The Synchronization of Business Cycles and Financial Cycles in the Euro Area*

William Oman
International Monetary Fund and CES, Université Paris 1 Panthéon-Sorbonne

Using a frequency-based filter, I document the existence of a euro-area financial cycle and high- and low-amplitude national financial cycles. Applying concordance and similarity analysis to business and financial cycles, I provide evidence of five empirical regularities: (i) the aggregate euro-area credit-to-GDP ratio behaved procyclically in the years preceding euro-area recessions; (ii) financial cycles are less synchronized than business cycles; (iii) business cycle synchronization has increased while financial cycle synchronization has decreased; (iv) financial cycle desynchronization was more pronounced between high-amplitude and low-amplitude countries, especially Germany; (v) high-amplitude countries and Germany experienced divergent leverage dynamics after 2002.

JEL Codes: E32, E44, E58, F36, F44, F45.

1. Introduction

The financial cycle is emerging as an important concept to capture macrofinancial dynamics (Borio 2014) and predict systemic banking crises (Drehmann, Borio, and Tsatsaronis 2012; Schüler, Hiebert, and Peltonen 2017). As a result, central banks are increasingly using the financial cycle as a rationale for countercyclical macroprudential

*I am very grateful to Michel Aglietta, Bergljot Barkbu, Rodolphe Blavy, Stijn Claessens, Olivier Darmouni, Mathias Drehmann, Jeffrey Franks, Dirk Krueger, Luc Laeven, Eric Monnet, Hanni Schoelermann, Bruno Tinel, William White, and an anonymous referee for helpful comments and suggestions on previous versions of this paper. The views expressed in this paper represent those of the author and not necessarily those of the International Monetary Fund, its Management, or its Executive Directors. Author contact: International Monetary Fund, 700 19th Street NW, Washington, DC 20431, USA. E-mail: WOman@imf.org.

policies. For instance, Constâncio (2016, 2017) argues that policies targeting the financial cycle, such as macroprudential policy, can powerfully complement policies that target the business cycle, such as monetary policy, since business and financial cycles are not always synchronized.

As a concept distinct from the business cycle, the financial cycle originates from work carried out at the Bank for International Settlements (Borio, Kennedy, and Prowse 1994; Borio, Furfine, and Lowe 2001; Drehmann, Borio, and Tsatsaronis 2012; Borio, Disyatat, and Juselius 2013; Borio 2014; and Borio, Lombardi, and Zampolli 2016). Borio (2014) defines the financial cycle as "self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints, which translate into booms followed by busts." The financial cycle's focus on the co-movement of credit and asset prices means that it is closely related to two new stylized facts from the literature: (i) the increase in financialization and leverage in advanced economies since the 1970s, which is associated with deeper recessions (see Jordà, Schularick and Taylor 2011, 2013, 2016a, 2016b, 2017, and Schularick and Taylor 2012 for empirical evidence), economic booms and busts (see Geanakoplos 2010 for a model linking variations in leverage, asset price fluctuations) and financial instability (Brunnermeier and Sanikov 2014 and Adrian and Boyarchenko 2015); and (ii) the explosion of cross-border bank lending (Shin 2012; Lane and McQuade 2014).

Empirical work on domestic financial cycles remains relatively sparse and falls into two main categories: attempts to improve the measurement of financial cycles, and analyses of the synchronization of financial cycles or their component variables.

Recent studies on domestic financial cycle measurement have focused, like this paper, on euro-area financial cycles. European Central Bank (2014) documents heterogeneity across euro-area financial cycles. Stremmel (2015) identifies credit growth, the credit-to-GDP ratio, and the ratio of house prices to income as the best-fitted measures of financial cycles. Gorton and Ordoñez (2016) provide further implicit justification for using both credit and asset prices to study financial cycles, as they show that not all credit booms are followed by financial crises. Building on the methodology used in Stremmel (2015), Stremmel and Zsámboki (2015) find that financial cycles are less synchronized in tranquil periods and more synchronized

in periods of common financial stress. Galati et al. (2016), echoing Drehmann, Borio, and Tsatsaronis (2012), find that financial cycles are longer and more ample than business cycles. Gerdrup, Kvinlog, and Schaanning (2013) and Detken et al. (2014) similarly find that the average length of the financial cycle is around four times that of the business cycle.

Two recent papers use different methodologies to measure the financial cycle and arrive at similar conclusions. Rünstler and Vlekke (2018) apply multivariate unobserved-component models to France, Germany, Italy, Spain, the United Kingdom, and the United States, and find that, in those countries, financial cycles are longer than business cycles and range from thirteen to eighteen years. Moreover, they find that financial cycles are heterogeneous across European countries, with Germany standing out due to its very short and low-amplitude financial cycle and Spain, by contrast, having a much longer and more ample financial cycle. Looking at G-7 countries, Schüler, Hiebert, and Peltonen (2017) use a new spectral approach and find that financial cycles exhibit higher amplitude and persistence than business cycles, with financial cycles lasting 15 years on average, versus 6.7 years for G-7 business cycles, excluding Japan. They too find that Germany's financial cycle has the lowest amplitude and average length.

A related, nascent literature studies the synchronization of financial cycles or their component variables. Claessens, Kose, and Terrones (2011, 2012) analyze credit, housing, and equity cycles in twenty-one advanced economies, finding them highly synchronized within and across countries. Rey (2015) finds evidence of strong international co-movement among financial variables. Schüler, Hiebert, and Peltonen (2017) find that most G-7 financial cycles are closely related, but Germany's and Japan's are not. They find that G-7 countries' business cycles, by contrast, are closely linked. Samarina, Zhang, and Bezemer (2016) study credit cycles in sixteen euro-area countries over 1990–2013, which they decompose into mortgage credit and private non-financial credit. They find that credit cycles diverged between and within countries following the introduction of the euro.

Focusing on business cycle synchronization in the future European Economic and Monetary Union (EMU) countries before

the creation of EMU, Eichengreen (1991) finds a low degree of correlation of economic shocks among European countries. Giannone and Reichlin (2006) find mixed evidence on business cycle synchronization, with cyclical asymmetries among euro-area economies being relatively limited and comparable to those among U.S. regions. While McCarthy (2006) finds limited evidence that the creation of EMU has increased business cycle synchronization across euro-area countries, even if one includes the pre-EMU period, De Grauwe and Ji (2016) find a high degree of business cycle synchronization within the euro area over the period 1995–2014. Looking beyond Europe, Jordà, Schularick, and Taylor (2017) find that advanced economies have become more synchronized.

Finally, a third strand of the literature studies the relationship between financial integration and business cycle synchronization. Kalemli-Ozcan, Papaioannou, and Perri (2013) provide evidence and develop a model in which financial integration affects business cycle co-movement differently depending on whether shocks to the economy are real or financial.

According to the model, financial integration has a significant effect on business cycle co-movement in tranquil times (less synchronization) and in crisis episodes (more co-movement), consistent with the financial cycle evidence gathered by Stremmel and Zsámboki (2015). Monnet and Puy (2016) note that several studies find that trade and financial integration are associated with more business cycle synchronization (Bordo and Helbling 2003; Kose, Otrok, and Whiteman 2003, 2008; and Kose, Prasad, and Terrones 2003). On the other hand, Enderlein et al. (2016) argue that EMU has failed to promote better business cycle synchronization in the euro area. Cesa-Bianchi, Imbs, and Saleheen (2016) study the interaction of capital flows and business cycles, and find that, in response to common shocks, capital tends to flow systematically between similar countries, even as GDP growth rate discrepancies widen between them. This means that, in response to common shocks, synchronization falls as financial integration increases. Conversely, financial integration reinforces synchronization of business cycles in response to country-specific shocks.

Despite the extensive ground covered by this literature, I am not aware of any cross-country studies of the relationship between business cycles and financial cycles over a long period of time and

analyzing both co-movement and amplitude. This paper attempts to help fill that gap by analyzing the synchronicity between business and financial cycles in the euro area, both within and across countries, thus bridging three strands of the literature: financial cycles, business cycle synchronization, and financial cycle synchronization.

This empirical analysis seems particularly relevant to the euro area (EMU), for two main reasons. First, as noted above, there is evidence of lack of business cycle synchronization across EMU countries. This is problematic in a monetary union, as lack of cyclical convergence can complicate the monetary union's central bank's one-size-fits-all monetary policy. Significant differences in cyclical positions mean that the ECB's policy interest rate, which the ECB sets based primarily on the weighted-average euro-area inflation, may at any point in time be simultaneously too high for individual countries experiencing a depression and too low for countries experiencing a boom. Insofar as the financial cycle exacerbates business cycle divergence or generates its own cyclical divergence, this can pose a threat to macroeconomic and financial stability in EMU. Differences between the business cycle and the financial cycle, both across and within countries, may also create tensions between objectives of macroeconomic stabilization and financial stability. If such divergence exists, managing the euro-area financial cycle (or national financial cycles) should arguably be a priority for policymakers. The existence of financial cycle or business–financial cycle divergence would also strengthen the need to understand the relationship between business and financial cycles.

The second reason why the financial cycle is particularly relevant to EMU is that it may have played a role in the real economic divergence across member states since the introduction of the euro. In particular, there is evidence of resource misallocation in periphery EMU countries (Gopinath et al. 2015; Garcia-Santana et al. 2016), which resulted in very weak productivity growth and was plausibly induced by credit boom-bust cycles. Over time, lack of convergence risks undermining EMU's economic, social and political viability (Praet 2014; Enderlein et al. 2016; Franks et al. 2018).[1] One channel

[1]Indeed, one of the main objectives of the euro was to foster economic convergence between the poorest and richest economies in the euro area, defined as a narrowing of income gaps (Eichengreen 2007).

through which the financial cycle may hinder convergence is by generating misallocation of resources in less-developed EMU economies as a result of boom-bust dynamics in these countries—reflected in ample financial cycles—preventing them from achieving sustained economic convergence with wealthier EMU member states.[2]

I concentrate on the first of these two mechanisms. While both mechanisms are potentially important, gathering the stylized facts on the evolution of financial cycle synchronization within EMU is arguably a prerequisite to studying any possible link between financial cycle synchronization and economic convergence. To analyze financial cycle synchronization, and the relationship between business and financial cycles, I first measure business cycles and financial cycles since 1971 for the twelve founding EMU member states minus Luxembourg (due to limited data availability), henceforth EA11. To measure each country's business cycle and financial cycle, I apply the bandpass filter proposed by Christiano and Fitzgerald (2003) to GDP growth, and credit growth, the credit-to-GDP ratio and residential property price growth, respectively.[3] I then use a concordance statistic and a similarity measure to study the evolution of the synchronization of business and financial cycles both across and within the EA11 since 1971.

My analysis confirms three stylized facts from the literature on financial cycles, and contributes five new findings. In line with Drehmann, Borio, and Tsatsaronis (2012), Detken et al. (2014), Aglietta and Brand (2015), and Galati et al. (2016), I find that domestic financial cycles tend to be significantly more ample than business cycles, with their length and amplitude having increased since the mid-1980s.[4] Second, I document the existence of an

[2]Praet (2014) argues that the incomplete single market in capital, and the lack of a common approach to bank supervision and resolution, led "the financial cycle to take hold too strongly in [periphery euro area] countries in the upswing, and limited the potential for risk-sharing between jurisdictions in the downswing. This 'Minsky' cycle in turn masked the underlying lack of productivity convergence in the pre-crisis period."

[3]The EA11 countries are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain.

[4]This is true even though I use the same bandpass filter parameters to isolate medium-term cycles with a duration ranging from 32 to 120 quarters for both the business and the financial cycle. Indeed, medium-term business cycle fluctuations tend to be more ample than short-term fluctuations.

aggregate euro-area financial cycle, as in ECB (2014) and Merler (2015), and heterogeneous national financial cycles, in line with Rünstler and Vlekke (2018) and Schüler, Hiebert, and Peltonen (2017). Finally, I find that average financial cycle synchronization across countries increased during the crisis, in line with Stremmel and Zsámboki (2015).

The main contributions of the paper are to show that (i) each five-year period that preceded a euro-area recession after 1990 is characterized by a positive level of the aggregate euro-area leverage cycle; (ii) financial cycles are less synchronized than business cycles; (iii) following euro introduction, average business cycle synchronization increased while average financial cycle synchronization decreased; (iv) financial cycle desynchronization was more pronounced between high-amplitude and low-amplitude countries, especially Germany; and (v) the high-amplitude country group and Germany experienced divergence between their respective leverage cycles after 2002. The finding that Germany is atypical, with its financial cycle desynchronized from the rest of the euro area and its leverage cycle exhibiting a different pattern from that of other regions, enriches the finding of Rünstler and Vlekke (2018) and Schüler, Hiebert, and Peltonen (2017) that Germany stands out due to its very flat and desynchronized financial cycle.

The paper is organized as follows. Section 2 presents the methodology used to estimate business and financial cycles and their degree of synchronization within and across countries. Section 3 discusses the main features of business and financial cycles in the sample countries and country groups. Section 4 describes the results on business and financial cycle synchronization at the euro-area level and across countries, and on leverage cycle dynamics at the euro-area and country-group levels. Section 5 concludes.

2. Methodology

I measure the business cycle and financial cycle of each of the twelve founding euro-area member states minus Luxembourg (due to limited data availability): Austria, Belgium, Finland, France, Germany, Greece, Italy, Ireland, Netherlands, Portugal, and Spain, or EA11. As of 2016, these countries accounted for over 97 percent of euro-area GDP, justifying the use of EA11 as a proxy for the euro

area as a whole. In the next three sub-sections, I describe the methodology used to measure the financial cycle, the business cycle, and the leverage cycle, respectively.

The business and financial cycle estimates and synchronization calculations presented in this paper expand on my contribution to Franks et al. (2018). This paper differs from, and adds to, Franks et al. (2018) in several ways. Whereas the latter paper focuses on real economic convergence in the euro area and provides only a small subset of results on, and a brief discussion of, business and financial cycle synchronization, this paper provides a thorough discussion of the literature and methodology pertaining to financial cycles and a much larger set of results on business and financial cycle synchronization—both within and across EMU countries. Finally, this paper expands on Franks et al. (2018) by explicitly discussing the empirical regularities that emerge as well as their relevance for academic research and economic policy.

2.1 Financial Cycle, Business Cycle, and Leverage Cycle Measurement

2.1.1 Financial Cycle Measurement

In an influential contribution, Drehmann, Borio, and Tsatsaronis (2012) apply two approaches to measure the financial cycle—turning-point analysis and the bandpass filter developed by Christiano and Fitzgerald (2003)—to five financial variables (credit, the credit-to-GDP ratio, property prices, equity prices, and an aggregate asset price index). They distinguish short-term cycles (which they define as frequencies between 5 and 32 quarters) and medium-term cycles (which they define as frequencies between 32 and 120 quarters), and piece together four empirical findings: (i) they identify a well-defined financial cycle characterized by the co-movement of medium-term cycles in credit and property prices; (ii) the duration and amplitude of the financial cycle has increased since the mid-1980s, with an average duration of sixteen years; (iii) financial cycle peaks are closely associated with systemic banking crises; and (iv) financial and business cycles are related but distinct phenomena, with the medium-term component significant for both cycles, but more so for the financial cycle.

Although there is no consensus on the best measure of the financial cycle, recent studies provide support for the methodology proposed by Drehmann, Borio, and Tsatsaronis (2012). Stremmel (2015) assesses various financial cycle measures using graphical and statistical investigation techniques and finds that the best-fitted financial cycle measures include variables (the credit-to-GDP ratio, credit growth, and the ratio of house prices to income) that are similar to those used in this paper, as well as in Drehmann, Borio, and Tsatsaronis (2012), Aglietta and Brand (2015), Merler (2015), and Galati et al. (2016). Schüler, Hiebert, and Peltonen (2017) find that a composite financial cycle exploiting the co-movement of credit growth and house prices is the best indicator of systemic banking crises for G-7 countries over the past fifty years. Given that the objective of this paper is not to improve on the measurement of the financial cycle but to enhance our understanding of business and financial cycle synchronization, I opt for the most standard measurement of the financial cycle and follow Drehmann, Borio, and Tsatsaronis (2012) in the choice of filter and financial variables.[5]

Thus, to measure the financial cycle, I build a composite financial cycle based on the three variables proposed by Drehmann, Borio, and Tsatsaronis (2012): credit to the non-financial private sector, the ratio of credit to GDP, and residential property prices.[6] Following Drehmann, Borio, and Tsatsaronis (2012), to standardize the cycles before aggregation, all series are normalized to 1985:Q1 to ensure that the units are comparable. Also in line with Drehmann, Borio, and Tsatsaronis (2012), credit and residential property prices are in real terms (deflated by CPI) and in logs.[7] To isolate the

[5]As argued by Arnold et al. (2012) and Drehmann, Borio, and Tsatsaronis (2012), focusing on cyclical fluctuations at relatively low frequencies is appropriate given the lower frequency of systemic banking and financial crises.

[6]For three countries (Austria, Portugal, and Greece) residential property price data do not extend back far enough in time, and the house price cycle was therefore excluded from the composite financial cycle measure for these countries. However, data on residential property prices available from the Bank of Greece suggest that Greece experienced a pronounced house price boom between 1995 and 2008, similarly to Spain and Ireland.

[7]Thus, general inflation does not distort the financial cycle estimates, in line with the methodology used by Drehmann, Borio, and Tsatsaronis (2012), Aglietta and Brand (2015), and Schüler, Hiebert, and Peltonen (2017).

cyclical component of each series, I use the bandpass filter developed by Christiano and Fitzgerald (2003) and filter the data in annual growth rates.[8] Following Drehmann, Borio, and Tsatsaronis (2012) and Stremmel (2015), I set the upper bound parameter for the duration of each cycle that composes the financial cycle at 120 quarters. For the lower bound, I follow Drehmann, Borio, and Tsatsaronis (2012) and set it at thirty-two quarters. As these authors note, the 120-quarter upper bound ensures that the medium-term cyclical component does not include a long-term secular trend.[9] The filtered time series being continuous and additive (as measurement units are comparable), I build the composite financial cycle indicator by taking the simple average of the three filtered time series without using weights to form the composite financial cycle, in line with the methodology used in Drehmann, Borio, and Tsatsaronis (2012), Aglietta and Brand (2015), and Stremmel (2015).

2.1.2 Business Cycle Measurement

The aim of the paper being to establish stylized facts regarding the comparative behavior of business and financial cycles in the euro area, I use an agnostic statistical approach to measure both types of cycles. Therefore, I apply the same bandpass filter frequency band to measure the business cycle as for the financial cycle: a lower bound of 32 quarters and an upper bound of 120 quarters. This ensures that the two cycles are comparable. Another justification for this frequency band choice is the finding in Comin and Gertler (2006) that the medium-term cycle (defined as frequencies between 32 and 200 quarters) captures sustained swings in economic activity in the United States over the post-war period, and the finding in Beaudry, Galizia, and Portier (2016) that cyclically sensitive variables display peaks in the spectral density occurring at around 40 quarters. Finally, this frequency band choice is justified by the finding in Rünstler and Vlekke (2018) that cycles in credit and house

[8]The bandpass filter (Christiano and Fitzgerald 2003) is a two-sided univariate moving-average filter that isolates chosen frequencies in the time series.

[9]As noted in footnote 10, Drehmann, Borio, and Tsatsaronis (2012) document the greater relative volatility of the medium-term cyclical component for variables that compose the financial cycle. This implies that medium-term cycles are more important than short-term cycles in shaping the behavior of the financial cycle.

prices are highly correlated with the medium-term component of GDP cycles.[10,11]

Thus, in the same manner as for the financial cycle, I use the bandpass filter proposed by Christiano and Fitzgerald (2003) to extract the medium-term cyclical component (defined as frequencies between 32 and 120 quarters) of real, seasonally adjusted GDP, normalized to its value in 1985:Q1. The data are filtered in four-quarter differences in log levels.[12] Conceptually, this approach is similar to estimating the business cycle as an output gap by using a univariate or multivariate filter (e.g., Berger et al. 2015), as both approaches entail decomposing GDP or other macroeconomic time series into trend and cyclical components.

2.1.3 Leverage Cycle Measurement

To study the relationship between domestic business and financial cycles, I focus on the leverage cycle. I define the latter as the medium-term cyclical fluctuations in the credit-to-GDP ratio (in line with Drehmann, Borio, and Tsatsaronis 2012, who

[10]There are four further justifications for this frequency band choice. First, Drehmann, Borio, and Tsatsaronis (2012) document that, for several advanced economies, the medium-term cyclical component of GDP is more volatile than the short-term cyclical component. Second, these authors confirm that the greater relative volatility of the medium-term cyclical component also applies to the variables that compose the financial cycle, meaning that medium-term cycles are more important than short-term cycles in shaping the behavior of the financial cycle. Third, they note that the low frequency of financial crises makes low-frequency analysis relevant, and show that only 20–30 percent of high-frequency peaks are close to a crisis. Fourth, Schüler, Hiebert, and Peltonen (2017) find that, across G-7 countries, business cycle indicators share important medium- and long-term cycles with credit.

[11]While the exclusion of traditional business cycle frequencies from the chosen frequency band could justify calling the GDP cycle the "medium-term cycle," for simplicity and clarity when contrasting business and financial cycles—and given the findings in the literature on the low frequency of various cyclical dynamics—I refer to the medium-term GDP cycle as the business cycle.

[12]Notwithstanding the reasons for focusing on medium-term frequencies provided in footnote 10, the main findings of this paper are robust to using the same 8- to 120-quarter frequency band to measure both business cycles and financial cycles. See the robustness tests in online appendix A (online appendixes are available at http://www.ijcb.org). Such a frequency band broadly corresponds to the conventional decomposition of the data using a bandpass filter with business cycle frequencies set to be between two and thirty-two quarters (Christiano and Fitzgerald 2003; Comin and Gertler 2006).

identify the credit-to-GDP cycle as one of the three cycles that compose the financial cycle), and use the estimates generated for the filtered credit-to-GDP ratio series described in section 2.1.1. The leverage cycle therefore captures the medium-term cyclical component (defined as frequencies between 32 and 120 quarters) of the credit-to-GDP ratio (in percentage points and normalized to 1985:Q1), filtered in annual growth rates. The EA11 leverage cycle is the GDP-weighted average of the national leverage cycles of each of the eleven sample euro-area countries, measured in year-on-year percentage change.

2.2 Measurement of Business Cycle and Financial Cycle Synchronization

I divide the sample period into three subperiods: 1971:Q1–1998:Q4 (pre-euro area), 1999:Q1–2007:Q1 (pre-crisis euro area), and 2007:Q2–2015:Q1 (crisis period). The justification for this choice of periods is that the aim of this paper is to study business and financial cycle synchronization under EMU, which leads to a natural break at the introduction of the euro in 1999. The choice of 2007:Q1 is justified by the fact that, in many euro-area countries, the business cycle (and in several cases the housing boom) peaked around 2007:H1, and by the fact that the turmoil of the global financial crisis also began in the middle of 2007. An additional advantage of choosing 2007:Q1 is that this allows for the two EMU subperiods to comprise a similar number of quarters. I focus on two complementary measures of synchronization: the concordance statistic and the similarity measure.

2.2.1 Co-movement: Concordance Statistic

The concordance statistic is a bivariate synchronization index, which provides a measure of the degree of co-movement between two cycles. The concordance statistic was proposed by Harding and Pagan (2003) (see also McDermott and Scott 2000, and Claessens, Kose, and Terrones 2011). Following these authors, the concordance statistic, CI_{xy}, for variables x and y is defined as

$$CI_{xy} = \frac{1}{T}\sum_{t=1}^{T}[C_t^x \cdot C_t^y + (1 - C_t^x) \cdot (1 - C_t^y)], \tag{1}$$

where

$$C_t^x = \{0, \text{ if } x \text{ is in recession phase at time } t; \\ 1, \text{if } x \text{ is in expansion phase at time } t\}$$

$$C_t^y = \{0, \text{ if } y \text{ is in recession phase at time } t; \\ 1, \text{if } y \text{ is in expansion phase at time } t\}.$$

The concordance static measures the fraction of time that two series are in the same phase of their respective cycles, with the series being fully procyclical (countercyclical) if the concordance statistic is equal to one (zero).

I compute concordance statistics for each of the fifty-five country pairs in my sample and assemble summary statistics for the sample of country pairs.

2.3 Amplitude: Similarity Measure

A second aspect of cyclical synchronicity, which complements concordance, is the difference in amplitude between two cycles at a given point in time. What makes the focus on amplitude informative is that, as noted by Mink, Jacobs, and de Haan (2012) and Belke, Domnick, and Gros (2016), there can be significant differences in cyclical positions even when national cycles are highly correlated.

To study amplitude discrepancies between different cycles, I opt for the similarity measure proposed by Mink, Jacobs, and de Haan (2012). The similarity measure is defined by Mink, Jacobs, and de Haan (2012) such that it maximizes similarity of a given variable in the cross-section. Although Mink, Jacobs, and de Haan (2012) apply the similarity measure to output gaps, the measure can readily be applied to business and financial cycles. Indeed, conceptually business and financial cycles are analogous to output gaps, as they measure the deviation of GDP and credit, credit-to-GDP, and residential property prices, respectively, from their long-term trend.

Following Mink, Jacobs, and de Haan (2012), the similarity measure, $\gamma_{ir}(t)$, is defined as

$$\gamma_{ir}(t) = 1 - \frac{|g_i(t) - g_r(t)|}{\sum_{i=1}^{n} |g_i(t)|/n}, \tag{2}$$

where $g_i(t)$ is the level of the business cycle or financial cycle (depending on which cycle is being analyzed) of country i at time t, and $g_r(t)$ is the level of the reference business cycle or

financial cycle for the country sample at time t. I follow Mink, Jacobs, and de Haan (2012) and set the reference business or financial cycle to be the median business or financial cycle level among sample countries at time t. This is done to maximize similarity in equation (2). As noted by Mink, Jacobs, and de Haan (2012), scaling by the average absolute business or financial cycle level implies that the similarity measure is scale invariant. Similarity is thus defined on a $[1 - n, 1]$ scale, with unity indicating that both cycles have the same amplitude.

To analyze the degree of amplitude similarity between the composite business and financial cycles of the high-amplitude and low-amplitude country groups, I apply equation (2) to these cycles by setting $g_i(t)$ equal to the composite business or financial cycle of the high- or low-amplitude group and keeping $g_r(t)$ equal to the median business or financial cycle level among sample countries at time t.

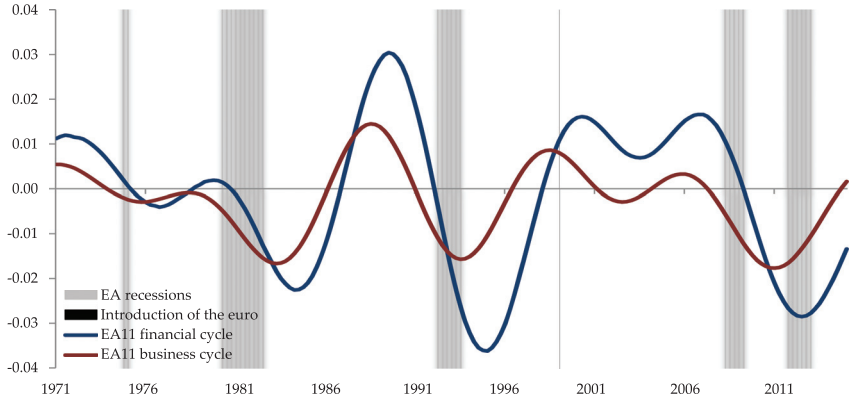
3. Main Features of Business Cycles and Financial Cycles in the Euro Area

I begin by describing the aggregate euro-area and national business and financial cycle estimates. Figure 1 shows the aggregate financial cycle and business cycle for the EA11, based on GDP-weighted averages of national financial and business cycles. Several elements stand out in the figure. First, the amplitude of the EA11 financial cycle is greater than that of the EA11 business cycle, and has increased since the mid-1980s. This result confirms the findings of studies that use the same methodology to measure the financial cycle (Drehmann, Borio, and Tsatsaronis 2012; Aglietta and Brand 2015; ECB 2015; Merler 2015; Galati et al. 2016). However, figure 1 shows that the magnitude of the EA11 financial cycle is relatively moderate, as its fluctuations are ranging from 3 to –4 percent.

Second, figure 2 shows significant heterogeneity in financial cycles across countries.[13] This is consistent with ECB (2014), which finds

[13]For the financial cycles of individual countries, see online appendix figures B1 and B2. Whereas Spain and Ireland experienced financial cycles of growing amplitude after around 1995, with the peak in their financial cycles (around 8 percent for Spain and 12 percent for Ireland) coinciding with the global financial crisis, Germany's financial cycle is remarkably flat over the entire 1971–2015 period, with the financial cycle oscillating between roughly 1 and –1 percent.

Figure 1. Euro-Area Financial Cycle and Business Cycle, and Recessions

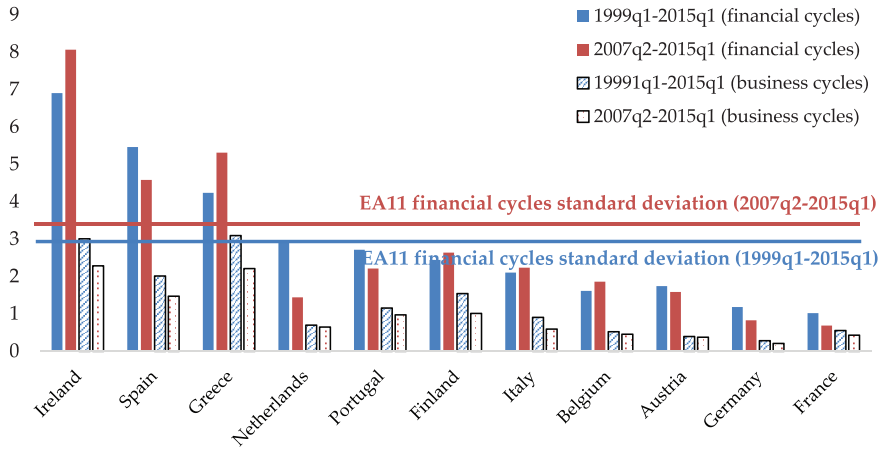


Sources: BIS, OECD, CEPR, author's calculations.
Notes: The blue line (colors are shown in online version at http://www.ijcb.org) shows the composite EA11 financial cycle, corresponding to the GDP-weighted average of the financial cycles of the eleven sample euro-area countries, in year-on-year percentage change. Following the methodology proposed by Drehmann, Borio, and Tsatsaronis (2012), the financial cycle is based on the credit-to-GDP ratio, credit to the non-financial private sector, and residential property prices. All series are normalized to 1985:Q1. The second and third variables are in real terms (deflated by CPI) and in logs. The financial cycle is defined as the simple average of the medium-term cyclical component (defined as frequencies between 32 and 120 quarters) of the three series, filtered in annual growth rates. For three countries (Austria, Portugal, and Greece) residential property price data do not extend back far enough in time and were therefore excluded from the composite financial cycle measure. The red line shows the composite EA11 business cycle, corresponding to the GDP-weighted average of the business cycles of the eleven sample euro-area countries, in year-on-year percentage change. The business cycle is defined as the medium-term cyclical component (also defined as frequencies between 32 and 120 quarters) of real, seasonally adjusted GDP normalized to 1985:Q1. The shaded areas represent euro-area recessions (from the quarter following the peak through the quarter of the trough) as defined by the CEPR Euro Area Business Cycle Dating Committee.

that, in the euro area, financial cycles tend to be more volatile than business cycles (with strong cross-country heterogeneity), as well as Rünstler and Vlekke (2018) and Schüler, Hiebert, and Peltonen (2017).

It is important to stress the high degree of heterogeneity between financial cycles across different regions. To investigate regional

Figure 2. Standard Deviation of National Business and Financial Cycles, 1999:Q1–2007:Q1, 2007:Q2–2015:Q1



Sources: Author's calculations.
Notes: See figure 1. The blue and red lines indicate the standard deviation, in percent, of the financial cycles of all eleven countries in the sample over 1999:Q1–2015:Q1 and 2007:Q2–2015:Q1, respectively.

financial cycle patterns within EMU, I separate countries into five country groups: (i) the entire sample of euro-area countries (EA11), (ii) countries with high financial cycle amplitude, (iii) countries with low financial cycle amplitude, (iv) low-amplitude countries excluding Germany, and (v) Germany (which is described as a "country group" for simplicity). Germany is singled out due to its atypical financial cycle, the dynamics of which are documented in section 4.[14] Given that this paper focuses on the behavior of financial cycles in the euro area, to determine whether a country falls into the "high-amplitude" or "low-amplitude" group, I analyze the volatility of national financial cycles over two periods: the entire euro period

[14]Indeed, Germany has by far the lowest overall financial cycle volatility. The ratio of the standard deviation, over the entire sample period, of Germany's financial cycle (1.1 percent) to the standard deviation of all eleven financial cycles in the sample (3.4 percent) is a little lower than one-third. This result is robust to using an 8- to 120-quarter bandpass filter to measure financial cycles. On this measure, the ratio of the standard deviation, over the entire sample period, of the German financial cycle (1.6 percent) to the standard deviation of all eleven financial cycles in the sample (4.3 percent) is a little higher than one-third.

(1999:Q1–2015:Q1) and the crisis subperiod (2007:Q2–2015:Q1). I classify countries as "high amplitude" if the standard deviation of their financial cycle is higher than the standard deviation of all national financial cycles in the EA11 group during both the entire EMU period and the crisis period. If not, I classify them as "low amplitude." The high-amplitude group includes Spain, Ireland, and Greece; the low-amplitude group includes Germany, France, Italy, Netherlands, Belgium, Austria, Finland, and Portugal (figure 2).[15] I then construct composite financial cycles for each group using GDP-weighted averages of the financial cycle estimates of its constituent countries.

The difference in financial cycle amplitude between high-amplitude countries on the one hand and Germany and France on the other hand over the 1999–2015 period is particularly large, as shown in figure 2. For the high-amplitude group, the standard deviation of its financial cycle (computed as the simple average of the standard deviations of the financial cycles of Spain, Ireland, and Greece) is about twice as large as the euro-area average standard deviation. For Germany, this number is about 60 percent lower than the euro-area average. For France, it is about 70 percent lower. This results in a ratio of 13 to 1 and 16 to 1 between the standard deviations of the financial cycles of high-amplitude countries and Germany and France, respectively, over the 1999–2015 period.[16] The lower dispersion of France's financial cycle over 1999–2015 relative to Germany's is partly an artefact of the offsetting dynamics of the three financial times series that make up its financial cycle, however.[17]

[15]The finding that the high-amplitude group is composed of Spain, Ireland, and Greece is robust to using an 8- to 120-quarter frequency bandpass filter to measure financial cycles. See online appendix figure A2.

[16]Although France displays the lowest financial cycle amplitude among the countries in the sample during the 1999–2015 period, the dynamics of its financial cycle (i.e., the timing of its upswings and downswings) are closer to high-amplitude financial cycle, especially during the 2007–15 period (see the bilateral concordance statistics for France versus Spain, Ireland, and Greece in online appendix table B3). This is the reason why, in section 4, I focus on the divergence between the financial cycles of high-amplitude countries and Germany.

[17]As online appendix figure B2 shows, in the early 2000s France experienced a strong upswing in its house price cycle, and a downswing in its credit and credit-to-GDP cycles, resulting in a flat overall financial cycle in those years (figure 1). By contrast, Germany experienced low dispersion combined with

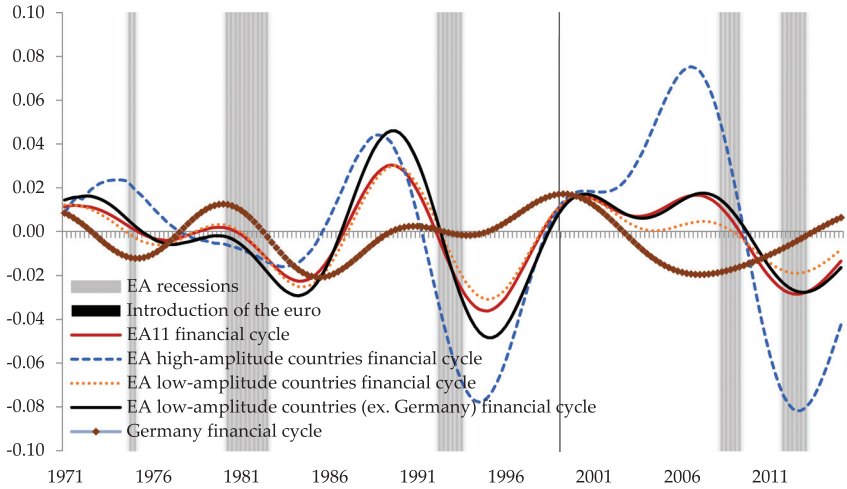
The finding that Spain, Ireland, and Greece stand out among euro-area countries as having high-amplitude financial cycles is consistent with Hyppolite (2016), who identifies these three countries as sharing the characteristic of having experienced strong growth in external debt linked to real estate bubbles that began in the mid-1990s. Hyppolite also notes that the balance of payments approach to explaining the euro-area crisis in so-called periphery countries fits Ireland, Portugal, and Spain, but not Greece, whereas an approach that links external debt to real estate bubbles can explain crisis dynamics in Spain, Ireland, and Greece, and fits the case of Portugal less well, which is consistent with the results of this paper.

Figure 3 shows the (composite) financial cycle for each of the five country groups described above: EA11, high amplitude, low amplitude, low amplitude excluding Germany, and Germany. There are several striking patterns. First, until 2002, the high- and low-amplitude financial cycles are quite strongly correlated, with the amplitude of the high-amplitude group starting to increase in the late 1980s. Second, the magnitude of low-amplitude countries' financial cycle does not vary significantly over the sample period, with a peak-to-trough difference of around 4–5 percentage points throughout the period. Third, the composite financial cycle of high-amplitude countries diverges markedly from the German financial cycle from 2002 to 2012, with the former growing explosively from 2002 until its peak in mid-2006—that is, on the eve of the first phase of the global financial crisis.[18] Fourth, the downswing in all financial cycles except that of Germany coincides with the timing of the euro-area recession in 2008–09. Fifth, the magnitude of the reversal in the financial cycle of high-amplitude countries between 2006:Q4 and 2012:Q3 is symmetric to the preceding upswing, falling from about 8 percent to about –8 percent. Finally, the negative part of the financial cycles of all groups except Germany starts in

strong co-movement in all three financial time series that make up its financial cycle, resulting in a slightly more volatile financial cycle than that of France in the 2000s.

[18]In 1999:Q4, all country groups' (composite) financial cycles stood at around 1.6–1.7 percent. At the peak of the high-amplitude group's financial cycle upswing, its financial cycle stood at 7.5 percent, while Germany's financial cycle stood at –1.9 percent.

Figure 3. Euro-Area Financial Cycles: EA11, High-Amplitude Countries, Low-Amplitude Countries, Low-Amplitude Countries excluding Germany, and Germany



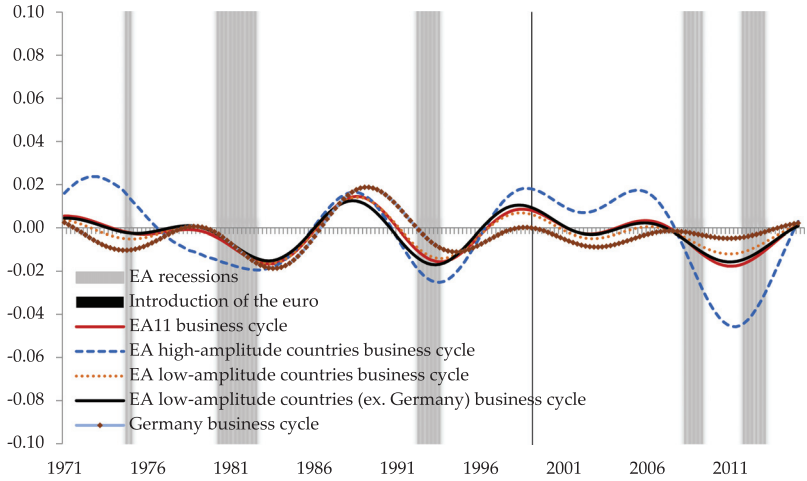
Sources: BIS, OECD, CEPR, author's calculations.
Notes: See figure 1. High-amplitude countries include Spain, Ireland, and Greece; low-amplitude countries include Germany, France, Italy, Netherlands, Belgium, Austria, Finland, and Portugal.

2009:Q2—that is, at the same time as the euro-area crisis, which erupted in Greece in 2009 and spread to Ireland in 2010 and Portugal, Spain, and Italy in 2011.[19]

Figure 4 shows the business cycles of the same five country groups. Two main differences between it and figure 3 are apparent. First, the amplitudes of all country-group business cycles are

[19]Financial cycles are very heterogeneous across euro-area countries. Online appendix figure B4 shows enormous divergence between Germany's and Spain's financial cycles between 1999 and 2015. Germany's financial cycle entered a downward phase around 1999, which lasted until 2007. In contrast, Spain's financial cycle remained in an upturn phase from 1995 until 2007, and then experienced a severe reversal until 2013. Online appendix figure B5 shows that France's financial cycle is highly correlated with that of the EA11 throughout the period 1971–2015. Interestingly, France also stands close to the euro-area average in terms of key macroeconomic indicators, such as GDP growth, inflation, investment, and unemployment.

Figure 4. Euro-Area Business Cycles: EA11, High-Amplitude Countries, Low-Amplitude Countries, Low-Amplitude Countries excluding Germany, and Germany



Sources: OECD, CEPR, author's calculations.
Notes: See figure 1. High-amplitude countries include Spain, Ireland, and Greece; low-amplitude countries include Germany, France, Italy, Netherlands, Belgium, Austria, Finland, and Portugal.

much smaller and much more homogeneous. Indeed, the standard deviation, over the sample period, of the financial cycles of all EA11 countries is over twice the standard deviation of the business cycles of all EA11 countries.[20] Second, the business cycles are much more correlated, with no clear divergence between the business cycles of any of the five country groups. There is one commonality with figure 3, however. Similarly to the boom-bust financial cycle it experienced around the 2008–09 eura-area recession, the high-amplitude country group exhibits a more positive business cycle than other country groups in the run-up to the 2008–09 euro-area recession, followed by a deeper downturn.

[20]This finding is robust to using an 8- to 120-quarter frequency band to measure business and financial cycles. On this measure, the standard deviation of EA11 financial cycles is 1.8 times that of EA11 business cycles.

4. Results

In this section, I study the synchronization of business and financial cycles across and within countries, and between selected country groups.[21] Building on the stylized facts documented in section 3 on the distinct cyclical dynamics of different country groups, I center the analysis around the same country breakdown: the entire sample of euro-area countries (EA11), high-amplitude countries, low-amplitude countries, low-amplitude countries excluding Germany, and Germany. Germany is singled out and compared with these country groups, reflecting the idiosyncratic nature of the German financial cycle, which is documented below.[22]

Findings focus on six areas: (i) the leverage cycle at the aggregate euro-area level (figure 5); (ii) business cycle and financial cycle concordance and similarity across the euro area (table 1, first six rows); (iii) the concordance of the composite business cycles and financial cycles of high-amplitude countries and low-amplitude countries and of Germany and high-amplitude countries (table 1, first two columns, fourth to twelfth rows); (iv) the similarity of the composite business cycles and financial cycles of high-amplitude countries and low-amplitude countries relative to the median euro-area business cycle and financial cycle (table 1, last two columns, last six rows); (v) the concordance of business cycles and financial cycles within euro-area countries (table 2); and (vi) the leverage cycle at the level of country groups (figure 6). I discuss each finding in turn, from the more general (pertaining to the euro area) to the more specific (pertaining to groups of countries within the monetary union).

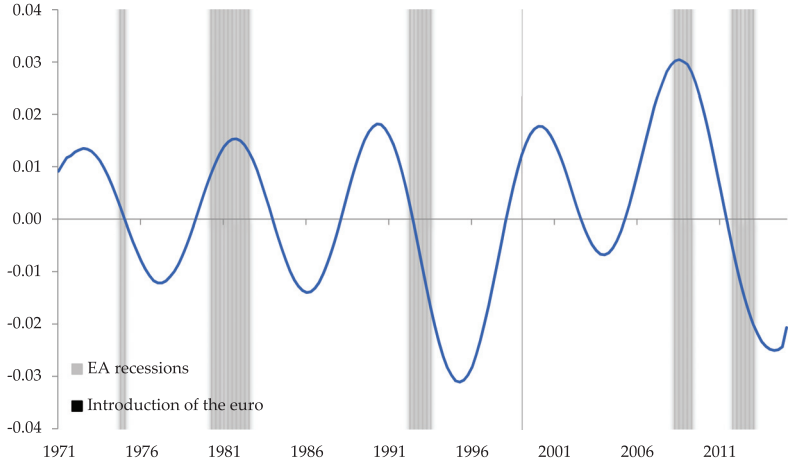
The first finding is summarized in figure 5, which plots the aggregate EA11 leverage cycle. The figure shows that, in the five-year periods preceding each euro-area recession after 1990, the average level of the aggregate euro-area leverage cycle was positive. This is confirmed by online appendix table A1, which quantifies the EA11 leverage cycle in each of these five-year periods.[23]

[21] For detailed results, including figures and tables on individual countries, see online appendix figures B1–B7 and tables B1–B3.

[22] As noted in section 3, each composite business or financial cycle is weighted by the GDP levels of its constituent countries.

[23] This finding is robust to using the same 8- to 120-quarter frequency bandpass filter to measure the leverage cycle. See online appendix figure A5 and table A2.

Figure 5. Euro-Area Leverage Cycle



Sources: BIS, OECD, CEPR, author's calculations.
Notes: The composite EA11 leverage cycle corresponds to the GDP-weighted average of the leverage cycles of the eleven sample euro-area countries, in year-on-year percentage change. Following the methodology proposed by Drehmann, Borio, and Tsatsaronis (2012), the leverage cycle corresponds to the medium-term cyclical component (defined as frequencies between 32 and 120 quarters) of the credit-to-GDP ratio (in percentage points and normalized to 1985:Q1), filtered in annual growth rates.

Several empirical regularities stand out. First, the volatility of the aggregate euro-area leverage cycle has increased, with peaks rising from a little under 2 percent prior to the 1990–93 recession to close to 3 percent prior to the 2008–09 recession, and troughs widening from less than –1.5 percent in the 1970s and 1980s to around –3 percent in the 1990s and 2000s. Troughs were observed two to five years after the end of each euro-area recession that occurred after 1980. Second, the number of years during which the leverage cycle was positive is roughly proportional to the severity of the ensuing recession: the buildup in leverage lasted four years prior to the 1992–93 recession, and eight years prior to the 2008–09 recession. This empirical regularity is consistent with Jordá, Schularick, and Taylor (2013) and Jordá, Schularick, and Taylor (2016a), who find that aftermaths of leveraged booms are associated with slower growth in GDP, investment, and credit, and with Jordá, Schularick, and Taylor (2017), who document an association

Table 1. Concordance Statistics and Similarity Measures for Business Cycles and Financial Cycles across Euro-Area Countries

	Period	Concordance		Similarity	
		Business Cycles	Financial Cycles	Business Cycles	Financial Cycles
EA11	1971–1998	0.76 (0.76)	0.66 (0.65)	0.54 (0.33)	0.32 (0.15)
	1999–2007	0.78 (0.78)	0.49 (0.57)	0.27 (0.08)	0.33 (0.21)
	2007–2015	0.94 (0.95)	0.64 (0.71)	0.52 (0.38)	0.37 (0.32)
High- vs. Low-Amplitude Countries	1971–1998	0.69 (0.68)	0.65 (0.67)	—	—
	1999–2007	0.77 (0.80)	0.52 (0.50)	—	—
	2007–2015	0.94 (0.95)	0.68 (0.75)	—	—
High- vs. Low-Amplitude Countries (ex. Germany)	1971–1998	0.71 (0.69)	0.68 0.68	—	—
	1999–2007	0.81 (0.81)	0.67 (0.53)	—	—
	2007–2015	0.95 (0.96)	0.87 (0.81)	—	—
Germany vs. High-Amplitude Countries	1971–1998	0.65	0.59	—	—
	1999–2007	0.70	0.24	—	—
	2007–2015	0.91	0.32	—	—
High-Amplitude Countries	1971–1998	—	—	0.18	0.39
	1999–2007	—	—	−0.38	−0.24
	2007–2015	—	—	0.04	−0.15
Low-Amplitude Countries	1971–1998	—	—	0.84	0.69
	1999–2007	—	—	0.67	0.72
	2007–2015	—	—	0.73	0.62

Source: Author's calculations.
Notes: Cells show the concordance statistics and similarity measures for various country groups. All numbers are GDP-weighted averages, with simple averages in parentheses, except for the concordance statistics for Germany versus high-amplitude countries and the similarity measures for high- and low-amplitude countries, which are simple averages (as they are calculated using the composite business and financial cycles for high- and low-amplitude countries). The similarity measures for high- and low-amplitude countries correspond to the similarity of these country groups' composite business or financial cycles with the median euro-area business or financial cycle, respectively (see section 2.2.2 for details on the methodology). The concordance statistic measures the fraction of time that two series are in the same phase of the cycle, with the series being perfectly procyclical (countercyclical) if the statistic is equal to one (zero). The similarity measure maximizes similarity of a given variable in the cross-section with respect to a reference value (set to be the median value, for all sample countries, of the variable under consideration). GDP-weighted averages and simple averages are calculated using the bilateral concordance statistics or similarity measures of all sample countries. High-amplitude countries include Spain, Ireland, and Greece; low-amplitude countries include Germany, France, Italy, Netherlands, Belgium, Austria, Finland, and Portugal. The exact periods shown in the table are 1971:Q1–1998:Q4, 1999:Q1–2007:Q1, and 2007:Q2–2015:Q1.

Table 2. Concordance of Business Cycles and Financial Cycles within Individual Euro-Area Countries

	1971–1998	1999–2007	2007–2015
Austria	0.86	0.76	0.75
Belgium	0.62	0.64	0.56
Finland	0.62	0.58	0.72
France	0.90	0.42	0.75
Germany	0.79	045	0.56
Greece	0.68	0.27	0.53
Ireland	0.77	0.61	0.63
Italy	0.41	0.36	0.78
Netherlands	0.77	0.67	0.75
Portugal	0.46	0.55	0.28
Spain	0.80	0.55	0.88
Average	0.70	0.53	0.65
GDP-Weighted Average	0.72	0.47	0.69

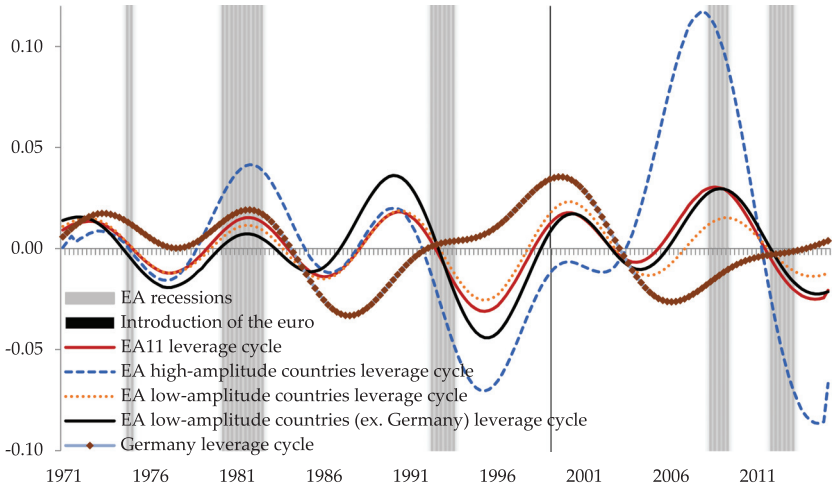
Source: Author's calculations.
Notes: See table 1 for the definition of the concordance statistic. The exact periods shown in the table are 1971:Q1–1998:Q4, 1999:Q1–2007:Q1, and 2007:Q2–2015:Q1.

between higher leverage and lower real volatility but larger tail events.

The second finding is that, across countries, the overall degree of financial cycle synchronicity is lower than the overall degree of business cycle synchronicity. Table 1 (first three rows, first two columns) shows that the average degree of bilateral concordance is much higher for business cycles than for financial cycles. Table 1 (first three rows, last two columns) shows that the average similarity of cyclical amplitude is higher for business cycles than for financial cycles.[24] The evidence of a high degree of co-movement across euro-area economies is consistent with De Grauwe and Ji (2016), who find similar levels of cross-country bilateral business cycle correlations.

[24]These findings, as well as those in the rest of this section that refer to table 1, are robust to using an 8- to 120-quarter frequency band to measure both business and financial cycles. See online appendix table A1.

Figure 6. Euro-Area Leverage Cycles: EA11, High-Amplitude Countries, Low-Amplitude Countries, Low-Amplitude Countries excluding Germany, and Germany



Sources: BIS, OECD, CEPR, author's calculations.
Notes: Each line represents the (composite) leverage cycle of a country group or country. See figure 5 for the definition of the leverage cycle. High-amplitude countries include Spain, Ireland, and Greece; low-amplitude countries include Germany, France, Italy, Netherlands, Belgium, Austria, Finland, and Portugal.

The third finding is that, following euro introduction, average business cycle synchronization increased while average financial cycle synchronization decreased. As summarized in table 1 (first twelve rows, first column), business cycle concordance increased continuously and in a broad-based manner, reaching a very high level in the crisis period.[25] By contrast, financial cycle concordance fell in the boom period and rose in the crisis period (table 1, first three rows, second column).[26] The latter rise likely reflects the role of the global financial crisis, which was associated with a severe financial

[25] For average business cycle concordance statistics for individual countries, see online appendix table B1.

[26] Average financial cycle concordance statistics for individual countries were also much more dispersed following euro introduction, especially in the boom period. See online appendix table B2.

cycle downturn in most euro-area countries (see online appendix figure B3). This pattern is consistent with Stremmel and Zsámboki (2015), who find evidence that financial cycles are less synchronized in tranquil periods and more synchronized in episodes of common financial stress.

While the average degree of business cycle amplitude similarity decreased somewhat in the boom period (table 1, first three rows, third column), it remained relatively high, and increased in the crisis period. The finding that business cycle concordance increased with the introduction of the euro, which increased trade and financial integration among euro-area countries, is consistent with the literature on the global co-movement in output in the post-war period.[27] High-amplitude countries are an exception, as there was increased business cycle amplitude dispersion between high- and low-amplitude countries in the crisis period (table 1, bottom six rows, third column), likely reflecting the severity of the recessions in these countries. For financial cycles, amplitude similarity remained stable at a lower level (table 1, first three rows, fourth column) but also masked amplitude dispersion between high- and low-amplitude countries. I turn to this result below.

The fourth finding is that financial cycle desynchronization was more pronounced between countries with high financial cycle amplitude and countries with low financial cycle amplitude, especially Germany. There is evidence of divergence between the financial cycles of high- and low-amplitude countries, especially Germany, in terms of concordance (table 1, fourth to twelfth rows, second column). This pattern partly reflects the explosive financial cycle upswing and the severe financial cycle downswing experienced by Spain, Ireland, and Greece before and after 2007, respectively.[28] The

[27]Bordo and Helbling (2003) find much higher output correlation among sixteen countries during the 1973–2001 period than during the 1942–1973 period, with common shocks being the dominant influence across all regimes.

[28]High-amplitude countries consistently had the lowest business cycle similarity in the two euro subperiods, with similarity measures ranging from 0.1 to −1.1, while Germany had the fourth-lowest similarity in the crisis period (0.44). See online appendix figure B6. High-amplitude countries had the lowest financial cycle similarity in the two euro subperiods (except for Greece in the boom period), with similarity measures ranging from −0.1 to −0.9, and Germany had the fourth-lowest similarity in the crisis period (0.18). See online appendix figure B7.

relatively high and stable degree of average financial cycle similarity contrasts with the divergence in amplitude similarity between high- and low-amplitude countries (table 1, last six rows, last column). Furthermore, Germany stands out due to its decorrelated financial cycle, in terms of concordance, in both the boom period and the crisis period (online appendix table B2). In the crisis period, the dynamics of Germany's financial cycle contrasted even more sharply with euro-area dynamics, as average financial cycle concordance rose to close to its pre-euro level.[29]

This is particularly striking vis-à-vis high-amplitude countries (online appendix table B3). The asymmetric nature of the euro-area crisis may account for the coexistence, in the crisis period, of high average concordance of financial cycles and, especially, business cycles, and low business and financial cycle similarity between high- and low-amplitude countries. The increased concordance of the cycles following the onset of the crisis likely reflects the fact that most euro-area countries experienced a deterioration in financial conditions during this period. This pattern is consistent with the finding of Monnet and Puy (2016) that financial crisis periods are characterized by a strong positive impact of financial integration on co-movement. By contrast, the increase in the dispersion of financial cycle amplitudes likely reflects the fact that only some countries' financial systems were severely affected in 2009–11 (notably Greece, Ireland, Portugal, Spain, and Italy, as reflected in the increase in their sovereign bond spreads—roughly in that chronological order).

The fifth finding is that the concordance of business and financial cycles within individual euro-area countries exhibits a similar pattern to that of financial cycles across countries. Indeed, the average degree of concordance of business and financial cycles within

[29] Although France had the lowest average concordance statistic in the region in the 1999–2007 period at 0.38, its financial cycle experienced relative resynching with the rest of the euro area in the crisis period, with France's average concordance statistic rising to 0.78, above the euro-area average of 0.64. Spain displays a similar pattern to France, being relatively desynchronized from the other countries in 1999–2007, but resynchronizing in 2007–15, with its average concordance statistic rising from 0.45 in the former period to 0.75 in the latter. Overall, therefore, Germany seems to be a much more significant outlier than France in terms of the relative desynching of its financial cycle from other euro-area countries. See online appendix table B2.

countries fell significantly in the boom phase that followed euro introduction and rose back to its pre-euro level in the crisis phase (table 2), as did the average concordance of financial cycles across countries (table 1, first three rows, second column).

The finding that business cycle synchronization is high and increased between the 1970s and 2015 while financial cycle synchronization decreased in the ebullient 1999–2007 period is consistent with the evidence presented by Schüler, Hiebert, and Peltonen (2017). The finding that Germany is an outlier within the euro area due to its very low-amplitude financial cycle and its desynchronization from high-amplitude countries is consistent with the evidence in Rünstler and Vlekke (2018) and Schüler, Hiebert, and Peltonen (2017) that Germany's financial cycle stands out among major advanced economies. The evidence that high-amplitude countries stand out due to the large amplitude of their financial cycles is, prima facie, consistent with the finding of Rünstler and Vlekke (2018) that Spain has a particularly large financial cycle.

Finally, to further investigate regional patterns in the relationship between domestic business and financial cycles, I analyze the behavior of the leverage cycle, which captures medium-term fluctuations in the credit-to-GDP ratio, as described in section 2.1.3.

Figure 6 plots the leverage cycle for the five country groups described at the beginning of this section. The key features of the figure are consistent with the heterogeneous financial cycle patterns across country groups documented in figure 3. First, the magnitudes of the leverage cycles of the high- and low-amplitude groups are similar until 2002 but diverge after 2002. This divergence is driven by the increase in volatility of the high-amplitude group's leverage cycle. The volatility of the low-amplitude group's leverage cycle is stable over the sample period, with a peak-to-trough difference of around 4 percentage points throughout. By contrast, the volatility of the high-amplitude group's leverage cycle increases fourfold, rising from a peak-to-trough difference of around 5 percentage points in the 1980s to a peak-to-trough difference of over 20 percentage points in the 2000s. Second, the leverage cycle of the high-amplitude group diverges markedly from that of Germany from 2003 to 2014, with the former rising explosively from 2003 until its peak in 2007 and

the latter becoming increasingly negative between 2003 and 2006.[30] Third, the downswing in all the leverage cycles except Germany's coincides with the 2008–09 euro-area recession. Fourth, the reversal in the leverage cycle of the high-amplitude group between 2008:Q1 and 2014:Q3 is of a similar magnitude as the preceding upswing, with the leverage cycle falling from around 11 percent to around –9 percent. Moreover, the leverage cycles of all country groups except Germany became negative around 2012:Q1, close to the peak of the euro-area crisis. Finally, Germany displays a unique pattern. Not only does Germany's leverage cycle exhibit different cyclical patterns from the other country groups starting in 1990, but Germany is also the only region where the leverage cycle is negative at the height of the boom period, becoming negative in 2003:Q2 and reaching its trough in 2006:Q1. Conversely, Germany exhibits a positive leverage cycle as early as 2013:Q4, whereas all the other regions' leverage cycles remain negative throughout the second half of the crisis period.

In addition to the divergence between Germany and the high-amplitude group with respect to the leverage cycle, figure 6 shows that the 1992–93 and 2008–09 euro-area recessions were preceded by upswings in the leverage cycle of all country groups except Germany. Strikingly, the countries that diverged—Germany and high-amplitude countries—all played a systemic role during the crisis, as a creditor country for the former and as debtor countries for the latter. Taken together, these elements suggest that the procyclicality of financial and leverage cycles in some countries and their strong heterogeneity across countries matter.

5. Conclusion

This paper studies business cycle and financial cycle synchronization across and within euro-area countries. To the best of my

[30] In 2003:Q1, the leverage cycle of all country groups was close to zero. Between 2003:Q2 and 2007:Q4, the high-amplitude group's leverage cycle rose to 11 percent. Conversely, Germany's leverage cycle fell to –2 percent over the same period. The divergence continued for seven years after Germany's and the high-amplitude group's leverage cycles turned (in opposite directions) in 2006:Q1 and 2007:Q4, respectively. In 2014:Q2, the high-amplitude group's leverage cycle stood at –8.6 percent, while Germany's leverage cycle stood at 0.1 percent.

knowledge, financial cycle synchronization in the euro area has not been extensively analyzed so far. Three main results emerge. First, each five-year period that preceded a euro-area recession after 1990 is characterized by a procyclical upturn in the euro-area leverage cycle. This confirms the literature's findings on the relevance of the financial cycle in predicting financial crises (Borio 2014; Schüler, Hiebert, and Peltonen 2017), as financial crises have been shown typically to be followed by deep slumps (Reinhart and Rogoff 2009; Jordá, Schularick, and Taylor 2016a).

Second, I document heterogeneity and divergence across national financial cycles. I find that Germany's financial cycle has been remarkably flat throughout the sample period (1971–2015), while Spain, Ireland, and Greece—which I name "high-amplitude" countries—experienced remarkably ample financial cycles after the introduction of the euro. I also find that Germany's financial cycle diverged from the composite high-amplitude financial cycle after 2002. Average euro-area financial cycle concordance fell markedly during the boom period, and the financial cycle concordance of high-amplitude countries and Germany fell sharply during the boom and crisis periods that followed euro introduction. By contrast, I find that average business cycle synchronization increased gradually over time, albeit with the similarity of the composite business cycle of high-amplitude countries falling in the boom period.

Finally, consistent with the evidence of financial cycle divergence between high-amplitude countries and Germany, I find that leverage cycles diverged between high-amplitude countries and Germany from 2003 to 2014.

These findings contribute to the growing literature on the financial cycle (Borio 2014; Stremmel 2015; Schüler, Hiebert, and Peltonen 2017) and link it to the literature on business cycle synchronization (Kalemli-Ozcan, Papaioannou, and Perri 2013; De Grauwe and Ji 2016). The finding that, on average, the leverage cycle was positive in each five-year period preceding euro-area recessions after 1990 confirms the procyclical role of financial cycles, and hence of the financial system (Jordá, Schularick, and Taylor 2013; Borio 2014). The finding that financial cycle concordance across euro-area countries fell after the introduction

of the euro is consistent with Samarina, Zhang, and Bezemer (2016). The finding that Germany's financial cycle stands out as being particularly flat and desynchronized from the rest of the euro area is consistent with Rünstler and Vlekke (2018) and Schüler, Hiebert, and Peltonen (2017). The finding that business cycle concordance is relatively strong and broad based is consistent with De Grauwe and Ji (2016) and Schüler, Hiebert, and Peltonen (2017), respectively.

There are three reasons why the evidence on business and financial cycle synchronization presented in this paper matters for euro-area monetary and macroprudential policies. First, the financial cycle can have a large impact on economic fluctuations, notably through the leverage cycle, which generates economic booms and busts (Geankoplos 2010; Borio 2014; Jordá, Schularick, and Taylor 2017). Second, the existence of financial cycle asymmetries across euro-area member states implies that, at any given point in time, monetary policy may be inappropriate, for different reasons, for several member states. Third, to the extent that euro-area countries' position in the financial cycle and the magnitude of their financial cycles are influenced by the position and amplitude of other financial cycles (e.g., via cross-border capital flows), the synchronization of financial cycles may influence resource allocation and generate asset price bubbles, hindering cross-country economic convergence and making a systemic financial crisis more likely. The finding that financial cycles can become persistently desynchronized (in both concordance and amplitude) across member states therefore suggests that the ECB should integrate the financial cycle into its monetary and macroprudential policy framework, and that macroprudential policies should be countercyclical and country specific.

Three avenues for research would enhance our understanding of the relationship between business cycles and financial cycles: examining the relationship between financial cycles, potential growth and its drivers, and natural interest rates; studying the interaction between cross-border credit, financial cycles, and resource misallocation, including the effect of rising collateral values on credit and labor misallocation; and investigating the links, at the country level, between the structure of the financial system and the dynamics of the financial cycle.

References

Adrian, T., and N. Boyarchenko. 2015. "Intermediary Leverage Cycles and Financial Stability." Staff Report No. 567 (February), Federal Reserve Bank of New York.

Aglietta, M., and T. Brand. 2015. "La stagnation séculaire dans les cycles financiers de longue période." In *CEPII, L'économie mondiale 2016.* Paris: La Découverte.

Arnold, B., C. Borio, L. Ellis, and F. Moshirian. 2012. "Systemic Risk, Macroprudential Policy Frameworks, Monitoring Financial Systems and the Evolution of Capital Adequacy." *Journal of Banking and Finance* 36 (12): 3125–32.

Beaudry, P., D. Galizia, and F. Portier. 2016. "Putting the Cycle Back into Business Cycle Analysis." NBER Working Paper No. 22825 (November).

Belke, A., C. Domnick, and D. Gros. 2016. "Business Cycle Synchronization in the EMU: Core vs. Periphery." CEPS Working Document No. 427 (November).

Berger, H., T. Dowling, S. Lanau, W. Lian, M. Mrkaic, P. Rabanal, and M. Taheri Sanjani. 2015. "Steady as She Goes: Estimating Potential Output During Financial 'Booms and Busts'." IMF Working Paper No. 15/233 (November).

Bordo, M., and T. Helbling. 2003. "Have National Business Cycles Become More Synchronized?" NBER Working Paper No. 10130 (December).

Borio, C. 2014. "The Financial Cycle and Macroeconomics: What Have We Learnt?" *Journal of Banking and Finance* 45 (August): 182–98.

Borio, C., P. Disyatat, and M. Juselius. 2013. "Rethinking Potential Output: Embedding Information about the Financial Cycle." BIS Working Paper No. 404 (February).

Borio, C., C. Furfine, and P. Lowe. 2001. "Procyclicality of the Financial System and Financial Stability: Issues and Policy Options." *BIS Papers* 1 (March): 1–57.

Borio, C., N. Kennedy, and S. D. Prowse. 1994. "Exploring Aggregate Asset Price Fluctuations across Countries: Measurement, Determinants and Monetary Policy Implications." BIS Economic Paper No. 40 (April).

Borio, C., M. Lombardi, and F. Zampolli. 2016. "Fiscal Sustainability and the Financial Cycle." BIS Working Paper No. 552 (March).

Brunnermeier, M. K., and Y. Sannikov. 2014. "A Macroeconomic Model with a Financial Sector." *American Economic Review* 104 (2): 379–421.

Cesa-Bianchi, A., J. Imbs, and J. Saleheen. 2016. "Finance and Synchronization." CEPR Discussion Paper No. 11037.

Christiano, L., and T. Fitzgerald. 2003. "The Band Pass Filter." *International Economic Review* 44 (2): 435–65.

Claessens, S., M. A. Kose, and M. E. Terrones. 2011. "Financial Cycles: What? How? When?" In *NBER International Seminar on Macroeconomics 2010*, ed. R. Clarida and F. Giavazzi, 303–43 (chapter 7). National Bureau of Economic Research.

———. 2012. "How Do Business and Financial Cycles Interact?" *Journal of International Economics* 87 (1): 178–90.

Comin, D., and M. Gertler. 2006. "Medium-Term Business Cycles." *American Economic Review* 96 (3, June): 523–51.

Constâncio, V. 2016. "Principles for Macroprudential Policy." Speech at the ECB-IMF Conference on Macroprudential Policy, Frankfurt am Main, April 26.

———. 2017. "Macroprudential Policy in a Changing Financial System." Second ECB Macroprudential Policy and Research Conference, Frankfurt am Main, May 11.

De Grauwe, P., and Y. Ji. 2016. "Synchronisation in Business Cycles: An Endogenous Explanation." VoxEU.

Detken, C., O. Weeken, L. Alessi, D. Bonfim, M. M. Boucinha, C. Castro, S. Frontczak, G. Giordana, J. Giese, N. Jahn, and J. Kakes. 2014. "Operationalising the Countercyclical Capital Buffer." ESRB Occasional Paper No. 5.

Drehmann, M., C. Borio, and K. Tsatsaronis. 2012. "Characterising the Financial Cycle: Don't Lose Sight of the Medium Term!" BIS Working Paper No. 380 (June).

Eichengreen, B. 1991. "Is Europe an Optimum Currency Area?" NBER Working Paper No. 3579 (January).

———. 2007. *The European Economy since 1945: Coordinated Capitalism and Beyond.* Princeton and Oxford: Princeton University Press.

Enderlein, H., E. Letta, J. Asmussen, L. Boone, A. De Geus, P. Lamy, P. Maystadt, M. João Rodrigues, G. Tumpel-Gugerell, and A. Vitorino. 2016. *Repair and Prepare: Growth and the Euro after Brexit.* Gütersloh, Berlin, Paris: Bertelsmann Stiftung, Jacques Delors Institut – Berlin and Jacques Delors Institute in Paris.

European Central Bank. 2014. "Financial Stability Review: Capturing the Financial Cycle in Euro Area Countries." November.

———. 2015. "Real Convergence in the Euro Area: Evidence, Theory and Policy Implications." *Economic Bulletin* 5/2015 (July): 30–45.

Franks, J., B. Barkbu, R. Blavy, W. Oman, and H. Schoelermann. 2018. "Economic Convergence in the Euro Area: Coming Together or Drifting Apart?" IMF Working Paper No. 18/10 (January).

Galati, G., I. Hindrayanto, S. J. Koopman, and M. Vlekke. 2016. "Measuring Financial Cycles in a Model-Based Analysis: Empirical Evidence for the United States and the Euro Area." *Economics Letters* 145 (C): 83–87.

Garcia-Santana, M., E. Moral-Benito, J. Prijoan-Mas, and R. Ramos. 2016. "Growing like Spain: 1995-2007." CEPR Working Paper No. 11144 (March).

Geanakoplos, J. 2010. "The Leverage Cycle." In *NBER Macroeconomics Annual 2009*, Vol. 24, ed. D. Acemoglu, K. Rogoff, and M. Woodford, 1–65 (chapter 1). Chicago: University of Chicago Press.

Gerdrup, K., A. Kvinlog, and E. Schaanning. 2013. "Key Indicators for a Countercyclical Capital Buffer in Norway—Trends and Uncertainty." Staff Memo No. 13, Norges Bank.

Giannone, D., and L. Reichlin. 2006. "Trends and Cycles in the Euro Area: How Much Heterogeneity and Should We Worry about It?" ECB Working Paper No. 595.

Gopinath, G., S. Kalemli-Ozcan, L. Karabarbounis, and C. Villegas-Sanchez. 2015. "Capital Allocation and Productivity in South Europe." NBER Working Paper No. 21453.

Gorton, G., and G. Ordoñez. 2016. "Good Booms, Bad Booms." NBER Working Paper No. 22008.

Harding, D., and A. Pagan. 2003. "A Comparison of Two Business Cycle Dating Methods." *Journal of Economic Dynamics and Control* 27 (9): 1681–90.

Hyppolite, P.-A. 2016. "Towards a Theory on the Causes of the Greek Depression: An Investigation of National Balance Sheet Data (1997-2014)." Center for European Studies Paper Series, Harvard University.

Jordà, Ò., M. Schularick, and A. Taylor. 2011. "Financial Crises, Credit Booms, and External Imbalances: 140 Years of Lessons." *IMF Economic Review* 59 (2): 340–78.

———. 2013. "When Credit Bites Back." *Journal of Money, Credit and Banking* 45 (s2): 3–28.

———. 2016a. "Sovereigns versus Banks: Credit, Crises, and Consequences." *Journal of the European Economic Association* 14 (1): 45–79.

———. 2016b. "The Great Mortgaging: Housing Finance, Crises and Business Cycles." *Economic Policy* 31 (85): 107–52.

———. 2017. "Macrofinancial History and the New Business Cycle Facts." In *NBER Macroeconomics Annual 2016,* Vol. 31, ed. M. Eichenbaum and J. A. Parker, 213–63. University of Chicago Press.

Kalemli-Ozcan, S., E. Papaioannou, and F. Perri. 2013. "Global Banks and Crisis Transmission." *Journal of International Economics* 89 (2): 495–510.

Kose, M. A., C. Otrok, and C. Whiteman. 2003. "International Business Cycles: World, Region, and Country-Specific Factors." *American Economic Review* 93 (4): 1216–39.

———. 2008. "Understanding the Evolution of World Business Cycles." *Journal of International Economics* 75 (1): 110–30.

Kose, M. A., E. Prasad, and M. E. Terrones. 2003. "Financial Integration and Macroeconomic Volatility." *IMF Staff Papers* 50 (Special Issue): 119–42.

Lane, P. R., and P. McQuade. 2014. "Domestic Credit Growth and International Capital Flows." *Scandinavian Journal of Economics* 116 (1): 218–52.

McCarthy, M. 2006. "Comments on the Paper: Trends and Cycles in the Euro Area: How Much Heterogeneity and Should We Worry About It?" ECB Working Paper No. 595.

McDermott, M., and A. Scott. 2000. "Concordance in Business Cycles." IMF Working Paper No. 00/37 (March).

Merler, S. 2015. "Squaring the Cycle: Capital Flows, Financial Cycles, and Macro-prudential Policy in the Euro Area." Bruegel Working Paper No. 2015/14 (November).

Mink, M., J. P. A. M. Jacobs, and J. de Haan. 2012. "Measuring Coherence of Output Gaps with an Application to the Euro Area." *Oxford Economic Papers* 64 (2): 217–36.

Monnet, E., and D. Puy. 2016. "Has Globalization Really Increased Business Cycle Synchronization?" IMF Working Paper No. 16/54 (March).

Praet, P. 2014. "The Financial Cycle and Real Convergence in the Euro Area." Speech at the Annual Hyman P. Minsky Conference on the State of the US and World Economies, Washington D.C., April 10.

Reinhart, C., and K. Rogoff. 2009. "The Aftermath of Financial Crises." *American Economic Review* 99 (2): 466–72.

Rey, H. 2015. "Dilemma Not Trilemma: The Global Financial Cycle and Monetary Policy Independence." NBER Working Paper No. 21162.

Rünstler, G., and M. Vlekke. 2018. "Business, Housing, and Credit Cycles." *Journal of Applied Econometrics* 33 (2): 212–26.

Samarina, A., L. Zhang, and D. Bezemer. 2016. "Credit Cycle Coherence in the Eurozone: Was There an Euro Effect?" Mimeo, University of Groningen.

Schularick, M., and A. Taylor. 2012. "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises." *American Economic Review* 102 (2): 1029–61.

Schüler, Y. S., P. Hiebert, and T. A. Peltonen. 2017. "Coherent Financial Cycles for G-7 Countries: Why Extending Credit Can Be an Asset." Working Paper No. 43, European Systemic Risk Board (May).

Shin, H. S. 2012. "Global Banking Glut and Loan Risk Premium." *IMF Economic Review* 60 (2): 155–92.

Stremmel, H. 2015. "Capturing the Financial Cycle in Europe." ECB Working Paper No. 1811.

Stremmel, H., and B. Zsámboki. 2015. "The Relationship between Structural and Cyclical Features of the EU Financial Sector." ECB Working Paper No. 1812.