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The Non-Bank Credit Cycle*

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Abstract

We investigate the cyclical properties of non-bank credit and its relevance for financial stability. We construct a measure of non-bank credit for a large sample of countries and find that its cyclical properties differ from those of bank credit. Non-bank credit cycles are highly correlated with bank credit cycles in some countries but not in others. Moreover, non-bank credit cycles are less synchronised than bank credit cycles across countries. Finally, non-bank credit cycles could act as a leading indicator for currency, but not for systemic banking, crises. The opposite is true for bank credit cycles. These findings highlight the value added of monitoring non-bank credit.

Keywords: non-bank credit, credit cycle, leading indicator, financial crisis

JEL codes: G01, G23, F34

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1. Introduction

Most people would think about bank loans if they want to take credit. But credit comes in many forms. In modern financial systems, the size of non-bank credit is often as large, or even larger, than bank credit. The sources of non-bank credit are heterogeneous, as it can take the form of bond financing, or loans by a diverse group of lenders that include investment funds, non-bank mortgage providers, foreign lenders or the government. In this paper, we construct a new measure of non-bank credit for a large international sample of advanced and developing economies and investigate the role of non-bank credit in the financial system. In particular, we compare cycles in non-bank credit to bank credit cycles and study their relevance for financial instability, separately exploring the effects on systemic banking, currency and sovereign debt crises.

The existing literature has examined these questions for bank credit. The supply of bank credit is seen as procyclical (Becker and Ivashina, 2014; Langfield and Pagano, 2016). Banks are generally highly leveraged and subject to relatively large maturity and liquidity mismatches. When banks buffers increase during bad times, or when banks are hit by adverse shocks, they need to rebuild their buffers and will curtail credit as a result (and vice versa in good times).

There is less consensus on the cyclicality of non-bank credit. Bond credit, in particular, is found to be less procyclical than bank credit (Becker and Ivashina, 2014 and Langfield and Pagano, 2016). That is why the IMF (2015) refers to market-based financing as a spare tyre for periods when bank credit is restrained. But this issue on the cyclicality of non-bank credit has not been fully settled, as non-bank credit can take many more different forms. For example, securitization markets, which transform bank credit into non-bank credit, showed a strong boom-bust pattern around the financial crisis. Similarly, collateralized short-term funding can

result in procyclical leverage and investment behaviour as argued in Fostel and Geanakoplos (2008), and shown to be the case for U.S. broker dealers in Adrian and Shin (2009).

We contribute to this debate by showing that the cyclical properties of non-bank credit are heterogeneous across countries and different from those of bank credit. In some countries, non-bank credit cycles are highly synchronised with bank credit cycles, but not in others. Moreover, non-bank and bank credit cycles were less synchronised within countries in the period leading up to the global financial crisis, while non-bank credit is also less synchronised across countries than bank credit.[6]

With respect to financial instability, the literature has mainly focused on bank or total credit. Previous studies have already established a link between credit cycles and banking or currency crises (Borio and Lowe, 2002; Schularick and Taylor, 2012; Mendoza and Terrones, 2012). Several other studies have focused on financial cycles more generally (e.g. Claessens et al., 2011; Drehmann et al., 2012; Schüler et al., 2015). However, less research has been conducted on the role of non-bank credit. One strand in the literature stresses that a stronger reliance on non-bank debt or market-based finance, relative to bank credit, should be beneficial for economic growth and financial stability (e.g. Gambacorta et al., 2014; Bats and Houben, 2017). But at the same time several examples can be given of stress events in the non-bank sector, sometimes of a systemic nature (ESRB, 2016).[7]

[6] See also Herman et al. (2017), who find that bank and non-bank credit exhibit different dynamics throughout the business cycle in the US. In comparison with their approach, we study the cyclical properties of non-bank credit for a much larger group of countries, and compare it not only to bank credit, but also investigate its link with periods of financial instability.

[7] For example, in the early 1970s, in the UK, unregulated 'fringe institutions' funded themselves in the money markets and invested these funds largely in commercial property developments. Financial stress in this sector became known as the secondary banking crisis and led to legal reforms in the UK. On a similar tone, Kim et al. (2018) describe how non-bank mortgage companies in the US are vulnerable to liquidity pressures, and warn that they are vulnerable to a financial crisis. As a result, there may be additional information in non-bank credit developments for financial stability purposes.

We show that non-bank credit growth--or equivalently the non-bank credit cycle--can act as a leading indicator for currency crises and, perhaps, also for sovereign debt crisis (although the latter result is more uncertain due to the low number of sovereign debt crises). This result is in sharp contrast to total or bank credit growth, which are not helpful in predicting the incidence of currency crises. On the contrary, bank credit growth is a useful leading indicator for systemic banking crises, while non-bank credit growth fails to predict such incidences. These findings highlight the value added of monitoring non-bank credit next to the traditional focus on bank credit.

The remainder of this paper is organised as follows. Section 2 explains our definition of non-bank credit and takes a first look at our dataset of a global group of 36 countries. Section 3 investigates bank and non-bank cycle synchronicity within and across countries. Section 4 investigates the link to financial instability. Additional tables and figures are reported in the Appendix at the end of the paper.

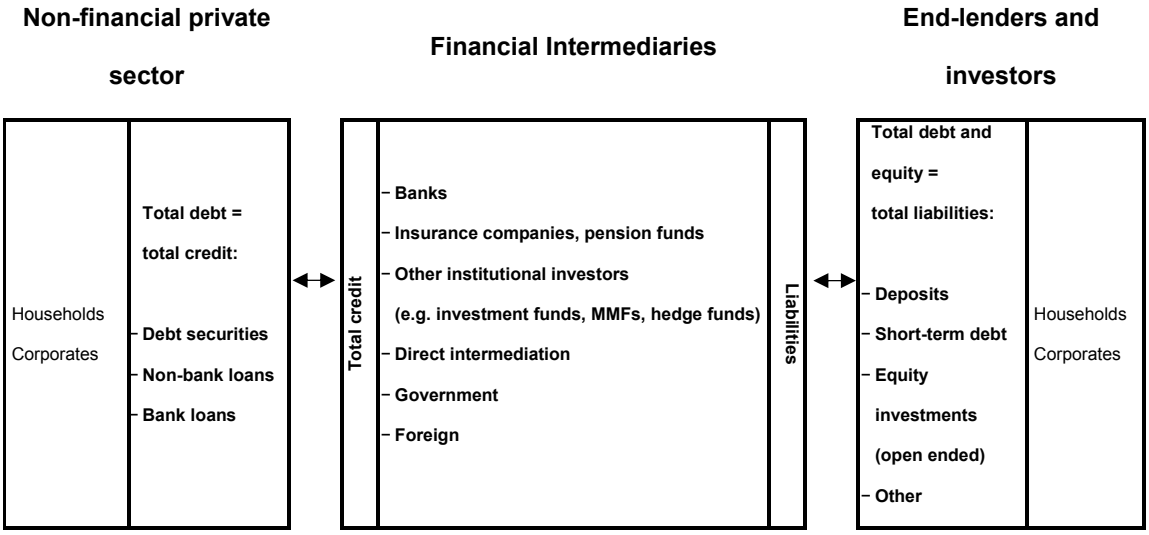
2. Data

Credit to the non-financial private sector consists of the loans and debt securities on the liability side of the balance sheets of households and corporates (Figure 1). Most of the literature focuses on loans provided by banks (i.e. bank credit), or credit from all bank and non-bank sources. Non-bank credit is provided by a broad range of lenders, including insurance companies, pension funds, Other Financial Institutions (OFIs)[8], the government and foreign non-bank credit providers. This makes it more complicated to study its properties, and

[8] OFIs include institutions such as Investment Funds, Money Market Funds, Finance Companies, Broker Dealers, ABS Issuers.

to design supervisory approaches. We take a macro approach, as our interest is in the overall role of non-bank credit as a source of funding for the private sector and its link to financial stability. This latter perspective has been motivated by increasing attention for the growing role of non-bank financial intermediation and shadow banking (e.g. FSB, 2018). But non-bank credit is broader than shadow banking, as the latter term (only) includes non-bank entities with short-term funding and potential financial stability risks related to leverage, liquidity and maturity mismatches and interconnectedness (FSB, 2013).

Figure 1. Credit intermediation: a stylized representation.



The measures of non-bank and bank credit are computed using the BIS long series database on private non-financial sector credit (Dembiermont et al., 2013) and the BIS locational banking statistics. The former database contains quarterly series of private credit data for more than 40 economies for a period covering at least 30 years. The database's measure of total private credit covers all loans and debt securities to non-financial corporations, households and non-profit institutions serving households. The first step for estimating non-bank credit is to subtract bank credit from total credit, with bank credit defined as all loans

and debt securities held by domestic banks.[9] What remains encompasses loans provided and debt securities held by all other sectors of the economy (e.g. insurance companies, pension funds, investment funds, other firms, households) and, for some jurisdictions, direct cross-border lending by foreign banks. The inclusion of direct cross-border lending by foreign banks calls for a second step, i.e. to subtract cross-border loans by foreign banks (i.e. non-resident bank loans). What results is the measure of non-bank credit used in this paper:

> ***Non-bank credit to private non-financial sector (PNF)*** *≈ All sector credit to PNF – (Domestic) Bank credit to PNF –Non-resident bank loans to PNF.*

The data on non-resident bank loans are sourced from the BIS locational banking statistics, which are available as of end-2013. Although this correction is therefore not possible for the years preceding 2013, non-resident bank credit is generally relatively small, with a median of 3% of GDP across the averages of the jurisdictions. We therefore exclude countries[10] which have an average large share of non-resident bank loans relative to non-bank credit and where the cross-border adjustments have a significant impact on the non-bank credit growth figures, i.e. Argentina, Greece, Hong Kong, Malaysia and Saudi Arabia. For the remaining countries, we use two alternative methods for addressing the lack of non-resident bank loan data prior to 2013. First, we calculate non-resident bank credit backward by using the growth rate between 2013q4 and 2015q4 over the period for which data are available. This leads to a declining share of non-resident bank credit when we go back further in time, in line with an increasing international orientation of the financial sector over our sample period. Second, we also use an unadjusted series for a robustness check, leaving out the correction before

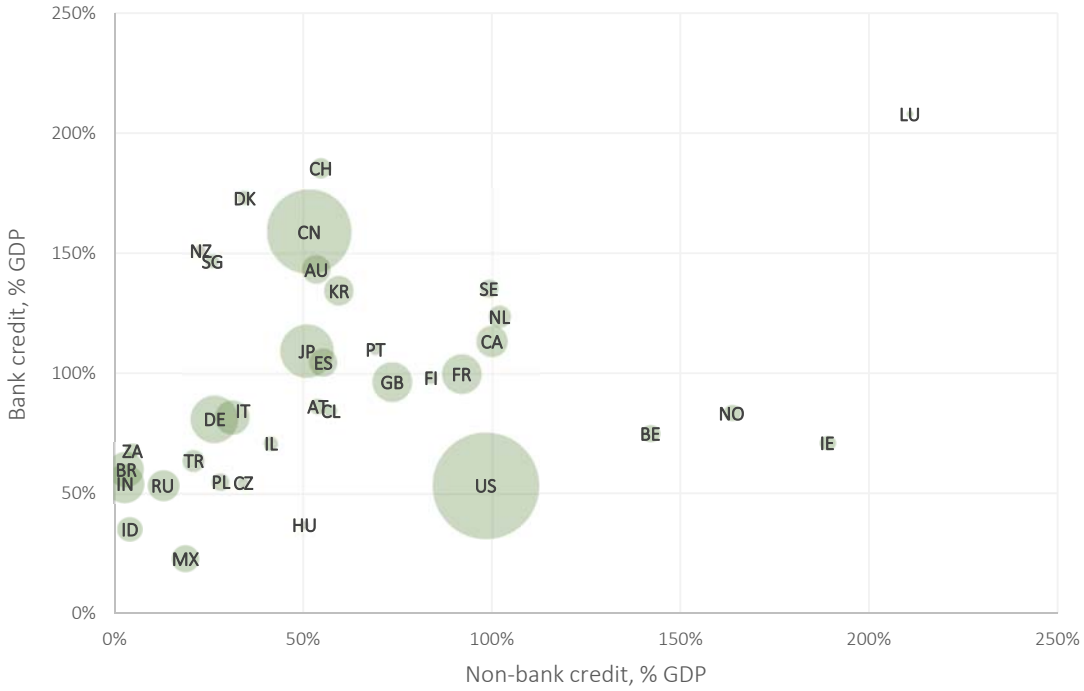
[9] See also Cizel et al. (2016).

[10] We also excluded Colombia from the sample for not having CPI data, which is necessary for credit cycle calculations, and Thailand, since the level of non-bank credit is very close to zero for some observations, so that it is not possible to calculate meaningful growth rates.

2013. This leads to a slight overestimation of non-bank credit before 2013. We compare the adjusted and unadjusted series directly, and find that differences are very small. Moreover, most of our analysis focuses on differences in growth changes in non-bank credit and those are negligible between the two datasets. Therefore, for the remainder of the paper the adjusted non-bank cycle is used for analyses. Figure A.1 shows the latest observation for total credit, split between domestic bank credit, non-bank credit and non-resident bank loans for all countries in our sample.

Figure 2. The size of bank and non-bank credit as a fraction of GDP

Data as of 2017q3. Size of the bubbles denotes the country's GDP



Note: country codes are AT=Austria, AU=Australia, BE= Belgium, BR=Brazil, CA=Canada, CH=Switzerland, CL= Chile, CN=China, CZ= Czech Republic, DE= Germany, DK=Denmark, ES=Spain, FI=Finland, FR=France, GB=Great Britain, HU=Hungary, ID=Indonesia, IE=Ireland, IL=Israel, IN=India, IT=Italy, JP=Japan, KR=South Korea, LU=Luxembourg, MX=Mexico, NL=The Netherlands, NO=Norway, NZ=New Zealand, PL=Poland, PT=Portugal, RU=Russia, SE=Sweden, SG=Singapore, TR=Turkey, US=The United States of America, ZA=South Africa.

Source: Authors' calculations and Bank for International Settlements statistics, https://www.bis.org/statistics/index.htm.

Figure 2 shows the latest observation in our sample for the size of non-bank credit (horizontal axis) and bank credit (vertical axis), as % of GDP. Many observations are above but relatively close to the 45-degree line, indicating that bank and non-bank credit generally are quite similar in size within countries. But some countries lean more towards bank credit (e.g. Denmark, China) and others more towards non-bank credit (e.g. the US, Ireland). Moreover, Advanced Economies (ADVs) show relatively larger sizes of non-bank credit than Emerging Market Economies (EMEs). In a few countries the size of non-bank credit is very small, i.e. Indonesia, India, Brazil and South-Africa.

3. The non-bank credit cycle and its interaction with bank credit

3.1 Calculating the cycle

Various approaches can be used to empirically isolate credit cycles, including traditional turning point analyses, frequency-based filter analyses and model-based approaches (see for example Aikman et al. (2015), Claessens et al. (2011), Drehmann et al. (2012) Farrell and Kemp, 2018). In this paper, we apply the Christiano-Fitzgerald (2003) filter to non-bank and bank credit data. Turning-point analyses is also performed using a dating algorithm introduced by Bry and Boschan (1971) (see results in Table A.3). The aim is to isolate the cyclical component in the frequency range between 32 and 120 quarters (i.e. to identify the credit cycles with a duration of between 8 and 30 years). Similar approaches for the credit cycle have been taken by Aikman et al. (2015) for the credit cycle, by Schüler et al. (2015), Strohsal et al. (2015) and Gonzalez et al. (2015) for the financial cycle. Drehmann et al. (2012) apply frequency-based filters, as well as turning point analysis. Outstanding credit in domestic currency data is deflated by the Consumer Price Index (CPI) for each respective jurisdiction

and expressed in logs, with the filter applied to the 4-quarter log changes. The frequency-based growth cycles were calculated per country and can be converted into levels by cumulating the growth rates, similar to Drehmann et al. (2012).

3.2 Non-bank and bank credit cycles

The full set of results for the frequency-based non-bank bank and bank cycles in individual countries are shown in the Appendix, Figure A.2. Note that since these are growth rate cycles, a negative value indicates a decrease in the level of outstanding credit in real terms, while increases are present when the growth cycles are positive. When the cycle is positive but declining, the cycle in levels is still increasing but at a decreasing rate. A turning point is therefore indicated when the growth rate cycle reaches zero. Results show that the amplitudes of the bank and non-bank cycles vary significantly across countries, reflecting the differing growth rates in non-bank credit over time (Figure A.2). This renders the calculation of an average global bank and non-bank cycle difficult. Against this backdrop various groupings of data were considered, namely Emerging Market Economies (EME), advanced economies (ADV), EU (EU) and non-EU countries (NONEU).[11]

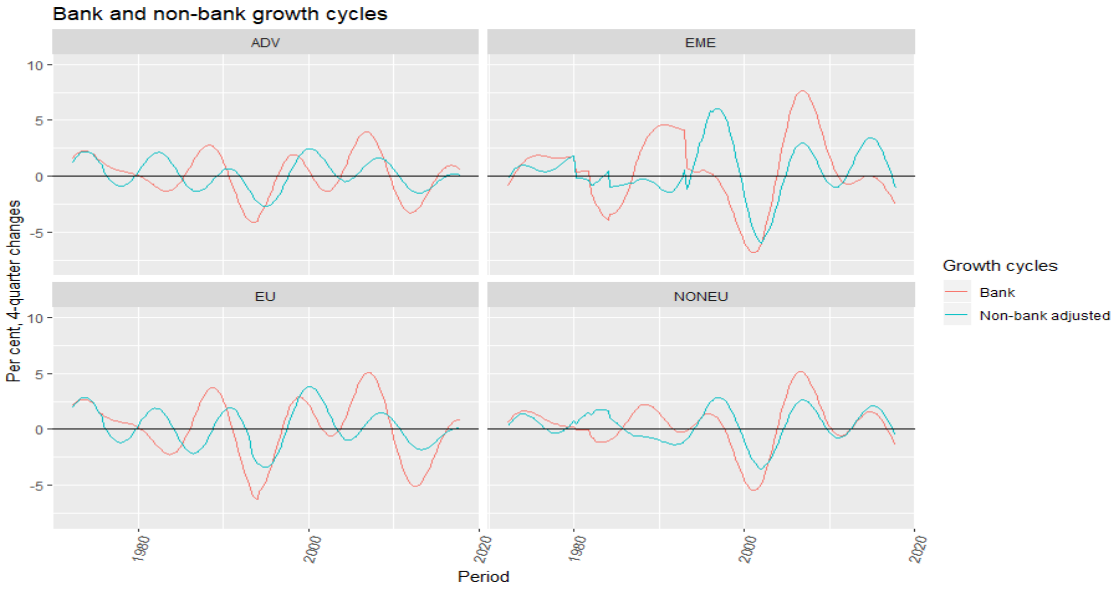
As can be seen in Figure 3, the non-bank credit growth shows its highest peak in EMEs in the 1990s, before the Asian financial crisis of 1997, where it reaches a turning point. The period before the global financial crisis stands out as a period with a strong upturn in bank credit cycles in all groups of countries, while non-bank credit also shows a peak around that time,

[11] A table of country groupings is available in the Appendix.

or slightly later. The downward cycle in bank credit is more severe in advanced and EU economies.

The robustness of these groupings is tested by using the correlation as well as concordance indices[12] between the unweighted and weighted-by-GDP cycles (see Table A.2 in the Appendix). Concordance indices measure how synchronised cycles are by focusing on the fraction of time periods that the cycles are in the same phase. Both the concordance and correlation between the unweighted and weighted-by-GDP cycles for all the groupings of countries generally yield more robust results for the non-bank cycle than that for the global aggregate cycle, especially for EU and Advanced economies.[13] However, results also indicate a higher correlation and concordance for bank cycles than for non-bank cycles in all groupings considered, confirming that the calculation of a global non-bank cycle is difficult.

Figure 3 Country groupings: Bank and non-bank growth rate cycles
(Unweighted)



Source: Authors' calculations and Bank for International Settlements statistics, https://www.bis.org/statistics/index.htm.

[12] As proposed by Harding and Pagan (2002).

[13] Correlations within country groups were also calculated over time (Figures A.2 and A.3) and show that within groupings the correlation between cycles changes over time.

These results are further confirmed with turning-point analyses. While on average we find that the duration of bank and non-bank cycles is similar within countries, it is clear that there are large differences when examining results on a country-by-country basis. Furthermore we find that on average the amplitude of the non-bank cycle is higher than the bank cycle. While this is related to the relative size of the non-bank sector (for example the non-bank credit cycle amplitude is much larger than the bank credit cycle's amplitude in countries where non-bank credit is relatively small), even for countries where non-bank credit is roughly the same size as bank credit (i.e. Great Britain, France, and Netherlands) the amplitude of the non-bank cycle still exceeds that of the bank credit cycle. Even though the amplitude of bank cycles does not differ significantly from those of non-banks in the country groupings used in Figure 3, both turning point analyses and frequency-based filters indicate that the relationship between cycles is not constant over time.

Given that the amplitude and duration of cycles vary significantly across countries and over time, and the correlation of country-groupings change over time (Figures A.3 and A.4), insight into global non-bank credit cycles is gained by examining the number of countries in upward phases over time.

Figure 4 shows the percentage of countries in the sample in which the bank and non-bank credit cycle is in an upward phase. We observe that upward phases in several countries at the same time are more common for bank credit than for non-bank credit, and the number of countries experiencing an upward phase in the non-bank cycle at one point in time never falls below 30%, while for banks this falls to 19%.

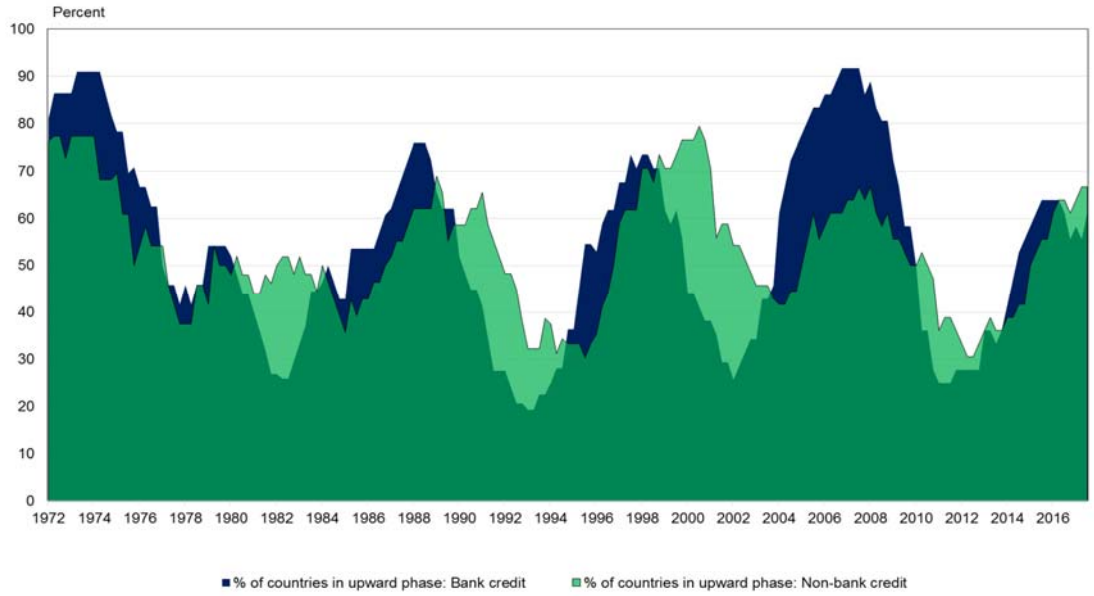
The peaks of the majority of countries in an upward phase of the bank credit cycle (i.e., 1973, 1987, 1997, 2007) coincide with global crisis periods. I.e. the OPEC oil price shock in 1973, Stock market crash in 1987, the Asian financial crisis in 1997 and the global financial crisis in 2007. Generally during these periods the number of countries experiencing an upward phase in the non-bank credit cycles does not exceed the number of countries experiencing an upward phase in the bank credit cycle, except in 2000. The period leading up to the global financial crisis appears special: more than 90 per cent of the countries (i.e., 33 out of the 36 countries in the sample) were in an upward phase of the bank credit cycle – this is the highest number during the sample period (Figure 4, blue shaded area).

Upturns in non-bank credit within countries are somewhat less synchronised (Figure 4, green shaded area). This is confirmed by grouped-country analyses as shown in the Appendix, Figure A.3. Correlations in non-bank credit were the highest in EMEs during the run-up to the Asian crisis, and in the EU during 1999-2001, at the time of the convergence plays in the run-up to monetary union. The highest number of countries experiencing an upward cycle in non-bank credit also occurred at this time (79% i.e. 27 out of 34 countries with available non-bank cycle data).

The higher percentage of countries in an upward phase at the same time for bank credit, on average, could be attributed to a number of reasons. Banks are more homogeneous as a group of lenders, and the large banks often operate across borders and generally not within only one country. Moreover, they are regulated as banks – i.e. they are a group of financial intermediaries recognised and regulated as banks across the globe. As discussed, non-bank credit is provided by a more diverse group of lenders, where the underlying financial intermediaries may not be as internationally connected as their banking counterparts. But at

the same time non-bank credit flows can be driven by international developments, especially when provided through the international bond market, which is highly integrated, while differences in interest rates can trigger large portfolio flows.

Figure 4. Percentage of countries in an upward phase in the same period for bank and non-bank cycles across countries



Source: Authors' calculations and Bank for International Settlements statistics, https://www.bis.org/statistics/index.htm.

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3.3 Cycles within countries: non-bank versus bank

To determine whether non-bank credit is a substitute for bank credit, i.e. acts as a spare tyre when bank credit contracts, the synchronization between the bank and non-bank growth cycles has to be determined. Therefore we now investigate the relationship between non-bank and bank credit cycles within each individual country. Given that the relationships appear to be time-dependent, the synchronisation of non-bank and bank cycles within countries is studied using various rolling-window Spearman rank correlation coefficients, following the Jordà et al. (2018) approach.[14] The Spearman rank correlation coefficient is calculated using credit cycles given that monotone but not necessarily linear relationships will be captured.[15] The windows are backward looking, therefore the value for the 5-year rolling window at 1990Q1 will include the correlation between 1985Q1 and 1990Q1. If there is a high correlation between bank and non-bank credit cycles within a country, this would indicate that the spare tyre argument is not valid. And a low correlation indicates a substitution between bank and non-bank credit, i.e., one cycle is expanding when the other is contracting in the most extreme case.

Individual level country results are shown in the Appendix and the same pattern is observed in several countries (Figures A.4). Specifically in Mexico, Portugal, Norway and Korea the negative correlation between banks and non-bank credit cycles is noteworthy from the 1990s

[14] Results reported in Figure A.5. Pearson correlation coefficients were also calculated, yielding similar results.

[15] We denote the Spearman correlation coefficient between countries *i* and *j* calculated over the 5-year window ending at time *t* as *si,j t* for *i*, *j* = 1, . . . *n*, where *n* is the cross-sectional sample size. A global measure of association between country-pairs for cycles can then be constructed as the average of these bilateral correlations as follows:

$$\bar{s}_t = \frac{\sum_i \sum_{j<i} s_t^{i,j}}{N}; \qquad N = \frac{n(n-1)}{2}$$

onwards, showing that bank and non-bank credit cycles are not synchronised. However in several countries the correlation has increased over time, for example Chile and China, where bank and non-bank credit is moving in a more synchronised manner. It is also interesting to note that for a group of economies the 5-year rolling window Spearman rank correlation is only briefly negative in the sampling period, including Hungary, the Netherlands, New Zealand, Poland and South Africa.

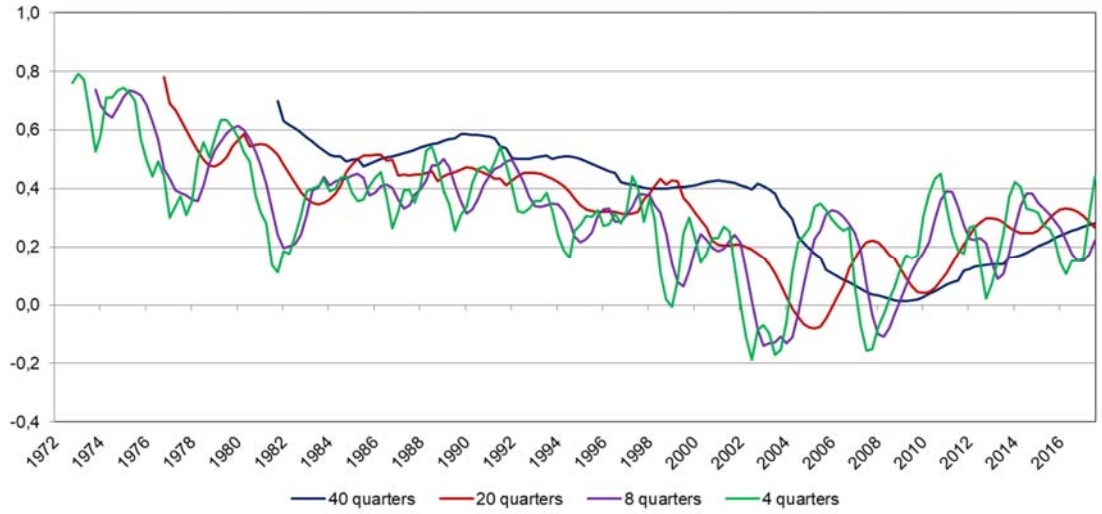
At a global level on average, the correlation between bank and non-bank credit growth has decreased from the 1970s up to early 2000s (Figure 5). It remained relatively low for several years and increased again during the past decade. During the period leading up to the global financial crisis non-bank and bank credit were less synchronised on average within the 36 countries in our dataset. This confirms the results in Figure 4, showing that while the number of countries experiencing an upward phase in non-bank credit was high, the correlation of the non-bank cycles among country pairs was relatively low, and thus the upward phases were occurring at different growth rates among countries. For banks, however, the number of banks in an upward phase was high, and the correlation of the bank cycles was high among country-pairs, indicating similar growth rates in bank credit among country pairs.

Overall, it is clear that while in certain economies there is an inverse relationship between bank and non-bank cycles, this relationship varies over time and differs among countries.

4. Non-bank Credit and Financial Crises

Given the apparent link between bank and non-bank credit growth cycle movements to financial crises periods, this section examines the implications of credit growth for the incidence of financial crises.

Figure 5. Correlation for non-bank and bank credit growth, within countries
(Spearman rank rolling window, average of all available countries over time)



Source: Authors' calculations and Bank for International Settlements statistics, https://www.bis.org/statistics/index.htm.

Bank credit growth is an important indicator of crisis episodes as shown in Schularick and Taylor (2012) and international efforts to enhance the stability of the financial system have placed it at the center of macroprudential tools, such as the countercyclical capital buffer. However, the focus has been mainly on bank or total credit to nonfinancial private sector irrespective of the type of financial institution extending said credit. Our analysis suggests that bank and non-bank credit cycles are not synchronized and that the relationship between the credit cycles changes over time, therefore both may be useful in predicting the incidence of crises. Moreover, not all crises are similar and separately considering bank and non-bank credit may provide useful insights given their importance for systemic banking or currency crises that many countries have experienced. Our benchmark analysis examines the effects of credit growth on the probability of crises episodes in order to stay close to the literature that has focused on credit growth. However, we complement our findings by studying the effect of credit cycles on the probability of crises as well, which we report in the Appendix.

We use the credit cycles' measure computed and discussed in Section 3 above. The results are similar across the two specifications, which could also be interpreted as an indication that the cyclical component of credit matters mostly for crises prediction.

We base our analysis on the crises database of Laeven and Valencia (2012), which includes all systemic banking, currency, and sovereign debt crises during the period 1970–2011 and covers all countries for which we have computed non-bank credit. We have opted for this database versus the databases in Reinhart and Rogoff (2009) or Jorda et al. (2017), because we are interested in the differential effects of bank and non-bank credit on distinct types of crisis episodes and we have restricted our analysis to the period after 1971 because of the lower availability of computed non-bank credit before. Hence, we do not need to go back further in time which would be possible with the alternative crises databases. The Laeven-Valencia database spans 162 countries, but we will restrict our analysis to the sample of 38 countries including Greece and Thailand such that we do not lose crisis observations (we obtain similar, but stronger, results if we exclude Greece and Thailand). Overall, our sample includes 79 crisis episodes out of which 42 are exclusively systemic banking crises, 28 exclusively currency crises, 6 exclusively sovereign crises, 2 jointly currency and sovereign crises, and 1 jointly systemic, currency and sovereign crisis. Detailed information about crises dates is shown in Table A.4.

We create a binary crisis indicator $C_{i.t}^{j}$, which takes value one if a crisis of type $j \in \{all,\ systemic,\ currency,\ sovereign\}$ occurred in county i in year t, and takes value zero otherwise. In particular, we estimate the following logit-panel regression:

$$logit\left(C_{i.t}^{j}\right) = \beta X_{i,t-1} + \gamma \Gamma_{i,t-1} + \theta_i + \varepsilon_{i,t},$$

where $logit\left(C_{i,t}\right) = log\left(C_{i,t}/(1 - C_{i,t})\right)$ is the log of the odds ratio,

$X_{i,t-1} = \Delta^4 \log(real\ credit_{t-1}) = \log(real\ credit_{t-1}) - \log(real\ credit_{t-5})$ is the lagged four-year growth of real total credit, real bank credit or real non-bank credit, $\Gamma_{i,t-1}$ is the vector of lagged control variables, and θ_i are the cross-sectional (country) fixed effects. Since crises are rare events, the use of fixed effects creates identification issues. As a result, we choose to use country-level fixed effects, but no time fixed effects. We include the lagged one-year real GDP growth ($\Delta^1 \log(real\ gdp_{t-1})$) and lagged inflation, which are also used in other studies (Dermirguc-Kunt and Detragiache, 1998; Danielsson et al. 2018).[16] Other control variables could include the growth in house prices and equity prices, the current account deficit, the government debt-to-GDP.[17]

Table 1 presents the results for total real credit to the non-financial business sector. The four-year lagged credit growth enters with a positive and statistically significant coefficient when all crises or systemic crises alone are considered; and the significance survives the inclusion of control variables. However, credit growth does not successfully predict currency crises in our sample. The results for sovereign crises alone should be taken with a grain of salt given the small number of observations. In addition to the real credit growth, lagged real GDP growth and lagged inflation enter with negative and positive signs, respectively, when all crises episodes are considered, but only inflation is statistically significant Thus, countries that experience lower inflation are less likely to experience a crisis episode.

[16] We have also considered four-year real GDP growth and four-year inflation as control variables and we obtain the same results. We have opted for one-year lagged control because GDP and inflation should respond to economic condition faster than credit aggregates and may captures the incidence of crises in a timelier manner.

[17] Kiley (2018) reconsiders the role of asset prices and current account deficits in predicting as leading indicators of financial crises and finds that they are superior to credit growth. Danielsson et al. (2018) shows that abnormally low asset price volatility is a good indicator of crises through history for a large sample of countries. Lee (forthcoming) show that a composite indicator of asset prices, lending standards, financial and non-financial leverage predicts international crises episodes. Catão and Milesi-Ferretti (2014) find that the ratio of net foreign liabilities to GDP is a good predictor of external crises. We do not include these indicators, because the purpose of our analysis is not to find alternative indicators that perform better than credit growth in crisis prediction models, but rather to examine the differential effect of bank credit and non-bank credit on the incidence of different types of crises.

Table 1: Total credit and financial crises

	All crises		Systemic crises		Currency crises		Sovereign crises	
$\Delta^4 real\ t\ credit_{t-1}$	2.09**	2.66***	3.20***	3.29***	0.71	1.31	2.11	4.04**
	(0.92)	(0.79)	(0.94)	(1.01)	(1.23)	(1.13)	(2.54)	(2.05)
$\Delta^1 real\ gdp_{t-1}$		--3.62		-0.31		1.44		-53.63**
		(3.72)		(3.47)		(7.40)		(27.00)
$inflation_{t-1}$		3.10**		0.72		3.61**		-5.01
		(1.53)		(2.38)		(1.68)		(10.31)
Num. of Obs.	972	972	883	883	459	459	103	103
Pseudo R^2	0.07	0.08	0.06	0.06	0.04	0.06	0.03	0.56
AUROC	0.71	0.72	0.68	0.68	0.64	0.71	0.66	0.95
Marginal effects								
$\Delta^4 real\ t\ credit_{t-1}$	0.08	0.10	0.09	0.09				0.006

*** p<0.01, ** p<0.05, * p<0.1. All of the specifications include fixed. The standard errors, reported in parentheses, are robust and clustered at the country level. We report marginal effects only when the coefficients are statistically significant.

In order to evaluate the ability of real credit growth to act as a leading indicator for crises, we compute the area under the receiving operating curve (AUROC) when all other controls are removed for the regression. AUROC has been suggested by Schularick and Taylor (2012) among others as a useful statistic to evaluate the ability of indicators to accurately signal the true incidence of a crisis.[18] We obtain an AUROC of 0.71 similar to Schularick and Taylor who find an AUROC of 0.72, providing some confidence in the ability of credit growth to predict crises in our sample. Finally, the estimated marginal effects show that a 1% increase in credit growth translates into about 0.1% increase in the probability of general and systemic crises.

Tables 2 and 3 present the results for the same regressions when real bank and non-bank credit growth are considered as leading indicators, respectively.[19] As mentioned, our objective is to study the differential impact of bank and non-bank credit on the probability of different types of crises. Indeed, bank credit real growth can act as a leading indicator for all crisis and especially systemic crises, as its coefficient is statistically significant even after the

[18] AUROC equal to 0.5 suggests that the indicator is not informative, while AUROC of 1 suggests that the indictor can perfectly discriminate crisis episodes.

[19] Tables A.5 and A.6 in the Appendix report the results when bank and non-bank credit cycles are considered as leading indicators. We exclude Greece and Thailand from the analysis, since we have not computed non-bank credit cycles for these two countries.

inclusion of control variables, and the AUROC is 0.70 when bank credit real growth is the only explanatory variable. The estimated marginal effects show that a 1% increase in bank credit growth translates into about 0.08% increase in the probability of general crises and systemic crises. Nevertheless, bank credit is not useful to discriminate currency (or sovereign) crises.

Table 2: Bank credit and financial crises

	All crises		Systemic crises		Currency crises		Sovereign crises	
$\Delta^4\ real\ b\ credit_{t-1}$	1.41**	2.14***	3.10***	3.32***	-0.04	0.42	0.21	3.28
	(0.69)	(0.60)	(0.88)	(0.94)	(0.83)	(1.80)	(0.84)	(2.54)
$\Delta^1\ real\ gdp_{t-1}$		-4.68		-1.72		0.81		-54.05**
		(3.75)		(3.89)		(0.11)		(25.29)
$inflation_{t-1}$		3.58**		1.58		3.29		-4.45
		(1.58)		(3.00)		(1.86)		(10.50)
Num. of Obs.	962	962	873	873	453	453	103	103
Pseudo R^2	0.06	0.08	0.07	0.07	0.04	0.05	0.00	0.55
AUROC	0.70	0.71	0.70	0.70	0.62	0.67	0.54	0.94
Marginal effects								
$\Delta^4\ real\ b\ credit_{t-1}$	0.06	0.08	0.08	0.09				

*** p<0.01, ** p<0.05, * p<0.1. All of the specifications include fixed. The standard errors, reported in parentheses, are robust and clustered at the country level. We report marginal effects only when the coefficients are statistically significant.

Turning to Table 3, real non-bank credit growth is also useful to predict crises episodes but its success concentrates on currency rather than on systemic crises. This is in contrast to bank or total credit which were mainly useful in predicting systemic crises episodes. The estimated marginal effects show that a 1% increase in credit growth translates into about 0.05% increase in the probability of general crises and currency crises episodes.

Table 3: Non-bank credit and financial crises

	All crises		Systemic crises		Currency crises		Sovereign crises	
$\Delta^4\ real\ nb\ credit_{t-1}$	1.24**	1.20**	0.45	0.43	1.51**	1.58**	3.56	3.69***
	(0.54)	(0.54)	(0.47)	(0.46)	(0.69)	(0.79)	(2.58)	(0.79)
$\Delta^1\ real\ gdp_{t-1}$		-2.59		0.96		3.37		-51.23**
		(3.68)		(4.17)		(7.76)		(27.39)
$inflation_{t-1}$		1.61		-1.41		3.12		-7.66
		(1.62)		(2.08)		(2.07)		(9.12)
Num. of Obs.	953	953	864	864	444	444	103	103
Pseudo R^2	0.06	0.07	0.03	0.03	0.07	0.08	0.19	0.58
AUROC	0.70	0.70	0.58	0.63	0.71	0.73	0.79	0.95
Marginal effects								
$\Delta^4\ real\ nb\ credit_{t-1}$	0.05	0.05			0.04	0.04		0.003

*** p<0.01, ** p<0.05, * p<0.1. All of the specifications include fixed. The standard errors, reported in parentheses, are robust and clustered at the country level. We report marginal effects only when the coefficients are statistically significant.

The differential ability of bank and non-bank credit to act as leading indicators for systemic and currency crises, respectively, is the main takeaway and contribution of our analysis with respect to crisis predictability. As mentioned, literature has agreed that credit growth is an important indicator for crises, but we augment this argument by showing that not all types of credit to the nonfinancial business sector should be treated equally.[20]

Bank credit is useful to explain systemic banking crises, while non-bank credit could better explain currency crises due to the reversal of capital flows resulting in sudden stops.

Although additional analysis is needed to uncover the underlying mechanism, we conjecture that panics related to sudden stops around currency crises could be better tied to reversals in non-bank credit. One explanation is that non-bank credit provision – and in particular bond financing – is at times more closely related to movements in international capital flows compared to bank credit supported by deposits in domestic currency. Non-financial corporations tend to borrow in foreign currency--included in our non-bank credit measure--when interest rates abroad are relatively lower (Keloharju and Niskanen, 2001; Habib and Joy, 2008). A reversal in capital inflows worsens the ability of firms to rollover their debt, while, at the same time, domestic authorities may need to maintain higher interest rates to support the peg. The latter can be harmful for the domestic economy especially if corporations are highly indebted and cannot substitute external for more expensive internal credit. Overall, the ability to maintain the peg may be curtailed when non-credit from abroad is elevated amplifying the consequences of adverse shocks that can lead to currency crises. While total

[20] It should be noted that non-bank credit real growth--as well as total credit growth--appear to be useful in predicting sovereign crises when control variables are included in the regressions. Despite the statistically significant coefficient, the low marginal effects in combination with the few incidents of sovereign crises could cast some doubt on the robustness of this result.

credit has been a leading indicator in several studies on early warning indicators for currency crises (based on the overview of the literature in Frankel and Saravelos, 2010), we are not aware of studies that have pointed specifically to the role of non-bank credit.

5. Conclusion

Our results show that the cyclical properties of bank non-bank credit differ from those of bank credit. First, the duration of non-bank credit cycles is, on average, similar to bank credit cycles, while the amplitude of non-bank cycles is larger generally for non-bank credit cycles than for bank credit cycles. Within countries the relationship between non-bank and bank credit cycles changes over time and generally has become less synchronised in the period up to the global financial crisis. Second, non-bank credit cycles are highly synchronised with bank credit cycles in some countries but not in others. Third, we find that non-bank credit is less synchronised than bank credit across countries.

Moreover, we argue that monitoring non-bank credit can bring additional information as a leading indicator for periods of financial instability, in particular currency crises. We complement the existing literature on leading indicators for financial crises by showing that bank credit is a useful indicator for systemic banking crises, while non-bank credit is helpful to predict currency crises; but not vice versa. These findings highlight the value added of monitoring non-bank credit next to the traditional focus on bank credit. Hence, we believe that the large and growing literature on financial cycles and credit cycles could be complemented by research on cycles in non-bank credit.

A key difference of non-bank credit to bank credit, is that non-bank credit can be provided by a range of suppliers. Hence, one direction that further research could take is to look for a more disaggregated approach, investigating the properties of the different components of

non-bank credit (i.e. debt securities and non-bank loans) and different sources of non-bank credit, such as investment funds, insurance companies, pension funds, governments and foreign lenders.

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Appendix.

Table A.1 Country groupings

Country	Country	EU countries	EMEs vs ADV
AT	Austria	EU	ADV
AU	Australia		ADV
BE	Belgium	EU	ADV
BR	Brazil		EME
CA	Canada		ADV
CH	Switzerland		ADV
CL	Chile		EME
CN	China		EME
CZ	Czech republic	EU	ADV
DE	Germany	EU	ADV
DK	Denmark	EU	ADV
ES	Spain	EU	ADV
FI	Finland	EU	ADV
FR	France	EU	ADV
GB	Great Britain	EU	ADV
HU	Hungary	EU	EME
ID	Indonesia		EME
IE	Ireland	EU	ADV
IL	Israel		ADV
IN	India		EME
IT	Italy	EU	ADV
JP	Japan		ADV
KR	Korea		ADV
LU	Luxembourg	EU	ADV
MX	Mexico		EME
NL	Netherlands	EU	ADV
NO	Norway		ADV
NZ	New Zealand		ADV
PL	Poland	EU	EME
PT	Portugal	EU	ADV
RU	Russia		EME
SE	Sweden	EU	ADV
SG	Singapore		ADV
TR	Turkey		EME
US	United States		ADV
ZA	South Africa		EME

Table A.2 Robustness test: The correlation and concordance* between weighted and unweighted cycles for all countries in the sample and for grouped countries

	Correlation	Concordence
All bank	0.81	0.79
All non-bank	0.23	0.56
EU bank	0.96	0.87
EU non-bank	0.81	0.76
ADV bank	0.87	0.84
ADV non-bank	0.55	0.72
EME bank	0.88	0.86
EME non-bank	0.36	0.67
Non_EU bank	0.58	0.70
Non_EU non-bank	0.26	0.52

* Correlation is measured as the correlation for the entire sample period between the unweighted and weighted-by-GDP series. Concordance, calculated as proposed by Harding and Pagan (2002), measures the percentage of total periods in which cycles are in the same phase. Numbers displayed were calculated over the entire sampling periods, subject to data availability.

Table A.3 Turning point analyses[1]

Country	Phase	Amplitude			Duration			Total cycle duration		
		Non-bank	Bank	Difference between non-bank and bank	Non-bank	Bank	Difference between non-bank and bank	Non-bank	Bank	Difference between non-bank and bank
AT	Expansion	16.4	9.1	7.37	13.3	16.4	-3.15	41.0	32.4	8.60
	Contraction	18.0	10.0	7.97	27.8	16.0	11.75			
AU	Expansion	16.6	12.1	4.43	26.3	28.5	-2.25	41.3	42.5	-1.25
	Contraction	17.1	13.6	3.52	15.0	14.0	1.00			
BE	Expansion	35.3	16.5	18.85	27.7	20.5	7.17	47.3	41.5	5.83
	Contraction	30.1	16.0	14.03	19.7	21.0	-1.33			
CA	Expansion	20.0	19.6	0.48	21.0	12.5	8.50	37.7	62.0	-24.33
	Contraction	18.4	18.6	-0.16	16.7	49.5	-32.83			
CH	Expansion	19.7	9.6	10.15	24.0	21.0	3.00	68.0	36.5	31.50
	Contraction	17.2	9.8	7.39	44.0	15.5	28.50			
CL	Expansion	31.7	17.8	13.95	17.0	16.3	0.67	45.0	36.1	8.92
	Contraction	40.0	16.3	23.70	28.0	19.8	8.25			
CN	Expansion	75.3	15.8	59.47	13.0	25.5	-12.50	29.0	37.5	-8.50
	Contraction	52.3	18.7	33.67	16.0	12.0	4.00			
CZ	Expansion	22.9	30.1	-7.16	14.5	16.5	-2.00	30.2	36.5	-6.33
	Contraction	26.0	20.3	5.69	15.7	20.0	-4.33			
DE	Expansion	17.5	7.0	10.44	15.8	25.0	-9.25	30.8	46.0	-15.25
	Contraction	17.2	7.7	9.48	15.0	21.0	-6.00			
DK	Expansion	24.1	11.6	12.48	27.7	17.3	10.42	58.0	43.5	14.50
	Contraction	29.9	13.5	16.46	30.3	26.3	4.08			
ES	Expansion	41.1	15.0	26.10	24.3	24.0	0.25	43.3	43.3	-
	Contraction	47.2	19.1	28.06	19.0	19.3	-0.25			
FI	Expansion	25.9	26.7	-0.83	38.3	37.0	1.33	49.3	73.5	-24.17
	Contraction	30.2	24.8	5.46	11.0	36.5	-25.50			
FR	Expansion	15.9	9.0	6.97	16.3	19.3	-3.00	48.6	39.8	8.83
	Contraction	17.6	8.9	8.65	32.3	20.5	11.83			
GB	Expansion	28.4	16.3	12.06	29.5	28.3	1.17	44.0	58.3	-14.33
	Contraction	31.6	20.5	11.09	14.5	30.0	-15.50			
ID	Expansion	159.0	17.7	141.32	18.0	16.0	2.00	69.5	35.3	34.17
	Contraction	112.2	28.9	83.25	51.5	19.3	32.17			
IE	Expansion	44.7	27.6	17.12	22.0	24.8	-2.75	46.0	40.5	5.50
	Contraction	40.6	30.7	9.84	24.0	15.8	8.25			
IL	Expansion	25.7	10.1	15.55	34.5	16.0	18.50	55.2	44.0	11.17
	Contraction	29.3	25.1	4.20	20.7	28.0	-7.33			
IN	Expansion	77.7	22.3	55.44	27.0	33.3	-6.33	41.3	56.3	-15.00
	Contraction	91.4	18.5	72.87	14.3	23.0	-8.67			
IT	Expansion	43.1	12.0	31.06	46.5	25.7	20.83	79.0	62.2	16.83
	Contraction	31.5	15.4	16.09	32.5	36.5	-4.00			
JP	Expansion	15.1	10.6	4.41	25.7	30.3	-4.67	70.7	51.3	19.33
	Contraction	18.0	12.3	5.78	45.0	21.0	24.00			
KR	Expansion	33.3	17.1	16.21	22.3	20.6	1.73	55.3	34.2	21.13
	Contraction	31.3	20.3	10.95	33.0	13.6	19.40			
MX	Expansion	76.5	61.5	14.96	14.3	27.7	-13.42	36.6	52.7	-16.08
	Contraction	68.2	57.5	10.70	22.3	25.0	-2.67			
NL	Expansion	17.8	11.5	6.29	17.7	20.8	-3.08	55.7	38.8	16.92
	Contraction	18.2	13.1	5.14	38.0	18.0	20.00			
NO	Expansion	19.8	20.4	-0.63	19.3	19.3	0.08	47.3	39.6	7.75
	Contraction	15.8	24.8	-8.96	28.0	20.3	7.67			
NZ	Expansion	58.6	11.2	47.41	19.0	23.3	-4.33	40.5	57.0	-16.50
	Contraction	52.9	17.1	35.71	21.5	33.7	-12.17			
PT	Expansion	29.9	14.3	15.61	28.3	18.4	9.85	41.3	35.4	5.85
	Contraction	28.4	18.9	9.55	13.0	17.0	-4.00			
RU	Expansion	48.6	25.1	23.49	14.0	13.5	0.50	25.5	28.0	-2.50
	Contraction	60.3	35.5	24.82	11.5	14.5	-3.00			
SE	Expansion	23.8	11.9	11.86	21.5	38.5	-17.00	38.8	60.5	-21.67
	Contraction	26.9	17.2	9.72	17.3	22.0	-4.67			
SG	Expansion	60.7	19.1	41.64	19.7	35.5	-15.83	51.0	69.5	-18.50
	Contraction	63.6	22.0	41.56	31.3	34.0	-2.67			
TR	Expansion	68.3	78.4	-10.08	18.7	10.0	8.67	44.7	30.0	14.67
	Contraction	87.1	62.5	24.60	26.0	20.0	6.00			
US	Expansion	7.9	14.9	-7.04	16.8	19.6	-2.80	36.3	34.0	2.30
	Contraction	8.8	16.0	-7.25	19.5	14.4	5.10			
ZA	Expansion	86.4	18.0	68.33	59.0	20.8	38.25	74.0	39.3	34.75
	Contraction	130.9	17.9	113.00	15.0	18.5	-3.50			
AVERAGE	EXP	40.5	19.0	21.5	23.6	22.6	1.0	47.6	44.9	2.6
	CON	41.3	20.9	20.5	24.4	22.4	2.1			

1 Results shown were calculated using R.

Table A.4 Crisis periods

Country	Code	Systemic crises	Currency crises	Sovereign crises
Austria	AT	2008		
Belgium	BE	2008		
Brazil	BR	1990, 1994	1976, 1982, 1987, 1992, 1999	1983
Chile	CL	1976, 1981	1972, 1982	1983
China, P.R.	CN	1998		
Czech Republic	CZ	1996		
Denmark	DK	2008		
Finland	FI	1991	1993	
France	FR	2008		
Germany	DE	2008		
Hungary	HU	1991, 2008		
India	IN	1993		
Indonesia	ID	1997	1979, 1998	1999
Ireland	IE	2008		
Israel	IL	1977	1975, 1980, 1985	
Italy	IT	2008	1981	
Japan	JP	1997		
Korea	KR	1997	1998	
Luxembourg	LU	2008		
Mexico	MX	1981, 1994	1977, 1982, 1995	1982
Netherlands	NL	2008		
New Zealand	NZ		1984	
Norway	NO	1991		
Poland	PL	1992		1981
Portugal	PT	2008	1983	
Russia	RU	1998, 2008	1998	1998
South Africa	ZA		1984	1985
Spain	ES	1977, 2008	1983	
Sweden	SE	1991, 2008	1993	
Switzerland	CH	2008		
Turkey	TR	1982, 2000	1978, 1984, 1991, 1996, 2001	1978
United Kingdom	GB	2007		
United States	US	1988, 2007		

Source: Laeven and Valencia (2012)

Table A.5 Bank credit cycle and financial crises

	All crises		Systemic crises		Currency crises		Sovereign crises	
$\Delta^4\ real\ b\ cycle_{t-1}$	-0.00	0.01	0.07*	0.08*	-0.05	-0.04	-0.06	-0.01
	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.08)	(0.05)
$\Delta^1\ real\ gdp_{t-1}$		-2.71		-3.56		2.07		-28.29***
		(3.84)		(4.41)		(8.61)		(9.16)
$inflation_{t-1}$		1.20		-1.44		1.69		-3.60
		(1.75)		(2.17)		(2.89)		(2.70)
Num. of Obs.	1038	1005	910	910	450	417	103	103
Pseudo R^2	0.04	0.08	0.04	0.04	0.05	0.06	0.05	0.27
AUROC	0.64	0.66	0.64	0.64	0.70	0.71	0.64	0.85

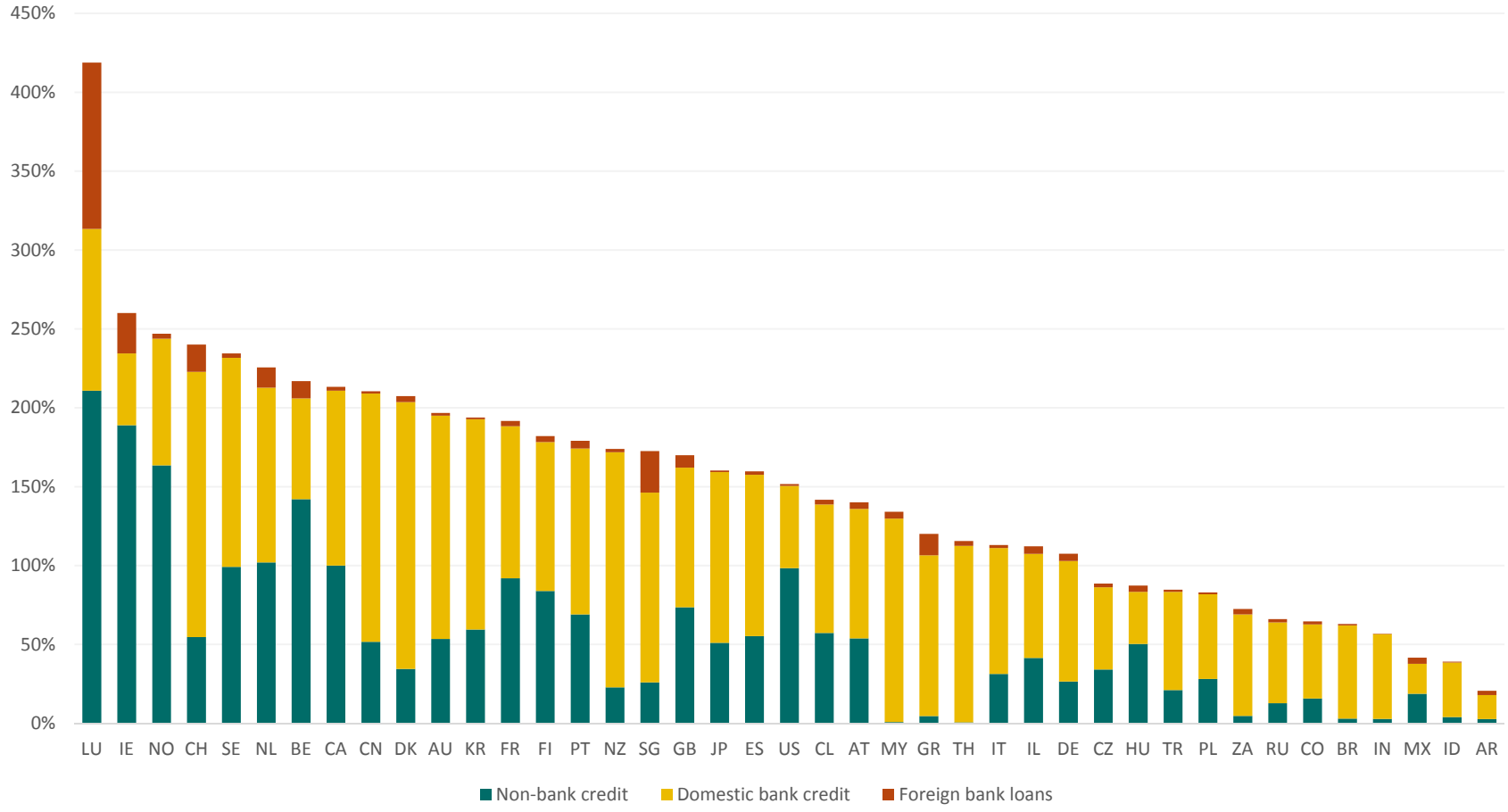
*** p<0.01, ** p<0.05, * p<0.1. All of the specifications include fixed. The standard errors, reported in parentheses, are robust and clustered at the country level.

Table A.6 Non-bank credit cycle and financial crises

	All crises		Systemic crises		Currency crises		Sovereign crises	
$\Delta^4\ real\ nb\ cycle_{t-1}$	0.07**	0.08**	0.03	0.03	0.13***	0.14***	0.06**	0.06**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
$\Delta^1\ real\ gdp_{t-1}$		-2.84		-0.08		1.07		-25.96***
		(3.52)		(4.17)		(8.60)		(8.61)
$inflation_{t-1}$		1.42		-1.88		2.98		-2.39
		(1.66)		(2.15)		(2.26)		(2.86)
Num. of Obs.	1038	1005	910	910	450	417	103	103
Pseudo R^2	0.07	0.07	0.03	0.03	0.11	0.13	0.03	0.29
AUROC	0.69	0.69	0.61	0.63	0.76	0.78	0.70	0.87

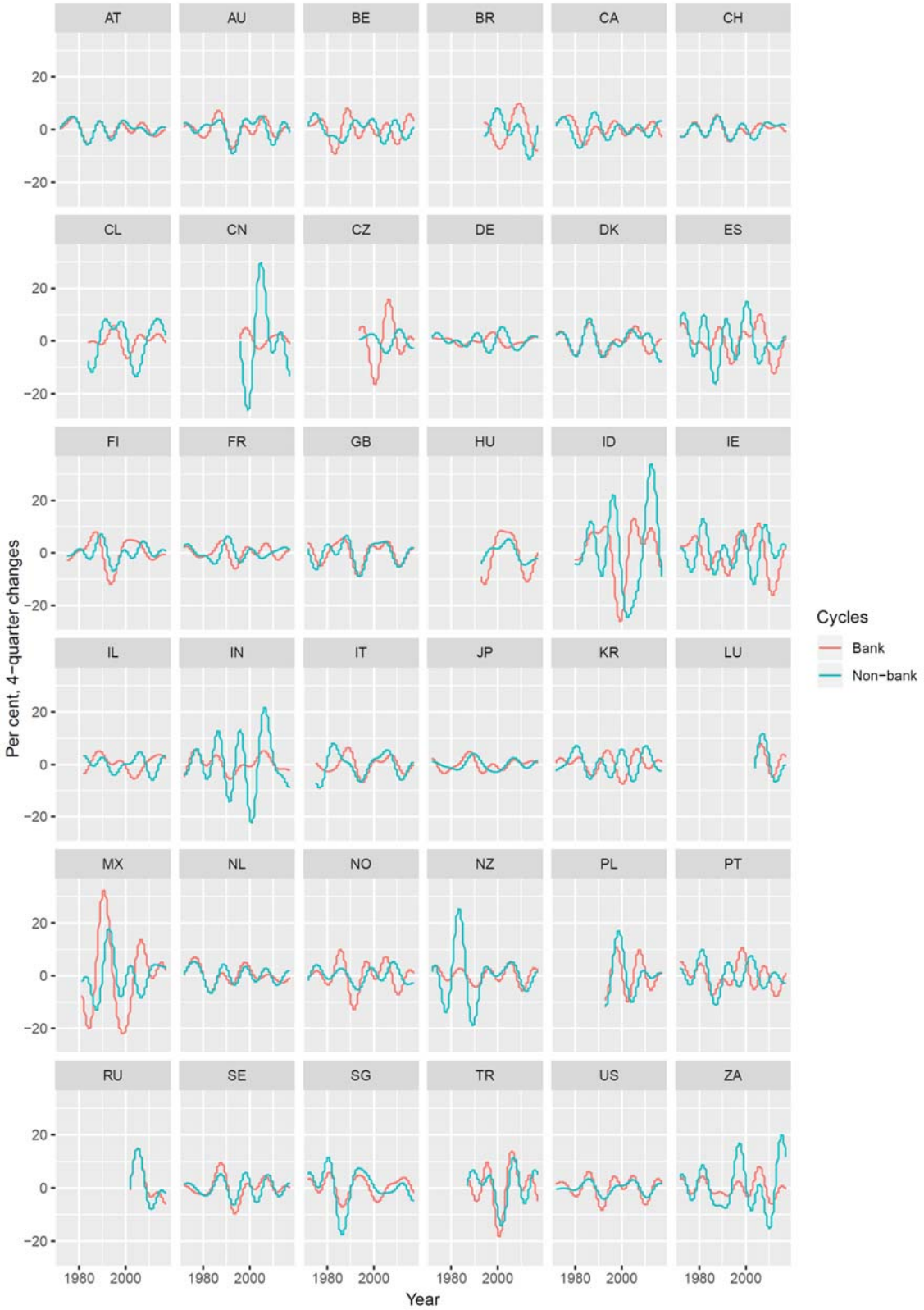
*** p<0.01, ** p<0.05, * p<0.1. All of the specifications include fixed. The standard errors, reported in parentheses, are robust and clustered at the country level.

Figure A.1 Components of total credit, 2017Q3, % GDP



Source: Authors' calculations and Bank for International Settlements statistics, https://www.bis.org/statistics/index.htm.

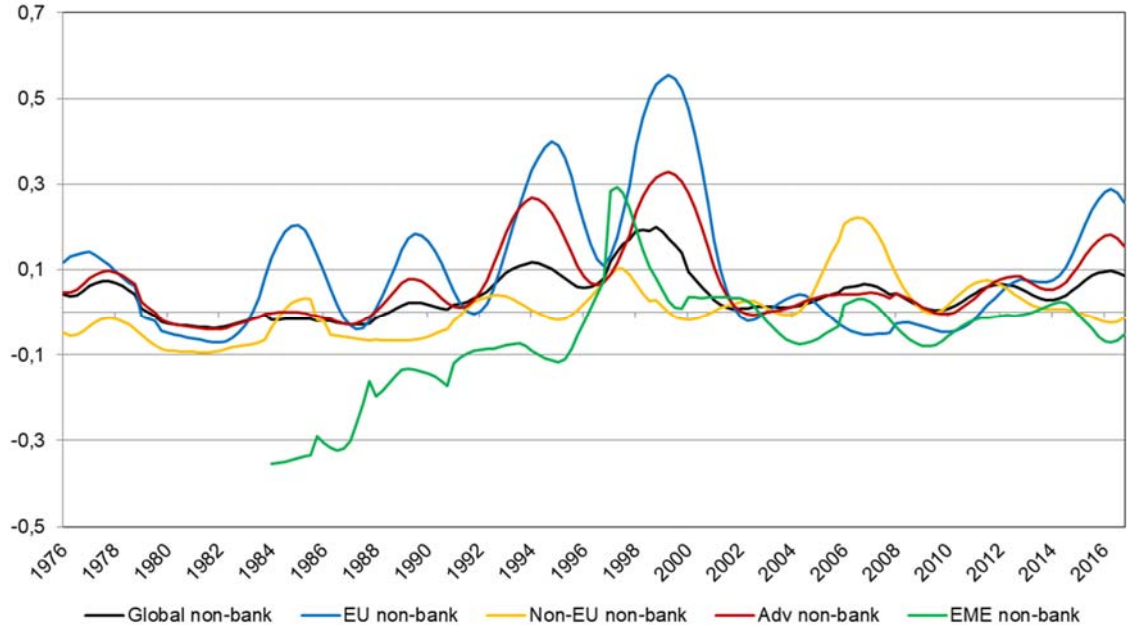
Figure A.2 (note: country codes are provided in Table A.1)



Source: Authors' calculations and Bank for International Settlements statistics, https://www.bis.org/statistics/index.htm.

Figure A.3 Correlation across country groups, non-bank credit

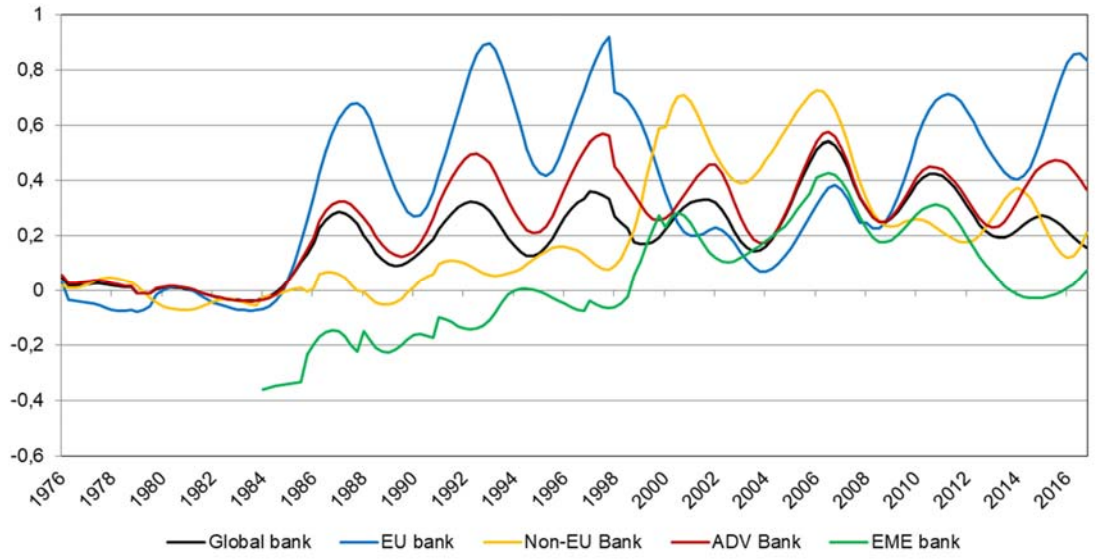
(Average for country pairs, Spearman rank, 5-year rolling windows)



Source: Authors' calculations and Bank for International Settlements statistics, https://www.bis.org/statistics/index.htm.

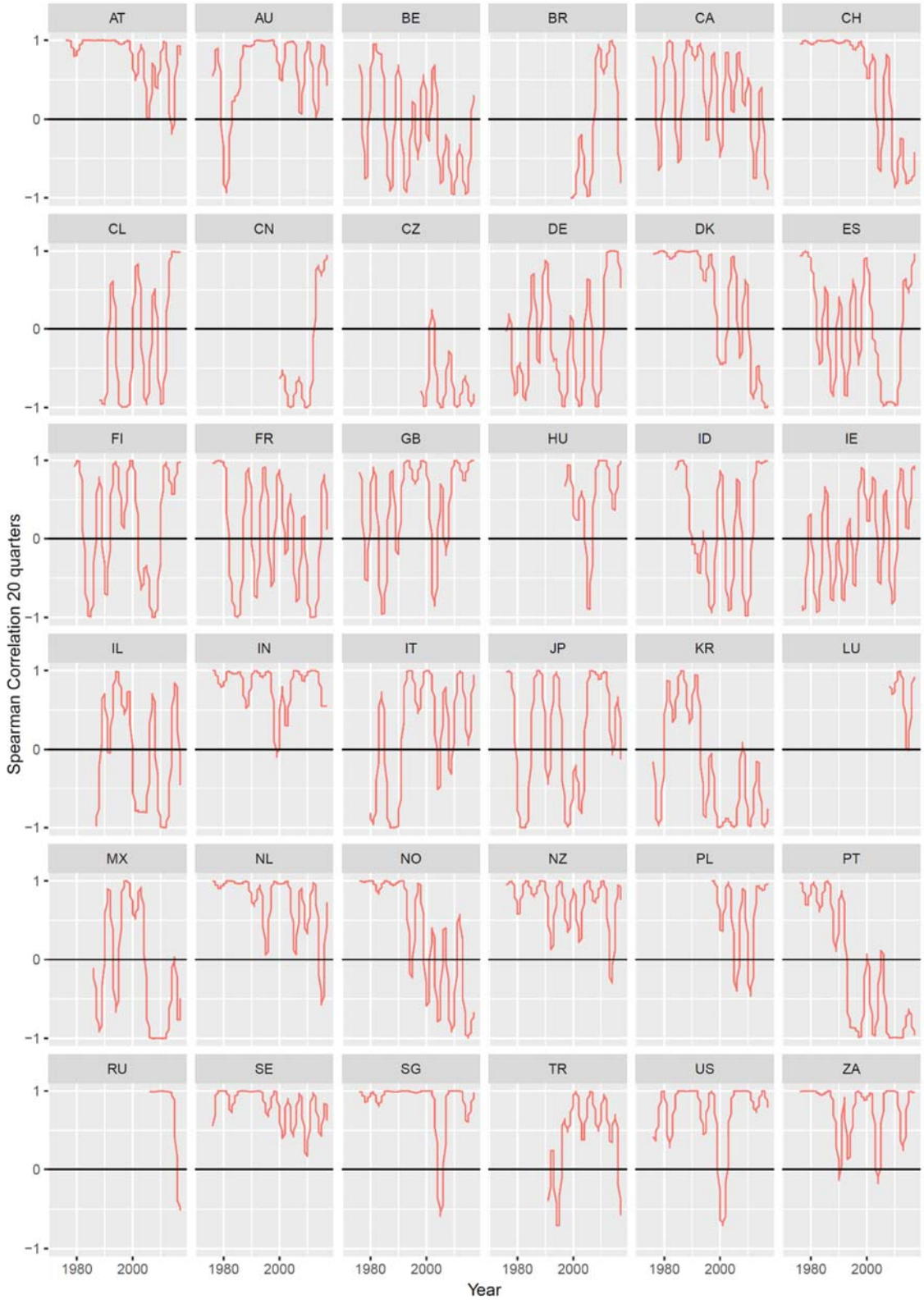
Figure A.4 Correlation across country groups, bank credit

(Average for country pairs, Spearman rank, 5-year rolling windows)



Source: Authors' calculations and Bank for International Settlements statistics, https://www.bis.org/statistics/index.htm.

Figure A.5 Spearman rank correlation: Bank and non-bank cycles within a country
(20 quarter rolling windows)



Source: Authors' calculations and Bank for International Settlements statistics, https://www.bis.org/statistics/index.htm.