN	1.00					
DEPO	-0.47*	1.00					DEPO	-0.05	1.00				
NEA	-0.72*	0.82*	1.00				NEA	-0.04	0.37*	1.00			
INTER	0.49*	-0.48*	-0.62*	1.00			INTER	-0.57*	0.51*	-0.18*	1.00		
DEBT	-0.02	-0.50*	-0.29*	-0.32*	1.00		DEBT	-0.27*	0.07	0.30*	0.26*	1.00	
SEC	-0.56*	0.90*	0.81*	-0.71*	-0.21*	1.00	SEC	-0.48*	0.19*	-0.19*	0.38*	0.59*	1.00

Note : * indicates significance of correlation coefficients at 5% level.

Table 5.3. Casual structure of the six endogenous variables

	Causality in order					
AUT	INTER	DEPO	SEC	DEBT	NEA	LOAN
DEU	DEBT	NEA	DEPO	SEC	LOAN	INTER
ESP	DEBT	NEA	LOAN	SEC	DEPO	INTER
IRL	DEBT	LOAN	DEPO	SEC	INTER	NEA
ITA	DEBT	NEA	SEC	INTER	LOAN	DEPO
NLD	DEBT	SEC	LOAN	DEPO	NEA	INTER

Note: Causal results from VAR-LiNGAM model. All the six variables are in causality order. The arrow points the causal direction.

Table 5.4. Instantaneous effect and contemporaneous effect of the six variables__Austria

Instantaneous effects						
B_0	INTER	DEPO	SEC	DEBT	NEA	LOAN
INTER	0.00	0.00	0.00	0.00	0.00	0.00
DEPO	0.06	0.00	0.00	0.00	0.00	0.00
SEC	-0.12	0.20	0.00	0.00	0.00	0.00
DEBT	-0.06	0.25	0.07	0.00	0.00	0.00
NEA	-0.62***	0.22	-0.35*	0.46**	0.00	0.00
LOAN	-0.28	0.74***	-0.04	0.29	-0.20	0.00
VAR-LiNGAM lagged effects						
Γ_1	INTER	DEPO	SEC	DEBT	NEA	LOAN
INTER	0.69**	-0.04	0.17	0.145	0.11	0.03
DEPO	0.02	0.64**	0.20	-0.05	-0.08	0.23
SEC	0.09	-0.17	0.90***	0.05	-0.01	0.05
DEBT	0.04	-0.39	-0.17	0.99***	0.02	-0.04
NEA	0.37	-0.17	0.24	-0.24	0.68**	-0.06
LOAN	0.20	-0.58**	0.004	-0.31	0.15	0.82***
Γ_2	INTER	DEPO	SEC	DEBT	NEA	LOAN
INTER	0.26*	-0.01	0.22	-0.05	-0.09	0.07
DEPO	-0.05	0.29**	-0.10	-0.12	0.005	-0.12
SEC	0.05	0.02	0.10	0.02	0.03	-0.09
DEBT	0.005	0.03	-0.04	0.05	-0.06	0.09
NEA	0.23	-0.107	0.22	-0.31**	0.31**	0.15
LOAN	0.099	-0.089	0.14	-0.02	0.11	0.09

Note: all variables are measured in ratio to total balance sheet. ***, **, *indicate significance at 1, 5, 10% level, respectively. This is the same for tables from table 5.5 to table 5.9

Table 5.5. Instantaneous effect and contemporaneous effect of the six variables__Germany

Instantaneous effects						
B_0	DEBT	NEA	DEPO	SEC	LOAN	INTER
DEBT	0.00	0.00	0.00	0.00	0.00	0.00
NEA	0.21	0.00	0.00	0.00	0.00	0.00
DEPO	1.07***	0.09	0.00	0.00	0.00	0.00
SEC	0.08	0.04	0.21	0.00	0.00	0.00
LOAN	0.15	-0.10	0.77	0.05	0.00	0.00
INTER	0.26	-0.71**	0.57*	-0.63*	-0.52	0.00
VAR-LiNGAM lagged effect						
Γ_1	DEBT	NEA	DEPO	SEC	LOAN	INTER
DEBT	0.93***	0.12	-0.19	0.34	0.14	0.19
NEA	-0.17	0.99***	-0.14	0.02	0.17	0.04
DEPO	-1.16***	0.14	0.71**	0.40	0.24	0.23
SEC	0.11	-0.10	-0.03	0.72**	-0.13	0.02
LOAN	-0.04	0.05	-0.62*	-0.12	0.83**	-0.06
INTER	-0.17	0.57**	-0.63*	0.36	0.66**	0.82**
Γ_2	DEBT	NEA	DEPO	SEC	LOAN	INTER
DEBT	0.05	-0.13	0.36**	-0.63***	-0.26	-0.18
NEA	0.14	-0.11	0.30*	0.02	-0.37**	-0.28*
DEPO	0.00	-0.02	0.50***	-0.71***	-0.37**	0.08
SEC	-0.11	0.06	-0.13	-0.06	0.19	-0.10
LOAN	-0.03	0.02	-0.16	-0.08	0.16	0.02
INTER	-0.07	0.19	0.10	0.18	-0.23	0.26

Table 5.6. Instantaneous effect and contemporaneous effect of the six variables__Spain

Instantaneous effect						
B_0	DEBT	NEA	LOAN	SEC	DEPO	INTER
DEBT	0.00	0.00	0.00	0.00	0.00	0.00
NEA	0.21	0.00	-0.04	0.00	0.00	0.00
LOAN	0.70**	0.00	0.00	0.00	0.00	0.00
SEC	0.04	-0.21	-0.19	0.00	0.00	0.00
DEPO	-0.49*	0.29	0.86***	0.33	0.00	0.39
INTER	0.36	-0.39	-0.08	-0.18	0.00	0.00
VAR-LiNGAM lagged effect						
Γ_1	DEBT	NEA	LOAN	SEC	DEPO	INTER
DEBT	1.10***	0.06	0.05	0.04	-0.05	0.05
NEA	-0.18	0.79***	0.21	0.07	-0.13	0.07
LOAN	-0.56*	0.09	0.84***	-0.16	0.03	-0.10
SEC	-0.26	0.18	0.05	1.00***	0.00	0.00
DEPO	0.21	-0.20	-0.64**	-0.14	0.78***	-0.17
INTER	-0.19	0.09	-0.08	0.14	0.48	0.72**
Γ_2	DEBT	NEA	LOAN	SEC	DEPO	INTER
DEBT	0.07	-0.17	-0.03	-0.04	0.06	-0.08
NEA	0.08	0.20	-0.07	-0.08	-0.02	-0.05
LOAN	-0.04	-0.19	0.02	0.11	0.08	0.09
SEC	0.45***	0.02	-0.01	0.09	0.15	0.00
INTER	-0.23	0.21	0.33**	0.00	-0.48***	0.33**
DEPO	0.26*	-0.09	-0.20	-0.09	0.16	-0.12

Table 5.7. Instantaneous effect and contemporaneous effect of the six variables__Ireland

Instantaneous effect						
B_0	DEBT	LOAN	DEPO	SEC	INTER	NEA
DEBT	0.00	0.00	0.00	0.00	0.00	0.00
LOAN	0.30	0.00	0.00	0.00	0.00	0.00
DEPO	-0.05	0.60**	0.00	0.00	0.00	0.00
SEC	-0.06	0.21	0.23	0.00	0.00	0.00
INTER	0.36	-0.47	0.66**	-0.23	0.00	0.00
NEA	0.93***	-0.56*	0.35	-0.49	-0.73	0.00
VAR-LiNGAM lagged effect						
Γ_1	DEBT	LOAN	DEPO	SEC	INTER	NEA
DEBT	1.02***	-0.06	0.04	-0.01	-0.09	-0.01
LOAN	-0.21	0.75**	0.33	0.01	0.06	0.14
DEPO	-0.09	-0.63**	1.02***	0.03	0.10	0.04
SEC	0.02	-0.28	-0.13	0.99***	0.10	0.07
INTER	-0.11	0.42	-0.52	0.10	0.78**	-0.19
NEA	-0.78**	0.49	-0.17	0.36	0.56**	0.78**
Γ_2	DEBT	LOAN	DEPO	SEC	INTER	NEA
DEBT	-0.14	0.08	-0.11	0.13	0.12	0.04
LOAN	-0.08	0.30**	-0.39**	0.08	-0.06	-0.13
DEPO	0.29*	-0.03	0.00	-0.11	-0.22	-0.08
SEC	0.04	-0.02	-0.05	0.07	-0.11	-0.08
INTER	0.19	0.37**	-0.21	-0.15	0.12	0.15
NEA	-0.02	0.08	0.02	-0.02	0.11	0.13

Table 5.8. Instantaneous effect and contemporaneous effect of the six variables__Italy

Instantaneous effect						
B_0	DEBT	NEA	SEC	INTER	LOAN	DEPO
DEBT	0.00	0.00	0.00	0.00	0.00	0.00
NEA	-0.10	0.00	0.00	0.00	0.00	0.00
SEC	0.03	-0.29	0.00	0.00	0.00	0.00
INTER	-0.06	-0.48**	-0.22	0.00	0.00	0.00
LOAN	0.46*	-0.37	0.65**	0.15	0.00	0.00
DEPO	-0.20	0.29	0.93***	0.55**	0.27	0.00
VAR-LiNGAM lagged effect						
Γ_1	DEBT	NEA	SEC	INTER	LOAN	DEPO
DEBT	1.03***	0.00	0.25	0.09	-0.14	-0.09
NEA	0.15	0.74**	0.04	0.01	-0.05	0.06
SEC	0.03	0.49*	0.95***	-0.01	-0.01	0.03
INTER	-0.06	0.39	0.06	0.75**	0.03	0.00
LOAN	-0.44	0.17	-0.77**	-0.14	0.87***	0.21
DEPO	0.08	-0.19	-0.78**	-0.38	-0.19	0.79***
Γ_2	DEBT	NEA	SEC	INTER	LOAN	DEPO
DEBT	0.02	-0.12	-0.17	-0.19	0.05	0.10
NEA	-0.02	0.18	-0.02	0.07	0.02	-0.02
SEC	-0.06	-0.21	0.04	0.06	-0.05	-0.08
INTER	0.17	0.16	0.11	0.23	-0.05	0.00
LOAN	-0.15	0.17	0.10	0.00	0.12	-0.20
DEPO	-0.01	-0.01	-0.17	-0.06	0.04	0.03

Table 5.9. Instantaneous effect and contemporaneous effect of the six variables__the Netherlands

Instantaneous effect						
B_0	DEBT	SEC	LOAN	DEPO	NEA	INTER
DEBT	0.00	0.00	0.00	0.00	0.00	0.00
SEC	0.15	0.00	0.00	0.00	0.00	0.00
LOAN	1.46***	-0.14	0.00	0.00	0.00	0.00
DEPO	0.16	0.28	0.57*	0.00	0.00	0.00
NEA	0.35	-0.19	-0.14	0.15	0.00	0.00
INTER	0.42	-0.51	-0.57*	0.55*	-0.67**	0.00
VAR-LiNGAM lagged effect						
Γ_1	DEBT	SEC	LOAN	DEPO	NEA	INTER
DEBT	0.97	-0.05	-0.05	-0.03	-0.03	-0.04
SEC	-0.01	1.03	-0.02	-0.07	-0.02	-0.05
LOAN	-1.30	0.17	0.89	-0.07	0.00	-0.14
DEPO	-0.23	-0.17	-0.38	0.80	0.01	0.02
NEA	-0.09	-0.06	0.04	0.01	0.50	-0.13
INTER	0.02	0.18	0.10	-0.10	0.12	0.44
Γ_2	DEBT	SEC	LOAN	DEPO	NEA	INTER
DEBT	0.18	-0.05	-0.09	0.11	0.06	0.04
SEC	-0.20	-0.06	-0.03	0.12	-0.02	0.02
LOAN	-0.35**	-0.16	0.06	0.15	-0.06	0.04
DEPO	-0.15	-0.15	-0.06	0.16	-0.08	-0.06
NEA	0.12	-0.18	-0.03	0.04	0.16	-0.03
INTER	-0.47***	0.21	0.39***	-0.31**	0.24*	0.29**

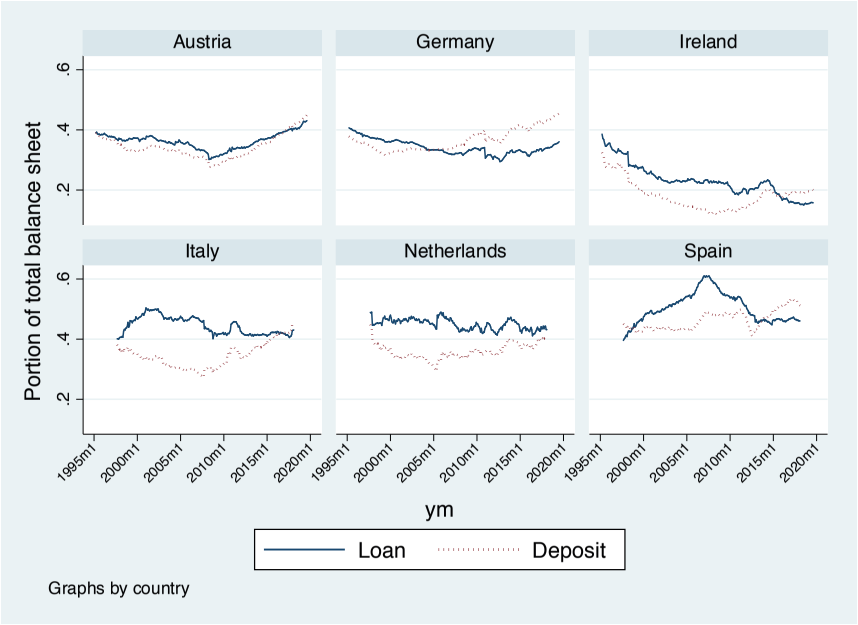


Figure 5.1. Loans and deposits. Two variables are ratios to total balance sheet

Data source: ECB statistics. The values are own calculation

5.7 Appendix:

The appendix contains six tables comprising the estimated coefficients of the lagged matrices or order one and two in the reduced form VAR--$\boldsymbol{A_j}$ in equation (5.3), where $\boldsymbol{A_j = \Gamma_0^{-1}\Gamma_j}$, indicating that the lagged effects in the reduced-form VAR are a combination of contemporaneous effects ($\boldsymbol{\Gamma_0^{-1}}$) and lagged effects ($\boldsymbol{\Gamma_j}$) from the structural VAR. Thus, it disguises the true dynamics effects between the six variables. We present these coefficients here to provide comparison with lagged effects from the structural VAR. In addition, the appendix contains the graphical evidence for the non-Gaussian test for each country.

Table 5A.1. Reduced form VAR coefficients matrix_Austria

Contemporaneous effects. _AUT													
Reduced VAR													
A_1	INTER	DEPO	SEC	DEBT	NEA	LOAN	A_2	INTER	DEPO	SEC	DEBT	NEA	LOAN
INTER	0.69***	-0.04	0.17	0.15	0.11	0.03		0.26*	-0.01	0.22	-0.05	-0.09	0.07
DEPO	0.06	0.63***	0.21	-0.04	-0.08	0.23		-0.03	0.29**	-0.09	-0.13	-0.002	-0.11
SEC	0.02	-0.04	0.92***	0.02	-0.04	0.10		0.01	0.08	0.06	0.01	0.04	-0.13
DEBT	0.02	-0.23	-0.06	0.97	-0.01	0.02		-0.02	0.11	-0.07	0.03	-0.06	0.05
NEA	-0.04	-0.09	-0.17	0.10	0.61	-0.05		0.05	-0.01	0.01	-0.29**	0.33**	0.14
LOAN	0.07	-0.14	0.09	-0.12	-0.06	0.99***		-0.02	0.16	-0.01	-0.03	0.05	-0.03

Table 5A.2. Reduced form VAR coefficients matrix_Germany

Contemporaneous effects_DEU													
Reduced form VAR													
A_1	DEBT	NEA	DEPO	SEC	LOAN	INTER	A_2	DEBT	NEA	DEPO	SEC	LOAN	INTER
DEBT	0.93***	0.12	-0.19	0.34	0.14	0.19		0.05	-0.13	0.36*	-0.63***	-0.26	-0.18
NEA	0.02	1.03***	-0.18	0.10	0.20	0.09		0.15	-0.13	0.38*	-0.11	-0.43**	-0.32*
DEPO	-0.16	0.36	0.48*.	0.78***	0.41	0.44*		0.06	-0.17	0.92***	-1.39***	-0.68***	-0.14
SEC	0.14	0.03	0.05	0.92***	-0.02	0.13		-0.09	0.01	0.11	-0.41**	0.01	-0.15
LOAN	-0.02	0.25	-0.25	0.57**	1.15***	0.31		0.01	-0.12	0.58***	-1.27***	-0.36**	-0.09
INTER	-0.12	-0.06	-0.18	-0.05	0.20	0.81***		-0.08	0.21	0.08	0.22	-0.19	0.51

Table 5A.3. Reduced form VAR coefficients matrix_Spain

ESP													
A_1	DEBT	NEA	LOAN	SEC	DEPO	INTER	A_2	DEBT	NEA	LOAN	SEC	DEPO	INTER
DEBT	1.10***	0.06	0.05	0.03	-0.05	0.05		0.07	-0.17	-0.03	-0.04	0.06	-0.08
NEA	0.4	0.80***	0.18	0.09	-0.14	0.09		0.09	0.18	-0.08	-0.10	-0.01	-0.07
LOAN	0.21	0.13	0.88***	-0.13	-0.002	-0.07		0.01	-0.31**	0.004	0.08	0.12	0.03
SEC	-0.26	-0.02	-0.15	1.01***	0.02	-0.002		0.43***	0.03	0.002	0.09	0.13	0.01
DEPO	-0.14	0.02	0.02	0.07	0.97***	0.05		0.27*	-0.17	-0.07	0.002	0.09	0.05
INTER	0.22	-0.21	-0.17	-0.06	0.51**	0.71***		-0.32**	0.10	0.35**	0.005	-0.49***	0.32***

Table 5A.4. Reduced form VAR coefficients matrix_Ireland

IRL													
A_1	DEBT	LOAN	DEPO	SEC	INTER	NEA	A_2	DEBT	LOAN	DEPO	SEC	INTER	NEA
DEBT	1.02***	-0.06	0.04	-0.01	-0.09	-0.01		-0.14	0.08	-0.11	0.13	0.12	0.04
LOAN	0.10	0.73****	0.34	0.01	0.03	0.13		-0.12	0.32**	-0.43***	0.11	-0.03	-0.11
DEPO	-0.08	-0.18	1.23***	0.03	0.12	0.12		0.23	0.16	-0.25	-0.04	-0.25	-0.15
SEC	-0.04	-0.16	0.23	1.00***	0.14	0.12		0.08	0.08	-0.19	0.07	-0.18	-0.14
INTER	0.17	-0.02	0.09	-0.12	0.77***	-0.20		0.33**	0.33**	-0.17	-0.20	0.05	0.15
NEA	-0.02	0.06	-0.07	-0.05	-0.13	0.83***		-0.28*	-0.25	0.28*	0.13	0.20	0.14

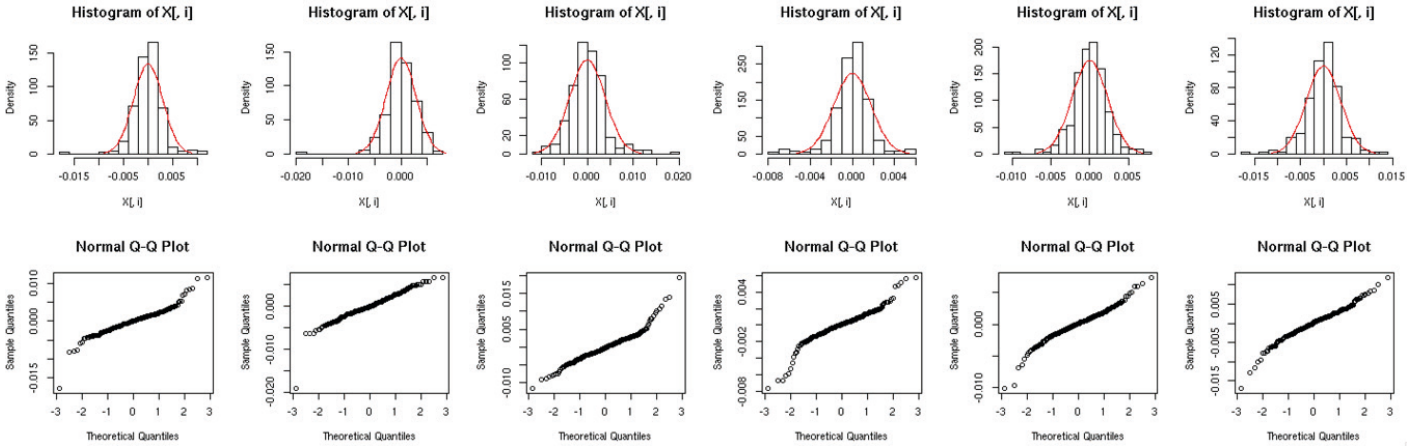
Table 5A.5. Reduced form VAR coefficients matrix_Italy

ITA													
A_1	DEBT	NEA	SEC	INTER	LOAN	DEPO	A_2	DEBT	NEA	SEC	INTER	LOAN	DEPO
DEBT	1.03***	0.00	0.25	0.09	-0.14	-0.09		0.02	-0.12	-0.17	-0.19	0.05	0.10
NEA	0.05	0.74***	0.01	0.01	-0.04	0.07		-0.02	0.20	0.00	0.09	0.02	-0.03
SEC	0.04	0.27	0.95***	-0.01	0.00	0.01		-0.06	-0.27*	0.04	0.03	-0.06	-0.07
INTER	-0.15	-0.03	-0.17	0.74***	0.06	-0.03		0.19	0.13	0.11	0.19	-0.05	0.02
LOAN	0.02	0.06	-0.07	-0.01	0.82***	0.15		-0.14	-0.12	0.07	-0.08	0.09	-0.18
DEPO	-0.16	0.28	-0.05	0.00	0.08	0.86***		-0.01	-0.14	-0.02	0.11	-0.02	-0.10

Table 5A.6. Reduced form VAR coefficients matrix_the Netherlands

NLD													
A_1	DEBT	SEC	LOAN	DEPO	NEA	INTER	A_2	DEBT	SEC	LOAN	DEPO	NEA	INTER
DEBT	0.97***	-0.05	-0.05	-0.03	-0.03	-0.04		0.18	-0.05	-0.09	0.11	0.06	0.04
SEC	0.14	1.02***	-0.03	-0.07	-0.02	-0.05		-0.17	-0.07	-0.04	0.14	-0.01	0.03
LOAN	0.10	-0.04	0.82***	-0.10	-0.05	-0.19		-0.07	-0.22	-0.07	0.29**	0.03	0.10
DEPO	0.02	0.08	0.07	0.72***	-0.03	-0.10		-0.21	-0.31**	-0.12	0.38**	-0.06	0.02
NEA	0.21	-0.25	-0.08	0.14	0.50**	-0.12		0.19	-0.20	-0.06	0.07	0.17	-0.03
INTER	0.17	-0.13	-0.28	0.29	-0.21	0.59**		-0.51***	0.31**	0.38**	-0.34**	0.11	0.26*

Figure 5A.1. Non-Gaussian test on error correction terms for Austria



Note: Resulting residuals of a 3-lagged VAR. From the left to right, the variables are LOAN, DEPOSIT, INTER, SEC, DEBT, NEA. The first row is the histograms of residuals for the six variables with overlaid Gaussian distribution with corresponding mean and variance. The asymmetric distribution of the bars indicates the non-Gaussian of the six residuals. The second row is corresponding normal quantile-quantile-plots of six residuals. If an error correction term is normality, the q-q plot should be a straight 45-degree line. Our six q-q plots reject the normality of the correction terms.
For the next six countries, all the variables are in the same order.

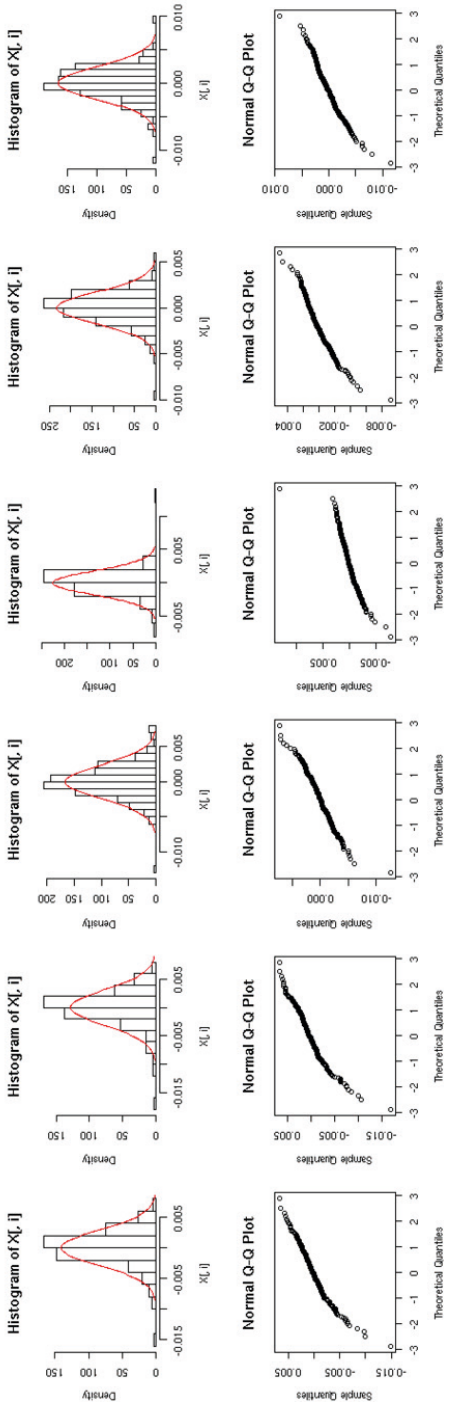


Figure 5A.2. Non-Gaussian test on error correction terms for Germany

Note: see figure 5A.1.

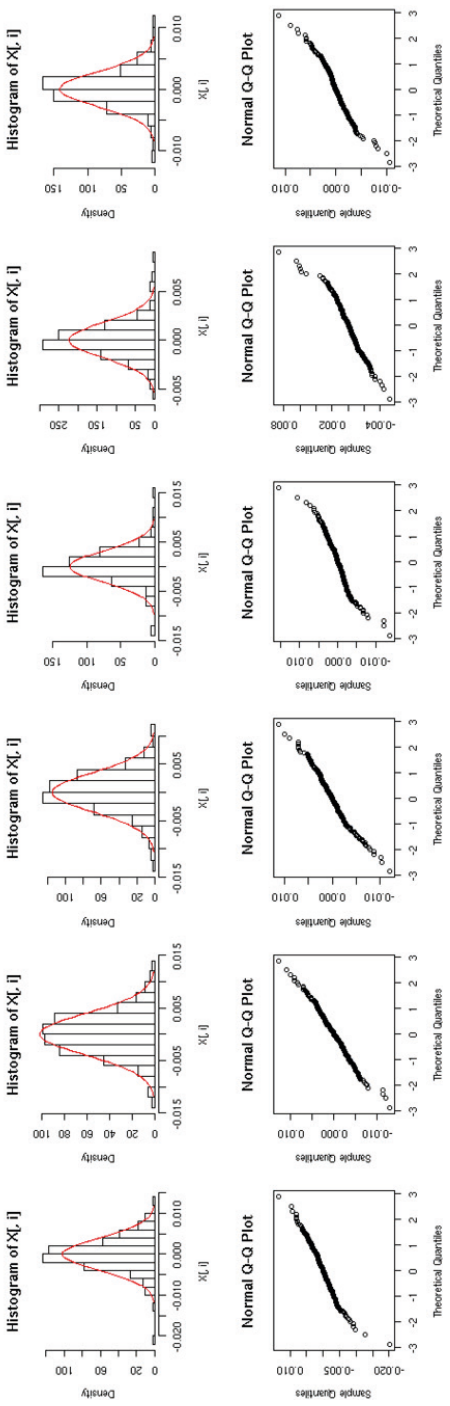


Figure 5A.3. Non-Gaussian test on error correction terms for Spain

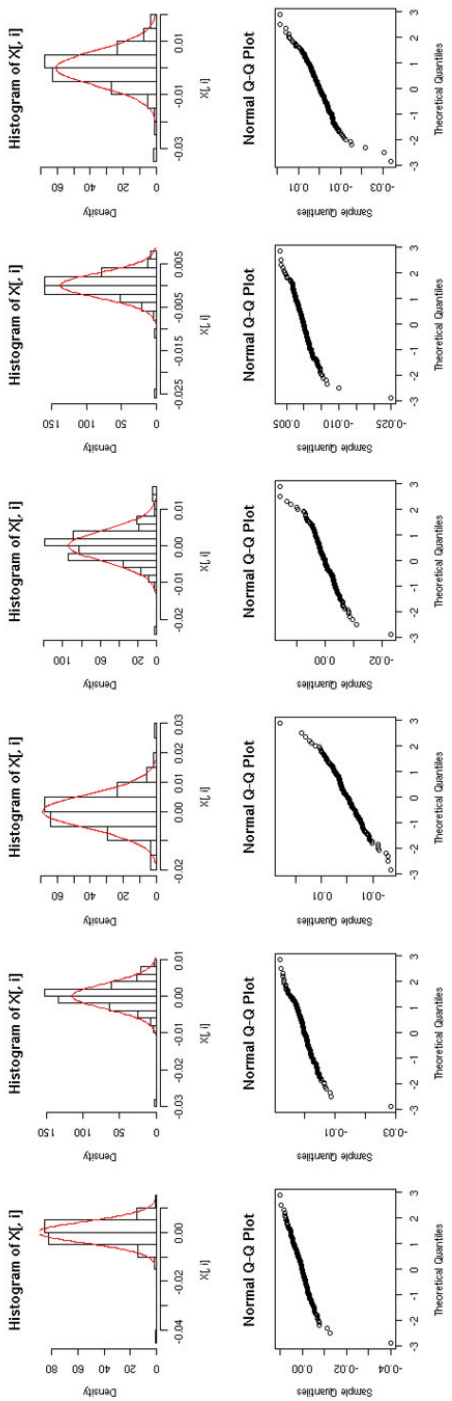


Figure 5A.4. Non-Gaussian test on error correction terms for Ireland

Note: Resulting residual of a 4-lag VAR. Others see figure 5A.1.

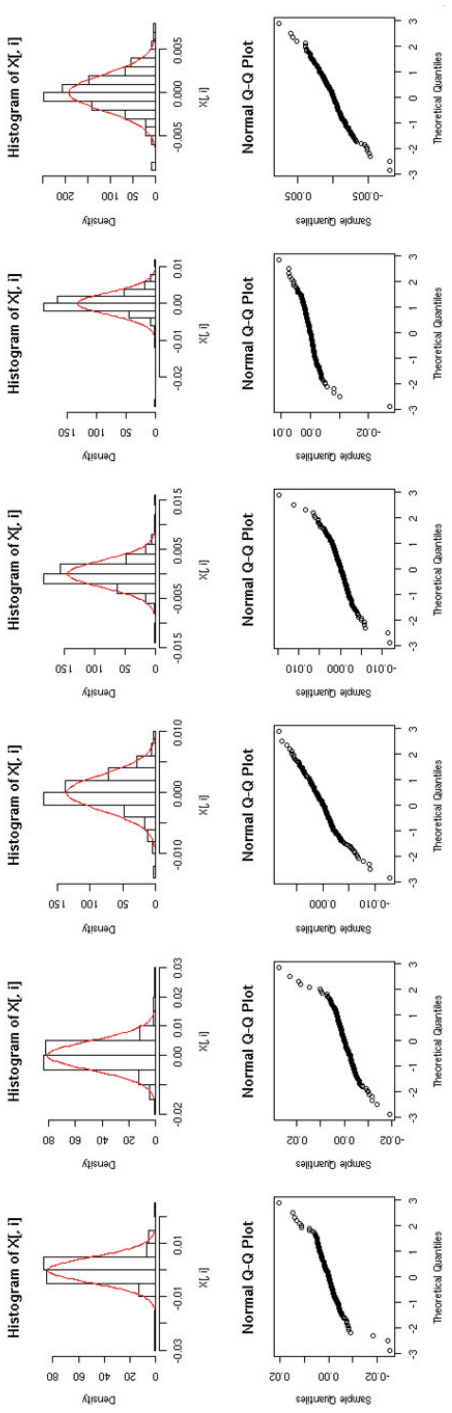


Figure 5A.5. Non-Gaussian test on error correction terms for Italy

Note: see figure 5A.1.

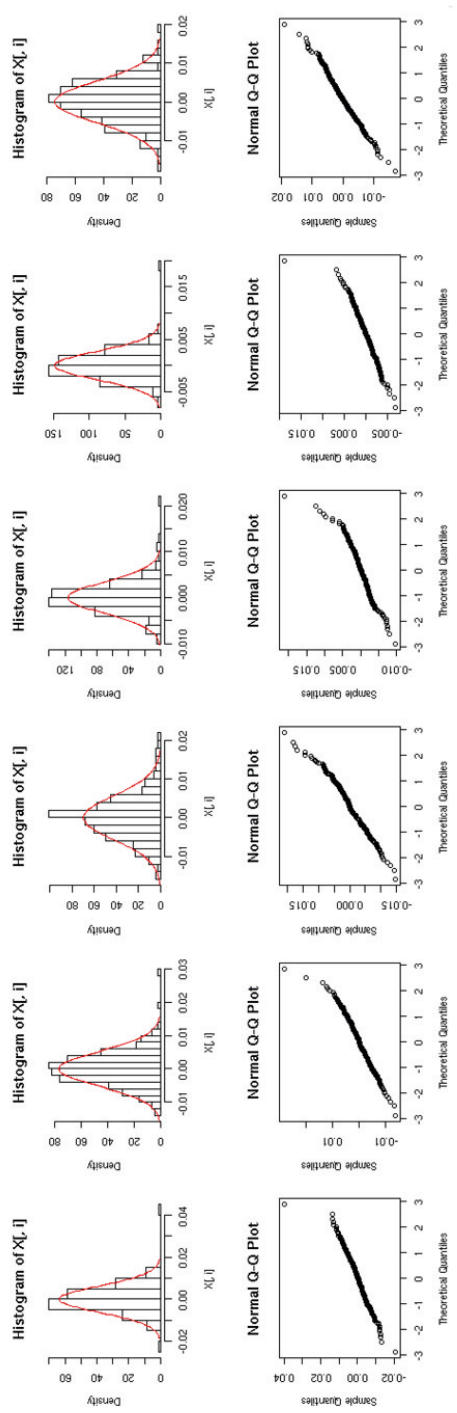


Figure 5A.6. Non-Gaussian test on error correction terms for the Netherlands

Note: Resulting residuals of a 4-lag VAR. Others see figure 5A.1.

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