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Credit cycle coherence in the eurozone: Was there a euro effect? ☆

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ABSTRACT

This paper examines effects of the euro introduction on credit cycle coherence in the eurozone through six channels. We construct and describe credit cycles for total bank credit, household mortgages and non-financial business loans for 16 EMU economies over 1990–2015. Credit cycle coherence is measured by synchronicity of cycle movements and similarity of their amplitudes. We find that the effect of euro introduction runs through elimination of currency risk and higher capital flows, which decrease coherence of total credit and mortgage credit cycles, but increase coherence of business credit cycles. Falling interest rates contribute to the convergence of total and mortgage credit cycles. Financial deregulation and legal harmonization are associated with lower coherence of all credit cycles, while trade openness has the opposite impact. The findings impinge on monetary policy effectiveness in the eurozone, with implications for macroprudential policy.

1. Introduction

The 2007 crisis and its aftermath sparked a revival of interest in credit cycles. Credit is 'back from the wilderness' (Borio and Lowe, 2004) and the credit (or financial) cycle was rediscovered (Borio, 2014). It is now broadly recognized that credit cycles may account for differences in growth and stability, and in policy impacts across countries, just as business cycle coherence matters to differences in policy effectiveness. Cycle coherence is especially relevant in the EMU with its common monetary policy, and many authors studied drivers of the eurozone business cycle coherence. In this paper we ask the same question for credit cycles. Did the euro introduction promote credit cycle convergence across the EMU? What are the channels through which a euro effect is transmitted? No one analyzed these questions to date, as far as we are aware.

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We recognize that credit is not homogeneous. There are large differences within and across countries in the growth of household mortgage credit and business credit and in their macroeconomic effects. In a balanced panel of 14 countries from 1990 to 2012 Bezemer et al. (2016) find an increase in mortgage loans as a percentage of total bank loans from 20% to 50% (see also Jorda et al., 2016). This change in credit allocation has implications for growth and stability. It may also impinge on monetary policy effectiveness, which depends on credit market conditions (Bernanke and Gertler, 1995)—a concern that is especially relevant in the context of the single monetary policy.

In our empirical work we therefore define credit cycles for 16 EMU economies over 1990–2015 based on band-pass filters (Drehmann et al., 2012), for total bank credit but also for household mortgages and non-financial business loans separately. These are the two most important credit categories, jointly accounting for over 77% of the total stock of bank credit in our sample in 2015.

Following the methodology of Mink et al. (2012), for each credit aggregate we construct two measures for credit cycle coherence: in terms of synchronicity (do credit cycles move in the same direction?) and similarity (do credit cycles have similar amplitudes?). We then ask if the euro introduction increased credit cycle coherence, and analyze the question using ordered probit and tobit models. We account for several channels of the euro introduction effect. We find that the effect of euro introduction runs through elimination of currency risk and higher capital flows, which decrease coherence of total credit and mortgage credit cycles, but increase coherence of business credit cycles. Falling interest rates contribute to the convergence of total and mortgage credit cycles. Financial deregulation and legal harmonization are associated with lower coherence of all credit cycles, while trade openness has the opposite impact. We undertake extensive robustness analyses, studying the pre-crisis period as distinct from the 1990–2015 sample; 8 non-EMU economies as distinct from 16 EMU countries; and cycles based on real credit as distinct from credit/GDP ratios. The findings underline the importance of differentiating between credit types in understanding credit cycles, and differentiating between the channels of euro introduction effect.

The next section discusses motivations for the present paper, exploring the linkages between credit cycles, credit composition, and monetary union. In Section 3 we construct credit cycles and coherence measures, and in Section 4 we explore data trends. Section 5 presents the empirical analysis of the channels through which EMU membership might have affected credit cycle coherence. Section 6 concludes with a summary and reflection on the findings and their policy relevance.

2. Credit cycles, credit composition and common currency areas

A key motivation for our paper is that common-currency benefits are larger if member states show larger similarity in their macroeconomic shocks and in their (business) cycles, as the theory of optimum currency areas (OCA) indicates (Mundell, 1961; Frankel and Rose, 1998). This has sparked an extensive literature on business cycle convergence within the European Economic and Monetary Union (EMU). Some studies find evidence for increased correlation of business cycles within the EMU, particularly after euro adoption (Crespo-Cuaresma and Fernández-Amador, 2013; Enders et al., 2013; Gächter and Riedl, 2014), others report weak output coherence with no effects of the euro changeover (Giannone et al., 2008; Canova et al., 2012; Mink et al., 2012). In addition, business cycles have de-synchronized since the onset of the global financial crisis (Gächter et al., 2012). Did the euro increase or decrease coherence of cycles within the EMU?[1] In the present paper we ask the same question for credit cycles in the euro area.

The question is innovative; we are not aware of previous studies of the euro's effect on credit cycle coherence. Research interest in EMU financial or credit cycles is still scant (Aikman et al., 2015), a deficit which may have theoretical reasons. A currency union implies financial integration (e.g., Ingram, 1969; Mundell, 1973; Rose and Engel, 2002), but OCA theory is silent on financial optimality conditions.[2] This literature motivates the study of financial and credit market conditions in the eurozone.

And yet there is a natural motivation to focus on credit conditions in OCA. Its theoretical emphasis on shocks puts credit markets center stage in understanding the optimality of monetary union. Credit may amplify or even originate shocks, as in Kiyotaki and Moore (1997), Brunnermeier and Sannikov (2014), Boissay et al. (2016), or in Minsky's 'Financial Instability Hypothesis' (Minsky, 1978). Monetary policy shocks may affect bank capital and lending (e.g., Kishan and Opiela, 2000; Stein and Kashyap, 2000; Mishkin, 2001; Ashcraft, 2006). All this suggests that in addition to well-known factors such as capital flows (Lane, 2006), international portfolio diversification (McKinnon, 2002) and integration of financial markets (Baele et al., 2004; Kim et al., 2005), the coherence of credit cycles in the EMU is important to stability threats and monetary policy effects in the common currency area.

Mortgages, which connect credit markets and real estate asset markets, take on particular relevance in this context – especially given their abundant growth in recent years. Asset market shocks may have real effects through the bank lending channel, by changing banks' balance sheet strength and risk perception, as well as borrowers' net worth and willingness to borrow (Black et al., 2010; Davis and Zhu, 2009; Disyatat, 2011; Jiménez et al., 2012). The literature finds that household

[1] See e.g., De Haan et al. (2008) for a survey of studies on business cycle convergence in EMU.

[2] This neglect in OCA theory of credit was criticized by Goodhart (1998), who argues that it leads to the neglect of the sustainability of debt structures and of political underpinnings of a viable currency union. Others argue that OCA theory should include optimality conditions on capital flows and integrated credit markets, in analogy to optimality conditions on labor mobility (Priewe, 2007). Praet (2014) points to the possibility that financial factors may contribute to capital misallocation.

mortgage loans and business loans have fundamentally different impacts on growth and stability (Werner, 1997; Werner, 2012; Jappelli et al., 2013; Bezemer, 2014; Bezemer et al., 2016). While business credit tends to support stable growth, expansion of household mortgage loans depresses income growth (Barba and Pivetti, 2009; Sutherland et al., 2012; Jappelli et al., 2013), increases the probability of a financial crisis (Claessens et al., 2010; Cecchetti et al., 2011) and worsens its consequences in terms of output loss and recession duration (Lane and Milesi-Ferretti, 2011; Berkmen et al., 2012; Babecky et al., 2013; Beck et al., 2014).[3]

Differences between mortgage and business credit cycles matter to monetary policy impacts. 'Credit View' literature shows that the effectiveness of monetary policies depends on credit market conditions (Bernanke and Gertler, 1995). This is a motivation to understand if and how these conditions differ between both credit types. Another concern is that the effects of ECB monetary policy on aggregate bank lending are heterogeneous across euro area countries (Angeloni et al., 2002; De Santis and Surico, 2013), particularly during the global financial crisis (Cour-Thimann and Winkler, 2012). Also, different credit aggregates respond differently to policy shocks (Ciccarelli et al., 2013; Ciccarelli et al., 2015). Giannone et al. (2012) find that, during the crisis period, short-term loans to non-financial corporations behaved according to past regularities, but longer-term loans to the private sector—among which home mortgages—declined more than what would have been expected, given the observed path of real and nominal variables. By constructing separate credit cycles for both types we hope to shed more light on these different behaviors, with direct relevance to the effectiveness of monetary policies. If monetary policy effects differ according to the stage of the credit cycle, this might imply that optimal monetary policy must account for credit channel heterogeneity.[4]

In sum, the different growth rates of credit to firms and to households, their different impacts on growth and stability, and their different impacts on policy effectiveness all suggest that they are not well described in a common credit cycle. This motivates the construction of separate cycles for household mortgage credit and non-financial business credit.

3. Data and methodology

3.1. Empirical literature on credit cycles

We base our methodology on recent empirical work on credit cycles. In this literature, financial or credit cycles are defined as systematic variations in credit supply (Borio, 2014). Borio (2014) measures the financial cycle as the trend-corrected expansion and contraction in credit-to-GDP and property prices over time. Here financial cycles are much longer (around 16 years) and have a larger amplitude than business cycles; their peaks coincide with banking crises; they help to predict financial distress risk; and they are dependent on monetary policy regimes.

Drehmann et al. (2012) analyze credit and property cycles and compare the behavior of short-term cycles with medium-term cycles between 32 and 120 quarters (8–30 years). They find that the volatility of these medium-term credit cycles is larger than of short-term cycles. We located several other recent papers where credit or financial cycles are constructed (Igan et al., 2011; Hiebert et al., 2014; Meller and Metiu, 2015; Stremmel and Zsámboki, 2015; Aikman et al., 2015; Galati et al., 2016). The principal dimensions on which they differ are: their basis for credit cycle (credit-to-GDP or real credit in log); the method of cycle construction (band-pass filters or turning-point analysis); and the length of the cycle (between 7 and 25 years).

Of these papers, several also study credit cycle coherence. Meller and Metiu (2015) use concordance measures and clustering techniques to study non-financial sector credit cycle synchronization of 13 advanced economies. They find significant differences between countries, and group them in two clusters with distinct credit cycles. Galati et al. (2016) use an unobserved component time series model with state-space methods for US and 5 EMU states over 1970–2015. They identify heterogeneous cycles in credit-to-GDP gap between EMU countries of 8–25 years. Importantly, they note that total and bank credit cycles co-move strongly in the euro area, and have comparable length and amplitudes. This suggests that our focus on bank credit may capture wider dynamics.

Igan et al. (2011) examine synchronization of cycles in house prices, residential investment, bank credit, interest rates, and GDP within and across advanced countries over 1981–2006. They observe significant co-movement of cycles and strong effects of US-originated shocks and monetary policy shocks on business and house price cycles, both in all advanced economies and within the EU. Differences in cycles across countries are possibly due to the differences in trade openness, regulatory framework for the financial sector and mortgage market characteristics.

Stremmel and Zsámboki (2015) apply a band-pass filter to 7 indicators to construct a financial cycle indicator for 21 EU economies. They find that the best-fit financial cycle includes credit-to-GDP, house prices and credit growth. During stress periods, financial cycles are more similar, but in normal times there are large differences. This motivates us to undertake a robustness check in which we exclude from the analysis the post-2007 crisis years, when credit cycle coherence dramatically increased.

[3] This occurs through several channels. Mian and Sufi (2014) show that U.S. households with more mortgage debt reduced their spending more than others after 2007 (also, Mian and Sufi, 2009; Dynan, 2012). Banks holding more household mortgage loans on their books reduce lending to business more, and firms that borrow from these banks have significantly lower investment (Black et al., 2010; Jiménez et al., 2012; Chakraborty et al., 2016).

[4] In this context, Lambertini et al. (2013) suggest that both savers and borrowers are better off when the interest rate optimally responds to credit growth.

3.2. Data

We examine credit cycles in 16 EMU countries over the period 1990Q1–2015Q4, with quarterly data. The choice of the sample period is constrained by data availability on disaggregated credit. EMU countries include those 16 which adopted the euro before 2015.[5] We use a recently constructed dataset on domestic bank credit to the private sector, collected from central bank statistics on the consolidated balance sheets of monetary financial institutions. On the asset side of the balance sheet, loans are reported separately as mortgages to households, household consumption credit, credit to non-financial business, and credit to non-bank financial business. Household mortgages and loans to non-financial business are the two principal credit categories. We refer to Bezemer et al. (2017) for a detailed description of the dataset.[6]

3.3. Credit cycles construction

Adding to the studies mentioned above, we will examine credit cycles for household mortgages, non-financial business loans and total bank credit in the euro area. We follow the literature where credit cycles are based on credit as a ratio to GDP (e.g., Drehmann and Tsatsaronis, 2014; Galati et al., 2016). As a robustness check, we also construct cycles based on the logarithm of real (CPI-deflated) credit. Following Drehmann et al. (2012) we apply the band-pass filter of Christiano and Fitzgerald (2003) in order to isolate the component of each credit series which corresponds to a medium-term frequency.[7] We construct medium-term cycles in order to capture credit dynamics well. As the maximum length of time series observations in our sample is 26 years, we select frequencies between 32 and 104 quarters.

3.4. Measuring synchronicity and similarity of credit cycles

Previous studies use various methods to measure credit (or financial) cycle coherence, such as standard correlation coefficient of credit gaps (Aikman et al., 2015), dynamic correlations between cycles (Igan et al., 2011), and concordance index (Meller and Metiu, 2015). One limitation of these measures is that they conflate two dimensions of coherence—their comovement and their amplitudes (Gächter et al., 2012; Hiebert et al., 2014). In this paper, we follow the methodology proposed by Mink et al. (2012), developed for business cycles analysis, to measure separately *synchronicity* in movements of cycles and *similarity* of their amplitudes.

Let $c_i(t)$ denote the credit gap of country i in period t, where the credit gap is the deviation of credit-to-GDP from its trend (that is, its cyclical component). $c_r(t)$ is the reference credit gap at time t, defined as the median credit gap for all EMU countries in the sample.[8]

Synchronicity between the credit cycle of country i and the reference credit cycle at time t is defined as the product of country i and the reference credit gaps, divided by the absolute value of this product:

$$\eta_i(t) = \frac{c_i(t)c_r(t)}{|c_i(t)c_r(t)|}. \tag{1}$$

The synchronicity variable indicates that the credit cycle of country i moves in the same (1) or opposite (-1) direction as the reference cycle.

We then define credit cycle *similarity* as the difference in credit cycle amplitude between country i credit gap and the reference credit gap:

$$\theta_i(t) = 1 - \frac{|c_i(t) - c_r(t)|}{\frac{1}{n}\sum_{i=1}^{n}|c_i(t)|}. \tag{2}$$

Similarity is defined on a scale $[1-n, 1]$, where value 1 indicates that both credit cycles have identical amplitudes and are perfectly synchronized.

Below we explore synchronicity and similarity of total-credit cycles and of cycles for the two credit aggregates.

[5] Estonia, Malta, Slovakia, and Slovenia joined after 2006Q4. We will exclude them from the analysis in a robustness check. Lithuania joined only in 2015, therefore we do not treat it as an EMU member.

[6] The length of cycles we consider is dictated by data availability of disaggregated credit for enough countries since the 1990s. An alternative data source for disaggregated credit is the Bank for International Settlements (BIS) "long series on total credit". This offers series which are substantially longer than ours for a limited number of countries. In Appendix B, we construct cycles from the longer BIS series for 7 EMU countries since the 1970s and compare them to our cycles, in order to ensure that our cycle results are not driven by shorter time series. The resulting cycles are sufficiently similar to our cycles, for the years they have in common, to conclude that there are no serious concerns regarding bias due to sample selection. A drawback of the BIS data for our purposes is that household mortgage credit is not separately reported.

[7] Christiano and Fitzgerald (2003) provide an optimal finite sample linear approximation to the 'ideal band-pass filter' (i.e. one which given unlimited observations would remove all fluctuations outside the pass band but leaves fluctuations inside the pass band unaltered and does not affect the series in any other way). Compared to the commonly used Hodrick and Prescott (1997) filter, the Christiano and Fitzgerald filter extracts medium-term components from series by specifying the frequency range of interest and computes cyclical components for all observations, including those at the beginning and at the end of the data series.

[8] Using the median for calculating the EMU reference maximizes synchronicity and similarity measures (Mink et al., 2012).

4. Stylized facts and data trends

4.1. Credit cycles in the EMU

Fig. 1 shows credit cycles for total bank credit, non-financial business credit and household mortgage credit for 16 EMU economies over 1990–2015. Most countries experienced credit booms between 2003 and 2007, followed by a credit crunch during the global financial crisis. Although the timing of cycle phases was rather similar, amplitudes differ substantially from country to country.

There are clear differences between countries' total and disaggregated credit cycles in terms of magnitudes and fluctuations. In Belgium and Finland, mortgage cycles have a similar amplitude and move in the same direction as total credit cycles, while non-financial business credit cycles move in the opposite direction. The reverse is true for Italy, Malta, Slovakia and Slovenia where total and business credit cycles co-move closely, while mortgage cycles move in the opposite direction. Ireland and Spain have non-financial business credit cycles with larger amplitudes than mortgage cycles, whereas Estonia, France and Portugal have non-financial business credit cycles and mortgage cycles with similar amplitudes. All types of credit cycles co-move closely to each other in most countries in the eurozone periphery (Estonia, Spain, Ireland). Several core EMU economies had clearly dissimilar credit cycles in terms of their amplitudes.

4.2. Credit cycle synchronicity and similarity across countries

We proceed to examine coherence of credit cycles in EMU countries. Table 1 shows the means of synchronicity and similarity over 1990–2015 of total, non-financial business, and mortgage credit cycles across countries. We observe large differences in amplitudes ('similarity') of both cycles with the total-credit cycle.

We find low synchronicity of non-financial business credit cycles with the EMU cycle, while mortgage cycles are more synchronous in 8 countries. This could be due to the global housing boom in the 2000s, preceding the global financial crisis. EMU-average similarity is low, suggesting that amplitudes of all types of credit cycles are dissimilar.

There is large heterogeneity between countries in coherence of their credit cycles with the EMU reference cycle. Total-credit cycles in Luxembourg and Malta are most synchronized with the EMU cycle, while Germany and Belgium are the least. These observations support studies (Hiebert et al., 2014; Praet, 2014; Galati et al., 2016) which argue that financial cycles of individual countries within the euro area are still very heterogeneous.

Notably, synchronicity need not imply similarity. For instance, in Spain, Luxembourg, and Ireland total credit cycles move quite synchronously with the EMU reference cycle, but have very distinct amplitudes compared to the EMU cycle. This observation supports the view that it is helpful to examine synchronicity of cycles movements and similarity of their amplitudes separately.

5. Euro effects on credit cycle coherence

5.1. Model specification and data

In this section we examine possible channels of the euro introduction on credit cycle coherence. The analysis is conducted on quarterly data for 16 EMU countries over 1990Q1–2015Q4 (in a robustness check, we also limit the analysis to the pre-crisis period 1990Q1–2007Q3). One approach is to adopt a dummy variable for EMU entry, but a drawback is that this is indistinguishable from a pure time effect. Moreover, the impact of EMU membership might well be reflected not in a decision to adopt the euro, but in the institutional, legal, economic, and financial changes that it triggers. These changes could form the channels through which an euro adoption effect on credit cycle coherence runs, and observing them directly gets us closer to the actual effect. We therefore attempt to capture these channels.

Galati and Tsatsaronis (2001) study the impact of the euro introduction on markets for money, equity, bonds and foreign exchange. They note that EMU reduced transaction costs and increased cross-border activity, access to investors, and investment opportunities. The development of an EMU interbank market increased liquidity and financial market requirements were partly harmonized. The first two channels we consider are therefore currency risk and legal harmonization, as also used in studies on the euro effect by Kalemli-Ozcan et al. (2010) and Kalemli-Ozcan et al. (2013).

We measure currency risk by exchange rate regime data based on the classification of Reinhart and Rogoff (2004) and Ilzetzki et al. (2011). We use the "fine" classification ranging from 1 (hard peg) to 13 (freely floating exchange rate).[9] Lower values of the index indicate lower currency risk; value 1 indicates no currency risk.

Legal harmonization is proxied by the number of legislative reforms (directives) in financial services which a country adopted by period t, of all the 27 directives in the Financial Services Action Plan (FSAP), which ran until 2008. The information on exact dates of transposition of directives by each country is taken from Kalemli-Ozcan et al. (2010), and by additional data collection from the website of European Commission. The index is a simple count of directives and ranges between 1 and 27.[10]

[9] As a robustness check, we will use the "coarse" classification instead, ranging from 1 to 4.

[10] We do not include the post-FSAP directives as many countries have not yet adopted them and the information on exact transposition dates is not available.

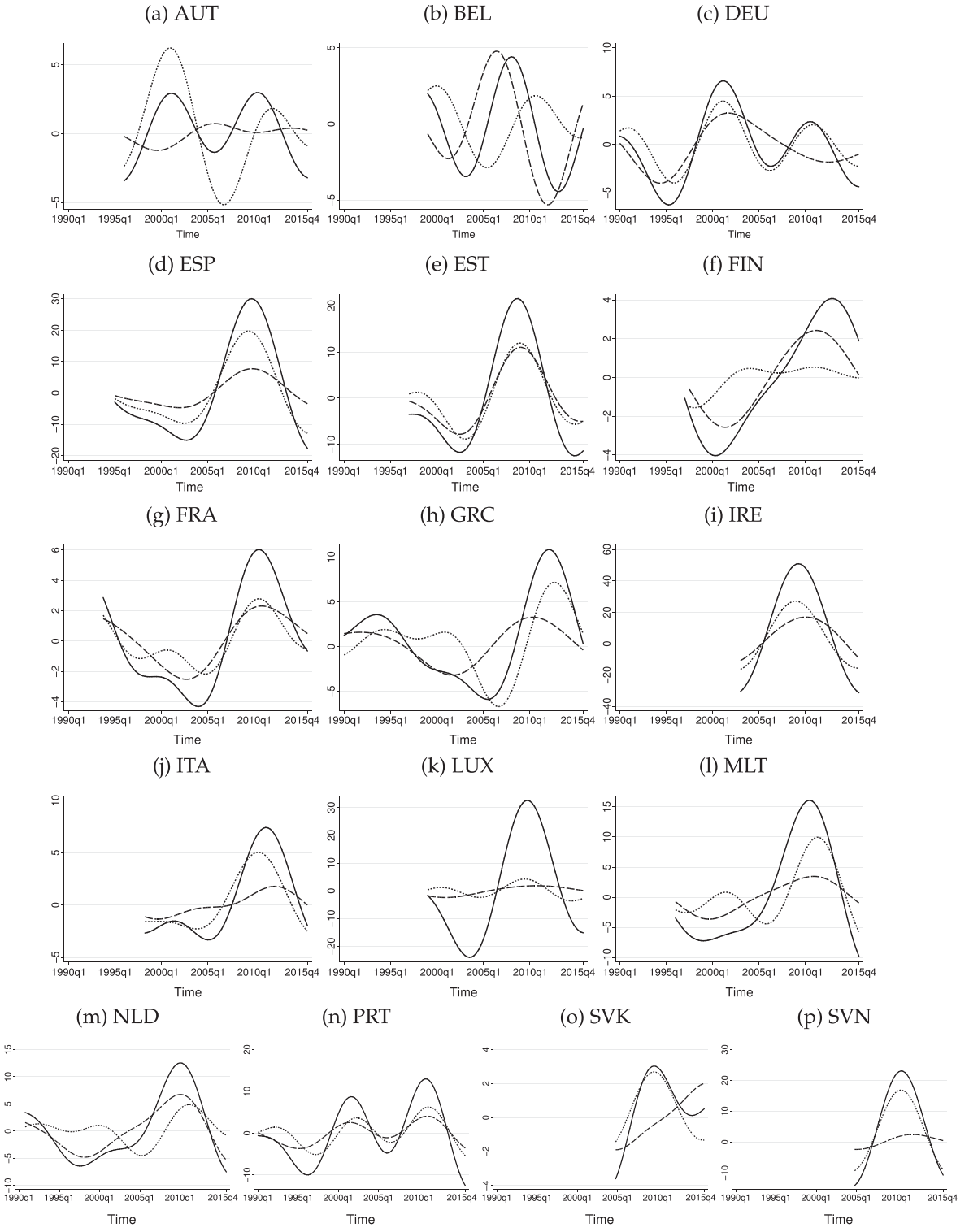

Fig. 1. Credit cycles in EMU economies. *Notes:* Based on authors' calculations. Solid lines show total credit cycles, dashed lines—mortgage credit cycles, and dotted lines—non-financial business credit cycles.

Table 1
Synchronicity and similarity of credit cycles.

	Synchronicity			Similarity		
	Total credit cycle	Non-fin. bus. credit cycle	Mortgage cycle	Total credit cycle	Non-fin. bus. credit cycle	Mortgage cycle
AUT	0.375	0.325	0.725	0.477	0.091	0.544
BEL	0.294	0.765	0.000	0.420	0.659	−0.285
DEU	0.231	0.519	−0.250	0.315	0.257	−0.092
ESP	0.881	0.452	0.857	−0.270	−1.122	0.108
EST	0.658	0.184	0.711	−0.138	−0.326	−0.681
FIN	0.737	0.054	0.919	0.606	0.560	0.875
FRA	0.685	0.618	0.551	0.681	0.747	0.569
GRC	0.365	0.212	0.519	0.280	0.063	0.453
IRE	0.692	0.500	0.769	−1.806	−1.955	−1.948
ITA	0.775	0.521	0.803	0.722	0.659	0.710
LUX	0.912	0.588	0.971	−0.594	0.635	0.913
MLT	0.900	0.825	0.850	0.487	0.461	0.661
NLD	0.822	0.505	0.564	0.618	0.601	0.005
PRT	0.346	0.673	0.231	0.169	0.387	0.231
SVK	0.600	0.644	0.022	0.615	0.688	0.239
SVN	0.867	0.867	0.467	−0.022	−0.486	0.429
EMU average	0.611	0.500	0.533	0.212	0.168	0.203

Notes: The Table reports means of synchronicity and similarity for 16 EMU countries over 1990Q1–2015Q4.

Another possible channel of euro introduction runs through credit market conditions. Better (perceived) credit market conditions—notably, lower credit risk perception—encourages more lending and investment, influencing credit cycles and their coherence. Measuring credit market conditions is not trivial. One possible risk perception measure is credit default swaps (CDS). However, these data is available only from 2004 and for only some of the countries in our sample. We therefore consider real interest rates, which reflect credit risk and loan availability. We use real long-term interest rates on 10-year government bonds where possible. But since the data on long-term rates is missing for several countries for long time periods, we also report results for real short-term interest rates.

Two other channels are credit market deregulation and capital mobility. EMU contributed to financial deregulation in its member states. More deregulated credit markets experience higher credit growth (Lane and McQuade, 2014), which could make credit cycles more synchronized during the credit booms. Credit cycles across the EMU became more synchronized and similar in the 1990s, when most countries liberalized their capital accounts in preparation for EMU accession. Since *de jure* capital account liberalization measures do not vary much over EMU countries after 1999, we use instead a capital mobility measure: net capital flows as percentage of GDP.

Trade openness constitutes another channel. It increased EMU business cycles synchronization (Inklaar et al., 2008) and financial integration (Kalemli-Ozcan et al., 2010). It is plausible that trade openness also affected credit cycles coherence. We include real GDP growth to control for general macroeconomic conditions.

As an extension to the main analysis, we consider two additional channels—cross-border lending activity and house prices. Previous studies find that the euro introduction has increased financial integration, measured by cross-border bank lending (Kalemli-Ozcan et al., 2010), which subsequently contributed to the divergence of business cycles in the euro area (Kalemli-Ozcan et al., 2013). Cross-border activity, induced by the euro adoption, might also influence credit cycle coherence. House prices may matter too. The development of residential property prices in the euro area has been heterogeneous across countries. In some countries, high housing demand was driven by the decline in interest rates, accompanying the euro introduction. The resulting house price boom led to more mortgage lending in those countries, causing the divergence of mortgage cycles.

The baseline model specification is the following:

$$Y_{it} = \alpha + \beta EMU_{it} + \kappa CHAN_{it} + \gamma CTRL_{it} + \theta_t + \mu_i + \epsilon_{it}, i = 1, \ldots, N; t = 1, \ldots, T, \quad (3)$$

where Y_{it} is credit cycle synchronicity/similarity of country i in period t; EMU_{it} is a dummy variable for EMU membership; $CHAN_{it}$ is the matrix of 'channels' through which the euro effect might run (currency risk, legal harmonization, credit market conditions, credit market deregulation, trade openness, net capital flows, cross-border activity, house prices). $CTRL_{it}$ is a matrix of control variables; μ_i are unobserved country-specific fixed effects; θ_t are quarterly time-fixed effects, and ϵ_{it} is a white noise error term with mean 0.

The description of all variables, their data sources, and descriptive statistics are presented in Tables A.1 and A.2 in the Appendix A. Correlation analysis (available on request) suggests that explanatory variables are not highly correlated with each other. Notably, the EMU dummy is (unsurprisingly) strongly negatively correlated with the currency risk proxy (−0.74). If only for this reason, we will not include the EMU dummy jointly with the variables capturing channels in one model.

Since synchronicity measures take values −1 or +1, we estimate an ordered probit model. The distribution of similarity is continuous with an upper bound of +1. Therefore, we estimate a tobit model. In both ordered probit and tobit we include country- and time-fixed effects and we use robust standard errors clustered at the country level.[11]

5.2. Estimation results

In the benchmark analysis we examine synchronicity and similarity of credit-to-GDP cycles for a period 1990Q1–2015Q4 in 16 EMU countries. To probe robustness, we will then alternatively use the log of real credit, examine the pre-crisis period separately, modify the country samples and introduce cross-border lending and house prices.

We start the analysis by looking at a direct EMU membership effect on credit cycle synchronicity and similarity, without considering any channels or control variables, in Table 2. The coefficient for the EMU dummy is significant only for synchronicity of total and (weakly) non-financial business credit cycles, suggesting that the euro introduction led to divergence of those cycles from the EMU cycle. Thus, there is little evidence for a direct euro effect. The significance of time fixed effects suggests that coherence of credit cycles is driven mainly by the time trend and not associated strongly with the euro introduction itself.

We now replace the EMU dummy with variables capturing six channels of the euro introduction effect, plus real GDP growth. Since the sample size depends on the interest rate data, we report the results in two tables—for real short-term interest rates (Table 3) and real long-term interest rates (Table 4).

The results in Tables 3 and 4 suggest that the elimination of currency risk due to euro adoption leads to divergence of total credit cycles from the EMU reference cycle, both in terms of synchronicity and similarity. However, removal of currency risk increases business credit cycles synchronicity. This outcome is consistent with Kalemli-Ozcan et al. (2010) who find that lower currency risk improves financial integration between the euro area countries, by reducing transaction costs and encouraging trade and investment. The resulting rise in business lending across EMU economies contributed to the convergence of business credit cycles. At the same time, higher financial market efficiency stimulates borrowing unevenly across countries, which could explain divergence of total credit cycles. This finding serves to stress that different types of credit cycles within a country move in different ways, with total credit cycles becoming less coherent due to removal of currency risk implied in the euro adoption.

Legal harmonization is associated with less synchronized business and mortgage credit cycles with the EMU reference cycle. Although countries implemented legislative reforms in financial services, this contributed to divergence of their credit cycles. This could be related to country differences in the size and characteristics of financial sector, which legal harmonization seemed to amplify.

The decrease in real short-term interest rates that followed euro introduction increased mortgage credit cycle coherence. Short-term rates might be affected by monetary policy conduct, which resulted in more synchronized and similar mortgage cycles. Real long-term interest rates might be capturing more of a market effect rather than a policy effect, reflecting market conditions and expectations. Reduction of long-term rates makes mortgage credit cycles more synchronous. This may well reflect the synchronized mortgage booms across many EMU states, with low long-term interest rates, after the euro introduction.

Credit market deregulation is associated with less similar amplitudes of total and business credit cycles as well as less synchronized total and mortgage credit cycles with the EMU cycle. This suggests that the deregulation wave that characterized many countries' preparation for euro adoption was a significant factor in the falling coherence of credit cycles. Further, countries with higher trade openness saw their total credit cycles become more similar in amplitudes and more synchronized with the EMU cycle. This result is in line with Kalemli-Ozcan et al. (2010) who find that trade contributed to financial integration in the euro area.

In sum, this benchmark analysis suggests that the effect of euro introduction on credit cycle coherence runs through lower currency risk (decreasing total credit cycle coherence but increasing business credit cycle synchronicity), lower interest rates (increasing coherence of mortgage cycles), legal harmonization and financial deregulation (decreasing cycles coherence), and trade openness (making total credit cycles more coherent).

5.3. Extension: additional channels

We continue with the analysis by considering two additional channels of the euro introduction effect: cross-border exposure and house prices. Since the data on cross-border exposure are available only for 11 EMU countries, whereas house prices data are only since 2000s in some countries, we do not include these channels in our benchmark specification, as it would substantially reduce the sample size. Instead, we examine them as an extension to our main analysis. We focus on the estimations for credit-to-GDP cycles and time period 1990Q1–2015Q4.

[11] Applying fixed-effect panel regressions for a continuous dependent variable yields qualitatively similar results to our tobit and probit models (results are available on request).

Table 2
Credit cycle coherence and EMU membership.

	Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
EMU membership	−1.027**	−0.533*	−0.247	−0.116	−0.163	0.269
	(0.444)	(0.312)	(0.623)	(0.198)	(0.235)	(0.178)
Observations	1247	1245	1245	1247	1245	1245
Pseudo *R*-squared	0.28	0.22	0.26	0.32	0.34	0.32

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the credit-to-GDP ratio. The Table reports coefficient estimates with robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Constant, country and time-fixed effects are included in the estimations (not reported).

Table 3
Credit cycle coherence and channels of EMU membership effects (with real short-term interest rates).

	Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
Currency risk	0.133 **	−0.047*	0.119	0.038	−0.009	0.003
	(0.053)	(0.025)	(0.083)	(0.024)	(0.017)	(0.037)
Legal harmonization	−0.129	−0.141 ***	−0.184 *	−0.017	0.028	−0.005
	(0.133)	(0.048)	(0.097)	(0.039)	(0.030)	(0.023)
Real short-term interest rate	−0.031	−0.001	−0.171**	−0.013	−0.002	−0.033**
	(0.031)	(0.022)	(0.071)	(0.012)	(0.008)	(0.016)
Credit market deregulation	−0.267 ***	0.002	−0.555 **	−0.169 ***	−0.200***	−0.078
	(0.095)	(0.057)	(0.223)	(0.027)	(0.047)	(0.103)
Net capital flows	−0.020	0.006	−0.020	−0.007	−0.009	−0.004
	(0.013)	(0.009)	(0.013)	(0.005)	(0.006)	(0.003)
Trade openness	0.008	−0.006	−0.004	0.009***	−0.003	0.003
	(0.008)	(0.004)	(0.010)	(0.003)	(0.002)	(0.003)
Real GDP growth	0.006	−0.002	0.000	0.003 **	0.001	0.008**
	(0.008)	(0.008)	(0.011)	(0.001)	(0.002)	(0.004)
Observations	1218	1216	1216	1218	1216	1216
Pseudo *R*-squared	0.30	0.24	0.34	0.38	0.36	0.35

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the credit-to-GDP ratio. The Table reports coefficient estimates with robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Constant, country- and time-fixed effects are included in the estimations (not reported).

Table 4
Credit cycle coherence and channels of EMU membership effects (with real long-term interest rates).

	Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
Currency risk	0.191***	−0.083 ***	0.132	0.047**	−0.022	0.008
	(0.045)	(0.014)	(0.090)	(0.024)	(0.015)	(0.035)
Legal harmonization	−0.133	−0.152 ***	−0.211 **	−0.019	0.022	−0.006
	(0.131)	(0.056)	(0.103)	(0.038)	(0.031)	(0.024)
Real long-term interest rate	−0.045	0.003	−0.081*	−0.009	−0.013	−0.012
	(0.039)	(0.028)	(0.046)	(0.025)	(0.024)	(0.009)
Credit market deregulation	−0.164	−0.041	−0.330	−0.136***	−0.207***	0.040
	(0.116)	(0.091)	(0.254)	(0.043)	(0.063)	(0.075)
Net capital flows	−0.021	0.010	−0.021 *	−0.005	−0.005	−0.004
	(0.015)	(0.009)	(0.012)	(0.004)	(0.004)	(0.003)
Trade openness	0.017*	−0.005	−0.004	0.009**	−0.005**	−0.001
	(0.009)	(0.004)	(0.010)	(0.004)	(0.002)	(0.002)
Real GDP growth	0.019**	−0.005	−0.009	0.004 **	0.000	0.004*
	(0.010)	(0.007)	(0.011)	(0.002)	(0.002)	(0.002)
Observations	1145	1143	1143	1145	1143	1143
Pseudo *R*-squared	0.33	0.23	0.33	0.39	0.37	0.39

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the credit-to-GDP ratio. The Table reports coefficient estimates with robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Constant, country- and time-fixed effects are included in the estimations (not reported).

5.3.1. Cross-border exposure

The data for cross-border exposure are collected from the BIS Locational Banking Statistics. This database provides quarterly data on outstanding claims and liabilities of banks located in BIS reporting countries. In addition, it reports sectoral details for cross-border positions on the bank vs. non-bank sector. Our primary measure for cross-border exposure is the sum of total claims and liabilities as a share of GDP.[12]

Table 5 reports the estimation results including cross-border exposure. We dropped Luxembourg from this part of analysis, as its cross-border exposure is extremely high compared to other countries in the sample (values for Luxembourg lie between 1680% and 4460% of GDP, while the sample mean is 398%) which could drive the outcomes. In addition, including Luxembourg increases correlation between cross-border exposure and trade openness from 0.69 to 0.85, which may exacerbate a multicollinearity problem.[13] We find that our benchmark results in subsection 5.2. remain qualitatively similar. The increase in cross-border activity leads to less similar amplitudes of all credit cycles with the EMU cycle, but has no impact on synchronicity. While Kalemli-Ozcan et al. (2013) report that cross-border exposure causes divergence of business cycles, we add that it also contributes to amplitude divergence of credit cycles in EMU.

5.3.2. House price changes

We calculate quarterly changes of real house prices based on the data from OECD and BIS statistics. Table 6 presents the estimation results including the real house price changes. The outcomes are comparable to our benchmark results. Notably, the acceleration in house prices growth is associated with more similar amplitudes of mortgage credit cycles with the EMU reference cycle. This result is consistent with the stylized facts that higher mortgage lending in the euro area has been strongly related to the house price boom.

5.4. Robustness checks and additional analyses

We conducted an extensive sensitivity analysis to test robustness of the results. First, we focus on the pre-crisis period 1990Q1–2007Q3, excluding the large increase in credit cycle coherence during the crisis, which might drive the outcomes.

Table 7 reports the estimation results for short- and long-term interest rates. Currency risk is now a stronger channel: lower currency risk is significantly correlated with less coherent total credit and mortgage credit cycles, but more synchronous business credit cycles. Legal harmonization in the pre-crisis period is significantly associated with lower synchronicity but higher similarity of amplitudes of business credit cycles with the EMU cycle. The results for interest rates, credit market deregulation, and trade openness are comparable to those reported above. Additionally, more trade openness leads to more synchronous mortgage cycles. Moreover, countries with larger net capital flows before the crisis experienced divergence of their total and mortgage credit cycles, both in terms of synchronicity of movement and similarity of amplitudes. This suggests that capital flows fueled localized mortgage credit cycles during the credit boom years until 2007. All in all, the findings suggest that the dynamics in credit boom and bust periods differ. They are stronger for the pre-crisis period and add new insights, while still consistent with the results for the longer period.

Another robustness test was to use the logarithm of real credit (deflated by CPI) instead of credit-to-GDP to construct credit cycles and their coherence measures. This is also done in a number of studies reviewed above. We then analyzed the channels based on this modification, for both types of interest rates. Table 8 reports the results for the entire period, and Table 9 for the pre-crisis period.

The findings are now somewhat different, but do not contradict the benchmark conclusions. Lower currency risk increases coherence of all real credit cycles with the EMU reference cycle, both in terms of synchronicity and similarity; these results are more significant in the pre-crisis period. Thus, the euro introduction, through elimination of currency risk, contributed to the convergence of cycles in real credit across the EMU.

Lower real interest rates are associated with less synchronized real total and business credit cycles and less similar real total credit cycles. Credit market deregulation, just as in the benchmark analysis, significantly reduces similarity (and synchronicity in the pre-crisis period) of real total and business credit cycles with the EMU cycle. Countries with larger net capital flows have real total and mortgage credit cycles that diverge from the EMU cycle. Again, differentiating between credit aggregates matters. The trade openness effect is different than for credit-to-GDP cycles for a period including crisis years; it reduces synchronicity of real business and mortgage credit cycles. In sum, the analysis using real credit rather than credit-to-GDP adds more evidence on the importance of the currency risk channel, credit market conditions, deregulation, and external exposure.

A next robustness check was to construct coherence measures based on 12 EMU countries only, excluding 4 very recent EMU members (Estonia, Malta, Slovakia and Slovenia). These countries might still be less integrated with the rest of the EMU,

[12] We also tried alternative measures, including separately total claims-to-GDP and total liabilities-to-GDP, as well as distinguishing cross-border exposure to bank sector and to non-bank financial sector. All these measures are highly correlated with each other (correlation of 0.99) and produce almost identical results. Therefore, we choose the total exposure as it is the broadest measure available.

[13] We also reran the estimations without trade openness to alleviate the multicollinearity problem. This did not affect our main conclusions (results available on request).

Table 5
Credit cycle coherence and channels of EMU membership effects: cross-border exposure.

	Synchronicity			Similarity			Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
Currency risk	0.165***	−0.119***	0.261***	0.039 **	−0.068***	0.042*	0.177***	−0.131 ***	0.257 ***	0.037**	−0.068***	0.041*
	(0.063)	(0.040)	(0.045)	(0.016)	(0.017)	(0.025)	(0.067)	(0.040)	(0.051)	(0.016)	(0.018)	(0.025)
Legal harmonization	−0.203	−0.098	−0.077	−0.017	0.013	0.027	−0.193	−0.104	−0.070	−0.019	0.012	0.027
	(0.155)	(0.075)	(0.147)	(0.035)	(0.044)	(0.032)	(0.149)	(0.074)	(0.145)	(0.035)	(0.043)	(0.033)
Real short-term interest rate	−0.258**	0.179	−0.124	0.040	0.029	0.015						
	(0.110)	(0.173)	(0.090)	(0.029)	(0.039)	(0.024)						
Real long-term interest rate							0.011	−0.013	0.027	0.021	−0.005	0.005
							(0.038)	(0.061)	(0.061)	(0.023)	(0.024)	(0.013)
Credit market deregulation	−0.349*	0.004	−0.276	−0.267 ***	−0.244 ***	0.019	−0.339 *	−0.005	−0.274	−0.261***	−0.247***	0.021
	(0.184)	(0.177)	(0.242)	(0.069)	(0.074)	(0.076)	(0.185)	(0.207)	(0.247)	(0.072)	(0.077)	(0.078)
Net capital flows	−0.043**	0.021 *	−0.026	−0.013**	−0.004	−0.008	−0.035 *	0.017	−0.022	−0.012**	−0.005	−0.007
	(0.019)	(0.012)	(0.020)	(0.006)	(0.004)	(0.006)	(0.020)	(0.013)	(0.019)	(0.006)	(0.004)	(0.005)
Trade openness	0.050 **	−0.016	−0.033	0.003	−0.009 *	−0.014**	0.049 **	−0.014	−0.034	0.005	−0.009 *	−0.014**
	(0.021)	(0.015)	(0.021)	(0.006)	(0.006)	(0.007)	(0.022)	(0.016)	(0.022)	(0.006)	(0.005)	(0.007)
Real GDP growth	0.023 **	−0.004	−0.015	−0.005	−0.009 *	0.001	0.019 *	−0.001	−0.025 **	−0.003	−0.008 *	0.001
	(0.012)	(0.013)	(0.012)	(0.005)	(0.005)	(0.003)	(0.010)	(0.010)	(0.012)	(0.004)	(0.004)	(0.003)
Cross-border exposure	0.000	−0.001	0.002	−0.002**	−0.002***	−0.002**	0.000	−0.001	0.002	−0.002**	−0.002**	−0.001**
	(0.002)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)
Observations	832	830	830	832	830	830	832	830	830	832	830	830
Pseudo *R*-squared	0.36	0.26	0.42	0.50	0.45	0.38	0.36	0.25	0.42	0.50	0.45	0.38

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the credit-to-GDP ratio. The Table reports coefficient estimates with robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Constant, country- and time-fixed effects are included in the estimations (not reported).

Table 6
Credit cycle coherence and channels of EMU membership effects: house prices.

	Synchronicity			Similarity			Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
Currency risk	0.153***	−0.093***	0.080	0.061 ***	−0.031*	0.016	0.161***	−0.086 ***	0.076	0.054***	−0.034**	0.012
	(0.053)	(0.028)	(0.107)	(0.015)	(0.017)	(0.034)	(0.054)	(0.025)	(0.106)	(0.013)	(0.017)	(0.034)
Legal harmonization	−0.113	−0.127 **	−0.146	−0.023	0.005	−0.001	−0.116	−0.135 **	−0.159	−0.018	0.008	−0.001
	(0.145)	(0.062)	(0.118)	(0.039)	(0.032)	(0.030)	(0.141)	(0.062)	(0.116)	(0.039)	(0.032)	(0.029)
Real short-term interest rate	0.041	−0.044	0.037	0.022	0.002	−0.003						
	(0.041)	(0.045)	(0.078)	(0.014)	(0.013)	(0.011)						
Real long-term interest rate							0.000	−0.022	0.068	0.004	−0.010	0.013*
							(0.040)	(0.044)	(0.060)	(0.024)	(0.027)	(0.007)
Credit market deregulation	−0.235	−0.116	−0.587 **	−0.128 *	−0.178 ***	0.065	−0.241	−0.079	−0.578 **	−0.163**	−0.201***	0.056
	(0.163)	(0.193)	(0.251)	(0.075)	(0.064)	(0.080)	(0.163)	(0.203)	(0.274)	(0.079)	(0.069)	(0.077)
Net capital flows	−0.022*	0.013	−0.016	−0.012*	−0.006	−0.008**	−0.023	0.015	−0.019 *	−0.008**	−0.004	−0.006**
	(0.013)	(0.010)	(0.013)	(0.006)	(0.004)	(0.003)	(0.014)	(0.011)	(0.011)	(0.004)	(0.003)	(0.003)
Trade openness	0.022*	−0.004	−0.010	0.005*	−0.002	0.000	0.028 **	−0.001	−0.007	0.005*	−0.003	−0.001
	(0.011)	(0.008)	(0.014)	(0.003)	(0.003)	(0.003)	(0.011)	(0.007)	(0.014)	(0.003)	(0.003)	(0.003)
Real GDP growth	0.008	0.002	−0.024 *	0.001	0.000	0.001	0.014 *	0.002	−0.031 **	0.002	−0.001	−0.001
	(0.008)	(0.010)	(0.013)	(0.002)	(0.002)	(0.002)	(0.008)	(0.010)	(0.014)	(0.002)	(0.003)	(0.002)
Real house price change	0.015	−0.035	0.033	0.011	0.019	0.040**	0.010	−0.030	0.044	0.018*	0.019	0.043*
	(0.051)	(0.035)	(0.038)	(0.012)	(0.014)	(0.019)	(0.057)	(0.037)	(0.042)	(0.010)	(0.014)	(0.023)
Observations	1065	1064	1064	1065	1064	1064	1037	1036	1036	1037	1036	1036
Pseudo *R*-squared	0.32	0.25	0.35	0.42	0.38	0.39	0.33	0.24	0.37	0.44	0.39	0.40

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the credit-to-GDP ratio. The Table reports coefficient estimates with robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Constant, country- and time-fixed effects are included in the estimations (not reported).

Table 7
Credit cycle coherence and channels of EMU membership effects: pre-crisis period 1990Q1–2007Q3.

	Synchronicity			Similarity			Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
Currency risk	0.116***	−0.056	0.272***	0.032	−0.010	0.064*	0.209***	−0.110 ***	0.278 ***	0.044	−0.032	0.059*
	(0.074)	(0.042)	(0.071)	(0.046)	(0.028)	(0.038)	(0.062)	(0.042)	(0.074)	(0.043)	(0.029)	(0.031)
Legal harmonization	−0.019	−0.144 **	−0.160	0.006	0.047	0.003	−0.011	−0.149 **	−0.166	0.004	0.043	0.001
	(0.127)	(0.057)	(0.141)	(0.033)	(0.026)	(0.027)	(0.116)	(0.067)	(0.146)	(0.032)	(0.026)	(0.025)
Real short-term interest rate	−0.088*	−0.052	−0.186 **	−0.025	−0.023*	−0.023						
	(0.050)	(0.042)	(0.075)	(0.016)	(0.013)	(0.017)						
Real long-term interest rate							−0.117	−0.050	−0.340 ***	−0.033	−0.024	−0.043*
							(0.078)	(0.044)	(0.121)	(0.029)	(0.020)	(0.026)
Credit market deregulation	−0.571***	−0.046	−0.871 ***	−0.127 ***	−0.264 ***	−0.158	−0.511 *	−0.060	−0.993 ***	−0.057	−0.259***	−0.033
	(0.190)	(0.152)	(0.237)	(0.047)	(0.063)	(0.096)	(0.271)	(0.293)	(0.206)	(0.065)	(0.063)	(0.049)
Net capital flows	−0.016	−0.018	−0.036 *	−0.012**	−0.008	−0.009	−0.005	−0.014	−0.042 **	−0.012**	−0.006	−0.013**
	(0.024)	(0.013)	(0.019)	(0.006)	(0.006)	(0.007)	(0.024)	(0.016)	(0.021)	(0.006)	(0.005)	(0.007)
Trade openness	−0.004	0.000	0.066 ***	0.016***	0.005	0.011**	0.006	−0.001	0.074 **	0.018***	0.002	0.001
	(0.010)	(0.008)	(0.024)	(0.004)	(0.005)	(0.005)	(0.015)	(0.010)	(0.033)	(0.006)	(0.006)	(0.003)
Real GDP growth	0.003	0.000	0.026 *	0.004	0.004	0.008	0.024	−0.011	0.041 *	0.007	0.003	0.006
	(0.015)	(0.014)	(0.015)	(0.003)	(0.005)	(0.006)	(0.022)	(0.010)	(0.023)	(0.005)	(0.004)	(0.005)
Observations	690	688	688	690	688	688	645	643	643	645	643	643
Pseudo *R*-squared	0.35	0.21	0.41	0.41	0.37	0.32	0.37	0.20	0.43	0.42	0.38	0.35

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the credit-to-GDP ratio. The Table reports coefficient estimates with robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Constant, country- and time-fixed effects are included in the estimations (not reported).

Table 8
Credit cycle coherence and channels of an EMU membership effect: real credit, 1990Q1–2015Q4.

	Synchronicity			Similarity			Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
Currency risk	−0.105*	−0.122	−0.077	−0.022	−0.040*	−0.044	−0.175**	−0.170 *	−0.184 ***	−0.033	−0.038	−0.053**
	(0.063)	(0.083)	(0.058)	(0.038)	(0.024)	(0.029)	(0.069)	(0.091)	(0.053)	(0.037)	(0.026)	(0.026)
Legal harmonization	0.005	0.067	−0.017	−0.023	0.006	−0.026	0.050	0.082	0.006	−0.014	−0.002	−0.020
	(0.060)	(0.072)	(0.056)	(0.061)	(0.041)	(0.050)	(0.068)	(0.075)	(0.060)	(0.055)	(0.041)	(0.048)
Real short-term interest rate	0.055	0.055 *	−0.019	0.021	−0.003	0.009						
	(0.042)	(0.032)	(0.033)	(0.022)	(0.026)	(0.014)						
Real long-term interest rate							0.029	0.126 ***	−0.018	0.034 ***	0.000	0.002
							(0.066)	(0.044)	(0.064)	(0.013)	(0.022)	(0.022)
Credit market deregulation	−0.031	−0.149	−0.126	−0.164 ***	−0.238**	0.080	−0.046	−0.235	−0.215	−0.155**	−0.123	0.115
	(0.116)	(0.141)	(0.145)	(0.045)	(0.096)	(0.097)	(0.134)	(0.228)	(0.200)	(0.067)	(0.084)	(0.111)
Net capital flows	−0.010	0.002	−0.020	−0.007	−0.006	−0.010*	−0.024	0.000 **	−0.023 *	−0.004	−0.001	−0.009
	(0.018)	(0.009)	(0.013)	(0.005)	(0.006)	(0.006)	(0.019)	(0.008)	(0.013)	(0.003)	(0.003)	(0.006)
Trade openness	−0.005	−0.017 ***	−0.015***	0.007	−0.003	0.003	−0.009	−0.020 ***	−0.020 ***	0.009	−0.004	0.000
	(0.006)	(0.006)	(0.005)	(0.006)	(0.003)	(0.005)	(0.007)	(0.007)	(0.003)	(0.006)	(0.003)	(0.005)
Real GDP growth	0.017	−0.009 *	0.005	0.007 **	0.003	0.005 **	0.002	−0.012 **	−0.012	0.004	0.003	0.001
	(0.010)	(0.005)	(0.012)	(0.003)	(0.003)	(0.002)	(0.008)	(0.006)	(0.010)	(0.003)	(0.003)	(0.002)
Observations	1219	1217	1217	1219	1217	1217	1146	1144	1144	1146	1144	1144
Pseudo *R*-squared	0.39	0.27	0.28	0.29	0.30	0.27	0.45	0.29	0.34	0.32	0.33	0.27

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the logarithm of real credit (deflated by CPI). The Table reports coefficient estimates with robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Constant, country- and time-fixed effects are included in the estimations (not reported).

Table 9
Credit cycle coherence and channels of EMU membership effects: real credit, 1990Q1–2007Q3.

	Synchronicity			Similarity			Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
Currency risk	−0.086	−0.252***	−0.027	−0.067 **	−0.082***	0.005	−0.246**	−0.372 ***	−0.234*	−0.081***	−0.086***	−0.005
	(0.108)	(0.069)	(0.092)	(0.030)	(0.027)	(0.038)	(0.120)	(0.051)	(0.120)	(0.029)	(0.022)	(0.041)
Legal harmonization	0.097	0.084	0.091	−0.039	0.031	−0.015	0.156 **	0.097	0.135	−0.028	0.022	−0.011
	(0.079)	(0.074)	(0.083)	(0.063)	(0.036)	(0.051)	(0.078)	(0.078)	(0.091)	(0.059)	(0.038)	(0.051)
Real short-term interest rate	0.041	0.036	−0.002	0.011	−0.028	0.011						
	(0.036)	(0.032)	(0.034)	(0.021)	(0.030)	(0.017)						
Real long-term interest rate							0.406***	0.134 *	0.125	0.017	−0.036	0.012
							(0.113)	(0.078)	(0.181)	(0.028)	(0.044)	(0.016)
Credit market deregulation	−0.062	−0.114	0.189	−0.128 *	−0.470***	0.012	−0.349 **	−0.386	−0.091	−0.214**	−0.339 **	0.018
	(0.147)	(0.165)	(0.165)	(0.075)	(0.118)	(0.026)	(0.176)	(0.328)	(0.319)	(0.089)	(0.139)	(0.051)
Net capital flows	−0.025	0.011	−0.019	−0.020**	0.001	−0.014	−0.025	0.011	−0.017	−0.017**	−0.001	−0.013
	(0.020)	(0.008)	(0.019)	(0.010)	(0.006)	(0.009)	(0.018)	(0.010)	(0.016)	(0.008)	(0.005)	(0.009)
Trade openness	0.012	−0.008	0.020	0.018*	0.005	0.011**	−0.007	−0.007	0.004	0.024**	0.003	0.012*
	(0.017)	(0.007)	(0.018)	(0.010)	(0.006)	(0.005)	(0.015)	(0.007)	(0.012)	(0.011)	(0.005)	(0.007)
Real GDP growth	0.025	−0.003	0.016	0.008	0.009	0.005	−0.015	−0.006	−0.024	0.004	0.008	0.002
	(0.020)	(0.008)	(0.017)	(0.007)	(0.006)	(0.004)	(0.014)	(0.009)	(0.018)	(0.006)	(0.006)	(0.004)
Observations	691	689	689	691	689	689	646	644	644	646	644	644
Pseudo *R*-squared	0.46	0.21	0.39	0.33	0.35	0.29	0.55	0.26	0.50	0.36	0.34	0.27

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the logarithm of real credit (deflated by CPI). The Table reports coefficient estimates with robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Constant, country- and time-fixed effects are included in the estimations (not reported).

and this could result in different credit cycle coherence results. We re-estimated the models for the other 12 EMU economies using both credit-to-GDP and real credit cycles, both periods, and both interest rates. The results of this robustness check (available on request) are qualitatively similar to our benchmark findings. Notably, currency risk becomes a very strong and significant channel: elimination of currency risk in 'old' euro area countries increased the coherence of business credit cycles but drove apart total and mortgage credit cycles from the EMU reference (both in terms of synchronicity and similarity). The channel of credit market conditions is now also stronger. Lower short- and long-term interest rates are now associated more strongly with more coherent total credit-to-GDP and mortgage-to-GDP cycles but less synchronized real business credit cycles. Other channels are comparable to the full-sample results. This robustness exercise suggests that including countries which had little opportunity to exhibit euro adoption effects might dilute the findings somewhat.

We are aware that what we call 'euro effect' channels might not be specific to EMU countries only, but may also be relevant to non-EMU economies. They also experienced credit market deregulation, changes in currency risks, and so on. To test the sensitivity of our results to EMU sample selection, we conduct an analysis for 8 EU economies which are not EMU members, for which we have data on disaggregated credit (Bulgaria, Czech Republic, Denmark, Hungary, Lithuania, Poland, Sweden, the UK). To construct synchronicity and similarity measures for this group, we use the non-EMU reference credit gaps. We re-estimated models for different specifications of credit, time period, and interest rates. Tables A.3 and A.4 in Appendix A report the results for the whole period (results for the pre-crisis period are similar and available on request).

The findings show that legal harmonization and trade openness have stronger effects on credit cycle coherence in non-EMU countries than is the case for EMU countries. While legal harmonization leads to less synchronized credit cycles in the euro area, it is correlated with less similar amplitudes of credit cycles outside the euro area. Higher trade openness contributes to coherence of credit cycles.

The results for interest rates are comparable to the ones for EMU sample: the reduction of real interest rates significantly increases coherence of total and mortgage credit cycles outside EMU, both in terms of synchronicity and similarity. Thus, while interest rates are plausibly one channel through which the euro affected credit cycles coherence, this is not exclusively a 'euro' effect. In the same way, credit market deregulation leading to divergence of credit cycles is important in both EMU and non-EMU countries. Weaker channels in non-EMU economies are currency risk and net capital flows. Based on this analysis, we conclude that the proposed channels of the 'euro effect' in EMU countries run through lower currency risk and higher capital flows, in addition to significant – but not exclusively 'euro' specific – channels of deregulation, legal harmonization, interest rates, and trade openness.

Yet another sensitivity check was to experiment with different measures for channels. We used the "coarse" exchange rate regime classification ranging from 1 (hard peg) to 4 (free float), and we modified the legal harmonization index to include only the first 21 FASP Directives, for which we have information on transposition dates for all countries in the sample. These modifications did not qualitatively change the benchmark results. Additionally, lower currency risk became more significant in reducing synchronicity and similarity of mortgage cycles with EMU reference. These results are available on request.

We also conducted the analysis with year instead of quarter fixed effects (to minimize the loss of degrees of freedom); and we reran the regressions without time fixed effects. These modifications did not alter the main results, though without time dummies some coefficients became insignificant. This implies that controlling for time effects is important, since credit cycles coherence is partially driven by time trends. In addition, credit cycles coherence in EMU may be driven by global financial factors, which influence credit dynamics around the world. We included global credit volatility, proxied by the VIX index as our measure of global factors. This modification did not affect the main results, while VIX index was mostly insignificant.

As an extension to our analysis of the coherence of credit cycles between countries, we examined coherence within countries. That is, we calculated synchronicity and similarity between non-financial business credit and mortgage credit cycles, using first credit-to-GDP and then real credit as basis. The formulas for synchronicity and similarity are unchanged, but we replace the reference credit gap with the mortgage credit gap. The descriptive statistics (available on request) show that 10 EMU countries had non-financial business cycle and mortgage cycle moving in a similar direction, while several others (e.g., Austria, Belgium) experienced divergence between the two types of cycles. The amplitudes of two cycles within a country were always very different.

We then analyzed the channels for the 'euro' effect on coherence within countries between mortgage and business credit cycles, in the same regression framework as above. Table A.5 reports the results, for 16 EMU countries over 1990Q1–2015Q4,[14] for both real credit and credit-to-GDP cycles. The findings suggest that most of the 'euro' effect channels are either weak or insignificant for coherence between disaggregated credit cycles. Lower currency risk is weakly correlated to lower similarity of amplitudes between real business and mortgage credit cycles. Higher trade openness and GDP growth are associated with divergence of cycles within countries. Additionally, legal harmonization and higher long-term rates make credit cycles more similar in amplitudes. These results show that the drivers of between-country credit cycles coherence of

[14] The results for the pre-crisis period are qualitatively similar and are available on request.

the same types are different from the drivers of within-country coherence of business credit and mortgage credit cycles. This is in itself unsurprising; it serves to stress the heterogeneous outcomes between and within countries of EMU-wide trends and policies.

6. Conclusion

Credit cycles and their cross-country coherence matter to a range of macroeconomic outcomes and to EMU monetary policy effectiveness. The dynamics of household mortgage credit and loans to non-financial business have diverged significantly in recent decades. In this paper we construct and describe credit cycles for total bank credit, household mortgages and non-financial business loans for 16 EMU economies over 1990–2015. We explore their cross-country coherence in terms of similarity in amplitudes and synchronicity in the direction of movement. We also analyze the channels through which euro introduction could have impacted credit cycle coherence in the euro area.

We investigate if the effect of euro introduction is transmitted via elimination of currency risk, easing of credit conditions, legal harmonization, financial deregulation, trade and capital flows, as well as via cross-border exposure and house prices. We find, first, that the 'euro effect' runs though lower currency risk which decreased total-credit cycle coherence but increased synchronicity of business credit cycles. Second, legal harmonization decreases synchronicity of mortgage and business credit cycles. Third, lower real interest rates contribute to convergence of mortgage credit cycles. Fourth, credit market deregulation strongly decreases similarity of total and business credit cycles, as well as synchronicity of total and mortgage credit cycles. Trade openness increases coherence of total-credit cycles. Lastly, more cross-border exposure is associated with less similar amplitudes of all credit cycles, while house prices growth makes mortgage cycles more similar. The findings underline the importance of differentiating between credit types in understanding credit cycles, and differentiating between the transmission channels of euro introduction.

We undertake extensive robustness analyses, studying pre-crisis as distinct from 1990 to 2015 results; 8 non-EMU economies as distinct from 16 EMU countries; and cycles based on real credit as distinct from credit/GDP ratios. Excluding the post–2007 years, we find that effects of lower currency risk, interest rates and capital flows on credit cycle coherence before the crisis are stronger. This implies that including the crisis years may obscure these channels somewhat. In non-EMU countries, legal harmonization leads to credit cycle divergence, whereas trade openness has the opposite effect. These trends, while associated with euro introduction, had similar effect where they occurred outside the euro area. The benchmark findings are robust to the robustness analyses, which yield additional insights into the effects of euro introduction. Within countries, credit cycles for mortgages and business credit diverge more with more trade openness, higher GDP growth, and lower interest rates.

While these findings are new and policy relevant, it is important to identify their limitations. Credit cycles can be constructed in many ways, depending on choice of turning points and filters. They are considerably longer than business cycles, so that the length of the sample may prevent observing the full cycle. Their differences from a financial cycle – including both credit and property prices (Borio, 2014) – must be borne in mind. And our theoretical understanding of the significance of credit cycles is still very limited. We have alleviated this uncertainty as best we could by evaluating different ways of constructing the cycles (with real credit and credit/GDP), and by cross-checking with different data sources, longer series, a no-crisis sample, and variation in country samples.

That said, we surveyed recent trends and literature which indicate that credit cycles may have been neglected until recently. Early proponents such as Borio and Lowe (2004) argued for the importance of quantitative credit aggregates to understanding macroeconomic trends and policy effectiveness. A long-standing literature has argued that credit conditions matter to policy effectiveness (Bernanke and Gertler, 1995). This has been underscored by recent research on growth and differentiation of credit, and its link to long-term output growth, asset market developments, financial instability and severity of post-crisis recessions. More research into credit cycles, their drivers and impacts, appears a natural step.

This research has implications for monetary policy. Less coherent credit cycles in EMU hinder the effectiveness of common monetary policy conduct for individual member-states and the euro area as a whole due to heterogeneity of credit channel across EMU countries. Previous literature documents that ECB policy shocks have heterogenous effects on bank lending across countries and across different credit aggregates. This is possibly linked to the heterogeneity in credit cycles. Our differentiation between cycles in mortgages and non-financial business loans adds another dimension to heterogeneous policy effects. The ECB cannot directly address this credit cycle divergence as financial stability does not constitute the primary objective of monetary policy. However, it may indirectly contribute to synchronizing credit cycles across the euro area by fostering the reforms in financial markets towards more integration, harmonization, and completion of banking and capital unions.

There are also important implications for macroprudential policies. Given diverging credit cycles between and within countries in the euro area, and the infeasibility of conducting national monetary policies in EMU, there is a need for designing macroprudential policies that would address national specifics of credit cycles and systemic risks in the financial system (Houben and Kakes, 2013; Stremmel and Zsámboki, 2015).

Appendix A

See Tables A.1–A.5.

Table A.1
Description of variables and their data sources.

Variable	Description	Data sources
Synchronicity, $\eta_i(t)$	Calculated using formula (1) for total, non-financial business, and mortgage credit cycles	Central banks' statistics
Similarity, $\theta_i(t)$	Calculated using formula (2) for total, non-financial business, and mortgage credit cycles	Central banks' statistics
Currency risk	Indicator, "fine" classification – from 1 (hard peg) to 13 (free float); "coarse" classification – from 1 (hard peg) to 4 (free float)	Reinhart and Rogoff (2004) and Ilzetzki et al. (2011)
Legal harmonization	Indicator, measuring the number of FASP Directives adopted by a country by quarter *t*, takes values from 1 to 27	Kalemli-Ozcan et al. (2010), European Commission
Credit market conditions	Real short-term (3-month money market) interest rate; real long-term interest rate (on 10-year government bonds); real rates are calculated as nominal rates minus CPI inflation	Datastream
Credit market deregulation	Index consists of 3 components: ownership of banks (percentage of deposits held in privately owned banks), extension of credit (share of private sector credit in total bank credit), presence of interest rate controls/negative interest rates. The credit deregulation index is an average of the components. The index takes values from 1 to 10	Fraser Institute's Economic Freedom Indicators
Net capital flows	Net financial account in the Balance of Payments (inflows minus outflows), in % GDP	Eurostat
Trade openness	Export plus import of goods and services, in % GDP	IFS IMF
Real GDP growth	Quarterly growth rate of real GDP	IFS IMF
Cross-border exposure	Total claims and liabilities (all sectors), in % GDP	BIS Locational Banking Statistics
Real house price changes	Quarterly change in real house prices (nominal house price index deflated by CPI)	OECD, BIS
EMU membership	1 – a country is an EMU member, 0 otherwise	Own construction

Table A.2
Descriptive statistics (quarterly data, 1990Q1–2015Q4).

Variable	No obs.	Mean	Sd	Min	Max
Coherence measures					
Synchronicity, total bank credit cycle	1247	0.61	0.79	−1.00	1.00
Synchronicity, non-fin. bus. credit cycle	1245	0.50	0.86	−1.00	1.00
Synchronicity, mortgage credit cycle	1245	0.53	0.85	−1.00	1.00
Similarity, total bank credit cycle	1247	0.21	0.78	−4.22	1.00
Similarity, non-fin. bus. credit cycle	1245	0.17	0.90	−3.98	1.00
Similarity, mortgage credit cycle	1245	0.20	0.84	−3.25	1.00
Channels					
EMU membership	1248	0.73	0.45	0.00	1.00
Currency risk	1248	2.25	2.74	1.00	13.00
Legal harmonization	1248	14.41	11.66	0.00	27.00
Real short-term interest rate	1248	2.87	3.79	−2.86	41.10
Real long-term interest rate	1173	4.40	3.09	−0.85	40.50
Credit market deregulation	1248	8.63	1.25	5.00	10.00
Net capital flows	1221	0.48	6.88	−48.16	32.10
Trade openness	1248	113.94	75.54	26.52	425.31
Cross-border exposure	905	151.81	167.82	18.30	1226.61
Real house price changes	1078	0.38	2.36	−19.99	12.00
Real GDP growth	1246	0.56	4.64	−15.82	20.40

Notes: Descriptive statistics are based on the main specification of our analysis—that is, using credit-to-GDP ratios when constructing synchronicity and similarity measures for 16 EMU countries in our sample.

Table A.3
Credit cycle coherence and channels: non-EMU sample, credit-to-GDP, 1990Q1–2015Q4.

	Synchronicity			Similarity			Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
Currency risk	0.023	0.018	0.049	0.021	0.094*	0.059	−0.074	−0.078	0.081	0.008	0.091	0.108***
	(0.119)	(0.139)	(0.162)	(0.032)	(0.052)	(0.039)	(0.132)	(0.136)	(0.190)	(0.049)	(0.067)	(0.032)
Legal harmonization	−0.004	0.074	0.122	−0.045***	−0.035***	−0.016 ***	−0.013	0.054	0.102	0.001	0.035**	−0.009
	(0.027)	(0.050)	(0.165)	(0.009)	(0.010)	(0.006)	(0.040)	(0.064)	(0.166)	(0.007)	(0.016)	(0.010)
Real short-term interest rate	−0.023***	−0.071	−0.103	−0.034	−0.032	−0.046*						
	(0.034)	(0.047)	(0.119)	(0.028)	(0.032)	(0.024)						
Real long-term interest rate							−0.155	−0.014	−0.018	−0.021	−0.005	−0.076**
							(0.112)	(0.128)	(0.115)	(0.027)	(0.021)	(0.032)
Credit market deregulation	−0.137	0.002	−1.230***	0.145 **	−0.012	−0.378***	−0.314	0.212	−1.177***	0.083	−0.020	−0.402***
	(0.158)	(0.209)	(0.390)	(0.059)	(0.100)	(0.135)	(0.223)	(0.220)	(0.422)	(0.069)	(0.075)	(0.142)
Net capital flows	−0.019	0.025	−0.004	0.004	0.017	0.002	−0.020	0.031*	−0.003	0.000	0.012	−0.004
	(0.012)	(0.025)	(0.019)	(0.009)	(0.011)	(0.005)	(0.013)	(0.018)	(0.016)	(0.008)	(0.008)	(0.007)
Trade openness	−0.018 *	−0.015	0.008	−0.001	0.000	0.012	0.003	−0.002	0.009	0.002	0.000	0.008
	(0.010)	(0.014)	(0.022)	(0.004)	(0.005)	(0.008)	(0.019)	(0.018)	(0.024)	(0.004)	(0.003)	(0.006)
Real GDP growth	0.007	−0.007	−0.015	0.003 *	0.006 **	0.000	0.010	−0.011 *	−0.018	0.001	0.004	0.002
	(0.007)	(0.006)	(0.010)	(0.002)	(0.003)	(0.003)	(0.007)	(0.006)	(0.011)	(0.001)	(0.003)	(0.003)
Observations	617	617	609	617	617	609	550	550	550	550	550	550
Pseudo *R*-squared	0.30	0.37	0.45	0.38	0.30	0.32	0.31	0.35	0.42	0.37	0.28	0.37

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the credit-to-GDP ratio. The Table reports coefficient estimates with robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Constant, country- and time-fixed effects are included in the estimations (not reported).

Table A.4
Credit cycle coherence and channels: non-EMU sample, real credit, 1990Q1–2015Q4.

	Synchronicity			Similarity			Synchronicity			Similarity		
	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage	Total	Non-fin.bus.	Mortgage
Currency risk	−0.065	−0.053	0.095	0.035	0.042	0.041	−0.133	−0.142	0.141	0.057	0.045	0.094*
	(0.170)	(0.188)	(0.083)	(0.062)	(0.056)	(0.073)	(0.204)	(0.245)	(0.109)	(0.055)	(0.066)	(0.056)
Legal harmonization	−0.002	0.040	−0.011	−0.044***	−0.029***	0.033 ***	−0.027	−0.009	0.004	0.023	0.046 **	0.070***
	(0.030)	(0.029)	(0.016)	(0.010)	(0.009)	(0.011)	(0.029)	(0.033)	(0.027)	(0.017)	(0.018)	(0.010)
Real short-term interest rate	−0.134 ***	−0.043	−0.178**	−0.016	−0.020	−0.009						
	(0.040)	(0.058)	(0.072)	(0.016)	(0.023)	(0.024)						
Real long-term interest rate							0.089	0.144	−0.183*	−0.032	−0.015	−0.148***
							(0.132)	(0.118)	(0.109)	(0.041)	(0.018)	(0.040)
Credit market deregulation	0.063	0.154	−1.835***	−0.036	−0.033	−0.217 ***	−0.596*	0.285	−1.895***	−0.131*	−0.019	−0.176**
	(0.089)	(0.125)	(0.224)	(0.025)	(0.032)	(0.081)	(0.318)	(0.350)	(0.237)	(0.068)	(0.106)	(0.071)
Net capital flows	0.001	0.013	0.014	−0.005	0.010	0.000	0.013	0.035*	0.004	−0.012**	0.005	−0.012
	(0.014)	(0.020)	(0.010)	(0.005)	(0.008)	(0.009)	(0.021)	(0.020)	(0.011)	(0.005)	(0.005)	(0.007)
Trade openness	−0.018	−0.020	0.063***	0.007***	0.006*	0.011 **	0.014	−0.007	0.078***	0.010***	0.006	0.018***
	(0.020)	(0.020)	(0.016)	(0.002)	(0.004)	(0.004)	(0.020)	(0.019)	(0.022)	(0.003)	(0.004)	(0.002)
Real GDP growth	0.010	0.003	−0.001	−0.001	0.002 **	−0.002	0.005	−0.001	0.008	0.001	0.003 *	0.003*
	(0.006)	(0.006)	(0.017)	(0.002)	(0.001)	(0.002)	(0.007)	(0.004)	(0.017)	(0.002)	(0.002)	(0.002)
Observations	622	622	609	622	622	609	550	550	550	550	550	550
Pseudo *R*-squared	0.28	0.38	0.51	0.39	0.35	0.20	0.31	0.37	0.50	0.40	0.36	0.31

Notes: The dependent variable is synchronicity/similarity of total bank credit, non-financial business credit, and household mortgage credit cycles. Credit is measured by the logarithm of real (deflated by CPI) credit. The Table reports coefficient estimates with robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Constant, country- and time-fixed effects are included in the estimations (not reported).

Table A.5
Synchronicity/similarity between non-financial business and mortgage credit cycles, 16 EMU, 1990Q1–2015Q4.

	Credit-to-GDP cycles				Real credit cycles			
	Synchronicity		Similarity		Synchronicity		Similarity	
Currency risk	−0.019	−0.022	−0.134	−0.002	−0.036	−0.023	10.679 *	12.291*
	(0.053)	(0.051)	(0.872)	(0.451)	(0.044)	(0.045)	(6.480)	(7.155)
Legal harmonization	−0.095	−0.110	−0.255	−0.187	−0.054	−0.065	2.526 **	2.547
	(0.087)	(0.090)	(0.606)	(0.250)	(0.088)	(0.085)	(1.239)	(1.730)
Real short-term interest rate	−0.007		0.072		0.021		4.945	
	(0.042)		(0.590)		(0.033)		(3.882)	
Real long-term interest rate		0.059		0.197**		−0.021		−0.210
		(0.070)		(0.078)		(0.029)		(0.921)
Credit market deregulation	0.205	0.127	10.990	0.697	0.045	0.001	−0.591	−6.067
	(0.139)	(0.157)	(7.402)	(0.589)	(0.072)	(0.084)	(7.810)	(9.131)
Net capital flows	0.004	0.010	0.003	−0.062	0.002	0.007	−0.910	−1.060
	(0.009)	(0.010)	(0.133)	(0.067)	(0.011)	(0.010)	(0.668)	(0.816)
Trade openness	−0.015**	−0.009	−0.089	0.015	−0.024***	−0.022***	0.314	0.576
	(0.007)	(0.009)	(0.107)	(0.025)	(0.003)	(0.004)	(0.317)	(0.416)
Real GDP growth	−0.019 **	−0.020 **	−0.559	−0.107	−0.010 *	−0.005	−0.254	−0.082
	(0.008)	(0.008)	(0.506)	(0.111)	(0.006)	(0.007)	(0.370)	(0.225)
Observations	1216	1143	1216	1143	1217	1144	1217	1144
Pseudo *R*-squared	0.26	0.27	0.01	0.02	0.34	0.35	0.02	0.03

Appendix B. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jimonfin.2017.07.002.

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