Money and credit overhang in the euro area

Jingyang Liu[a,*,1], Clemens J.M. Kool[a,b]

[a] *Utrecht University School of Economics, The Netherlands*
[b] *Utrecht University School of Economics, CPB Netherlands Bureau for Economic Policy Analysis, The Netherlands*

ABSTRACT

In this paper, we employ panel co-integration techniques to identify and estimate homogeneous long-run equilibrium relations for money and credit for 10 euro area countries. Over the period 1999–2013, we do find evidence of such long-run relations when accounting for a structural break in 2008. While money and credit follow similar long run trends, the short and medium term relation between money and credit overhang is weak, throwing doubt on the hypothesis that money creating potential drives credit booms. Especially in current account deficit countries, we observe a sizable build-up of credit overhang prior to 2008. Positive (negative) credit overhang is strongly related to net foreign borrowing (lending).

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 has revived interest in the role of money and bank credit as determinants of macroeconomic development and in the relation between money and credit.[2] 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. 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. In recent years, 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. 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 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. To determine the degree of excess money and credit, we estimate equilibrium relations for money and credit for the whole period 1999–2013 as well as two sub periods and test whether these are stable. We choose for a panel setup of 10 euro area countries to be able to exploit the heterogeneity in country-specific economic developments and to reduce omitted variable bias. Given the current debate on the potential role of cross-country imbalances in causing excess credit, we explicitly incorporate net foreign bank credit in our analysis. Based on our 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 find 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. 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

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overhang in this period. Net foreign credit is shown to be strongly related to the size of the overhang: including it into the analysis considerably reduces the estimated overhang for most countries. 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 2, we will give a review on the literature about money and credit in the euro area. In Section 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 contains an overview of the sources of our data and their stylized characteristics. Section 5 presents and discusses the empirical results. Section 6 concludes.

2. Literature review

To provide a background for our analysis, we briefly survey the literature on money and credit, where we confine ourselves to literature related to the euro area. In Section 2.1 we discuss euro area money demand and potential monetary overhang. We pay attention both to research on the aggregate euro area money demand relation as to research that takes a disaggregate perspective, using individual country data.[3] In Section 2.2 we turn to a similar discussion of bank credit to the private sector in the euro area. We include the literature that analyzes the relation between domestic credit and external imbalances in this section.

2.1. Money demand in the euro area

The money demand function provides a theoretical framework for the relation between monetary aggregates, real activity and financial markets. The stability of money demand plays a dominant role in discussions on the appropriate form of monetary policy. There is a substantial empirical literature on euro area money demand. However, almost all research focuses on euro area wide aggregates and does not pay attention to the information in country-specific developments.

Early money demand studies for the euro area as a whole by Coenen and Vega (2001), Calza et al. (2001), 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.[4] Later studies typically need to include additional variables such as stock prices, stock price volatility or cross-country capital flows, to retain money demand stability. Examples are Carstensen (2006), Dreger and Wolters (2010) and De Santis et al. (2013).

Only a few studies analyze euro area money demand using the information in country-specific developments of euro area members. Dedola et al. (2001) compare aggregate and national money demand estimations in the pre-euro era. Carstensen et al. (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.[5] This provides more scope for finding a stable money demand function than for the euro area as a whole

because possible 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 pays much attention to the consequences of the estimated money demand function for national monetary developments in comparison to the euro area as a whole.

We now 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. 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.[6]

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.

2.2. Credit in the euro area

The empirical literature on credit and its relation to economic developments in the euro area is much more limited than is the case for money. Calza et al. (2003) and Calza et al. (2006) estimate equations relating private sector credit to economic activity (GDP) and interest rates for the euro area as a whole. Their setup and purpose is similar to the money demand research discussed in the previous section as they try to establish the existence of a long-run equilibrium relation. Both studies report suggestive evidence of the existence of a stable long-run credit demand function.[7] They also compute a credit overhang measure using the error correction term and investigate to what extent it serves as a predictor of future inflation. The idea of credit overhang is strongly related to the theory of credit cycles and the corresponding pro-cyclicality of credit. The concept of credit cycles dates back to Schumpeter and Minsky. Kiyotaki and Moore (1997) provide a theoretical basis for such cycles. We refer to Borio (2014) for an overview.

Related work on credit dynamics in the euro area includes Hristov et al. (2012) and Darracq Paries et al. (2014). Both use a VAR

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[3] Since ECB monetary policy has been approximately formulated as an interest rate policy, money supply (at the aggregate level) has been endogenous and demand-determined. This is a fortiori the case for individual member countries, which are unconstrained in their demand preferences given the common monetary policy.

[4] These studies are typically based on the pre-euro period with samples ending in the late nineties. As a consequence, the euro area data are constructed from national series, using specific assumptions with respect to the conversion of exchange rates.

[5] 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, whereas individual countries are included with a different weight in the euro area average.

[6] 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.

[7] They assume credit is demand determined, with commercial banks setting a lending rate at which they are able to provide an almost infinitely elastic supply. It is debatable whether this is still warranted, especially after 2008 when banks got constrained by bad loans and stricter regulation, leading to recapitalization requirements and lending constraints.

framework and country-specific data and document cross-country heterogeneity to some extent. Hofmann (2004) follows a similar approach but extends the set of countries beyond the euro area. We have been unable to track credit demand research using the same panel design as Nautz and Rondorf (2011), Setzer et al. (2011) and Setzer and Wolff (2013) for monetary analysis in the euro area.

The literature relating domestic credit growth to external imbalances in the euro area is more extensive. Unger (2016) provides an overview. The divergent pattern of increasing current account deficits in southern euro area members and current account surpluses in northern euro area members prior to 2008 by now is a well-known stylized fact. Also, there is quite some evidence that current account deficits were financed to a large extent by foreign bank credit. Seminal references in this field are Borio and Disyatat (2011) and Lane and McQuade (2014).[8] Overall, there is suggestive evidence of a positive relation between net foreign credit and domestic credit growth. However, the direction of causality is unclear.

3. Setup

In this paper, we first search for stable relations between money and credit respectively on the one hand and a number of standard economic driving variables on the other, which are common to all countries in the euro area. 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 estimated long-run relations. 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.

3.1. Hypotheses

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), IMF (2009) and Bezemer and Zhang (2014) for example provide supportive evidence of such hypothesis. Jorda et al. (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-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 estimating long run relations for money and credit in the euro area with and without (outstanding) net foreign credit as an additional explanatory variable.[9] 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).[10] 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.

3.2. Model

In this paragraph, we provide a brief basis for the empirical specification of the money and credit equation to be estimated. 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:

$$M^d/P = f(Y, R, Z) \tag{1}$$

where M^d is some nominal money aggregate, P represents the price

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[8] We refer to Kool et al. (2013) for additional evidence and discussion.

[9] A country with positive outstanding net foreign credit has net claims on the rest of the world.

[10] 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 from the 1950 to the 1990s, but a joint growth rate since.

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 (1998). Real GDP is the most common scale variable and is expected to exert a positive effect on money demand. 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, 2010). 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 net foreign credit to account for cross-border dynamics in money and credit markets as an additional variable. Net foreign credit is defined as the net level of foreign assets (loans) of the domestic banking sector. Intuitively, lending to foreign banks may decrease the scope for domestic money and credit expansion. Overall, it leads to the following Eq. (2):

$$m_{it} - p_{it} = a_{it} + \beta'_{it} y_{it} + \gamma'_{it} R_{it} + \theta'_{it} NFC_{it} + \varepsilon_{it} \qquad (2)$$

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 and NFC net foreign credit as a percentage of GDP. 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 $\beta_{it} > 0$, $\gamma_{it} < 0$ and $\theta_{it} < 0$ denote the hypothesized income elasticity, and semi-elasticities with respect to the opportunity cost and net foreign credit.

For the modelling the credit market, we draw on Bernanke and Blinder (1988). A simple way to model credit demand is:

$$CR^d / P = L(Y, RR, Z_1) \qquad (3)$$

where CR is nominal credit, RR is the real loan rate, say bonds, and Z_1 comprises additional factors. Theoretically, credit demand depends positively on income and negatively on the loan rate. Credit supply is typically written as:

$$CR^s / P = S(Y, RR, (1-t)D, Z_2) \qquad (4)$$

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, as money-creating banks standardly increase loans and deposits simultaneously, 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, similar to money demand Eq. (2):

$$c_{it} - p_{it} = \alpha'_{it} + \beta'_{it} y_{it} + \gamma'_{it} RR_{it} + \theta'_{it} NFC_{it} + \varepsilon_{it} \qquad (5)$$

where c is private credit taken in logs and RR represents real borrowing costs. In our analysis, we take the nominal bond yield corrected for inflation as proxy for RR.[11] The parameter $\beta'_{it} > 0$ denotes the elasticity

of credit with respect to the income variable. The impact of the cost of credit is captured by the semi-elasticity γ'_{it}. Most research using some variant of Eq. (5) assumes it can be interpreted as a credit demand function.[12] In that case, γ'_{it} is expected to be negative. However, when supply effects are important, the sign of γ'_{it} becomes indeterminate. θ'_{it} is expected to be negative: the higher the stock of outstanding foreign credit, the lower domestic credit and vice versa.

Since the variables entering Eqs. (2) and (5) 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 and consequently also estimates of the equilibrium path of money and private credit aggregates. In addition, it allows for the computation of excess money for each country individually.

3.3. Methodology

We estimate Eqs. (2) and (5) using the 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.[13] 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.[14]

4. Data

The sample contains ten original Euro area members, Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain. The 11th original euro country Luxemburg is excluded due to data accessibility. The same holds for Greece that entered shortly after the introduction of the euro. The time span is from 1999Q1 to 2013Q3.

We choose M3 as the preferred monetary aggregate. End-of-month M3 data are obtained from Datastream and ultimately come from national central bank statistics.[15] For each country, we construct quarterly M3 as averages of monthly data. Quarterly private credit is defined as credit to the non-financial sector and is collected from BIS statistics.[16] Quarterly monetary aggregates and private credit are 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

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(footnote continued)

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.

[12] See Calza et al. (2003), Calza et al. (2006) and Hofmann (2004).

[13] See also Stock and Watson (1993) and Kao (1999).

[14] This is closely related to the approach taken by Nautz and Rondorf (2011), Setzer et al. (2011) and Setzer and Wolff (2013) in the case of euro area money demand.

[15] Note that in the euro area, country-specific monetary aggregates represent the contribution of member states to the euro area aggregate (Setzer and Wolff, 2013; Nautz and Rondorf, 2011).

[16] Since its start, the euro area has expanded and now contains 19 countries. A comparison of the aggregate amount of money and 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.

[11] We would prefer to use a forward-looking, expected, real interest rate. However,

the ratio of nominal to real GDP multiplied by 100. To obtain real monetary aggregates and real private credit, the nominal M3 and credit are deflated by the GDP deflator, respectively. In the subsequent empirical analysis, real M3, real private credit and real GDP are expressed in logarithms. The monthly 10-year government bond yields per country come from the ECB.[17] Quarterly interest rates are constructed as period averages and are expressed as annual percentages. Real interest rates are defined as the nominal long term interest rate deflated by contemporaneous inflation as measured by annual percentage change in the GDP deflator.

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 positon 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.[18] 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.[19] The data are converted to euros, using the 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 1 provides stylized statistics for the 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. The log levels of money, 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). 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 sub-period distinction shows that especially average money, credit and real GDP growth rates experienced a substantial decrease from 1999–2008 to 2008–2013. Annual real money growth fell from an average of about 5 percent to approximately zero, while real credit growth declined on average from close to 7 to −1. Real GDP growth amounted to about 2,4 percent per year before 2008 and became negative (−0,6) thereafter. Changes in nominal and real interest rates and net foreign credit appear less dramatic, though for all three overall variation increases.

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 Figs. 1–3 for the central variables in our analysis. In Fig. 1, we graphically show the average annual growth rate of real money 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 Fig. 1 is that there is indeed substantial variation across countries and time. The band width is quite small in the early years of the sample and then widens to a difference of about 30 percent in 2007–2008 to decline somewhat in the second half of the period. In the first sub-period, the minimum growth rate is reasonably stable,[20] while the maximum moves around quite a lot. In the second sub-period both minimum, maximum and average growth rates fall, and the minimum rates becomes much less stable. Average money growth reaches a peak of 12% in 2007Q4, with the maximum growth rate across members above 30% and the minimum growth rate around 7%. Note that average real money growth moves roughly in line with real GDP growth.

Fig. 2 shows a corresponding picture for real credit. The main characteristics in terms of dynamics are similar to those of money growth, reflecting the close relation between money and credit.[21] Note though that there are also differences in their respective time paths. Private credit growth reaches a cross-country maximum rate of about 30 percent in the first quarter of 2006, preceding the peak in money growth. At that time, the minimum growth rate was about zero and the average 10 percent. As for money, growth rates decline substantially afterwards with some countries experiencing significantly negative credit growth.

Finally, Fig. 3 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 and 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 quickly deteriorates 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 et al., 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 test 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 monetary aggregates, 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 three variables. For the nominal and real long term interest rate and net foreign credit the time trend is excluded. Table 2 contains the results for the total period 1999–2013. Overall, the three methods arrive at the same assessment with respect to non-stationarity. For the level series, the null hypothesis of a unit root is never rejected except for the case of the real interest rate using the Fisher (PP) test. When we apply panel unit root tests to first differenced variables, the null hypothesis is consistently

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[17] Over the sample period, the use of the long rate does also have the advantage of not facing the zero lower bound problem.

[18] 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.

[19] 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.

[20] The Irish M3 series has a level shift in 2003 which we corrected manually prior to the analysis.

[21] Private credit is the main counterpart of monetary aggregates in the bank balance sheet.

Table 1
Descriptive data.

Panel A 1999Q1-2013Q3

Var.	Level						First differenced					
	unit	Obs.	Mean	Std.	Min	Max	unit	Obs.	Mean	Std.	Min	Max
m	Real monetary aggregate, logarithm	590	8.32	1.01	6.53	9.94	% per quarter	580	0.88	2.04	−7.30	15.37
c	Real private credit, logarithm	590	8.41	1.03	6.34	10.05	% per quarter	580	0.97	2.28	−8.43	14.17
y	Real GDP, logarithm	590	11.71	1.00	10.29	13.35	% per quarter	580	0.35	1.11	−5.46	6.00
R	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
RR	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
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 monetary aggregate, logarithm	380	8.21	1.01	6.53	9.85	% per quarter	370	1.38	1.80	−5.81	9.18
c	Real private credit, logarithm	380	8.31	1.05	6.34	10.05	% per quarter	370	1.71	2.11	−3.85	14.17
y	Real GDP, logarithm	380	11.68	1.01	10.29	13.32	% per quarter	370	0.63	0.92	−5.10	6.00
R	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
RR	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
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 monetary aggregate, logarithm	210	8.52	0.98	7.06	9.94	% per quarter	210	0.00	2.15	−7.30	15.37
c	Real private credit, logarithm	210	8.59	0.98	7.26	9.98	% per quarter	210	−0.33	1.97	−8.43	5.71
y	Real GDP, logarithm	210	11.76	1.00	10.51	13.35	% per quarter	210	−0.15	1.23	−5.46	3.89
R	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
RR	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
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
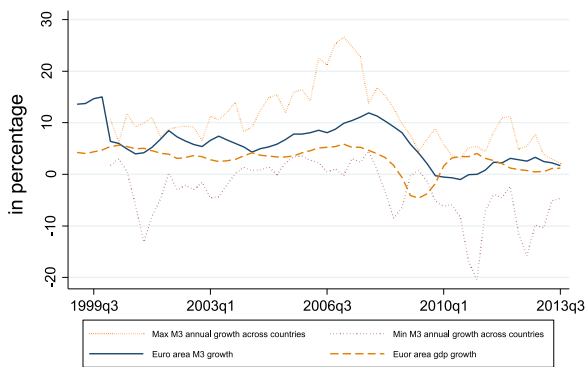
Fig. 1. Monetary annual growth rate. Data source: ECB statistics, growth rates are own calculation. Sample period: 1999q1-2013q3.
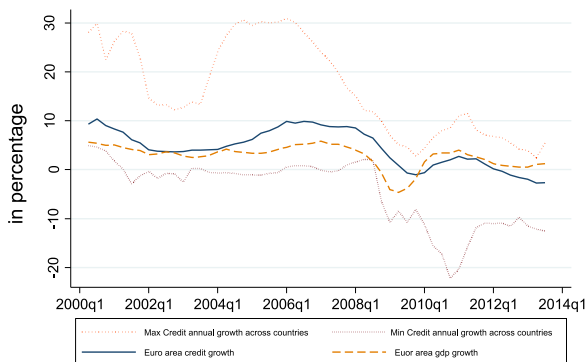

Fig. 2. Private Credit growth rate. Data source: ECB statistics, growth rates are own calculation. Sample period: 1999q1-2013q3.
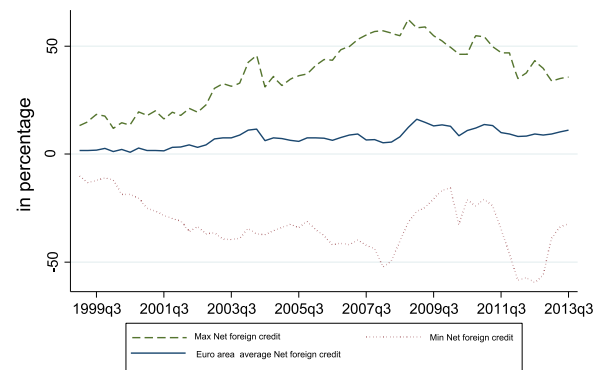

Fig. 3. Net foreign credit. Note:Here net positon is scaled by annual nominal GDP. Data source: BIS locational bank statistics, net position is own calculation.

rejected. Therefore, we conclude that the five variables are integrated at order one, i.e. I(1).

5. Empirical analysis

In Section 5.1 we investigate whether long-run equilibrium relations exist for money and credit respectively, based on the specifications in Eqs. (2) and (5). We estimate these equations using quarterly data for the total period 1999–2013 and the two sub-periods 1999–2008, ending just before the default of Lehmann Brothers in October 2008, and 2008–2013, and provide a brief discussion. Subsequently, we use the results to address three core issues in Section 5.2. 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?

Table 2
Panel unit root test.

	$\bar{m}$	$\bar{c}$	$\bar{y}$	$\bar{R}$	$\overline{RR}$	$\overline{NFC}$
IPS	3.86(0.99)	4.72(1.00)	2.10(0.98)	1.95(0.97)	0.25(0.60)	−1.31(0.10)
ADF	−2.45(0.99)	−2.22(0.99)	−1.84(0.97)	−0.83(0.80)	−1.81(0.96)	0.61(0.27)
PP	−2.86(0.99)	2.49(0.99)	−1.69(0.95)	−1.64(0.95)	1.19(0.11)	0.52(0.30)
LLC	1.85(0.97)	0.84(0.80)	−0.41(0.34)	2.03(0.98)	2.31(0.99)	−1.30(0.10)
IPS	−11.00(0.00)	−10.28(0.00)	−4.82(0.00)	−9.90(0.00)	−21.41(0.00)	−18.26(0.00)
ADF	2.96(0.01)	2.66(0.00)	8.03(0.00)	9.30(0.00)	21.64(0.00)	9.77(0.00)
PP	38.30(0.00)	49.42(0.00)	31.42(0.00)	31.44(0.00)	101.32(0.00)	74.96(0.00)
LLC	−6.90(0.00)	−7.56(0.00)	−14.75(0.00)	−6.47(0.00)	2.05(0.99)	−19.17(0.00)

NOTE:
a. The bar above denotes that the variables are demeaned by cross-country average.
b. For the unit root test on M3, Credit and GDP, a time trend is included since we can observe a trend over the sample period.
c. The null hypothesis of IPS, FISHER and LLC is that all panels contain a unit root, the alternative hypothesis is that some panels are stationary.

5.1. Long-run equilibrium relations for money and credit

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 3 provides the results for both money and credit. The money equation always contains real GDP and the nominal long-term bond yield, while net foreign credit is either included or excluded (denoted by Y/N in the table). For credit, real GDP and the real long-term bond yield are always included, while net foreign credit is either included or excluded (denoted by Y/N in the table). We do the co-integration test both for the full period 1999–2013 and the two sub periods. The null hypothesis of no co-integration is always strongly rejected both for money and credit when the full period is considered, regardless of the inclusion of net foreign credit. In the first sub period, the null hypothesis is rejected for money with or without net foreign credit, but for credit only when net foreign credit is included. The latter finding is consistent with the intuition that net foreign credit is more important for credit dynamics than money dynamics. In the second period, the null cannot be rejected in almost all cases. 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.

We use the Kao and Chang (1999) DOLS approach to estimate the following panel equation[22]:

$$y_{it} = \alpha_i + \beta x_{it} + \sum_{j=-q_1}^{q_2} \gamma_{it} \Delta x_{it+j} + v_{it} \tag{6}$$

where y is either real money or real credit and x is the vector of other variables (real GDP, the nominal or real interest rate and net foreign credit). Our preferred co-integrating regression typically includes one lag and one lead, i.e. DOLS(1,1).[23]

Table 4 contains the results for money. We do the panel co-integration estimation for the full period 1999Q1-2013Q3 as well as the sub periods 1999Q1-2008Q3 and 2008Q4-2013Q3, with net foreign credit either included or excluded. A number of points stand out. First, the income elasticity is always close to and slightly below one and very significant. Second, the interest coefficient is significantly positive for the full period, but negative in the first sub period and positive in the second one. Third, the effect of net foreign credit is significantly negative over the full period, as well as the first sub period, but significantly positive in the period after 2008. The inclusion of net credit has no significant effect on the other coefficients. In general, the first period results are in line with theory and earlier empirical research.

Monetary theory suggests 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.

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

Table 3
Panel co-integration test.

Time span	$\overline{NFC}$	Group PP	Group ADF
Panel A: dependent variable– the (log of)Real M3			
1999Q1-2013Q3	N	2.91(0.00)	−2.57(0.01)
	Y	−2.55(0.01)	−2.00(0.02)
1999Q1-2008Q2	N	−3.28(0.00)	−2.29(0.01)
	Y	−3.95(0.00)	−2.48(0.00)
2008Q3-2013Q3	N	0.79(0.79)	−2.70(0.00)
	Y	0.42(0.66)	−1.92(0.28)
Panel B: dependent variable– the (log of)Real Credit			
1999Q1-2013Q3	N	−1.71(0.04)	−1.50(0.07)
	Y	−2.40(0.01)	−2.09(0.02)
1999Q1-2008Q2	N	−0.94(0.17)	−0.02(0.49)
	Y	−2.91(0.00)	−2.76(0.01)
2008Q3-2013Q3	N	0.54(0.71)	−0.82(0.21)
	Y	−0.08(0.47)	−0.24(0.41)

Note: Group PP and Group ADF refers to Pedroni (1999) panel co-integration test. The group tests are for null of no co-integration amongst a multivariate vector. Tests are performed with automatic lag selection criterion SIC.

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[22] For details on the properties of the DOLS estimator we refer to Kao and Chiang (1999) and Phillips and Moon (1999).
[23] The estimation results change little when using default DOLS(2,1) as a robustness check.

Table 4
Results of monetary aggregates panel co-integration.

Period	1999Q1-2013Q3		1999Q1-2008Q3		2008Q4-2013Q3		1999Q1-2013Q3	
Real GDP ($\bar{y}$)	0.985*** [0.273]	0.989*** [0.265]	0.984*** [0.361]	0.997*** [0.340]	0.981*** [0.321]	0.972*** [0.314]	0.985*** [0.273]	0.991*** [0.263]
Nominal interest rate ($\bar{R}$)	0.018*** [0.006]	0.018*** [0.006]	−0.042 [0.038]	−0.167*** [0.036]	0.019*** [0.004]	0.014*** [0.004]	−0.013 [0.035]	−0.172*** [0.033]
Nominal interest rate ($\bar{R}$)*DUM							0.031 [0.035]	0.191*** [0.033]
Net foreign credit ($\overline{NFC}$)		−0.001** [0.000]		−0.003*** [0.000]		0.002*** [0.000]		−0.003*** [0.000]
Net foreign credit $\overline{NFC}$*DUM								0.004*** [0.000]
Obs.	590		380		210		590	
WaldChi2	19.23	24.56	9.25	60.15	27.31	61.61	19.65	160.06
Prob.	(0.000)	(0.000)	(0.01)	(0.000)	(0.000)	(0.000)	(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.

et al. (2011) use the short term interest rate and only find insignificant effects. None of these studies uses net foreign credit as an explanatory variable. In short, our first period results also are in line with the literature.

Obviously, the second period results show significant sign changes in the coefficients of net foreign credit and the nominal interest rate. This suggests a change in the relation around the time of the 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, the effects of bank fragility on loan supply, new rules for microprudential and macroprudential regulation and the start of unconventional monetary policies by the ECB may have played a role.

To capture the change directly, we again estimate the relation over the full period but include a time dummy that is one from 2008Q4 onward and zero before as well as interaction effects of the nominal interest rate and net foreign credit with this dummy. The results of this estimation – the insignificant dummy coefficient remains unreported – confirm the shift in coefficient signs found in the sub period regressions. The Wald test rejects the presence of non-linearities.

Table 5 has the same layout as Table 4 and contains 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 both for the whole sample and each sub period. It supports earlier evidence by Lane and McQuade (2014) and Unger (2016) 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 to make inferences on the direction of causality. Finally, we find a significantly negative interest coefficient in the first sub period, but a significantly positive one in the second period and the whole period, respectively. Our discussion in Section 3 showed that the sign of the interest rate effect ultimately depends on the shocks hitting the credit market. It is quite obvious that the great 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. The last two columns of Table 5 again directly capture the break using the same dummy as in the money demand equation. It supports the finding of a break in the interest rate coefficient and no break in the net foreign credit coefficient.

Overall, it is important to point out the close correspondence between the trend dynamics of money and credit in the euro area as

Table 5
Results of credit panel co-integration.

Period	1999Q1-2013Q3		1999Q1-2008Q3		2008Q4-2013Q3		1999Q1-2013Q3	
Real GDP ($\bar{y}$)	0.978*** [0.423]	1.008*** [0.315]	1.000*** [0.443]	1.029*** [0.348]	0.998 [0.695]	1.014* [0.525]	0.995** [0.418]	1.021*** [0.312]
Real interest rate ($\overline{RR}$)	0.039*** [0.005]	0.045*** [0.004]	−0.035*** [0.007]	−0.015*** [0.005]	0.066*** [0.006]	0.068*** [0.004]	−0.031*** [0.008]	−0.013*** [0.006]
Real interest rate ($\overline{RR}$)*DUM							0.101*** [0.009]	0.085*** [0.007]
Net foreign credit ($\overline{NFC}$)		−0.006*** [0.000]		−0.006*** [0.000]		−0.004*** [0.000]		−0.004*** [0.000]
Obs.	590		380		210		590	
WaldChi2	62.76	288.13	35.15	108.76	137.63	245.02	169.46	321.38
Prob.	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(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.
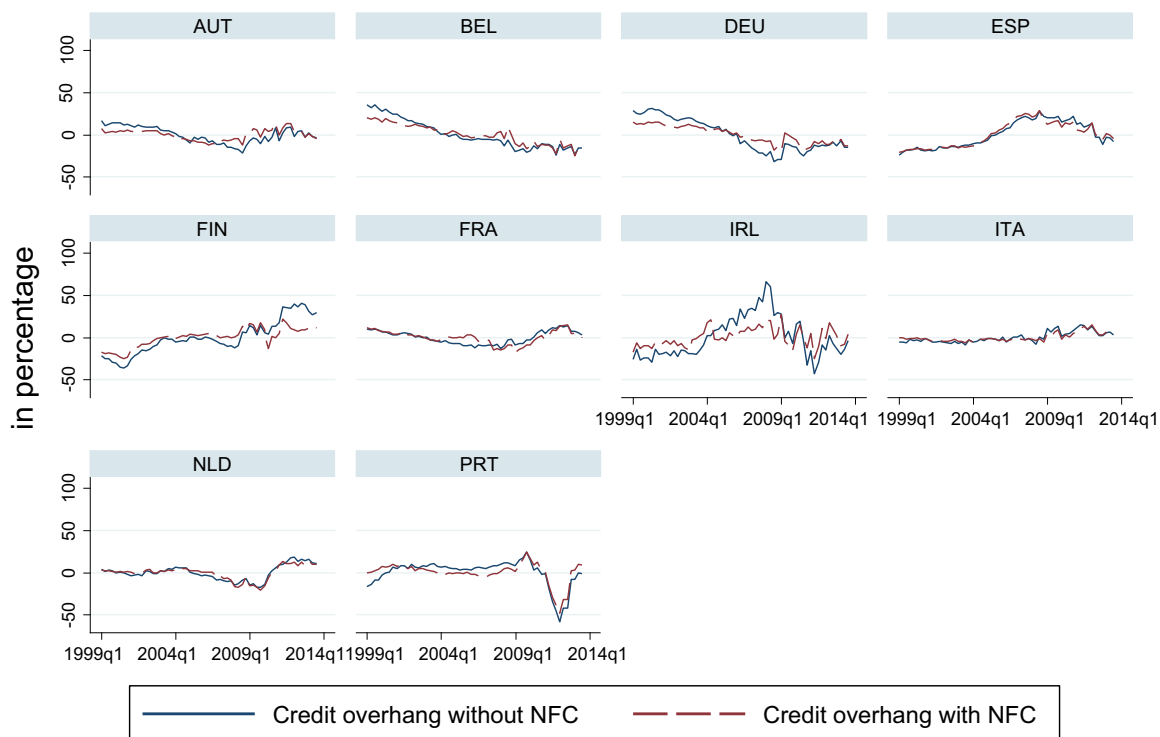
Fig. 4. Credit overhang with and without NFC. Both are with dummy. The overhang(s) are re-scaled to average zero over the sample period.

a whole. Both are close to proportionally related to the development of real GDP. In addition, both respond to in the same way to interest rate development and net foreign credit, though with differing sensitivities. In that sense, our estimation supports the joint trend movement of money and credit.

5.2. 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. We are particularly interested in three issues. First, the degree to what extent 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. 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 3.

Fig. 4 for each country shows the computed credit overhang for the full sample based on the estimations including the dummy and with and without net foreign credit respectively, corresponding to the last two columns of Table 5. A few things stand out. First, as hypothesized, credit overhang – when net foreign credit is excluded - rises and reaches substantial 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 too low credit levels compared to the equilibrium.[24] For Italy, credit overhang is close to zero in this period. This evidence 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 distinction

between North and South is also demonstrated in Table 6, 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).

Turning to the potential role of net foreign credit, we compare the timepath of the computed overhang for the specifications including and excluding net foreign credit for each country. Fig. 4 shows that the inclusion of net foreign credit in general reduces the estimated overhang, compared to the overhang when net foreign credit is excluded.The effect is strongest in Ireland and Portugal, but also visible for most of the Northern countries. Exceptions are Spain and the Netherlands. Overall, it provides evidence of a clear link between domestic credit growth and net foreign credit as hypothesized: countries with a strong positive credit overhang tend to borrow substantially from abroad, while countries with negative credit overhang tend to be net international lenders. No conclusions on causality can be drawn.

A similar analysis for money overhang shows first, that in most countries money overhang is close to zero prior to the crisis, and second, that the difference between overhang with and without net foreign credit is relatively small. Ireland is the exception. It shows a substantial increase in money overhang in the run-up to 2008, a non-negligible part of which is captured by the net foreign credit variable. Bilateral correlation coefficients for money overhang in pairs of countries show less of a North-South pattern than credit correlations.[25]

To analyze the relation between credit overhang and money overhang per country, we first present graphical evidence in Fig. 5. For the comparison, we use the 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

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

[25] To save space, we do not report the money overhang figure corresponding to Fig. 4 and correlation table corresponding to Table 6. However, they are available from the authors on request.

Table 6
Correlation of credit overhang (without NFC).

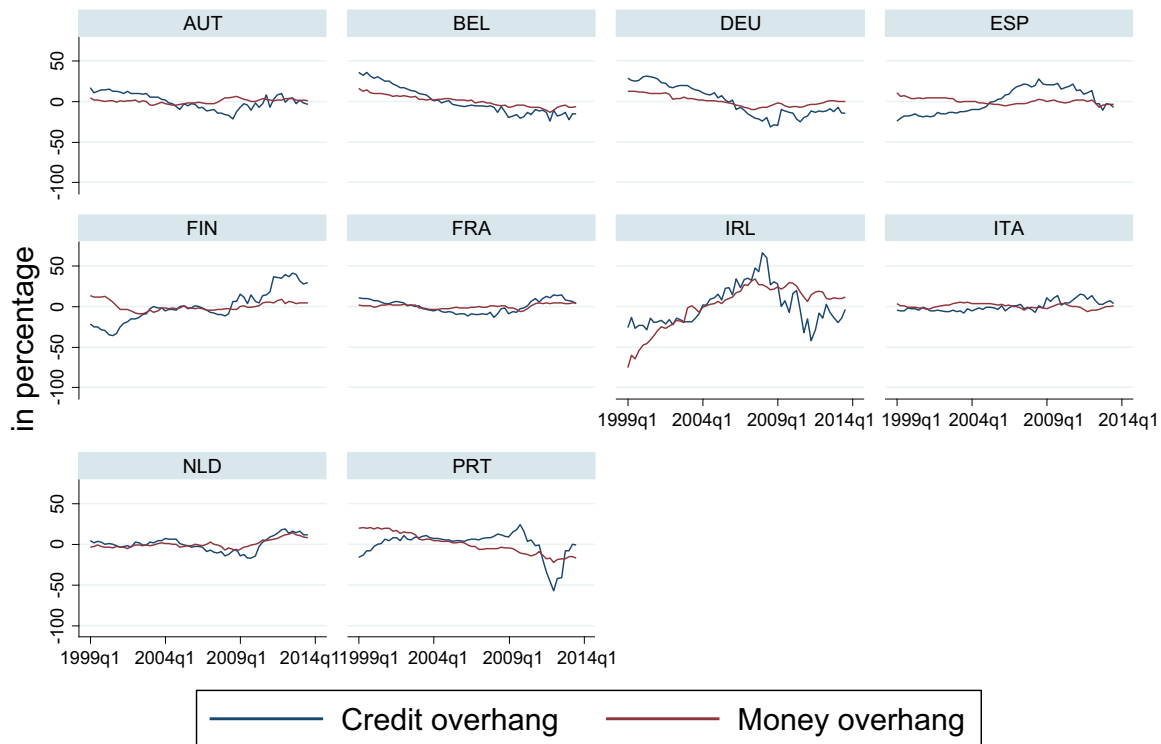|	AUT	BEL	DEU	ESP	FIN	FRA	IRL	ITA	NLD	PRT
AUT	1.00									
BEL	0.68**	1.00								
DEU	0.80**	0.89**	1.00							
ESP	−0.78**	−0.78**	−0.91**	1.00						
FIN	−0.31**	−0.83**	−0.67**	0.46**	1.00					
FRA	0.69**	0.25	0.28**	−0.39**	0.23	1.00				
IRL	−0.84**	−0.43**	−0.59**	0.60**	−0.02	−0.79**	1.00			
ITA	−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 significance at 5% level.

Fig. 5. Credit and monetary overhang with dummy excluding NFC. The overhang(s) are re-scaled to average zero over the sample period.

Table 7
Correlation between money and credit overhang (without NFC).

	$\rho(ohm, ohc)$	$\rho(\Delta ohm, \Delta ohc)$	$\rho(\Delta 5ohm, \Delta 5ohc)$
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 significance at 5% level.

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 credit overhang. Table 7 contains additional evidence in the form of bilateral correlations between the two.[26] 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, correla-

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

tions 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.

6. 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. We employ a panel co-integration approach to estimate equilibrium relation for money and credit respectively allowing us to exploit heterogeneity across countries. In the estimation, we assume a common long run relation, but heterogeneous dynamics across countries. Variables are time-demeaned to reduce cross-sectional dependence issues and omitted variables bias.

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 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.

To determine the degree of excess money and credit, we start with estimating equilibrium relations for money and credit for the whole period 1999–2013 and two sub periods. Explanatory variables are real GDP, the (nominal or real) interest rate and net foreign credit. Both for money and credit, the evidence suggests structural changes have taken place in the long run relations around the 2008 financial crisis. The impact of the financial crisis has many dimensions. Potential factors behind the structural change in long run money and credit dynamics include the divergence in sovereign bond yields due to default risk premiums, the effects of bank fragility on loan supply, new rules for micro-prudential and macro-prudential regulation and the start of unconventional monetary policies by the ECB.

Taking into account the estimated structural change in 2008, we find evidence of a long-run relation between real money, real GDP, the long-term nominal interest and net foreign credit. Similarly, we find evidence of a long-run relation between real credit, real GDP, the real interest rate and net foreign credit. Overall trend money and credit show a strong co-movement. They exhibit almost equal sensitivities to GDP and move in the same direction – though with different size – when interest rates or net foreign credit change.

Subsequently, we compute money and credit overhang measures. Using these, we first show that indeed 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 the inclusion of net foreign credit as an explanatory variables typically reduces the credit overhang measure, driving it closer to zero. This holds both for countries with negative and positive overhang. 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, expect Ireland. For Ireland the build-up of money and credit overhang seems to go together. Credit overhang dynamics are much more pronounced than that of money. The role of net foreign credit in money overhang estimates is also 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.

References

Avouyi-Dovi, S., Drumetz, F., Sahuc, J.G., 2012. The money demand function for the euro area: some empirical evidence. Bull. Econ. Res. 64 (3), 377–392.

Bernanke, B., Blinder, A., 1988. Credit, money, and aggregate demand. Am. Econ. Rev. 78 (2), 435–439 , (Retrieved from)⟨http://www.jstor.org/stable/1818164⟩.

Bezemer, D.J., Zhang, L., 2014. From Boom to Bust in the Credit Cycle: The Role of Mortgage Credit. University of Groningen, Faculty of Economics and Business.

Borio, C., 2014. The financial cycle and macroeconomics. What have we Learnt? J. Bank. Financ. 45, 182–198.

Borio, C., Disyatat, P., 2011. Global imbalances and the financial crisis: Link or no link? BIS Working Paper No. 346.

Brand, C., Cassola, N., 2004. A money demand system for euro area M3. Appl. Econ. 36 (8), 817–838.

Calza, A., Gerdesmeier, D., Levy, J., 2001. Euro area money demand measuring the opportunity costs appropriately.IMF Working Paper No.01/179.

Calza, A., Gartner, C., Sousa, J., 2003. Modelling the demand for loans to the private sector in the euro area. Appl. Econ. 35 (1), 107–117.

Calza, A., Manrique, M., Sousa, J., 2006. Credit in the euro area: an empirical investigation using aggregate data. Q. Rev. Econ. Financ. 46 (2), 211–226.

Carstensen, K., 2006. Stock market downswing and the stability of european monetary union money demand. J. Bus. Econ. Stat. 24 (4), 395–402.

Carstensen, K., Hagen, J., Hossfeld, O., Neaves, A.S., 2009. Money demand stability and inflation prediction in the four largest EMU countries. Scott. J. Political Econ. 56 (1), 73–93.

Choi, I., 2001. Unit root tests for panel data. J. Int. Money Financ. 20 (2), 249–272.

Coenen, G., Vega, J.L., 2001. The demand for M3 in the euro area. J. Appl. Econ. 16 (6), 727–748.

De Santis, R.A., Favero, C.A., Roffia, B., 2013. Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability. J. Int. Money Financ. 32, 377–404.

Dedola, L., Gaiotti, E. Silipo, L., 2001. Money Demand in the Euro Area: Do National Differences Matter?. Banca d'Italia working paper no 405.

Dreger, C., Wolters, J., 2010. M3 money demand and excess liquidity in the euro area. Public Choice 144 (3–4), 459–472.

Dreger, C., Wolters, J., 2014. Money demand and the role of monetary indicators in forecasting euro area inflation. Int. J. Forecast. 30 (2), 303–312.

Ericsson, N.R., 1998. Empirical modeling of money demand. Empir. Econ. 23 (3), 295–315.

Goodhart, C., Hofmann, B., 2008. House prices, money, credit, and the macroeconomy. Oxf. Rev. Econ. Policy 24 (1), 180–205.

Gutierrez, L., 2003. On the power of panel cointegration tests: a Monte Carlo

comparison. Econ. Lett. 80 (1), 105−111.

Hofmann, B., 2004. The determinants of bank credit in industrialized countries: do property prices matter? Int. Financ. 7 (2), 203−234.

Im, K.S., Pesaran, M.H., Shin, Y., 2003. Testing for unit roots in heterogeneous panels. J. Econ. 115 (1), 53−74.

Jordà, Ò., Schularick, M., Taylor, A.M., 2016. Sovereigns versus banks: credit, crises, and consequences. J. Eur. Econ. Assoc. 14 (1), 45−79.

Kao, C., 1999. Spurious regression and residual-based tests for cointegration in panel data. J. Econ. 90 (1), 1−44.

Kao, C., Chiang, M.H., 1999. On the estimation and inference of a cointegrated regression in panel data. Available at SSRN 1807931,

Kiyotaki, N., Moore, J., 1997. Credit cycles. J. Political Econ. 105 (2), 211−248.

Kool, C.J., Regt, E.D., Van Veen, T., 2013. Money overhang, credit overhang and financial imbalances in the euro area. CESifo Working Paper Series No. 4476.

Laidler, D., 1984. The "Buffer Stock" notion in monetary economics. Econ. J. 94 (Suppl.), S17−S33.

Lane, P.R., McQuade, P., 2014. Domestic credit growth and international capital flows. Scand. J. Econ. 116 (1), 218−252.

Levin, A., Lin, C., Chu, C.S.J., 2002. Unit root tests in panel data: asymptotic and finite-sample properties. J. Econ. 108 (1), 1−24.

Mark, N.C., Sul, D., 2003. Cointegration vector estimation by panel DOLS and long-run money demand. Oxf. Bull. Econ. Stat. 65 (5), 655−680.

Masuch, K., Pill, H., Willeke, C., 2001. Framework and tools of monetary analysis. Monet. Anal.: Tools Appl., 117.

McLeay, M., Radla, A., Thomas, R., 2014. Money creation in the modern economy. Bank Engl. Q. Bull. Q1, 14−27.

Nautz, D., Rondorf, U., 2011. The (in) stability of money demand in the euro area: lessons from a cross-country analysis. Empirica 38 (4), 539−553.

Pedroni, P., 1999. Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxf. Bull. Econ. Stat. 61 (s1), 653−670.

Pedroni, P., 2000. Fully Modified OLS for Heterogeneous Cointegrated Panels. Nonstationary Panels Panel Cointegration and Dynamic Panels, Advances in Econometrics 15. JAI Press, 93−130.

Pedroni, P., 2001. Purchasing power parity tests in cointegrated panels. Rev. Econ. Stat. 83 (4), 727−731.

Pedroni, P., 2004. Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Econ. Theory 20 (03), 597−625.

Phillips, P.C., Moon, H.R., 1999. Linear regression limit theory for nonstationary panel data. Econometrica 67 (5), 1057−1111.

Schularick, M., Taylor, A.M., 2012. Credit booms gone bust: monetary policy, leverage cycles, and financial crises, 1870−2008. Am. Econ. Rev. 102 (2), 1029−1061.

Setzer, R., Wolff, G.B., 2013. Money demand in the euro area: new insights from disaggregated data. Int. Econ. Econ. Policy 10 (2), 297−315.

Setzer, R., Van den Noord, P., Wolff, G.B., 2011. Heterogeneity in money holdings across euro area countries: the role of housing. Eur. J. Political Econ. 27 (4), 764−780.

Stock, J.H., Watson, M.W., 1993. A simple estimator of cointegrating vectors in higher order integrated systems. Econ.: J. Econ. Soc., 783−820.

Unger, R., 2016. Asymmetric credit growth and current account imbalances in the Euro Area. No.166, FIW−Working Paper, FIW.