The long history of financial boom-bust cycles in Iceland

Part II: Financial cycles*

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Abstract

Claudio Borio recently quipped that "macroeconomics without the financial cycle is like Hamlet without the Prince" (Borio, 2014, p. 183). We rise to his call to arms and tackle the Prince's existential question head-on. Our findings suggest that indeed there exists a well-defined financial cycle in Iceland that has gradually become more prominent, in particular with increased liberalisation and deepening of the domestic financial system since the 1980s. Using a dataset spanning more than a century and including data on credit, house prices, and bank balance sheet size and composition, we find that the aggregate cycle is much longer than the typical business cycle, with a median duration of fifteen years, and seems to be getting longer and more intense over time. We find that there is a large difference in economic performance over different phases of the financial cycle, suggesting that it has played a prominent role in the country's macroeconomic development. In fact, we find that almost all of the peaks in the financial cycle coincide with some kind of a financial crisis and that cyclical expansions provide a robust early-warning signal for subsequent crises. Furthermore, our results show that the aggregate cycle provides a marked improvement over individual financial and macroeconomic variables in signalling ensuing financial crises, highlighting the importance of the interaction of different financial variables in amplifying financial imbalances. We find strikingly strong ties between the Icelandic financial cycle and its global counterpart (proxied by the US financial cycle), with almost all of the cyclical peaks in the Icelandic financial cycle occurring close to peaks in the global cycle (usually coinciding or with the Icelandic peak lagging by a year or two). There is also evidence that these spillover effects have been growing stronger over time. Our findings suggest that understanding economic fluctuations in Iceland is hard without understanding the financial cycle and that we ignore the financial cycle at our peril. We conclude the paper with a first attempt at exploring some of the policy questions that our findings raise.

Keywords: Financial cycle, business cycle, medium-term, financial crises, global financial spillovers, Iceland
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"History does not repeat itself, but it rhymes"
Mark Twain

1 Introduction

Claudio Borio recently quipped that "macroeconomics without the financial cycle is like Hamlet without the Prince" (Borio, 2014, p. 183). We rise to his call to arms and tackle the Prince's existential question head-on. Our findings suggest that indeed there exists a well-defined financial cycle in Iceland that has gradually become more prominent, in particular with increased liberalisation and deepening of the domestic financial system since the 1980s. We find that this financial cycle has played a key role in the country's macroeconomic developments and, in particular, the financial crises that have regularly hit the economy over a period spanning more than a century. We also find that Iceland is no island in the vast ocean of global high finance, uncovering extremely strong spillover effects from the global financial cycle.

To analyse the financial cycle we use a database constructed for the first part of our study on the history of financial crises in Iceland (Einarsson et al., 2015), which spans the period 1875-2013 and contains annual data on financial prices and volumes, as well as banking system assets, leverage, and liability composition. Here, we focus on the lower frequency properties of our financial variables, i.e. cycles that are longer than typical business cycles. For this, we follow the approach in the growing literature on financial cycles (cf. Drehmann et al., 2012, and Aikman et al., 2014) and filter the data using a band-pass filter to extract cycles with a duration of eight to thirty years. We show that these medium-term cycles dominate typical business cycles in explaining the developments of our financial variables and most of the macroeconomic variables that we also include in our study.

While there is no agreed upon definition of the financial cycle, the term generally refers to the co-movement of a set of financial variables including both quantities and prices (Bank for International Settlements, 2014). Accordingly, Borio (2014, p. 183) characterises the financial cycle as the "self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints, which translate into booms followed by busts", making the term closely tied to the concept of the financial system's pro-cyclicality (cf. Borio et al., 2001, and Daníelsson et al., 2004).

To capture the aggregate financial cycle, Borio (2014) argues that the most parsimonious representation of the cycle is in terms of the interaction between credit and property prices, although other variables may provide useful complementary information. On this basis, we measure the financial cycle as the low-frequency cyclical co-movement of a set of financial variables, conceptually similar to the standard approach for defining the business cycle. We use a broader collection of variables than just credit and house prices to attain additional insight and to expose potentially important small open economy features of the financial cycle and its interaction with the domestic economy. To make this operational, we aggregate the medium-term cycles in our financial variables using a principal component

approach, which gives the linear combination of the variables that explains most of the combined variability of the individual cycles. We find that not all of our financial variables contribute to this aggregate financial cycle, but the ones that do attain roughly equal weights. This aggregate cycle is found to capture more than 60% of the variability of the aggregate financial data over the whole sample period, rising to more than 80% in the post-1980 period. We identify seven complete cycles in this aggregate measure with a median duration of fifteen years, which incidentally is identical to the average interval between serious multiple financial crisis episodes found in Part I of our study. We also find evidence that these aggregate financial cycles have become longer and more intense over time.

The financial cycle in Iceland is therefore found to be much longer than the typical business cycle and its intensity and length is found to have increased over time relative to the business cycle. There is also a large difference in economic performance over different phases of the financial cycle: the average growth rate of output and domestic demand is almost three times higher in the expansionary phase of the financial cycle than in the contractionary phase of the cycle (rising to almost four times higher in the post-1980 period).

This large difference in economic activity over different phases of the financial cycle shows how important the financial cycle is for understanding macroeconomic dynamics in Iceland. This is never as clear as in the latter stages of the expansionary phase of the financial cycle, when balance sheets become overextended and asset prices peak, and the subsequent bust when these imbalances are unwound, which can have severe effects on economic activity and even lead to a financial crisis. We find indeed that almost all of the cyclical peaks coincide with some kind of a financial crisis. We also find that expansions in the financial cycle provide a robust early-warning signal for subsequent financial crises and that the aggregate cycle provides a marked improvement over individual financial and macroeconomic variables in signalling ensuing financial crises, highlighting the importance of the interaction of different financial variables in amplifying financial imbalances.

Previous studies have consistently failed to find important links between the Icelandic business cycle and the business cycles of other developed economies (e.g. Gudmundsson et al., 2000, and Einarsson et al., 2013b). The prevalent view has therefore been that the Icelandic business cycle is dominated by country-specific supply shocks, such as idiosyncratic shocks to its important resource sectors. Our results suggest that this consensus may need to be revised as it overlooks the importance of the financial channel through which global shocks penetrate the Icelandic economy. We find strikingly strong ties between the Icelandic financial cycle and its global counterpart, which is proxied by the US financial cycle (captured by a composite measure of medium-term cycles in credit and house prices): over the whole sample period these two financial cycles spend over 70% of the time in the same cyclical phase and almost all of the cyclical peaks in the Icelandic financial cycle occur close to peaks in the global cycle, with the peaks usually coinciding or the Icelandic peak lagging by a year or two. There is also evidence that these spillover effects have been growing stronger over time. We test whether there are additional regional spillover effects captured by the financial cycles in Denmark and Norway, both of which have strong political, economic, and cultural ties with Iceland, and the UK, given its strong and long-standing trade and financial links. We find limited evidence for

the regional effects beyond the strong global spillover effects captured by the US financial cycle. There is, however, some evidence of spillover effects from the Danish credit cycle in the first half of the 20th century, consistent with the prominent role of Danish financing of the domestic financial system during that period.

Our results are very much in the spirit of the findings of recent papers on the importance of the financial cycle in other industrial countries, such as Claessens et al. (2011, 2012), Drehmann et al. (2012), and Aikman et al. (2014). Our study adds to this growing literature by adding yet another country to the sample of countries studied, a country that has been exposed to numerous financial crises of various types over a period spanning over a century, of which the most recent financial tsunami is only the latest example. But our paper also contributes to the literature by showing how more detailed data on bank balance sheets can provide further insights into the analysis of the financial cycle and by highlighting important small open economy features of the cycle and its interactions with the domestic economy, including the importance of contagion from the global financial cycle. We also present a simple way to aggregate individual financial variables that captures their relative importance to the aggregate cycle which allows us to document the importance of individual components to a given cyclical episode.

Our findings highlight the overarching importance of the financial cycle for economic fluctuations in Iceland. The strikingly high co-movement of the Icelandic financial cycle with its global counterpart and the strong coincidence of the cycle and financial crises have already been discussed, but our results show that the cycle's reach goes beyond that. They suggest that it is hard to understand capital flows, the surprisingly high volatility of private consumption in Iceland, and fiscal policy dynamics, to name only three important issues in the domestic economic debate, without understanding the financial cycle. Our results also raise some fundamental policy questions, such as how to design a policy framework that takes the financial cycle into account and its tendency to amplify real economic activity over the boom and bust phases. The strong global spillover effects may also suggest the need for capital flow management measures that compliment other policy tools and may even raise new questions concerning the optimal exchange rate regime for Iceland. We discuss issues these in turn, but to us it is clear that this can only be viewed as a first attempt and that further analysis is likely to be needed to explore the full implications of our findings.

The remainder of the paper is organised as follows. Section 2 presents the data and the motivation for their inclusion in our study. In Section 3 we analyse the key properties of medium-term cycles of individual financial and macroeconomic variables. In Section 4 we use evidence from the previous section to construct a composite measure of the financial cycle in Iceland and discuss its main properties. Here we also discuss its relationship with the conventional business cycle and how different phases of the financial cycle interact with economic activity. In Section 5 we look at possible spillover effects from the global financial cycle and whether there are possible additional regional spillover effects from Scandinavia and the UK. Section 6 moves on to analyse the interaction of the Icelandic financial cycle and domestic financial crises and in Section 7 we highlight some policy implications coming out of our analysis. Section 8 concludes the paper.

2 The data

To analyse the financial cycle in Iceland, we use a range of financial variables that cover aggregate financial prices and volumes on the one hand and bank balance sheets on the other hand. We also include a number of key macroeconomic variables which are used to analyse the development of the real economy over the financial cycle and how it interacts through various macro-financial linkages with the cycle. These variables and their motivation are further discussed below while Appendix 1 summarises the data graphically. A more detailed description of the data, their sources, and their properties and behaviour in the run-up to and aftermath of financial crises can be found in Part I of our study (Einarsson et al., 2015).

The fact that financial cycles usually take a long time to complete – decades even – calls for a longer data span than is usually required for analysing most other macroeconomic phenomena. We have therefore constructed a database based on annual data over a period spanning 139 years (1875-2013).[1] As is often the case, the need for a long data span necessitates the use of annual data which comes at the cost of losing higher frequency information on financial cycles found in quarterly data. However, by covering such a long time period we gain some unique insight into the domestic financial cycle that would be lost by focusing on a shorter one, and the tragic but universal truth that "we've been there before" when it comes to financial boom-bust cycles really becomes all too clear.

2.1 Financial variables

Credit, money, and house prices

The first set of financial variables includes the variables which are central to any analysis of financial cycles, i.e. credit, money, and house prices.[2] The credit cycle, as reflected in surges and shortfalls of liquidity, easing and tightening of financial constraints, and their accompanying balance sheet expansions and deleveraging can have severe repercussions for economic activity and overall macroeconomic stability. Hence, studies of financial cycles logically include credit aggregates as one of the key elements capturing the nexus between the financial system and the real economy (Claessens et al., 2011, 2012, Drehmann et al., 2012, Jordà et al., 2013, 2014, 2015, Aikman et al., 2014, and Taylor, 2015). As our credit measure

[1] There are exceptions where we were not able to extend the data all the way back to 1875. These are broad money, credit and the two non-core bank liabilities variables which date back to 1886, and house prices which we only managed to extend back to 1900.

[2] The results from Schularick and Taylor (2012) suggest that money played a more prominent role in the financial boom-bust cycle up to World War II (WWII), but has become less important as the role of non-monetary financing of financial institutions has increased. Our analysis does not include stock prices as stock market data does not extend further back than the mid-1980s (Drehmann et al., 2012, find that stock prices do not help explaining the financial cycle in a number of developed economies) but the medium-term cycle in stock prices does show a strong co-movement with the financial cycle over the short period available, in particular in the latest boom-bust episode. Juselius and Drehmann (2015) also emphasise the role of the aggregate debt service burden (interest payments plus amortisations relative to income) in addition to aggregate leverage (the stock of credit relative to asset prices). Historical data or estimates on debt service is, however, unavailable for Iceland.

we use total lending and bond holdings of the credit system (data on credit to the non-financial private sector over the whole sample is not available). We also include broad money (M3) in line with a number of studies examining to what extent monetary aggregates can serve as indicators for the state of the financial cycle or signal increasing vulnerabilities in the latter stages of financial cycle upswings (Borio and Lowe, 2004, Shin and Shin, 2011, and Kim et al., 2013). The credit and money series are included in real terms and as a ratio to GDP as different data transformations may reveal different information on the financial cycle. The credit-to-money ratio is also included to capture the extent of non-monetary funding of credit creation (for instance, through bond issuance or cross-border bank loans).

Another key variable of any analysis of the self-reinforcing interaction between financing constraints and perceptions of value and risk is real residential house prices. House prices are usually at the centre of any financial boom-bust cycle and a number of studies have established the prominent role of house price booms and busts (particularly if its debt-driven) during financial cycle peaks and troughs and in the run-up and aftermath of banking crises, with a house price boom leading into the crises, followed by a substantial and persistent decline after the bust (e.g. Bordo and Jeanne, 2002, Reinhart and Rogoff, 2008, and Jordà et al., 2015).

Banking system balance sheet

The second set of financial variables aims to capture the potentially important role of financial institutions' balance sheets in fuelling financial cycles. During booms, for example, financial constraints are generally loose due to abundant liquidity and rising net worth, allowing for balance sheet expansion of banks and other sectors within the economy. This is reversed in busts, where adverse spirals can kick in and induce disorderly deleveraging in the financial sector: obtaining funding becomes more difficult, making banks and other agents within the economy respond by fire-selling their assets, which reduces their net worth, and reinforces the balance sheet constraints (cf. Brunnermeier et al., 2013). Hence, information on the banks' balance sheets can potentially reveal additional insights into their role in amplifying shocks through various macro-financial linkages and financial sector interconnectedness (cf. Adrian and Shin, 2011, and the International Monetary Fund, 2013).

Our first balance sheet variable focuses on the asset side of the balance sheet, as measured by the ratio of total banking system assets to GDP. This measure provides insights into how banks' risk appetite with regards to channelling of funds to the real economy evolves over the financial cycle (Schularick and Taylor, 2012, and Kim et al., 2013). At the same time, it can also serve as a proxy for market liquidity of the banking system assets as they may become more difficult to sell with limited price impact once the banking system becomes very large relative to the economy. Finally, it can also capture the potential mismatch between the domestic authorities' capacity and the banking system's possible need for support in times of distress.

The second balance sheet variable we construct is a measure of banking system leverage (the ratio of banking system assets to bank equity) to capture to what extent assets are being financed with debt (cf. Drehmann et al., 2012). This leverage measure is more general than the credit-to-money ratio discussed above as it encompasses a greater number of assets and

liabilities, and can therefore provide additional information for analysing the financial cycle (although this measure is also subject to some disadvantages, as we discuss below).

Our final banking system balance sheet variable is the ratio of non-core banking liabilities to total liabilities, which reflects the claims on the domestic banks not held by the ultimate domestic creditors. This measure is a proxy for the funding liquidity position of the banking system and aims to capture to what extent banks shift towards more unsustainable sources of funding as the traditional (monetary) ones are exhausted in financial booms (cf. Borio et al., 2011, Hahm et al., 2013, and Kim et al., 2013). We also distinguish between foreign and total non-core liabilities to capture the possible distinctive vulnerabilities of relying on cross-border funding and their relation to banking and currency crises which could play an important role in the financial cycle of a small open (and at times tightly financially integrated) economy, such as Iceland.

2.2 Macroeconomic variables

We include seven macroeconomic variables to capture the multifaceted linkages between the financial cycle and economic developments in a small open economy such as Iceland. We use real GDP as our measure of overall economic activity but to capture the ability of the external account to serve both as a source and absorber of shocks, we also include the external balance and real domestic demand. This allows us to shed important additional light on the interactions between the financial cycle, cross-border capital flows and domestic spending in small open economies. Our approach is inspired by numerous studies suggesting that current account deficits and capital flows tend to be pro-cyclical and fuel asset price and financial boom-bust cycles (cf. Kaminsky and Reinhart, 1999, Aguiar and Gopinath, 2007, Korinek, 2011, and Broner et al., 2013).[3] With no data on the current account available for the whole period, we use the trade balance, which also serves as a proxy for capital flows (cf. Reinhart and Rogoff, 2009).[4]

We also include the exchange rate which can play a pivotal role in the real-financial nexus in small open economies. Some studies suggest that the exchange rate in very small open economies such as Iceland can be a source of shocks rather than a shock absorber (cf. Breedon et al., 2012) and others find the real exchange rate to be a leading indicator of currency and banking crises (cf. Kaminsky et al., 1998, Kaminsky and Reinhart, 1999, Goldstein et al., 2000,

[3] Aguiar and Gopinath (2007) find that this emerging market phenomenon is strongly linked to an unusually high ratio of permanent to temporary shocks. As Reinhart and Rogoff (2009) argue, policymakers in these countries seem to have a tendency to interpret favourable shocks as being permanent, leading to spending sprees and borrowing binges that ultimately lead to sudden stops in funding and sharp recessions and reversals in the current account. Korinek (2011) argues that exposure to international capital flows imposes externalities on countries in the form of financial instability arising from risky external debt accumulation by market participants who do not internalise the economy-wide effects of their borrowing decisions through exchange rate and asset price changes.

[4] Although cross-border banking liabilities can also serve as a proxy for (gross) capital flows, the first part of our study (Einarsson et al., 2015) suggests that the capital flow cycle over the whole period is better captured by the trade balance data. This probably reflects the tight management of the capital account for a large part of the sample period and that our cross-border banking liabilities measure does not capture the role played by the government and its investment funds in intermediating foreign credit to the domestic economy, especially during the post-WWII period up until 1970 when the banks' access to foreign funding remained severely restricted.

and Gourinchas and Obstfeld, 2012). Bruno and Shin (2015a, b) provide theoretical and empirical evidence consistent with these finding and emphasise the interactions between currency appreciations, borrowers' balance sheet strength, and greater risk-taking by banks in driving financial cycles and thereby affecting economic activity in small open economies. We include both the nominal (vis-à-vis the US dollar as emphasised by Avdjiev et al., 2015) and real (trade weighted relative consumer prices) value of the currency.

Finally, our set of macroeconomic variables includes inflation to capture the chronic inflation episodes and frequent inflation crises throughout Iceland's economic history and the terms of trade which have historically been found to be an important source of business cycle fluctuations and an important trigger of financial crises (cf. Gudmundsson et al., 2000, Daníelsson, 2008, and Einarsson et al., 2015).

3 Cycles in financial and macroeconomic variables

Early economic writers drew lessons from the financial boom-bust episodes which they experienced in their lifetime with regard to the factors affecting economic developments. Parts of Adam Smith's *Wealth of Nations* were thus inspired by the 1772 banking crisis and the pioneers of analysis into economic cycles, Sismondi and Dunoyer, used the first modern international financial crisis in 1825 to champion their argument for the importance of endogenous economic cycles (Sowell, 1972, and Benkemoune, 2009). Subsequent series of banking crises led to further analysis into the role of credit creation in the macroeconomy, especially by Knut Wicksell and the Austrian School. Emphasis on the role of financial factors in economic fluctuations and the presence of self-reinforcing interaction between medium-term "financial" cycles and the general business cycle culminated in the works of the Great Depression-era economists, such as Irving Fisher and Alvin Hansen. For example, writing about business cycles and lessons to be drawn from the Great Depression, Hansen (1941, p. 25) emphasised the importance of "building construction cycles" (a cycle closely related to the financial cycle due to its duration and the role played by credit and property prices) for understanding the Great Depression and business cycles in general:

> "It is […] not possible to give an adequate analysis of the major business cycle […] without taking account of the impact on that cycle of the longer cycle of building construction. This factor is one of the most profound of the various influences which cause one major business cycle to differ from another. And in this factor we are able to see against the background of earlier American experience a part of the explanation of the severity of the Great Depression starting in 1929."

However, financial features gradually lost their prominent role within macroeconomics in the post-WWII period and the lessons of the past were all but forgotten (Gertler, 1988). The recent global financial crisis, however, swiftly shifted the focus once again to the role of macro-financial linkages in explaining macroeconomic phenomena. A rapidly expanding literature has since emerged attempting to account for the importance of these financial features (cf. Brunnermeier et al., 2013, Taylor, 2015) and uncover the salient features of the financial cycle. In particular, Claessens et al. (2011, 2012), Drehmann et al. (2012), and Aikman et al. (2014)

all find evidence of cycles in financial variables that tend to be longer and of greater amplitude than standard business cycles. Drehmann et al. (2012) and Aikman et al. (2014) also find evidence of important links between these lower-frequency cycles and financial crises, suggesting an important role of these cycles in explaining such episodes.

3.1 Extracting cyclical components from the data

To identify short- and medium-term cycles in our data, we follow Aikman et al. (2014) and use the Christiano and Fitzgerald (2003) asymmetric band-pass filter to isolate the pre-specified frequency range of the data.[5] The short-term cycles we aim to identify coincide with typical business cycles, which are commonly thought to last between 5 quarters and 8 years. However, our use of annual data dictates that we restrict the minimum phase of these short-term cycles to 2 years. Following Drehmann et al. (2012), we identify the medium-term cycles as those that have a duration between 8 and 30 years. While the upper bound in their paper is dictated by data limitations, our earlier study (Einarsson et al., 2015) finds that major financial crisis occur in Iceland on average every fifteen years indicating that 8 to 30 years should be a sufficiently large window to focus on when identifying the financial cycle in Iceland.[6] As has become standard in this literature (cf. Comin and Gertler, 2006, and Drehmann et al., 2012), we apply the frequency filter to log-differences of the original variables, which under the common assumption that growth rates of economic series are stationary implies a zero trend in the filter. To construct the medium-term cycles in the original variables we then cumulate these growth series into log-levels starting from zero at the first observation of the variable.[7]

3.2 Key cyclical characteristics of individual series

We start by looking at some key cyclical properties of our financial and macroeconomic variables, applying the terminology commonly applied in business cycle analysis. We report results on the typical length and intensity of medium-term cycles in each variable and how they have evolved over time. We also compare the volatility of medium-term cycles to that of the corresponding short-term (business) cycles in the data to establish which cyclical component has been the key driver of the behaviour of each series. Finally, we look at how the medium-term cyclical components of the data correlate with each other, interpreting evidence of cyclical co-movement of the financial variables as suggesting the presence of a financial cycle.

[5] Claessens et al. (2011, 2012) use the Harding and Pagan (2002) turning point algorithm, while Drehmann et al. (2012) apply both the band-pass filter and the turning-point approach. In our previous study (Einarsson et al., 2015), we use the Hodrick-Prescott filter with a high smoothing parameter to analyse the cyclical behaviour of our financial and macroeconomic variables in the run-up to and aftermath of financial crises. Using the Hodrick-Prescott filter here to extract the medium-term cycles in the data gave broadly similar results to the band-pass filter but tended to identify more frequent and shorter cycles.

[6] Aikman et al. (2014) use an upper range of 20 years, while Comin and Gertler (2006) use an upper range of 50 years. Our results are found to be robust to variations in the upper range of duration of medium-term cycles.

[7] For the trade deficit and inflation (which can take both positive and negative values) and the two non-core bank liability measures (which equal zero for some years), we use the log-difference of one plus the variable.

Duration and intensity of medium-term cycles

The upper panel of Table 1 reports the key properties of the medium-term cyclical component of all our variables. We show the median duration and amplitude of the expansionary and contractionary phases of the medium-term cycles, and the median duration of a complete cycle (measured from peak to peak). In addition, we report the median "slope" (defined as the ratio of amplitude to duration) of expansionary and contractionary phases which measures how violent each cyclical phase is. The table shows that the financial variables have a cyclical phase lasting 5 years or more except real house prices, where each phase lasts 4 years. A complete house price cycle is therefore shorter than those of the other financial variables, where a complete cycle lasts 10 years or more (with an average cycle of 11.5 years). GDP, and most of the other macroeconomic variables, have cycles with a duration of 10 years and therefore tend to be shorter than the corresponding cycles in most of the financial variables. This is consistent with other studies, such as Claessens et al. (2011) and Drehmann et al. (2012). Our finding that the expansionary phase of the cycles in the financial variables tend to be longer than the contractionary phase is also consistent with these studies.

We also find that medium-term cycles in the financial variables tend to have greater amplitude than the corresponding cycles in the macroeconomic variables. On average, the financial variables rise by 25% during the expansionary phase of the cycle and fall by almost 22% during the contractionary phase, which is roughly double that of the macroeconomic variables. Looking at individual variables, we find that cycles in house prices and the two non-core bank liability measures tend to be less intense than in the other financial variables, while the cyclical intensity of the nominal exchange rate is a particularly distinctive feature among the macroeconomic variables.

In the lower panel of Table 1 we repeat the exercise for three different subsamples. First, we split the sample in half with the first half covering the period up to the end of WWII and the second half covering the post-WWII period. The first subsample therefore covers the modernisation of the Icelandic economy, beginning around 1890, when increased foreign demand, technological innovation, and financial deepening paved the way for export-oriented industrialisation and ends with a "great leap forward" in terms of the modernisation of the economy during WWII (Jónsson, 2004), while the second subsample covers the period from which Iceland had caught up with other advanced economies in terms of income levels. The post-WWII subsample also corresponds to a period of rising homeownership and increasing importance of mortgage financing. The third subsample covers the post-1980 period, which splits the post-WWII subsample in half and roughly coincides with the modernisation of the Icelandic financial system and liberalisation of domestic financial markets (cf. Central Bank of Iceland, 2005 (Table 5.1), 2016), while also coinciding with a period of significant international financial liberalisation and globalisation (cf. Claessens et al., 2011, and Drehmann et al., 2012) and the global real estate lending boom of the last thirty years (Jordà et al., 2014).[8]

[8] We only report the subsample results for the aggregate data groups but the same development in the cyclical properties can be found for most of the individual variables. To simplify the presentation of our results, we also only report subsample results for the duration of a complete cycle and the average of the expansionary and contractionary phases of the cycle for our amplitude and slope measures. Further detail is available upon request.

Table 1 Key characteristics of medium-term cycles

	Duration			Amplitude		Slope	
	Expan-sion	Con-traction	Full cycle	Expan-sion	Con-traction	Expan-sion	Con-traction
Real house prices	4.00	4.00	8.00	0.07	-0.08	0.02	-0.02
Real credit	6.00	5.00	13.00	0.41	-0.38	0.04	-0.04
Credit-to-GDP ratio	8.00	5.00	13.00	0.29	-0.21	0.04	-0.03
Real M3	6.00	5.50	10.00	0.30	-0.23	0.04	-0.04
M3-to-GDP ratio	7.00	6.00	12.00	0.30	-0.29	0.04	-0.03
Credit-to-M3 ratio	10.00	7.00	14.00	0.45	-0.40	0.04	-0.04
Bank assets-to-GDP ratio	6.00	6.00	12.00	0.20	-0.22	0.03	-0.04
Bank leverage ratio	6.00	6.00	12.00	0.34	-0.27	0.04	-0.05
Foreign non-core liabilities	6.00	5.50	11.00	0.04	-0.04	0.01	0.00
Total non-core liabilities	5.50	6.00	11.50	0.07	-0.04	0.01	-0.01
Real GDP	5.00	5.00	10.00	0.11	-0.14	0.02	-0.02
Real domestic demand	5.00	5.50	10.00	0.16	-0.14	0.03	-0.03
Trade deficit-to-GDP ratio	5.00	6.00	10.00	0.04	-0.05	0.01	-0.01
USD exchange rate	5.00	5.00	10.00	0.26	-0.25	0.05	-0.05
Real exchange rate	5.00	4.50	10.00	0.09	-0.16	0.02	-0.03
Terms of trade	5.00	4.00	8.50	0.12	-0.11	0.02	-0.02
Inflation	5.00	4.00	8.50	0.08	-0.07	0.01	-0.01
				Averages			
Financial variables	6.45	5.60	11.65	0.25	-0.22	0.03	-0.03
Macroeconomic variables	5.00	4.86	9.57	0.12	-0.13	0.02	-0.02
All variables	5.85	5.29	10.79	0.20	-0.18	0.03	-0.03

Different subsamples (group averages)

	Duration			Amplitude			Slope		
	1875-1944	1945-2013	1980-2013	1875-1944	1945-2013	1980-2013	1875-1944	1945-2013	1980-2013
Financial variables	11.85	13.35	15.70	0.26	0.23	0.31	0.03	0.03	0.04
Macroeconomic variables	11.21	9.43	10.07	0.10	0.19	0.14	0.02	0.04	0.02
All variables	11.59	11.74	13.38	0.19	0.21	0.24	0.03	0.03	0.03

The upper panel of the table reports summary statistics for the medium-term cyclical component of each variable for the total sample (1875-2013). *Duration* is the number of years between troughs and peaks (for expansions) or peaks and troughs (for contractions). The duration of the full cycle is measured from peak to peak. *Amplitude* is the change from trough to peak (for expansions) or peak to trough (for contractions). *Slope* denotes the ratio between amplitude and duration. For the three subsamples reported in the lower panel of the table, the duration of a full cycle (from peak to peak), the average amplitude (average of expansionary and absolute value of contractionary phases) and average slope (average of expansionary and absolute value of contractionary phases) are given. Duration, amplitude and slope are in all cases obtained using sample medians.

Source: Authors' calculations.

Overall, we find that medium-term cycles in our financial variables have on average lengthened by almost four years compared to the first subsample to just under 16 years in the post-1980 period. The medium-term cycles in the macroeconomic variables have shortened, however. In line with the findings in Claessens et al. (2011) and Drehmann et al. (2012), we also find that the amplitude of medium-term cycles in both the financial and macroeconomic variables has increased on average over time.

Relative volatility of medium- and short-term cycles

Table 2 reports the relative volatility of the medium- and short-term cyclical components for each series across different sample periods, which gives an idea of the relative importance of the medium- and short-term cyclical components in explaining the overall behaviour of each variable. As the table shows, it seems that the financial series are dominated by cycles at the medium-term frequency, with the standard deviation of medium-term cycles more than double that of cycles at the business cycle frequency. The same applies for the macroeconomic variables, although the difference is smaller in most cases. The relative importance of the two components remains broadly stable for the financial variables across the whole sample period, although a notable exception are real house prices where the importance of the medium-term cycle is clearly rising over time. The importance of medium-term cycles is also increasing for the macroeconomic variables and by the post-1980 period they have in all cases become more volatile than cycles at the business cycle frequency. The dominance of medium-term cycles for explaining overall behaviour of the financial and macroeconomic variables can also be gauged from the figures in Appendix 3, which compare medium-term cycles in each variable with complete 2-30 year cycles. As the figures clearly show, the medium-term cycle captures a large part of the complete cycle in most of the series, suggesting that the business cycle (the difference between the two) plays a smaller role in explaining the overall variation in the data.

Table 2 Relative volatility of short- and medium-term cycles

	Total sample	1875-1944	1945-2013	1980-2013
Real house prices	1.76	1.11	2.09	2.35
Real credit	2.67	2.66	2.64	2.81
Credit-to-GDP ratio	2.21	2.20	2.20	2.24
Real M3	2.61	2.64	2.59	2.53
M3-to-GDP ratio	2.33	2.01	2.65	2.81
Credit-to-M3 ratio	2.99	3.71	2.32	1.68
Bank assets-to-GDP ratio	1.86	2.24	1.75	1.77
Bank leverage ratio	2.45	2.73	1.93	1.24
Foreign non-core liabilities	2.22	1.40	2.66	2.78
Total non-core liabilities	2.13	2.04	2.20	2.26
Real GDP	2.13	2.15	2.09	2.39
Real domestic demand	1.54	1.27	1.83	1.97
Trade deficit-to-GDP ratio	0.82	0.65	1.21	1.35
USD exchange rate	2.08	1.65	2.21	2.59
Real exchange rate	1.50	1.72	1.39	1.57
Terms of trade	0.93	0.85	1.30	1.96
Inflation	1.03	1.10	0.91	1.07
		Averages		
Financial variables	2.34	2.45	2.21	2.04
Macroeconomic variables	1.44	1.25	1.64	1.95
All variables	1.99	1.97	1.99	2.02

The table reports the relative standard deviations of medium-term (8 to 30 years) and short-term (2 to 8 years) cycles for each variable. A number above (below) unity indicates that the medium-term cyclical component is more (less) volatile than the short-term component.

Source: Authors' calculations.

The relative importance of medium-term cycles in the fluctuations in our financial and macroeconomic variables is consistent with what Drehmann et al. (2012) and Aikman et al. (2014) find for financial variables in several advanced economies and to what Comin and Gertler (2006) find for a range of macroeconomic variables in the US, although the findings from Drehmann et al. (2012) suggest that medium-term cycles tend to play an even greater role than is found here, suggesting that short-term cycles are relatively more important in explaining economic fluctuations in Iceland than in the larger advanced economies. This probably reflects the relatively less developed financial system in Iceland over a large part of our sample period, which makes financial cycles less likely to emerge and fester over long periods. But this could also reflect the volatile nature of the small and commodity-based Icelandic economy and the importance of exogenous macroeconomic shocks (Einarsson et al., 2013a, b, 2015). It could also reflect the dominance of stop-go economic policies and the relative failure of conventional macroeconomic stabilisation policy (both fiscal and monetary) in Iceland, which is traditionally aimed at stabilising cyclical fluctuations at the business cycle frequency.

Correlations of medium-term cycles in financial variables

The final part of our analysis of cyclical properties of individual variables looks at contemporaneous correlation coefficients of medium-term cycles in our financial variables over the whole sample and the three different subsamples.[9] Table 3 shows that medium-term cycles in most of the financial variables co-move when looking at the whole sample period, but the co-movement is not overwhelmingly strong except in a very few cases – and many of those simply reflect the fact that the series involve different transformations of the same variable (such as credit in real terms and as a ratio to GDP).

Table 3 Correlations of medium-term cyclical component of financial variables

	Real house prices	Real credit	Credit-to-GDP	Real M3	M3-to-GDP	Credit-to-M3	Bank assets-to-GDP	Bank leverage	For. non-core liab.	Total non-core liab.
Real house prices	1.00	0.38	0.15	0.50	0.28	-0.05	0.68	0.33	0.60	0.34
Real credit		1.00	0.87	0.08	-0.21	0.72	0.51	-0.31	0.55	0.72
Credit-to-GDP			1.00	-0.26	-0.29	0.86	0.48	-0.49	0.49	0.72
Real M3				1.00	0.84	-0.63	0.16	0.36	0.05	-0.20
M3-to-GDP					1.00	-0.74	0.10	0.27	-0.10	-0.38
Credit-to-M3						1.00	0.29	-0.49	0.40	0.71
Bank assets-to-GDP							1.00	-0.13	0.72	0.66
Bank leverage								1.00	0.08	-0.51
Foreign non-core liab.									1.00	0.71
Total non-core liab.										1.00

The table gives the contemporaneous correlations of the medium-term cyclical component of the financial variables for the total sample period. Shaded sells highlight correlation coefficients larger than or equal to 0.7.

Source: Authors' calculations.

[9] We look at cyclical correlations of our macroeconomic variables in the context of our analysis of the aggregate financial cycle in Section 4.2 below.

Table 4 Subsample correlations of medium-term cyclical component of financial variables

	Real house prices	Real credit	Credit-to-GDP	Real M3	M3-to-GDP	Credit-to-M3	Bank assets-to-GDP	Bank leverage	For. non-core liab.	Total non-core liab.
					1875-1944					
Real house prices	1.00	-0.46	-0.60	0.68	0.62	-0.69	-0.11	0.34	0.08	-0.38
Real credit		1.00	0.86	-0.23	-0.55	0.85	0.24	-0.54	0.48	0.79
Credit-to-GDP			1.00	-0.56	-0.50	0.93	0.36	-0.65	0.50	0.80
Real M3				1.00	0.71	-0.70	-0.16	0.45	0.10	-0.44
M3-to-GDP					1.00	-0.78	-0.02	0.41	0.14	-0.56
Credit-to-M3						1.00	0.26	-0.64	0.30	0.82
Bank assets-to-GDP							1.00	-0.50	0.36	0.49
Bank leverage								1.00	-0.03	-0.90
Foreign non-core liab.									1.00	0.23
Total non-core liab.										1.00
					1945-2013					
Real house prices	1.00	0.87	0.67	0.46	0.17	0.32	0.84	0.46	0.71	0.62
Real credit		1.00	0.89	0.37	0.11	0.52	0.76	0.13	0.68	0.69
Credit-to-GDP			1.00	0.06	-0.06	0.71	0.69	-0.11	0.62	0.67
Real M3				1.00	0.92	-0.61	0.32	0.28	0.03	-0.04
M3-to-GDP					1.00	-0.75	0.16	0.11	-0.19	-0.26
Credit-to-M3						1.00	0.35	-0.15	0.55	0.62
Bank assets-to-GDP							1.00	0.27	0.83	0.76
Bank leverage								1.00	0.19	0.00
Foreign non-core liab.									1.00	0.94
Total non-core liab.										1.00
					1980-2013					
Real house prices	1.00	0.96	0.90	0.60	0.30	0.63	0.93	0.61	0.78	0.76
Real credit		1.00	0.97	0.70	0.44	0.58	0.90	0.50	0.76	0.75
Credit-to-GDP			1.00	0.63	0.42	0.62	0.88	0.40	0.73	0.69
Real M3				1.00	0.92	-0.18	0.50	0.34	0.17	0.21
M3-to-GDP					1.00	-0.45	0.23	0.10	-0.16	-0.13
Credit-to-M3						1.00	0.67	0.30	0.86	0.80
Bank assets-to-GDP							1.00	0.55	0.85	0.83
Bank leverage								1.00	0.51	0.53
Foreign non-core liab.									1.00	0.98
Total non-core liab.										1.00

The table gives the contemporaneous correlations of the medium-term cyclical component of the financial variables for three different subsamples. Shaded sells highlight correlation coefficients larger than or equal to 0.7.

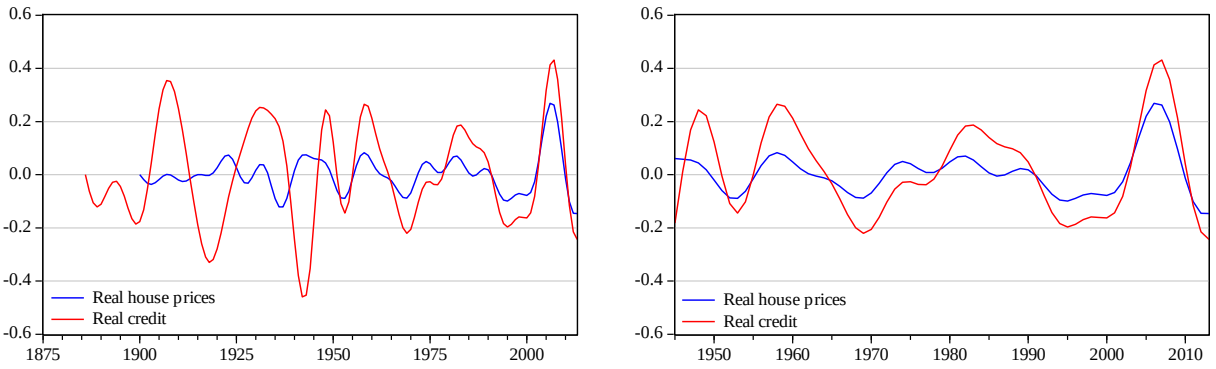
Source: Authors' calculations.

It is clear, however, when looking at the correlation coefficients over different subsamples in Table 4 that this relatively weak co-movement is very much concentrated in the first half of the sample period, i.e. the period up to the end of WWII. The co-movement increases significantly in the second half of the sample and further still in the post-1980 period: the number of correlation coefficients exceeding 0.7 increases from seven in the 1875-1944

period to eighteen in the post-1980 period and the number of coefficients exceeding 0.8 rises from five in the 1875-1944 period to eleven in the post-1980 period.[10]

In the most recent period, we find a strong correlation between the cyclical components of real house prices and most of the other financial variables, in particular credit and banking system assets. There is also a strong correlation between the cyclical components of credit and banking system assets and indeed most of the other financial variables. There are three exceptions, however, with the cyclical components of real money and the money-to-GDP and the leverage ratios having relatively weak links to the cyclical components of other financial variables. Overall, however, we clearly see how medium-term cycles in the financial variables gradually become more synchronised over time and how a "single aggregate financial cycle" emerges.

Figure 1 Medium-term cycles in house prices and credit
1875-2013 period (left) and 1945-2013 (right)



Source: Authors' calculations.

The increasingly strong low-frequency cyclical co-movement of many of the financial variables can also be seen in Figure 1, which shows the medium-term cyclical components of real house prices and real credit (the two financial variables Borio, 2014, argues most parsimoniously describe the financial cycle) over the whole sample and in the post-WWII period, respectively. The weak link between the two cycles in the period up to the end of WWII is worth noting: the cyclical components frequently move in the opposite direction (as reflected in the negative correlation between the two found in the upper-most panel of Table 3). This reflects the fact that a significant part of the credit expansion was directed towards other parts of the economy than the housing market (the fisheries sector in particular) and that the domestic mortgage market was undeveloped and house prices highly regulated. There may also be some measurement problems in the early period, as the house price data up to 1945 is based on building costs rather than market prices for housing (for further detail, see Einarsson et al., 2015). The figure shows, however, that the cyclical components of credit and house prices gradually start moving together in the post-WWII period and become increasingly tied together

[10] The simple average of correlation coefficients rises from 0.03 in the 1875-1944 period to 0.29 in the post-WWII period and further to 0.45 in the post-1980 period.

with closely synchronised peaks and troughs, but with the credit cycle showing greater amplitude (as reported in Tables 1 and 2 above).

4 The aggregate financial cycle

4.1 Estimating the financial cycle

The results from the previous section suggest a gradual emergence of an "aggregate financial cycle" in the post-WWII period which becomes even more apparent when looking at the post-1980 period of increasing financial deepening and sophistication in Iceland and growing international financial liberalisation and integration. Similar to Drehmann et al. (2012) and drawing on Borio's (2014) characterisation of the financial cycle as the pro-cyclicality of the financial system, we define an "aggregate financial cycle" as the low-frequency (here specified as cycles lasting from 8 to 30 years) cyclical co-movement of a set of financial variables including both quantities and prices, conceptually similar to the standard approach of defining the business cycle as the recurrent and broad-based co-movement of macroeconomic economic variables over a frequency typically specified as lasting from just over a year to 8 years (cf. Burns and Mitchell, 1946).

Thus, to obtain our estimate for the aggregate financial cycle we simply take a weighted average of the medium-term cycles in the ten financial variables included in our analysis. The weights are obtained using a principal component analysis, which basically allows us to obtain different linear combinations of our variables that maximise the variability of each combination, while ensuring that they remain orthogonal to each other. We thus identify the aggregate financial cycle as the first principal component, i.e. the one that explains most of the combined variability in our set of financial variables (see Hiebert et al., 2014, for a similar idea). We therefore take a broader approach of measuring the financial cycle than, for example, Aikman et al. (2014) and Schularick and Taylor (2012) (who focus exclusively on the credit cycle) and Drehmann et al. (2012) (who focus on a cycle comprising credit and house prices). Our approach is more akin to that taken in the literature on the "financial conditions index" (although the focus there is more on short-term co-movement in financial variables rather than trying to estimate a lower-frequency composite cycle as we do), cf. English et al. (2005), Swiston (2008), Ng (2011), and Angelopoulou et al. (2013). This approach allows us to attain additional insights into the nature of the financial cycle in such a small open economy by, for instance, exposing the potential feedback mechanisms from one component of the financial cycle to another, working through various linkages, e.g. the interaction of asset prices, borrower's collateral constraints, and banks' balance sheets, as well as its multifaceted relations with the domestic economy and its external account.[11] Table 5 shows the results.

[11] For our principal component analysis and the construction of the aggregate financial cycle we normalise all the financial variables so that they have a mean of zero and a standard deviation of unity. We also estimated the aggregate financial cycle using a dynamic factor analysis. The results were broadly the same: most of the cyclical peaks and troughs corresponded to those estimated from the principal component analysis but the dynamic factor analysis produced a cycle with greater short-term fluctuations. Schüler et al. (2015) estimate an aggregate financial

Table 5 Principal component estimation of the financial cycle

	First principal component				
	Unrestricted	Restricted			
	Total sample	Total sample	1875-1944	1945-2013	1980-2013
Proportion of variance	0.47	0.63	0.62	0.73	0.83
		Normalised factor loadings			
Real house prices	0.08	0.09	-0.15	0.14	0.15
Real credit	0.21	0.16	0.22	0.15	0.15
Credit-to-GDP ratio	0.22	0.16	0.24	0.15	0.14
Real M3	-0.07	–	–	–	–
M3-to-GDP ratio	-0.11	–	–	–	–
Credit-to-M3 ratio	0.21	0.13	0.23	0.11	0.13
Bank assets-to-GDP ratio	0.17	0.15	0.14	0.15	0.15
Bank leverage ratio	-0.12	–	–	–	–
Foreign non-core liabilities	0.17	0.15	0.11	0.15	0.15
Total non-core liabilities	0.23	0.16	0.21	0.15	0.14
Total	1.00	1.00	1.00	1.00	1.00

The table reports the proportion of variance explained by the first principal component of the medium-term cyclical components of the financial variables and the individual factor loadings of each financial variable. Column 2 reports the first principal component for all the ten financial variables, while columns 3-6 report the first principal component for the restricted set of seven financial variables that excludes the three variables that obtain negative loadings in column 2 (the two money measures and the leverage ratio) over the total sample period and three subsamples.

Source: Authors' calculations.

First, we show the unrestricted estimate over the full sample period, i.e. where all the ten financial variables are included. The normalised factor loadings suggest broadly similar weights for all the variables in the aggregate cyclical measure, except for the two money measures, and the bank leverage ratio. This is not surprising given the relatively weak cyclical correlation of these variables with the other financial variables reported in Tables 3 and 4 above. While the relatively weak role of money in driving the financial cycle is consistent with the declining role of money in boom-bust financial cycles in the post-WWII period in other industrial countries found by Schularick and Taylor (2012) and Aikman et al. (2014), the limited role of bank leverage found here probably reflects the impact of financial depression in Iceland over a large part of the post-WWII period. Thus, cyclical expansions of the leverage ratio typically reflect depressed financial savings and bank capital through rampant inflation and artificially low interest rates rather than the financial expansions reflected in the other financial variables. As discussed in Einarsson et al. (2015), there are also some measurement issues during the latest episode, with the declining leverage ratio in the run-up to the crisis reflecting the fact that the numerator (bank capital) is measured at book value, whose quality and quantity has since been seriously questioned (Rannsóknarnefnd Althingis, 2010). Hence, the credit variables, the bank assets-to-GDP ratio and the non-core liabilities measures seem to perform

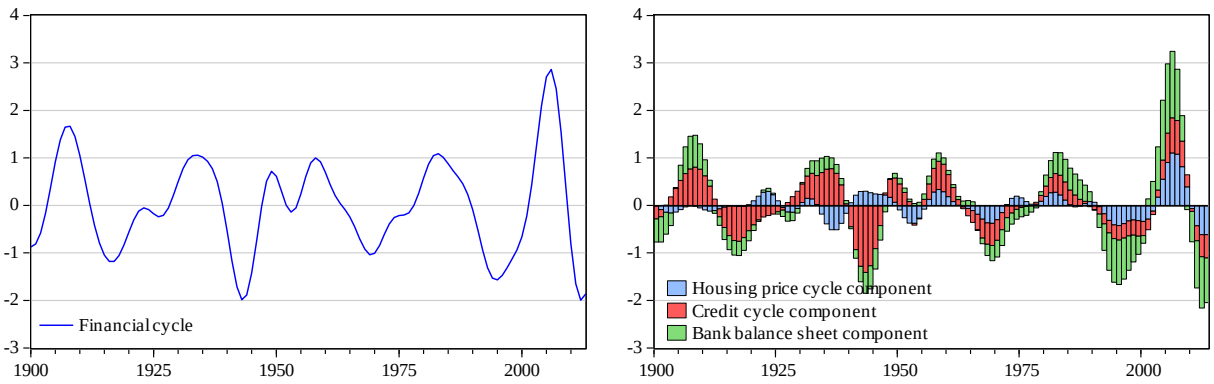
cycle for a number of European countries using multivariate spectral analysis that allows for time-varying weights of financial variables that includes credit, house and equity prices, and bond yields. For a discussion of different methods for extracting common financial cycles from a set of financial variables, see also Breitung and Eickmeier (2014).

better at capturing balance sheet overextension within the financial system than the two money measures and the leverage ratio.

As it is not meaningful in the context of our exercise to include financial variables with a negative weight in our measure of a common financial cycle, we exclude the three variables with negative loadings in our subsequent analysis of the aggregate cycle (Schüler et al., 2015, use similar arguments). The resulting "restricted" estimate in Table 5 gives broadly identical factor loadings for the remaining variables, while the variability of the aggregate financial data explained by the first principal component rises from just below 50% in the unrestricted version to more than 60%. The table also reports the normalised weights estimated over the three subsamples and it is clear from these that the weights stabilise at roughly equal weights for all the seven variables in the post-WWII period with the proportion of the total variability of the financial data captured by this aggregate measure gradually rising to more than 80% in the post-1980 period.[12] This is considerably higher than the proportion of variance explained by similarly constructed aggregate cycles for a number of Euro Area countries reported by Hiebert et al. (2014), which ranges from a third for Italy to roughly half for Ireland.

Figure 2 The financial cycle and contribution of individual cyclical components

Financial cycle (left) and contribution of medium-term components (right)



Financial cycle and contribution of individual cyclical components, weighted with their normalised factor loadings. *House price cycle component* refers to the contribution of the medium-term cycle in real house prices to the financial cycle, *Credit cycle component* refers to the weighted average contribution of medium-term cycles in real credit, credit-to-GDP and credit-to-M3 to the financial cycle, *Bank balance sheet cycle component* refers to the weighted average contribution of medium-term cycles in bank assets-to-GDP, foreign non-core bank liabilities ratio and total non-core liabilities ratio to the financial cycle. The individual components are normalised so that their sum has the same mean and standard deviation as the aggregate cycle.

Source: Authors' calculations.

Figure 2 shows the full-sample estimate of the financial cycle and an approximation of the contribution of individual components to the aggregate cycle estimated using the whole-sample factor loadings from Table 5. To ease the presentation, we summarise the seven

[12] Thus, a simple average of the financial variables (as suggested by Drehmann et al., 2012) would give almost an identical measure of the financial cycle. It may also be noted that when the three excluded variables are included in the subsample estimates, they obtain very small, albeit positive, weights and the aggregate cycle is basically identical to the one presented here (the correlation coefficients are in all cases equal to 0.97 or more). Our final measure of the financial cycle also appears robust to the information set used to extract it from the data, reflecting the high synchronisation of the medium-term cycle in these variables: for example, it is closely matched by a simple average that only includes house prices and credit (the variables used by Drehmann et al., 2012).

individual components into three groups, one denoted the "credit cycle" which contains the three credit transformations in our sample (real credit, credit-to-GDP, and credit-to-money), another denoted the "bank balance sheet cycle" which contains the three bank balance sheet variables in our sample (bank assets-to-GDP and the two non-core bank liabilities ratios), and the final one is the "house price cycle" which contains the contribution of the medium-term cycle in real house prices to the aggregate cycle.

We identify seven cyclical expansions over the whole sample period. Four stand out in terms of size: an expansion around the turn of the century which peaks in 1908, another one around the middle of the century which peaks in 1949 (following a large contraction during WWII, especially in credit as discussed in Einarsson et al., 2015), and the two most recent expansions, the latter one starting in the mid-1990s and peaking in 2006. The expansionary phase of the first two episodes lasts eight years, while the latter two last much longer or fourteen and eleven years, respectively. Looking at the composition of each expansion, shows that credit played a prominent role in the first expansion, while the second two expansions also show a large role of bank balance sheet expansion and, particularly in the most recent episode, house prices. It is also interesting to note that the initial phase of the latest expansion seems very much driven by an expansion of bank balance sheets, particularly in the privatisation phase of domestic financial institutions in the first years of the 2000s. It is only after a few years of balance sheet expansion, much of which took place across borders, that a significant expansion of domestic credit and house prices emerges. This suggests that additional insight is attained by including bank balance sheet data when estimating the aggregate financial cycle, due to the important role of financial institutions' balance sheet management in driving economy-wide cyclical movements (cf. Adrian and Shin, 2011) by reinforcing the interactions between financing constraints and perceptions of value and risks, operating partly across borders.

The three remaining financial expansions are smaller in comparison, each lasting between five and six years each: one in the early 1920s, another one in the early 1930s, and the third one in the late 1950s. The first seems predominantly driven by house prices while credit plays a bigger role in the second two. Finally, we see that the contributions to the contractionary phases of the financial cycle tend to mirror those of the expansionary phases, with all components contributing significantly to the enormous, yet relatively short-lived, contraction which troughs in 2012 following the cyclical peak in 2006.

4.2 Key properties of the financial cycle

Table 6 summarises the key properties of the financial cycle over the whole sample period and the three subsamples. The duration of a complete financial cycle is found to be 15 years on average and, as was typically found for individual financial variables, has been lengthening over time. This is primarily due to the lengthening of the expansionary phase of the cycle, while the duration of the contractionary phase remains unchanged over the sample period. Both phases of the cycle have, however, become more intense.

Although caution is warranted given the small sample of cyclical episodes used here, these results are broadly in line with those found by Drehmann et al. (2012) for a sample of

seven industrial countries. They obtain financial cycles of very similar length, or 16 years on average, and also find clear evidence of rising length and amplitude of the financial cycle as liberalisation progressed since the mid-1980s and macroeconomic conditions became more stable during the run-up to the recent global financial crisis.[13] With lengthening expansions, we also find that they have become longer than contractions in the most recent period, which is also consistent with the findings in Claessens et al. (2011) and Drehmann et al. (2012).

Table 6 Key characteristics of the financial cycle

	Total sample	1875-1944	1945-2013	1980-2013
Duration in expansions	7.00	7.00	8.50	12.50
Duration in contractions	9.00	9.00	8.50	9.00
Duration of complete cycle	15.00	13.00	19.00	24.00
Amplitude of expansions	1.70	1.21	2.41	3.27
Amplitude of contractions	-2.65	-2.83	-2.34	-3.74
Slope of expansions	0.21	0.17	0.31	0.28
Slope of contractions	-0.22	-0.31	-0.22	-0.51

The table reports summary statistics for the financial cycle. *Duration* is the number of years between troughs and peaks (for expansions) or peaks and troughs (for contractions). The duration of the full cycle is measured from peak to peak. *Amplitude* is the change from trough to peak (for expansions) or peak to trough (for contractions). *Slope* denotes the ratio between amplitude and duration. Duration, amplitude and slope are in all cases obtained using sample medians.

Source: Authors' calculations.

Table 7 gives the correlation coefficients of medium-term cycles in individual financial and macroeconomic variables with the aggregate financial cycle. Medium-term cycles in real credit, the credit-to-GDP ratio, and the total non-core bank liabilities ratio remain highly correlated with the financial cycle throughout the sample period, with correlation coefficients around 0.85 or higher, but other variables are less correlated with the cycle and some have correlation coefficients close to zero or even negative. Looking at different subsamples immediately reveals that this weak co-movement is typically concentrated to the first subsample. Thus, the number of financial variables who show strong co-movement with the aggregate cycle gradually rises and the average of correlation coefficients among the financial variables in the post-1980 period (0.74) is almost threefold that found in the first subsample (0.27). By the post-1980 period we see that all financial variables have a correlation coefficient of almost 0.8 or more, except the three variables left out in the estimation of the aggregate cycle, i.e. the two money measures and the bank leverage ratio. This is also borne out by Harding and Pagan's (2006) concordance index in Table 7, which measures the fraction of time individual series are in the same cyclical phase as the aggregate financial cycle (see also Appendix 3, which shows the development of the financial cycle and the medium-term cycles in individual series).[14]

[13] See Einarsson et al. (2015) and Central Bank of Iceland (2016) for discussions of Iceland's varying degree of financial liberalisation.

[14] Two series which are perfectly pro-cyclical (counter-cyclical) would therefore have a concordance index equal to unity (zero). For two series with fully independent cycles (hence, have a correlation coefficient equal to zero), however, the concordance index would equal 0.5.

Table 7 Correlations and concordance of individual variables with the financial cycle

	Contemporaneous correlations				Concordance index			
	Total sample	1875-1944	1945-2013	1980-2013	Total sample	1875-1944	1945-2013	1980-2013
Real house prices	0.51	-0.44	0.84	0.93	0.67	0.52	0.77	0.79
Real credit	0.89	0.93	0.89	0.92	0.86	0.80	0.90	0.88
Credit-to-GDP ratio	0.86	0.95	0.86	0.89	0.83	0.84	0.83	0.79
Real M3	-0.06	-0.40	0.12	0.42	0.48	0.36	0.55	0.59
M3-to-GDP ratio	-0.25	-0.49	-0.12	0.11	0.44	0.52	0.39	0.47
Credit-to-M3 ratio	0.74	0.89	0.65	0.79	0.83	0.86	0.81	0.71
Bank assets-to-GDP ratio	0.80	0.60	0.90	0.96	0.76	0.73	0.78	0.76
Bank leverage ratio	-0.32	-0.74	0.14	0.55	0.35	0.11	0.51	0.62
Foreign non-core liabilities	0.81	0.55	0.91	0.94	0.75	0.55	0.88	0.97
Total non-core liabilities	0.90	0.89	0.91	0.93	0.86	0.91	0.83	0.88
Real GDP	0.29	0.16	0.43	0.76	0.59	0.52	0.64	0.62
Real domestic demand	0.32	0.08	0.46	0.89	0.59	0.52	0.64	0.71
Trade deficit-to-GDP ratio	0.34	0.02	0.53	0.88	0.64	0.55	0.70	0.85
USD exchange rate	-0.01	-0.15	0.03	0.05	0.49	0.36	0.57	0.44
Real exchange rate	-0.02	-0.53	0.27	0.76	0.50	0.41	0.55	0.62
Terms of trade	-0.26	-0.45	-0.10	0.04	0.43	0.30	0.52	0.56
Inflation	-0.08	-0.56	0.41	0.44	0.54	0.34	0.67	0.68
				Averages				
Financial variables	0.49	0.27	0.61	0.74	0.68	0.62	0.72	0.75
Macroeconomic variables	0.08	-0.20	0.29	0.55	0.54	0.43	0.61	0.64
All variables	0.32	0.08	0.48	0.66	0.62	0.54	0.68	0.70

The table gives the contemporaneous correlations and concordance of the medium-term cyclical component of individual variables with the financial cycle. Shaded sells highlight numbers larger than or equal to 0.7.

Source: Authors' calculations.

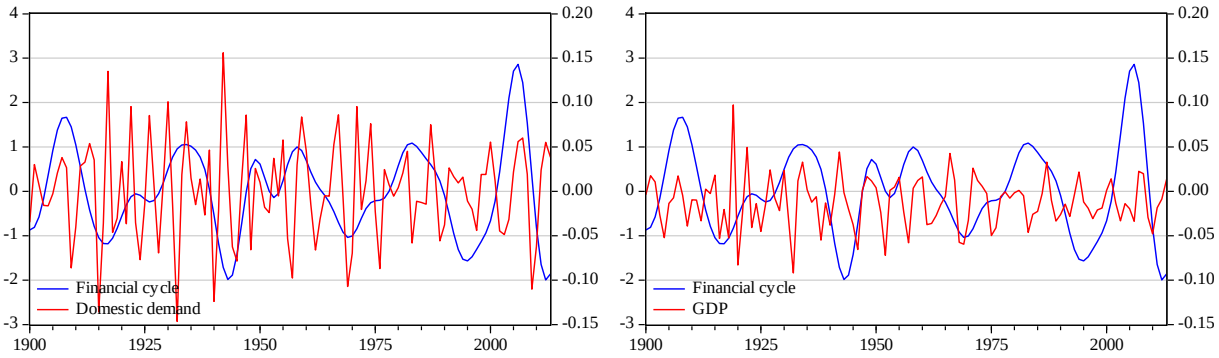
The data therefore clearly shows how different segments of the financial system have gradually become more and more synchronised over time, presumably reflecting the rising financial sophistication (cf. Claessens et al., 2011). However, this is not exclusive to the financial variables, as we see that medium-term cycles in some of the macroeconomic variables have also become more closely tied to the financial cycle. This holds particularly true for the cyclical components of domestic demand (the co-movement with GDP is also sizeable but still smaller than for domestic demand) and the trade deficit, which becomes almost completely synchronised with the financial cycle in the post-1980 period. This points to an important interaction between the financial cycle and capital flows with regard to the capacity to finance domestic expenditure, consistent with implications of many of the papers cited in Section 2.2 above. We will return to this theme in our discussion of some of the issues that our analysis give rise to in the next section and in Section 7 below.[15]

[15] Our results concerning the increasingly strong co-movement of individual variables with the aggregate financial cycle (and their increasingly strong co-movement with one another in Tables 3 and 4) do not rely on the inclusion of the latest boom-bust cycle (i.e. they hold whether we end the sample in 2003 or 2008).

4.3 The financial cycle and economic activity

Here we look at the interaction between the financial cycle and economic activity in more detail. In particular, we want to compare the financial cycle to the business cycle, i.e. the short-term cyclical component of output and demand. These are reported in Figure 3, which shows that the financial cycle is clearly longer than the business cycle – as it should be given the way the cyclical components are defined and constructed. Nevertheless, the difference in the duration of the two cycles is large: over the whole sample period a complete cyclical episode takes 15 years on average for the financial cycle (see Table 6 above), but only 3 years for the business cycle (for GDP but slightly longer, or 4 years for domestic demand). And the difference increases over time, with cyclical episodes occurring in the post-1980 period taking 24 years to be completed for the financial cycle while it rises by half a year for the business cycle. By the same token, we also see that financial cycle contractions tend to be much more drawn out than business cycle contractions: a typical financial contraction lasts 9 years but only 2 years for a typical business cycle contraction.

Figure 3 The financial cycle and the business cycle



Financial cycle (left axis) and short-term cycles in domestic demand and GDP (right axis).

Source: Authors' calculations.

As our measure of the financial cycle has no natural unit of measurement (it is constructed such that it has a standard deviation of unity over the whole sample), the comparison of the volatility of the two type of cycles becomes more difficult. But what Figure 3 suggests is that the financial cycle has gradually become more pronounced relative to the business cycle. This is confirmed in Table 8, which shows that the standard deviation of the financial cycle relative to the business cycle is roughly twice as high in the post-1980 period compared to the first subsample, while the relative duration increases by more than a half. The table shows that the financial cycle has also become longer and more intense relative to the medium-term cycle in economic activity.

Table 8 The financial cycle and the cyclical components of demand and GDP

	Total sample	1875-1944	1945-2013	1980-2013
	Short-term cycles in domestic demand and GDP			
St.dev. of financial cycle relative to dom. demand	1.00	0.88	1.13	1.70
St.dev. of financial cycle relative to GDP	1.00	0.84	1.21	1.98
Duration of financial cycle relative to dom. demand	3.75	3.25	4.75	5.33
Duration of financial cycle relative to GDP	5.00	4.33	3.80	8.00
	Medium-term cycles in domestic demand and GDP			
St.dev. of financial cycle relative to dom. demand	1.00	1.07	0.95	1.33
St.dev. of financial cycle relative to GDP	1.00	0.83	1.23	1.76
Duration of financial cycle relative to dom. demand	1.58	0.72	2.11	3.20
Duration of financial cycle relative to GDP	1.50	1.00	1.90	2.67

The table shows the relative standard deviation and duration (median peak to peak cycles in years) of the financial cycle and the short- and medium-term cycles in domestic demand and GDP, respectively. The cyclical components are all normalised to have a unit standard deviation over the full sample period to make units comparable. A number above (below) unity indicates that the relevant statistic is higher (lower) for the financial cycle than for GDP or domestic demand.

Source: Authors' calculations.

Finally, in Table 9 we look more closely at economic activity over different phases of the financial cycle. First, we see that there is a marked difference in median demand and output growth over the expansionary and contractionary phases of the financial cycle: over the whole sample period we find that growth is almost three times higher on average during expansionary phases of the financial cycle than during its contractionary phases.[16] This difference is less pronounced in the first subsample period when the financial cycle played a smaller role in affecting macroeconomic developments, but by the post-1980 period we see that growth is almost four times higher on average during expansions than during contractions. We also find that business cycle contractions that coincide with contractionary phases of the financial cycle tend to be more drawn out than contractions that coincide with expansionary phases of the financial cycle. Together, the results in Table 9 suggest that the financial cycle plays an important role in the boom-bust cycles in the Icelandic economy (especially in the post-WWII period), for example through which enhanced access to credit boosts domestic demand during the boom phase of the financial cycle, only to curtail it again in the contractionary phase of the cycle. We will return to these linkages in Section 7.[17]

[16] The financial cycle is found to be roughly half of the time in an expansionary phase and the other half in a contractionary phase. This holds for both the whole sample period and the three subsamples.

[17] These results can be interpreted as being consistent with the findings in the first part of our study (Einarsson et al., 2015) where we find that recessions tend to be more severe when they coincide with financial crises, which as we show in Section 6 below tend to coincide with peaks in the financial cycle. Our results are also consistent with Claessens et al. (2012) and Drehmann et al. (2012), who find that recessions that coincide with contractionary phases of the financial cycle tend to be longer and more severe. They can also be viewed as being consistent with the findings in Jordà et al. (2013, 2014, 2015), who find that recessions tend to be more severe when they are preceded by periods of strong credit growth, in particular if this is driven by a strong expansion in mortgage credit and interact with abnormal increases in house prices. Romer and Romer (2015) provide a more sceptical view on the real economic impact of financial crises.

Table 9 Domestic demand and GDP in different phases of the financial cycle

	Total sample	1875-1944	1945-2013	1980-2013
		Domestic demand		
Growth in expansionary phase of financial cycle	0.056	0.042	0.059	0.058
Growth in contractionary phase of financial cycle	0.024	0.033	0.017	0.015
Relative duration in contractions	2.00	1.50	2.00	2.00
		GDP		
Growth in expansionary phase of financial cycle	0.049	0.049	0.049	0.043
Growth in contractionary phase of financial cycle	0.018	0.047	0.013	0.012
Relative duration in contractions	2.00	3.00	2.00	2.00

The table shows the median growth rate of domestic demand and GDP over the expansionary and contractionary phases of the financial cycle, and the relative duration (in years) of contractions in each series that coincide with contractionary phases of the financial cycle relative to contractionary phases that do not coincide with contractionary phases of the financial cycle. Thus, relative duration above (below) unity indicates that short-term (business cycle) contractions that coincide with contractionary phases of the financial cycle are longer (shorter) than contractions that do not coincide with contractionary phases of the financial cycle.

Source: Authors' calculations.

5 The financial cycle and global spillovers

In the first part of our study (Einarsson et al., 2015) we found strong links between global financial crises and financial crises in Iceland: the dates of financial crises were found to correspond remarkably well and our empirical analysis suggested that global crisis episodes typically led to a two- to threefold increase in the probability of a banking or multivariate financial crisis in Iceland.[18]

The transmission channels of these global shocks are well known: financial crises frequently have an important international dimension of some kind, be that due to common sources of vulnerability in a financially integrated global economy, such as the credit and asset price bubbles experienced by many advanced economies in the run-up to the most recent crisis, or due to the transmission of crises from one country (often a global financial centre) to another as a result of cross-border contagion working through both financial and trade channels (see, for example, Kaminsky et al., 2003, Borio, James, and Shin, 2014, Lane and McQuade, 2014, and Avdjiev et al., 2015). Both types of channels were at work in the recent global crisis but they also played a part in many earlier episodes (cf. Bordo and Murshid, 2001).

One obvious extension of our analysis of the financial cycle in Iceland is therefore to investigate whether there are links between the domestic financial cycle and financial cycles in other countries. This is also relevant for the growing literature on general spillover effects which mainly focuses on how financial globalisation impacts the capacity of domestic policies to conduct independent monetary and financial policies (cf. Rey, 2013, Schoenmaker, 2013, and Obstfeld, 2015). We begin by analysing potential spillovers from the global financial cycle, which we proxy with the US financial cycle, given its international economic prominence and

[18] We used the database constructed by Reinhart and Rogoff (2011) which identifies different types of financial crises (banking, currency, inflation, external debt, stock market, and a general crisis indicator constructed as a simple average of individual crisis indicators) for 70 countries for the period up to 2010. We identified global financial crises as episodes when the PPP-adjusted GDP-weighted share (measured in Geary-Khamis US dollars from Penn World Tables) of countries in some type of a financial crisis (either banking or general) rises by more than three standard deviations above its sample average.

the fact that the US financial system has long served as a global financial centre. We then move on to look at the potential transmission channels through which the global and domestic financial cycles interact. Finally, we explore the possibility of additional regional channels by looking at the links between the domestic financial cycle and financial cycles in Denmark and Norway, given their close political, economic, and cultural links with Iceland, especially in the earlier part of the sample. We also look at potential regional spillovers from the financial cycle in the UK, given the long-standing trade and financial links between Iceland and the UK.

For the US we use the house price data collected by Shiller (2015), and data from Jordà et al. (2014) for the other variables (with updates until 2013 kindly made available by the authors). Data for the other three countries come from various sources, with Appendix 1 providing the details and graphs of the data for all the four countries. Similarly to our treatment of the Icelandic data, we transform the data to log-differences (except for the real interest rate, which is transformed using the log-difference of one plus the interest rate) and use the Christiano and Fitzgerald (2003) band-pass filter to identify cycles with periodicity of 8 to 30 years. The final estimate of the medium-term cycles for the individual series is then obtained by cumulating the resulting growth rates.

5.1 Spillover effects from the global financial cycle

We start by reporting the correlations of the Icelandic financial cycle with medium-term cycles of individual US financial series and an aggregate measure of the US financial cycle (explained below). The upper panel of Table 10 shows that there is a high and rising co-movement between the aggregate Icelandic financial cycle and medium-term cycles in many of the individual US series, especially real house prices, and the credit-to-GDP, the credit-to-money, and bank assets-to-GDP ratios, respectively. For example, the Icelandic financial cycle is found to be in the same phase as the medium-term cycle in the US credit-to-GDP ratio more than 70% of the time. This implies that over a period of just over a century, an era covering a number of different policy regimes and varying degree of financial openness in Iceland, the domestic financial cycle has spent roughly eighty years in the same phase as key financial variables in the US.

We construct a simple composite measure of the US financial cycle as the first principal component of the medium-term cyclical components of real house prices and the credit-to-GDP ratio, which are the two financial variables Borio (2014) argues most parsimoniously capture the aggregate financial cycle in advanced economies.[19] As Table 10 shows there are remarkably strong links between the Icelandic financial cycle and this simple measure of the global financial cycle: over the whole sample the simple correlation coefficient and concordance index measure above 0.7. Furthermore, both are rising over time: the correlation coefficient rises to

[19] The first principal component explains more than 70% of the total variability in these two variables. We experimented with a number of other variations for the composite indicator (available upon request), e.g. by also including the bank asset-to-GDP ratio, real credit, and the real long-term interest rate, with very similar results. As in Drehmann et al. (2012) we find the medium-term cycle in real stock prices to be relatively weakly synchronised with the cycle in other financial variables. Comparison of our estimate of the aggregate US financial cycle with the one constructed by Drehmann et al. (2012) shows that the estimates are practically identical for the period they estimate the cycle (from 1970).

almost 0.9 and the concordance index to almost 0.8 in the post-WWII period. Thus, the two aggregate cycles are tightly aligned, in particular in the second half of the sample period where the two series spend almost 80% of the time in the same phase.

Table 10 Correlations and concordance of US and Icelandic financial cycles

	Contemporaneous correlations				Concordance index			
US financial variables	Total sample	1875-1944	1945-2013	1980-2013	Total sample	1875-1944	1945-2013	1980-2013
Real house prices	0.73	0.53	0.84	0.90	0.60	0.49	0.67	0.74
Real credit	0.53	0.44	0.63	0.63	0.64	0.56	0.70	0.71
Credit-to-GDP ratio	0.62	0.67	0.62	0.63	0.72	0.67	0.75	0.74
Real M3	-0.33	-0.41	-0.28	-0.08	0.35	0.24	0.42	0.56
M3-to-GDP ratio	0.09	0.53	-0.16	-0.23	0.61	0.69	0.55	0.53
Credit-to-M3 ratio	0.63	0.66	0.63	0.81	0.68	0.62	0.72	0.62
Bank assets-to-GDP ratio	0.49	0.47	0.51	0.51	0.74	0.80	0.70	0.76
Real long-term interest rate	0.43	0.57	0.34	0.28	0.59	0.64	0.55	0.56
Real stock prices	0.00	0.32	-0.33	-0.33	0.44	0.56	0.36	0.38
Composite financial cycle	0.77	0.68	0.86	0.87	0.74	0.64	0.80	0.74

Dates of peaks in Icelandic and US financial cycles

Iceland	1908	–	1923	1934	–	1949	1958	–	1983	–	2006	
US	1907	1913	–	1931	1937	1949	1956	1964	1980	1988	2006	

Dates of troughs in Icelandic and US financial cycles

Iceland	–	–	1917	1926	–	1943	1953	–	1969	–	1994	2012
US	1901	1909	1919	–	1935	1943	1953	1961	1969	1983	1994	2012

The table gives the contemporaneous correlations and concordance of the medium-term cyclical component of US financial variables with the aggregate Icelandic financial cycle. The US composite financial cycle is obtained as the first principal component of the medium-term cycles in US real house prices and the credit-to-GDP ratio. Shaded sells highlight numbers larger than or equal to 0.7.

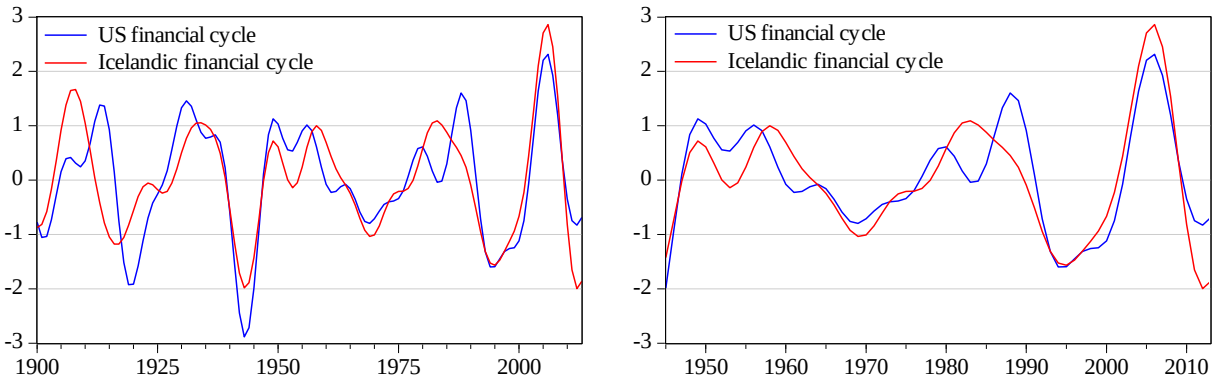
Source: Authors' calculations.

The strong link between the two financial cycles can also be seen in the two lower panels of Table 10, which report the dates of the peaks and troughs in the domestic and US aggregate financial cycles, as well as in Figure 4 which shows the two series over the whole sample and the post-WWII period, respectively. As discussed in Section 4.1, we find seven peaks and troughs in the Icelandic financial cycle since the start of the 20th century. Here we identify ten peaks and eleven troughs in the US aggregate financial cycle over the same period. Again the correspondence between the cycles is striking: six of the seven domestic peaks and troughs correspond to peaks and troughs in the US cycle (with the Icelandic peak typically coinciding with the US peak or lagging it by a year or two).[20]

[20] There are four US cyclical peaks that have no corresponding peaks in Iceland: the two peaks leading into the two World Wars, a peak in the mid-1960s and a peak in the late 1980s roughly coinciding with the US Saving & Loans crisis.

Figure 4 The US and Icelandic financial cycles

1900-2013 period (left) and 1945-2013 (right)



Source: Authors' calculations.

In Table 11 we take a closer look at the possible channels through which the global financial cycle seems to work its way to Iceland. To do this we simply regress the individual medium-term cycles of the Icelandic financial variables on a constant and the composite US financial cycle measure from above. The table reports significant spillover effects on many of the domestic financial variables, but most strongly through real credit and non-core bank liabilities, while there are also strong effects through total bank assets, real house prices and the credit-to-money ratio in the second half of the sample period. This indicates that there may be additional value from looking at the size and composition of the banks' balance sheet instead of just credit and house prices with regard to capturing the transmission of global financial spillovers to the domestic financial cycle and thereby to economic activity (see Section 4.3).

Table 11 Spillover channels from the US financial cycle to financial variables in Iceland

	Total sample		1875-1944		1945-2013		1980-2013	
	R^2	*p*-val.	R^2	*p*-val.	R^2	*p*-val.	R^2	*p*-val.
Real house prices	0.07	0.26	0.26	0.01	0.43	0.00	0.71	0.00
Real credit	0.56	0.00	0.53	0.00	0.59	0.00	0.74	0.00
Credit-to-GDP ratio	0.38	0.00	0.29	0.01	0.57	0.00	0.59	0.00
Real M3	0.00	0.64	0.08	0.21	-0.01	0.75	0.38	0.00
M3-to-GDP ratio	0.15	0.02	0.53	0.00	0.00	0.50	0.09	0.09
Credit-to-M3 ratio	0.42	0.00	0.48	0.00	0.35	0.00	0.20	0.03
Bank assets-to-GDP ratio	0.33	0.01	0.03	0.20	0.65	0.00	0.83	0.00
Bank leverage ratio	0.11	0.03	0.32	0.00	-0.01	0.81	0.19	0.07
Foreign non-core liabilities	0.21	0.01	-0.02	0.89	0.53	0.00	0.58	0.00
Total non-core liabilities	0.54	0.00	0.47	0.00	0.61	0.00	0.63	0.00
Aggregate financial cycle	0.59	0.00	0.45	0.00	0.73	0.00	0.76	0.00

The table reports the results from regressing the medium-term cyclical component of the Icelandic financial variables and the aggregate financial cycle, respectively, on a constant and the composite US financial cycle. Reported are the R^2 (degrees of freedom adjusted) and a *p*-value (based on Newey-West adjusted standard errors) for the null hypothesis that the US financial cycle is not statistically significant from zero.

Source: Authors' calculations.

The table also reports the regression results for the aggregate financial cycle, again showing the strong spillover effects reported earlier: the composite US financial cycle explains 60% of the variation in the Icelandic financial cycle over the whole sample period and, as discussed before, there is clear evidence that the links have been growing stronger over time with the explanatory power rising to more than 70% in the post-WWII period. This close co-movement of the Icelandic financial cycle with its global counterpart stands in stark contrast to earlier studies (such as Gudmundsson et al., 2000, and Einarsson et al., 2013b) on the domestic business cycle which have failed to find robust links between the domestic business cycle and the business cycles of other developed economies. We will return to this issue and its policy implications in Section 7 below.

5.2 Potential regional spillovers

The analysis above suggests that there are strong spillover effects from the US financial cycle to the financial cycle in Iceland and a simple regression analysis suggests that similar spillover effects from the financial cycles in Denmark, Norway and the UK to Iceland also exist. But, as the analysis in Appendix 4 suggests, these spillover effects may simply be reflecting the spillover effects from the US financial cycle working their way indirectly through these countries to Iceland.[21] Thus, to focus on possible additional regional spillover effects, we simply measure the "local" component of the financial cycles in Denmark, Norway and the UK as the residual from a regression of the financial cycle for each of these countries on the US cycle, which by construction captures the component of the financial cycle that is not explained by the US cycle. The importance of these local components of the financial cycle in these three countries for the Icelandic financial cycle is reported in Table 12.

Overall, we find these additional regional spillovers to be negligible. The global spillovers reported in the previous section therefore mostly stem from the spillover effects of the US financial cycle, with limited additional effects from financial cycles in Scandinavia and the UK. A possible exception is the first half of our sample period, which shows some evidence of additional regional effects from the Danish credit cycle and, perhaps to a lesser extent, the UK credit cycle. This would be consistent with the strong political, economic and cultural ties between Iceland and Denmark in this period (with Iceland a part of the Danish Kingdom until 1944) and the strong financial links between the two countries as reflected, for instance, in Danish ownership of one of the two principal commercial banks in Iceland and the fact that Danish banks were a chief source of external financing for the Icelandic banking system, Treasury, and key industries. The same applies to the UK, which in addition to strong trade links, was also a prominent source of financing for Icelandic entities in the latter half of that period (see Einarsson et al., 2015, for more detail). For the post-WWII period we see, however, that these additional regional effects all but disappear.

[21] The appendix shows that there is strong co-movement between the composite financial cycles in these four countries. A simple regression analysis shows that the composite US financial cycle explains about 40% of the Danish and Norwegian cycles and 50% of the UK cycle (in all cases found to be statistically significant from zero at the 1% critical level). The appendix also shows that there is a strong coincidence between financial crises in these four countries and that financial cycles have significant predictive power for these episodes.

Table 12 Additional spillover effects from local components of regional financial cycles

	Total sample		1875-1944		1945-2013		1980-2013	
	Corr.	Con.	Corr.	Con.	Corr.	Con.	Corr.	Con.
Danish credit-to-GDP	-0.08	0.51	0.48	0.78	-0.41	0.33	-0.37	0.35
Danish real house prices	0.02	0.54	0.06	0.51	0.00	0.55	0.23	0.53
Danish financial cycle	-0.04	0.54	0.39	0.69	-0.24	0.45	-0.12	0.41
Norwegian credit-to-GDP	0.06	0.53	0.23	0.60	-0.01	0.48	0.02	0.59
Norw. real house prices	-0.15	0.44	-0.06	0.47	-0.19	0.42	-0.22	0.44
Norwegian financial cycle	-0.04	0.46	0.17	0.58	-0.10	0.38	-0.09	0.50
UK credit-to-GDP	-0.06	0.51	0.61	0.64	-0.49	0.42	-0.68	0.32
UK real house prices	-0.08	0.48	-0.22	0.38	-0.02	0.55	0.27	0.68
UK financial cycle	-0.09	0.50	0.37	0.53	-0.26	0.48	-0.30	0.47

The table reports the contemporaneous correlation and concordance index for the aggregate Icelandic financial cycle and the local component of the medium-term cyclical components of the credit-to-GDP ratio and real house prices, and the composite financial cycle, respectively, in Denmark, Norway and the UK. The local cyclical components are obtained as the residual from regressing the original cyclical components on a constant and the composite US financial cycle. Shaded sells highlight numbers larger than or equal to 0.7.

Source: Authors' calculations.

6 The financial cycle and financial crises

The analysis in Section 4.3 showed that median GDP and domestic demand growth is markedly higher during expansionary phases of the financial cycle than during its contractionary phases, and that recessions coinciding with financial cycle contractions are typically longer than other recessions. This suggests an important role of the financial cycle in facilitating real economy expansions and triggering its subsequent downturns. This can also be seen from the left-hand panel of Figure 5 which shows the tight connection between the financial cycle and its local component on the one hand, and particularly nasty real economy episodes on the other which we define as "demand disasters" in the spirit of Barro's and Ursúa's (2008) specification of "consumption disasters" (i.e. episodes where per capita domestic demand contracts by more than 10% from peak to trough).[22]

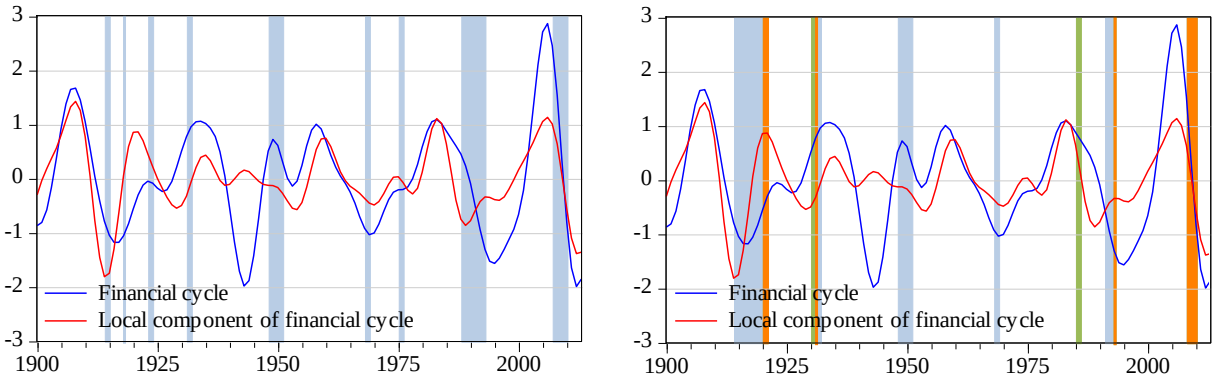
One important manifestation for this co-movement of the financial cycle and excessive fluctuations in economic activity is through possible financial disruptions once balance sheets become overextended in the latter stages of expansionary phases of the financial cycle. Many studies (including ours, see Section 5 in Einarsson et al., 2015) have indeed found that financial distresses are typically associated with more severe economic recessions. What remains to close the circle is therefore to look whether there are close links between different phases of the financial cycle and the timing and incidence of these financial disruptions. Again, and consistent with the findings in Drehmann et al. (2012) and Aikman et al. (2014) for other industrial countries, we find a clear link: the right-hand panel of Figure 5 clearly shows that financial crises, whether they are banking crises or full-blown multiple financial crises, are

[22] We use domestic demand instead of private consumption as consumption data is not available prior to 1945. This criteria gives us nine disaster episodes that occur every 12 years and last for almost 3 years on average (1914-15, 1918, 1923-24, 1931-32, 1948-51, 1968-69, 1975-76, 1988-93, and 2007-10). See Einarsson et al. (2015) for more detail.

closely aligned with peaks in the financial cycle, both the aggregate cycle and its local component.

Figure 5 The financial cycle, demand disasters and financial crises

Demand disasters (left) and financial crises (right) shown as shaded areas



Shaded areas denote demand disasters (grey shaded area, left), multiple financial crises (grey shaded area, right), and banking crises (green shaded area, right). Orange shaded areas denote periods where banking and multiple financial crises coincide (see Table A.3.1 in Appendix 3 for details on financial crisis dates).

Sources: Einarsson et al. (2015) and authors' calculations.

The close links between the financial cycle and excessive financial turmoil can also be seen in Table 13, which shows that almost all the identified cyclical peaks coincide with some kind of a financial distress at a similar date (over 70% of the peaks in the aggregate cycle and over 80% of the peaks in its local component have some kind of a financial crisis within the three year window specified by Drehmann et al., 2012).[23] Some of the crises hit soon after the cycle turns, but as in Drehmann et al. (2012) who focus on systemic banking crises in the period from 1970 and onwards, we find cases where the cycle continues to expand for some time after the crisis hit. This applies to the first two systemic banking crises in the early 1920s and 1930s, and may reflect a slower and somewhat more muted propagation mechanism between the financial system and the real economy at the prevailing degree of financial development compared to that existing in the post-WWII period. For example, in the last episode we find that the cyclical peak leads the crisis by two years.[24]

The chronology in Table 13, together with our previous analysis, suggests that financial booms may fuel the economic expansion and increase the risks of overheating and

[23] The only cyclical expansion that does not have a financial crisis at a similar date is the one peaking at the beginning of the 20th century which is not associated with any type of financial crisis in Iceland. However, as we discuss in Einarsson et al. (2015), this financial expansion did coincide with some strain on the domestic financial system following the global banking panic in 1907 (starting in the US following the San Francisco earthquake in 1906 and the collapse of copper prices in 1907), which led to some loss of access to foreign funding for Icelandic financial institutions.

[24] This episode also stands out in terms of its size: enormous financial and macroeconomic imbalances had built up which were sharply unwound once the financial crisis hit the economy in 2008 with a twin banking and currency crises, which saw the currency fall by more than 50% and over 90% of the domestic financial system collapsing. The impact on the real economy once the financial cycle turned and the financial crisis hit was truly devastating: output fell by 8% and per capita domestic demand by more than a quarter, while unemployment rose by 7 percentage points, making this latest episode truly the perfect storm (see Einarsson et al., 2015).

overextension in the financial system and therefore sow the seeds of the subsequent bust. This raises the question whether expansions of the financial cycle may provide a robust early-warning signal for financial crises. Indeed, this is what we find. As Table 14 shows, a financial cycle expansion is within three years followed by a banking crisis in almost 60% of all expansionary phases and by a multiple financial crisis in just under 50% of all expansionary phases (see Appendix 3 for a summary of financial crises dates). Not all cyclical peaks are followed by a financial crisis, however: just under 30% of expansions are not followed by a banking crisis and just under 15% of the expansions are not followed by a multiple financial crisis.

Table 13 Peaks in the financial cycle and financial distresses

Cyclical peaks

Aggregate cycle	Local component	Financial distresses at similar dates
1908	1908	No financial crisis identified but there was a sharp deterioration of access to foreign funding for local banks following the global banking panic in 1907
1923	1921	A currency crisis in 1919-20 and a systemic banking crisis in 1920 (part of a multiple financial crisis lasting from 1914 to 1921)
1934	1935	A systemic banking crisis in 1930-31 and a currency crisis in 1932 (part of a multiple financial crisis lasting from 1931 to 1932)
–	1943	No currency or banking crisis but an inflation crisis in 1940-43
1949	–	A currency crisis in 1950, followed by an inflation crisis in 1950-51 (part of a multiple financial crisis lasting from 1948 to 1951)
1958	1960	A currency crisis in 1960
–	1975	Inflation and currency crises lasting from 1973-89 and 1974-85, respectively
1983	1983	Coincides with the ongoing inflation and currency crises from above and a non-systemic banking crisis in 1985-86
–	1993	A twin currency and (non-systemic) banking crisis in 1993 (part of a multiple financial crisis lasting from 1991-93)
2006	2006	Currency and banking crises from in 2008-9 and 2008-10, respectively (part of a multiple financial crisis lasting from 2008 to 2010)

The table gives the dates of peaks in the aggregate financial cycle in Iceland and its local component. These dates are compared to periods of financial turmoil at similar dates (see Appendix 3 for further detail).

Sources: Einarsson et al. (2015) and authors' calculations.

As the table shows, this compares favourably with the early warning capacity of the individual financial and macroeconomic variables (and the local component of the aggregate cycle as well): the fraction of expansions that are followed by a crisis is higher for the aggregate cycle and the fraction of expansions that are not followed by a crisis is lower. The ratio between the "good" and "bad" signals can be interpreted as a "noise-signal" ratio, and we see that in all cases does the aggregate financial cycle outperform the individual variables and its local component.[25] This suggests that by combining information from different financial variables

[25] This is a slightly different approach to the early-warning exercise in our earlier study (Einarsson et al., 2015) where we measure the signalling properties of individual variables based on deviations that exceed 1.5 standard deviations from a smooth Hodrick-Prescott trend. There we find that individual variables do not provide robust enough early-warnings for ensuing financial crises.

and highlighting their important interaction in amplifying financial imbalances, the aggregate financial cycle provides a better signal of future financial distresses than individual financial variable considered in isolation (see also Claessens et al., 2011, Borio, 2014, and Schüler et al., 2015).

Table 14 Cyclical expansions and financial crises

	Banking crises			Multiple financial crises		
	Expansions close to crises	Expansions not close to crises	Noise-signal ratio	Expansions close to crises	Expansions not close to crises	Noise-signal ratio
Real house prices	0.33	0.58	1.75	0.33	0.50	1.50
Real credit	0.40	0.50	1.25	0.30	0.40	1.33
Credit-to-GDP ratio	0.40	0.50	1.25	0.30	0.40	1.33
Real M3	0.18	0.55	3.00	0.36	0.45	1.25
M3-to-GDP ratio	0.40	0.50	1.25	0.40	0.40	1.00
Credit-to-M3 ratio	0.50	0.38	0.75	0.38	0.25	0.67
Bank assets-to-GDP ratio	0.36	0.55	1.50	0.27	0.45	1.67
Bank leverage ratio	0.27	0.55	2.00	0.27	0.45	1.67
Foreign non-core liabilities	0.30	0.50	1.67	0.20	0.40	2.00
Total non-core liabilities	0.36	0.55	1.50	0.27	0.45	1.67
Real GDP	0.17	0.58	3.50	0.50	0.50	1.00
Real domestic demand	0.17	0.58	3.50	0.50	0.50	1.00
Trade deficit-to-GDP ratio	0.29	0.64	2.25	0.36	0.57	1.60
USD exchange rate	0.21	0.64	3.00	0.43	0.57	1.33
Real exchange rate	0.29	0.64	2.25	0.36	0.57	1.60
Terms of trade	0.13	0.67	5.00	0.27	0.60	2.25
Inflation	0.33	0.67	2.00	0.27	0.60	2.25
			Averages			
Financial variables	0.35	0.51	1.59	0.31	0.42	1.41
Macroeconomic variables	0.23	0.63	3.07	0.38	0.56	1.58
All variables	0.30	0.56	2.20	0.34	0.48	1.48
			Financial cycle			
Financial cycle	0.57	0.29	0.50	0.43	0.14	0.33
Fin. cycle (local comp.)	0.44	0.44	1.00	0.33	0.33	1.00

Expansions (not) close to crises gives the fraction of medium-term cyclical expansions that are (not) followed by a financial crises within a 3 year window. The *noise-signal ratio* gives the ratio between the two fractions. Shaded sells denote cases where individual variables outperform the aggregate financial cycle. Thus, for expansions close to crises, they denote numbers higher than the corresponding number for the financial cycle but for expansions not close to crises and the noise-signal ratio, they denote numbers lower than the corresponding number for the financial cycle.

Sources: Authors' calculations.

7 Discussion and some policy implications

The existence of a clearly defined financial cycle in Iceland and the strong interaction of the cycle with real economic activity on the one hand, and the global financial cycle on the other, raises some fundamental issues with important policy implications, while also providing important new insights into a number of prevalent issues in the domestic economic debate. In this section, we touch upon several of these issues and highlight some of the key policy

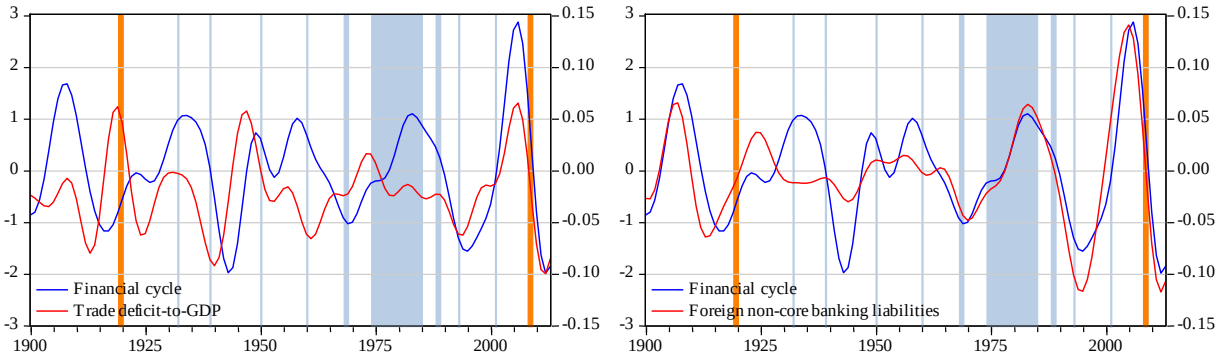
implications, but this can only be viewed as a first attempt. Further analysis is likely to be needed to explore the full implications of our findings.

7.1 The financial cycle, capital flows and sudden stops

Our previous analysis in Table 7 shows that the medium-term cycle in the trade deficit closely co-moves with the aggregate financial cycle and that this co-movement has strengthened over time, with the cycles becoming highly synchronised by the post-1980 period. Thus, a financial cycle expansion tends to coincide with an expansion in the lower-frequency component of the trade deficit, which is consistent with a trade deficit building up in the expansionary phase of the financial cycle and reversing at roughly the same time as the aggregate cycle turns.

Figure 6 The financial cycle, capital flows and sudden stops

Currency crises (grey) and sudden stop crises (orange) shown as shaded areas



Financial cycle (left axis) and medium-term cycles in the trade deficit-to-GDP ratio and the ratio of foreign non-core bank liabilities to total liabilities (right axis). Currency crises are denoted as shaded grey areas and currency crises that coincide with sudden stop of capital inflows as orange shaded areas (see Table A.3.1 in Appendix 3 for details on currency crisis dates).

Sources: Einarsson et al. (2015) and authors' calculations.

This is consistent with the analysis in the previous part of our study (Einarsson et al., 2015), which also shows that large trade reversals tend to coincide with currency crises, and is also evident from Figure 6, which shows that cyclical peaks in the trade deficit are frequently followed by a currency crisis and that the timing of these crises typically coincides with the cyclical trough. The same is also apparent when looking at the medium-term cycles in the ratio of foreign non-core funding of domestic banks, especially during the first period of relatively liberal capital movements up until 1930 and again from 1970 and onwards when domestic banks' access to foreign credit improved again. The figure also shows that two of the more dramatic cyclical reversals, in the early 1920s and in 2008, which show a large trade balance reversal coinciding with a sharp exchange rate depreciation, also coincide with sudden stop crises and the introduction of widespread capital controls.[26] Figure 6 therefore clearly points to

[26] Sudden stop crises are defined as episodes where financing a large current account deficit suddenly becomes more difficult and capital inflows reverse, typically forcing a sharp narrowing of the current account deficit and a currency depreciation. We follow Calvo et al. (2008) and Forbes and Warnock (2012) in defining sudden stop crises as episodes where reversals in the trade deficit that exceed two standard deviations coincide with output contractions. This gives us two episodes: 1919-20 and 2008-9, both of which saw very large currency depreciations

an important link through which the expansionary phase of the financial cycle facilitates the build-up of external imbalances, only to make reversals in the financial cycle go hand in hand with sharp reversals in capital flows and even currency crises.

7.2 The financial cycle and the consumption boom-bust cycle

Einarsson et al. (2013b) show that private consumption is more volatile in Iceland than in other industrial countries and that this high volatility cannot be accounted for by more volatile external conditions (either export volumes or terms of trade). They also find that private consumption is more volatile than income, a common finding among emerging market economies but an unusual feature among advanced economies (cf. Aguiar and Gopinath, 2007). This unusually high consumption volatility is also consistent with Barro and Ursúa's (2008) finding that the frequency of consumption disasters is by far the highest in Iceland among advanced economies in the post-WWII period (and even in the higher region among the emerging market economies in their sample).

Einarsson et al. (2013b) document the cyclical volatility (at business cycle frequency) in several sub-components of private consumption, showing that a notable feature of the consumption cycle in Iceland is the high volatility of durable goods consumption, and that this volatility is strongly correlated with fluctuations in the exchange rate. They also find that as the volatility of the exchange rate increased following the move to a more flexible exchange rate regime in 2001, so did short-term fluctuations in total consumption, and durable consumption in particular. One possible explanation offered by Einarsson et al. (2013b) is that this reflects the high import content of durable goods in Iceland, which in turn reflects the country's relatively small manufacturing sector and its narrow production structure. But this could also reflect effects of the financial cycle, with rising asset prices and easing credit conditions during the expansionary phase of the cycle (which tend to coincide with the expansionary phase of the real exchange rate cycle in the most recent period as shown in Table 7 above), working to reduce financial constraints and make leveraged consumption spending easier. As the cycle subsequently reverses, so do financial conditions.

Figure 7 compares the medium-term cycles in total private consumption and its key subcomponents with the financial cycle.[27] There seems to be a strong link between the financial cycle and the medium-term cyclical components in consumption of semi-durable and durable goods, which appears to have become stronger since the late 1980s consistent with the increasing financial deepening and liberalisation discussed earlier. Not surprisingly, these links are less apparent in non-durable consumption shown in the second figure (note the different scale of the two figures). This suggests that the financial cycle may be an important source of

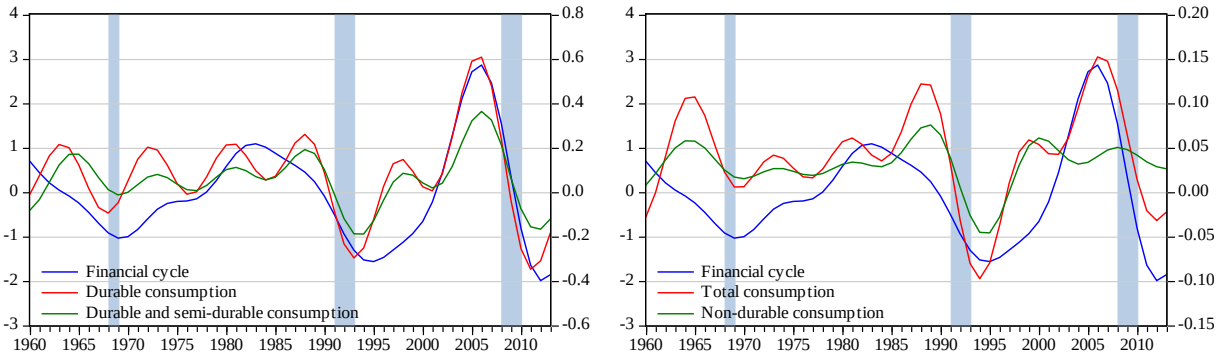
and a reversal of trade balance amounting to 20-30% of GDP from peak to trough. Widespread capital controls were also introduced in 1931 but this episodes falls short of the sudden stop criteria used here. See Central Bank of Iceland (2016) for a discussion of capital controls in Iceland.

[27] The data is only available from 1957 and was constructed by our colleague Hördur Gardarsson from detailed historical data on consumption by items from Statistics Iceland. As before, we use log-differences of the constant-price data before extracting the medium-term cycles from the variables and then cumulate the resulting series to obtain the medium-term cycles in levels.

consumption volatility in Iceland which is an issue that needs further exploring, including its relation to capital flows and exchange rate movements discussed above, and fiscal policy discussed below.

Figure 7 The financial cycle and consumption

Multiple financial crises shown as shaded areas



Financial cycle (left axis) and medium-term cycles in total consumption and its subcomponents (right axis). Shaded areas denote multiple financial crises (see Table A.3.1 in Appendix 3 for details on crisis dates).

Sources: Authors' calculations.

7.3 The financial cycle and fiscal policy

Einarsson et al. (2013b) find evidence that government expenditure in Iceland tends to be positively correlated with the business cycle and a Central Bank of Iceland (2012) report documents strong pro-cyclicality of both government spending and tax policy in the lead-up to the financial crisis in 2008. There was a strong pick-up in government revenue in the run-up to the crisis as the asset price bubble and the enormous expansion of credit and balance sheets (cf. Table 7.c in Einarsson et al., 2015) led to rising income from taxes (on income, consumption, property and capital gains), import tariffs, excise and stamp duties. The government seemed to interpret this windfall income as being permanent (cf. Aguiar and Gopinath, 2007, and Reinhart and Rogoff, 2009) and thus went on a spending spree and cut taxes substantially at the same time. This could suggest an important role for the financial cycle in explaining the pro-cyclicality of fiscal policy in Iceland, which indeed seems to be supported by the data (the importance of the financial cycle for fiscal policy is also discussed in. Bénétrix and Lane, 2011, Poghosyan, 2015, and Budina et al., 2015).

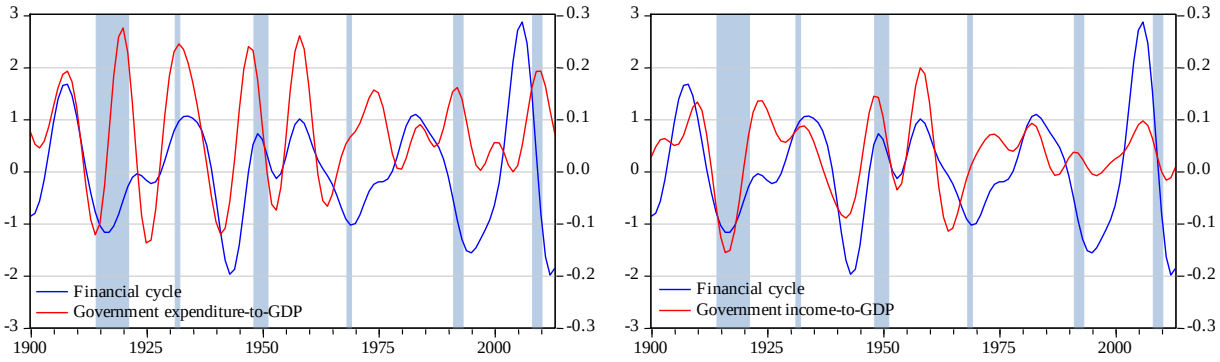
Figure 8 shows the medium-term cycles in current spending and income of the Treasury together with the aggregate financial cycle.[28] Both spending and income tend to co-move with the financial cycle (with a whole-sample concordance index above 0.6 for spending and above 0.7 for income). The data show, however, that the strong co-movement of cyclical income and the financial cycle has been rising over time while the opposite is true for cyclical spending:

[28] The data is obtained from Statistics Iceland (from *Hagskinna: Icelandic Historical Statistics* (Tables 15.3 and 15.4) for the period 1876-1944). Both spending and income are as ratios to nominal GDP and, identical to the treatment of other variables, we use log-differences before extracting the cyclical component from the variables and then cumulate the resulting series to obtain the medium-term cycles in the variables.

the concordance index for income rises from 0.73 in the period until the end of WWII to 0.79 in the post-1980 period, while it falls from 0.71 to 0.47 for expenditure. Government income therefore seems highly sensitive to the financial cycle and the co-movement between the two has strengthened over time, presumably in part reflecting the increasing financial deepening, and the rising homeownership and financial wealth in the economy. Fluctuations in the financial cycle have also crept into current government spending, and although the concurrent co-movement between the two seems to have declined over time, a significant link between the financial cycle and lagged spending remains. The latest boom-bust cycle is a clear example of this, with the expansion of the financial cycle followed by a strong cyclical expansion in current spending that peaks in 2010. This suggests an additional channel through which the financial cycle reinforces the boom-bust dynamics of the Icelandic economy and at the same time strengthening even further the interlinkages between the financial cycle, capital flows, and domestic demand, as discussed above.

Figure 8 The financial cycle and fiscal policy

Multiple financial crises shown as shaded areas



Financial cycle (left axis) and medium-term cycles in the government expenditure and income ratios to nominal GDP (right axis). Shaded areas denote multiple financial crises (see Table A.3.1 in Appendix 3 for details on crisis dates).

Sources: Authors' calculations.

7.4 Some policy implications

Our uncovering of the financial cycle in Iceland and its main characteristics raises a number of issues for domestic policymakers, highlights the importance of financial factors in many of the challenges that economic policy has failed to overcome throughout the country's economic history, and contributes to the rapidly expanding literature on the financial cycle, especially with regard to portraying its salient features in small open economies.

Our findings suggest that the financial cycle plays a pivotal role in fuelling the characteristic boom-bust behaviour of the Icelandic economy, while at the same time revealing strikingly strong spillovers from the global financial cycle. The key underlying macro-financial amplifying mechanism shows up in the expansionary phase of the cycle when easing financial constraints facilitate domestic demand growth, especially credit-financed expenditure, with the global financial cycle serving a further amplifying role by supporting domestic bank balance sheet expansion and credit extension. As the boom progresses, macro-financial fragilities build

up in the form of balance sheet overextensions, asset price overvaluations, and external imbalances, ultimately leading to the expansionary phase of the financial cycle giving way for a contraction with a resulting economic recession, external adjustment, and, in many cases, a financial crisis.[29]

This implies that to obtain better economic policy outcomes, the financial cycle and its associated macro-financial linkages need to be taken into account in the design of the overall policy framework and in implementation across different policy areas. The recent reforms of the policy framework in Iceland represents a step in that direction as it entails a broader view of monetary and financial stability, greater awareness of the systemic risk associated with the build-up of macro-financial imbalances, and the introduction of new policy tools to strengthen the resilience of the financial system and, hopefully, constrain to some extent the boom-bust dynamics that have been so prominent (Central Bank of Iceland, 2016). However, it remains to be seen how effective these reforms will be.

Our results also indicate that further reforms are desirable to increase the authorities' capacity to safeguard macroeconomic and financial stability. First, more coordinated and robust policy anchors are needed for the monetary, financial, and fiscal policy spheres, so that no single policy authority becomes overburdened. The financial cycle entails powerful, pro-cyclical, and long-lasting forces, which to a significant degree originate outside the domestic economy domain, increasing the negative effects of pro-cyclical policy behaviour. Hence, a firm, wide-reaching, and robust commitment to countercyclical stabilisation becomes even more important. This holds particularly true now, as the economy re-opens its capital account and again faces possible global headwinds in its conduct of independent monetary policy with relatively illiquid domestic financial markets and exceptional global conditions.

Second, capital flow management measures should be considered to complement other stabilisation policies in light of the important role played by cross-border capital flows in the aforementioned macro-financial linkages. However, as our results clearly demonstrate, international spillovers do not necessarily cease when the capital account is heavily controlled. Hence, expectations should be kept in check with regard to what such measures can hope to accomplish. On the other hand, Iceland's experience does not rule out that the use of capital flow management measures, as a complement to an otherwise comprehensive, coordinated and credible stabilisation policy, would be able to moderate to a greater extent the domestic impact of the global financial cycle and the entrenched boom-bust characteristic of the economy.

Third, our results highlight the need to strengthen the analytical foundations for policy making within small open and financially integrated economies. This implies further research into the strong spillover dynamics from the global financial cycle to its domestic counterpart, which in the case of Iceland could challenge the prevalent view of relatively weak links between the domestic and global business cycle (Gudmundsson et al., 2000, and Einarsson et al., 2013b), which has been an important argument in the debate on the country's currency and exchange rate regime (Central Bank of Iceland, 2012). Our results can also only be taken as a first step in

[29] These results are consistent with the findings in the first part of our study with regard to the important role played by domestic demand expansions and collapses, alongside global crisis spillovers, in the financial crises which have taken place in Iceland over the period of more than a century (Einarsson et al., 2015).

analysing the capacity of financial cycle developments to function as an early warning for risks of financial distress. Further work is also needed into mapping and modelling the important role played by financial factors in affecting macroeconomic developments. This includes uncovering the underlying financial sector externalities at work (cf. Korinek, 2011, and De Nicolò et al., 2012) and taking financial factors into account in assessment of key policy-relevant unobservables, such as the output gap, the neutral rate of interest, and the equilibrium real exchange rate (Borio, Disyatat, and Juselius, 2014 and Berger et al., 2015).

Fourth, the fact that the duration of the contractionary phase of the latest financial cycle episode was shorter than on average over the whole sample, may be interpreted as evidence of a more successful crisis management and resolution this time around compared to earlier episodes, especially given the exceptional scope of pre-crisis macro-financial imbalances (Einarsson et al., 2015). Although further evidence is needed, it seems clear that bank resurrection and private sector debt restructuring was more comprehensive in the aftermath of the 2008 financial crisis than in earlier episodes, in addition to being supported by wide-reaching resource reallocation in the real economy and policy improvements (Central Bank of Iceland, 2016).

Finally, it is clear that the features of the financial cycle in Iceland, especially the presence of strong global spillovers and a prominent boom-bust interaction between credit, capital flows, and domestic demand are likely to apply to other small open economies. This holds particularly true for small open emerging market economies, many of which have already attained certain experience in adjusting their policy frameworks to lean against global spillovers and increase capacity for domestic stabilisation. The jury is still out, however, with regard to how successful they will be. As in the case of Iceland, efforts to tame and understand the financial cycle are likely to offer serious policy challenges for years to come.

8 Conclusions

In the first part of our study of financial booms and busts in Iceland (Einarsson et al., 2015), we identified and dated different types of financial crises over a period spanning more than a century and analysed the main properties of these episodes and the development of key macroeconomic and financial variables in the run-up to these crises and in the period when they unfold. Here, we take the analysis a step further and attempt to use the same dataset to capture the low-frequency co-movement of a number of financial variables in a single and well-defined financial cycle.

Our findings suggest that indeed there exists such a financial cycle in Iceland and that it has gradually become more prominent, in particular with increased liberalisation and deepening of the domestic financial system since the 1980s. The aggregate cycle is much longer than the typical business cycle, with a median duration of fifteen years, and seems to be getting longer and more intense over time. The underlying cycles in most of the individual financial variables are also becoming more tightly aligned with the aggregate cycle over time and the proportion of variability in the underlying individual cycles captured by the aggregate cycle is growing ever larger and exceeds 80% in the post-1980 period.

We find that there is a large difference in economic performance over different phases of the financial cycle: the average growth rate of output and domestic demand is almost three times higher in expansionary phases of the financial cycle than in its contractionary phases (rising to almost four times higher in the post-1980 period). We also find that economic contractions that coincide with the contractionary phases of the financial cycle tend to be more drawn out than contractions that do not coincide with the contractionary phases of the cycle. The financial cycle therefore seems to have played a prominent role in the country's macroeconomic development. In fact, we find that almost all of the peaks in the financial cycle coincide with some kind of a financial crisis and that cyclical expansions provide a robust early-warning signal for subsequent crises. Furthermore, our results show that the aggregate cycle provides a marked improvement over the capacity of individual financial and macroeconomic variables to signal ensuing financial crises, highlighting the importance of the interaction of different financial variables in amplifying financial imbalances.

We find strikingly strong ties between the Icelandic financial cycle and its global counterpart, which is proxied with the US financial cycle (captured by a composite measure of medium-term cycles in credit and house prices): over the whole sample period these two financial cycles spend over 70% of the time in the same cyclical phase and almost all of the cyclical peaks in the Icelandic financial cycle occur close to peaks in the global cycle, with the peaks usually coinciding or the Icelandic peak lagging by a year or two. There is also evidence that these spillover effects have been growing stronger over time. There is limited evidence, however, of additional regional spillover effects from Scandinavia and the UK.

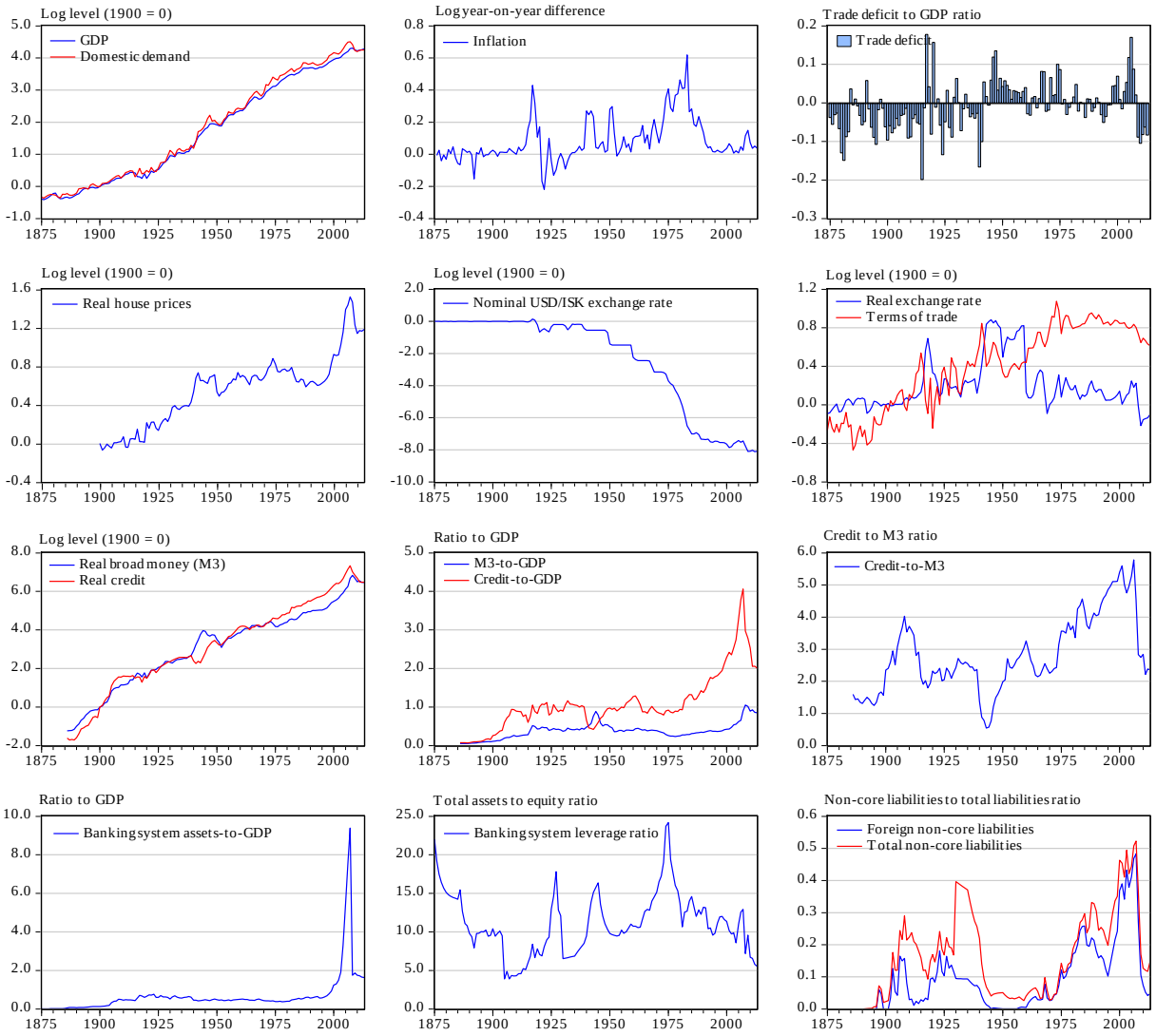
This tight link between the domestic and global financial cycles highlights the importance of accounting for the financial channel through which global developments penetrate the Icelandic economy and may call the prevalent view of the Icelandic business cycle being dominated by idiosyncratic supply shocks into question. Our results also suggest that understanding capital flows, the surprisingly high volatility of private consumption in Iceland, and fiscal policy dynamics, to name only three important issues in the domestic economic debate, is hard without understanding the financial cycle. We conclude the paper with a first attempt at exploring some of the policy questions that our findings raise.

Appendix 1 The data

Icelandic data

The data used in this paper is obtained from various sources described in detail in Einarsson et al. (2015). Most of the data span the period 1875-2013, but there are a few exceptions: money, credit and non-core banking liabilities are only available from 1886, while we were only able to stretch the house prices data back to 1900. Figure A.1.1 shows the data.

Figure A.1.1 The data for Iceland



Source: Details on the data sources can be found in Einarsson et al. (2015).

International data

United States

For all the series except house prices we use data from Jordà et al. (2014), which covers the period 1870-2011, with an updated dataset to 2013 kindly made available by the authors (this dataset is an update of an earlier dataset from Schularick and Taylor, 2012). There is a gap in the Jordà et al. credit series in 1941-44 which we fill using log-linear interpolation. For house prices we use Shiller (2015) with updates from the author available from (http://irrationalexuberance.com/main.html?src=%2F).

Denmark

For the credit-to-GDP ratio we use data on the ratio of loans from banks and mortgage-credit institutes to GDP from Abildgren (2006) for the period 1875-1965 (Tables A.2, A.3 and A.9) combined with data on the ratio to GDP using total credit from banks to the private non-financial sector from the BIS' *Total Credit Statistics* database from 1966-2013 (http://www.bis.org/statistics/totcredit.htm?m=6%7C326). For house prices we use data from Abildgren (2006) on prices for one-family houses from 1938-69; combined with prices for farms from 1875-1937 (Table A.16). These series are combined with data on residential property prices from the BIS' *Residential Property Price* database from 1970-2013 (http://www.bis.org/statistics/pp.htm?m=6%7C288). Data on domestic consumer prices are from Abildgren (2006) for the period 1875-2005 (Table A.10) and the IMF *World Economic Outlook* database for 2006-13.

Norway

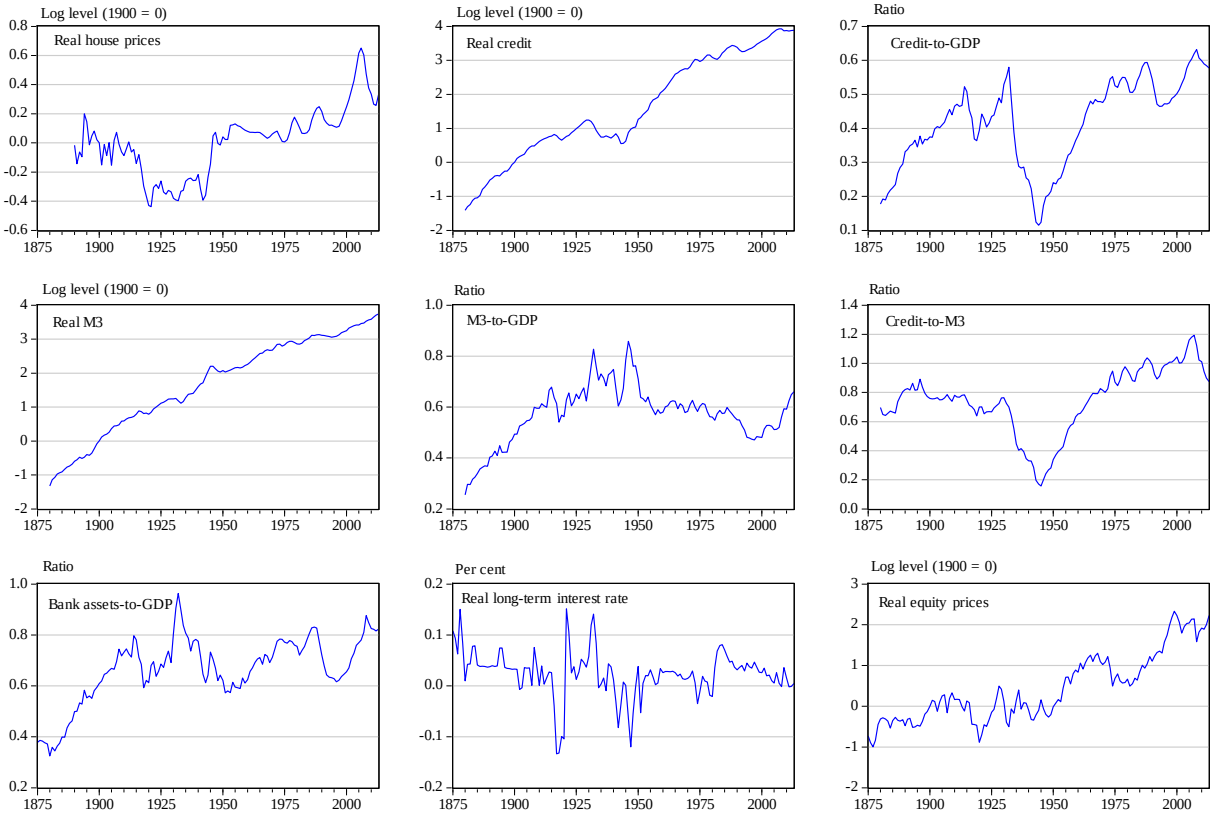
We use Eitrheim et al. (2004, 2007), with updates from the Norges Bank *Historical Database* as a source for credit (total credit private banks), nominal GDP, house prices (country-wide prices), and domestic consumer prices (consumer price index). There is a gap in the GDP series from 1940-45 and linear interpolation is therefore used to provide data for the credit-to-GDP series for that period.
http://www.norges-bank.no/en/Statistics/Historical-monetary-statistics/.

United Kingdom

We use the Bank of England historical dataset (*Three Centuries of Macroeconomic Data*, Version 2.2) as a source for credit (total stock of bank and building society lending), nominal GDP, house prices (property prices) and domestic consumer prices (consumer price index).
http://www.bankofengland.co.uk/research/Pages/onebank/threecenturies.aspx.

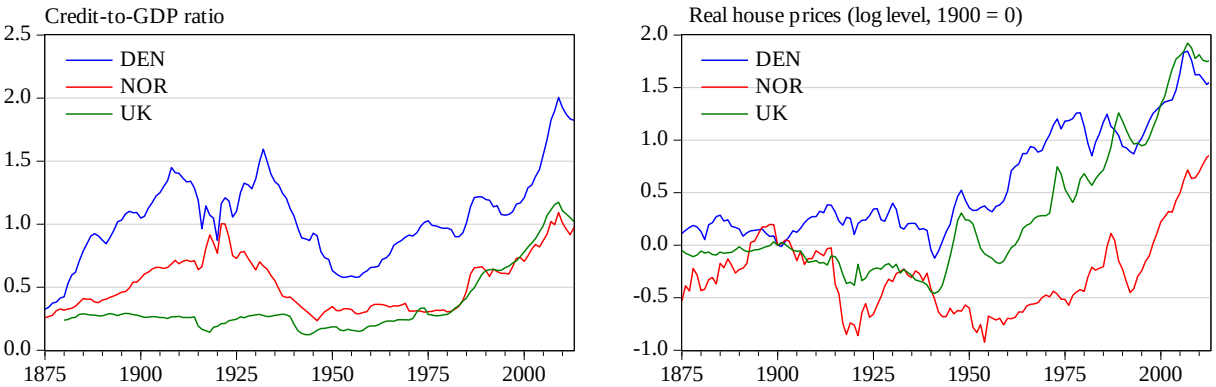
The following figures show the data: first Figure A.1.2 for the nine US variables used, followed by Figure A.1.3 for the credit-to-GDP ratio and real house prices for Denmark, Norway and the UK.

Figure A.1.2 The data for the US



Sources: Jordà et al. (2014) and Shiller (2015).

Figure A.1.3 The data for Denmark, Norway and the UK

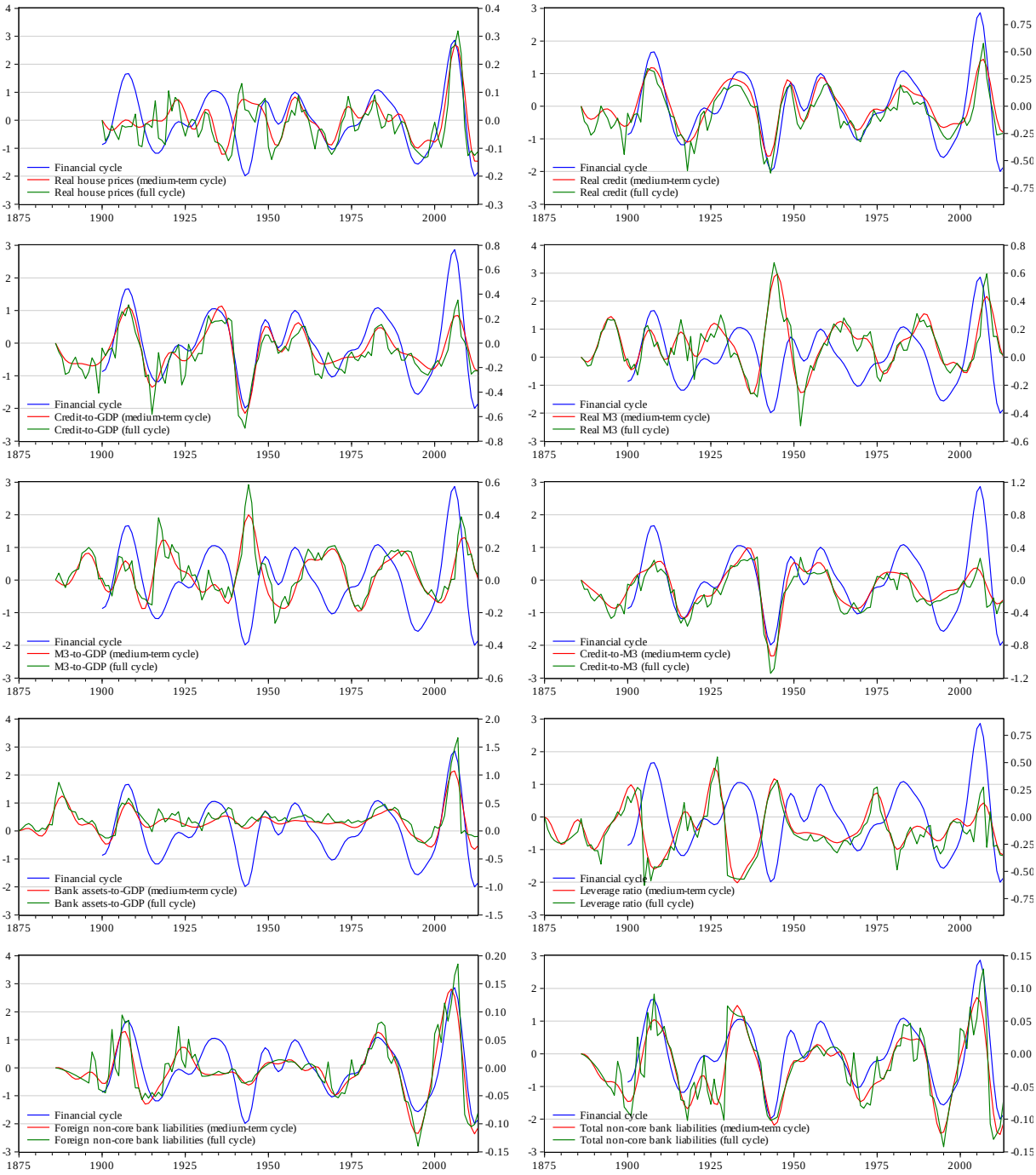


Sources: Abildgren (2006), Bank of England, Bank of International Settlements, Eitrheim et al. (2004, 2007), International Monetary Fund, and Norges Bank.

Appendix 2 Cyclical components of the domestic data

This Appendix reports the medium-term (8 to 30 year) and complete (2-30 year) cycles of individual domestic financial and macroeconomic variables, and compares these cycles to the composite measure of the aggregate financial cycle.

Figure A.2.1 The financial cycle and cycles in individual financial variables

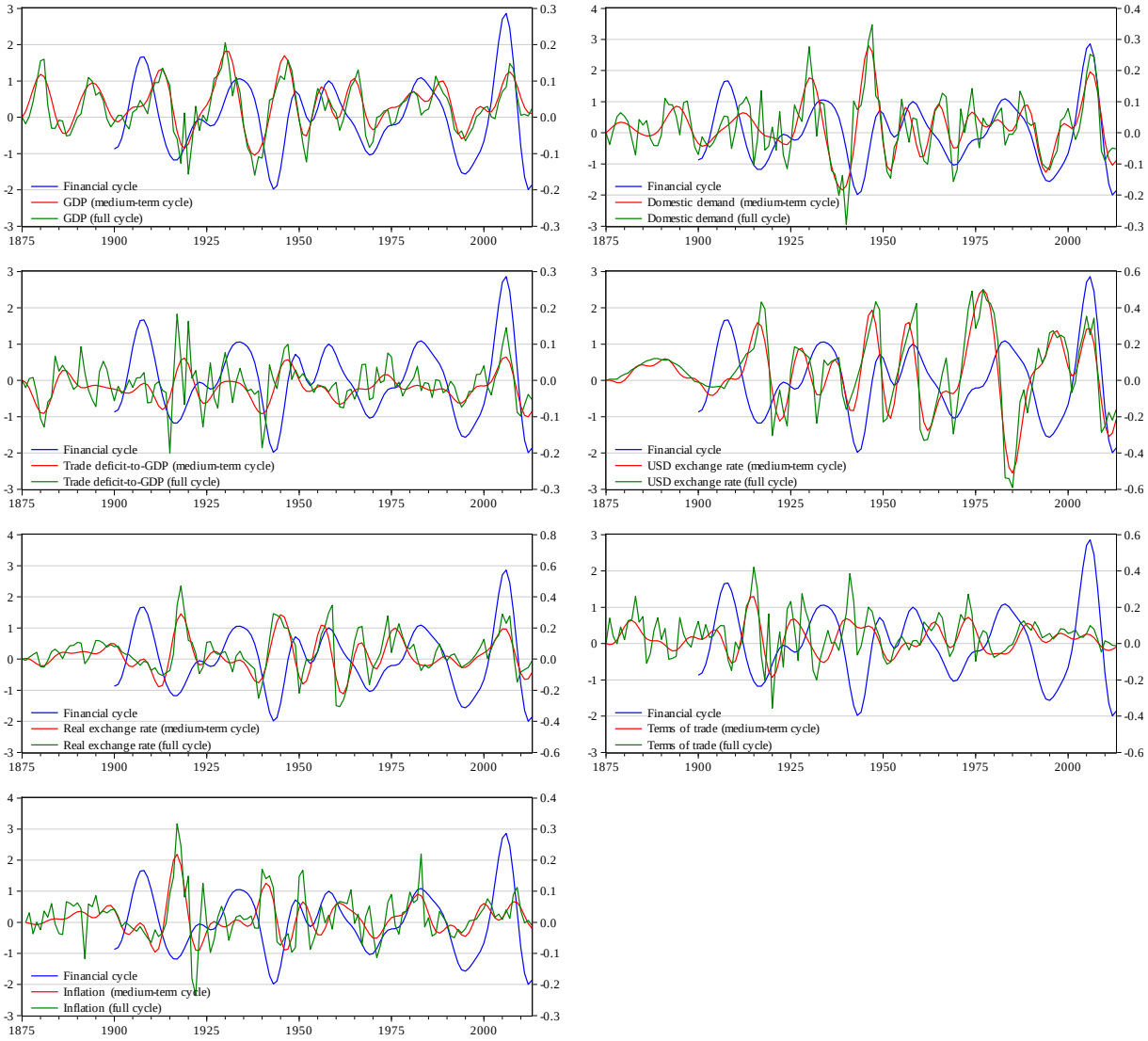


Financial cycle (left axis) and medium-term (8 to 30 year) and full (2-30 year) cycles in individual financial variables (right axis).

Source: Authors' calculations.

The figures show how most of the variables are dominated by their medium-term cyclical components and how closely most of these medium-term cycles coincide with the aggregate financial cycle.

Figure A.2.2 The financial cycle and cycles in individual macroeconomic variables



Financial cycle (left axis) and medium-term (8 to 30 year) and full (2-30 year) cycles in individual macroeconomic variables (right axis).

Source: Authors' calculations.

Appendix 3 Financial crises in Iceland

In this Appendix we summarise the dates of different types of financial crises in Iceland over the period 1875-2013 and give a short description of the criteria used to date these episodes. For a detailed description and analyses, see Einarsson et al. (2015).

Currency and inflation crises

Table A.3.1 shows the dates of different types of financial crises in Iceland over the period 1875-2013. Currency and inflation crises are identified using the numerical threshold (15% per annum for annual currency depreciations and 20% per annum for annual inflation) suggested by Reinhart and Rogoff (2009, 2011).[30] This gives us eleven currency crises and five inflation crises with an average duration of 2.4 and 5.4 years, respectively. Not surprisingly, the two types of crises are closely connected with all the inflation crises coinciding with currency crisis episodes, with the temporal sequence usually from a currency crisis to an inflation crisis. One episode stands out in terms of its longevity: the currency and inflation crisis starting in the mid-1970s which lasts for more than a decade with a cumulative depreciation amounting to almost 98% and inflation averaging at almost 40% per year. Some of the shorter currency crisis episodes are also nastier than others: the crises in the early 1920s, in 1950, the two crises in the 1960s, and the latest one, all saw the currency collapsing by close to 50%. As discussed in Einarsson et al. (2015), two of these episodes (the first and the last) also coincided with a full-blown sudden stop crisis that eventually led to the introduction of capital controls.[31]

Banking crises

For dating banking crises, we follow the standard practice in the literature in basing our event criteria on identifying dates where there are significant signs of financial distress in the banking system, as reflected in large-scale bank runs (be that a conventional run on deposits or a more "modern" run on wholesale funding) that lead to the closure, merging, or public sector takeover of a significant share of the banking system (see e.g. Reinhart and Rogoff, 2009, and Laeven and Valencia, 2013).

This gives us five banking crisis episodes, occurring every 22 years and lasting for 2 years on average. Three of these episodes are defined as systemic: the two early episodes in the early 1920s and 1930s, and the latest episode starting in 2008. All three would register as serious on any banking crisis barometer (although the latest one beats them all, hands down): all involved between two-thirds to more than 90% of the banking system and coincided with a contraction in real credit that amounted to 10-20% in the first two episodes to more than 80% in the latest one. The two other episodes (in the mid-1980s and early 1990s) are smaller, non-systemic crises that only involved one, albeit important, financial institution in distress.

[30] There are a few exemptions explained in Einarsson et al. (2015).

[31] The currency crisis in the early 1930s also led to an introduction of capital controls but this episode falls short of the criteria for identifying sudden stop crises used (a trade balance reversal exceeding two standard deviations and coinciding with collapsing output; cf. Calvo et al., 2008, and Forbes and Warnock, 2012).

Table A.3.1 Financial crises in Iceland 1875-2013

Currency crises	Inflation crises	Banking crises	Multiple financial crises
1919-20	1916-18	1920-21	1914-21
1932	–	1930-31	1931-32
1939	1940-43	–	–
1950	1950-51	–	1948-51
1960	–	–	–
1968-69	1969	–	1968-69
1974-85	1973-89	–	–
1988-89	–	1985-86	–
1993	–	1993	1991-93
2001	–	–	–
2008-9	–	2008-10	2008-10

The dates of currency and inflation crises as identified by the numerical thresholds suggested by Reinhart and Rogoff (2009, 2011): exchange rate crises are defined as episodes where annual depreciations is greater than 15% per annum and inflation crises as episodes where annual inflation is in excess of 20% per annum. The dates identified for the 1985-86 and 1993 banking crises are obtained from Caprio and Klingebiel (2003) (also used by Reinhart and Rogoff, 2009, 2011), while we use Laeven and Valencia (2013) to date the start of the latest banking crisis. The dating of the two pre-WWII banking crises is based on archived documentation. Identification of multiple financial crises is based on the Harding and Pagan (2006) non-parametric common cycle algorithm.

Source: Einarsson et al. (2015).

Multiple financial crises

To capture the clustering nature of the financial crises in Iceland, we also apply a version of Harding and Pagan's (2006) non-parametric common cycle algorithm to identify the more serious multiple financial crisis episodes. This gives us six multiple crises occurring every 15½ years on average. The first two episodes occur during the early 1900s: the first coincided with the World War I (WWI) and lasted into the early 1920s, when a sharp collapse in economic activity led to an inflation crisis that was followed by a sudden stop and a currency crisis and eventually by a systemic banking crisis; while the second crisis coincided with the outbreak of the Great Depression in the early 1930s when another systemic banking crisis followed a recession and morphed into a currency crisis in 1932. There are two further episodes occurring at the end of the 1940s and in the late 1960s that are related to a serious deterioration of external conditions, in both cases leading to currency and inflation crises: the first followed a sharp deterioration of terms of trade and a contraction in economic activity; the second of these episodes following a collapse in fish catch, a major export item. The fifth episode occurs during the early 1990s when falling economic activity, following attempts to rein in the chronic inflation of the 1970s and the 1980s, led to a twin currency and (non-systemic) banking crisis in 1993. The final episode is the most recent one when a build-up of large imbalances in the run-up to the crisis were followed by a sudden stop and a twin currency and banking crisis in 2008.

Appendix 4 Global financial cycles and crises

Figure A.4.1 compares the estimated aggregate financial cycles from 1900 to 2013 for the four countries used to analyse global and regional spillovers to Iceland and the dates of banking and general financial crises in these countries, as identified by Reinhart and Rogoff (2011).[32] The figure shows that peaks in our measure of the US financial cycle closely coincide with the dates of banking crises in the US. From the start of the 20th century, Reinhart and Rogoff identify five banking crises in the US: in 1907, 1914, 1929-33, 1984-91, and 2007-10, and our composite financial cycle peaks within a three year window of the start of four of these episodes – it is only in the mid-1980s that the cyclical peak falls outside this three year window (occurring four years after the start of the crisis). There are also cyclical peaks that do not coincide with a banking crisis, but some of them coincide with other types of financial crises, such as the currency crisis in 1947. The broader defined measure of financial crises (general financial crises) gives a greater number of crises, but again we find that a significant number of those coincide with peaks in the financial cycle (eight of the total fifteen to be exact).

For the other three countries, the same results emerge: most of the financial crises identified by Reinhart and Rogoff (2011) coincide with a cyclical peak in our composite measure of their respective financial cycles. In fact, for the four countries we find that almost 80% of the banking crises identified coincide with a cyclical peak within a three year window; ranging from 50% in Denmark to 100% in Norway (with the US and the UK at roughly 80% in-between). The number of general crises coinciding with cyclical peaks is lower but still high: 61% of crises coincide with a cyclical peak within a three year window on average (ranging from roughly a half in the US and Denmark to over 60% in the UK and almost 80% in Norway).

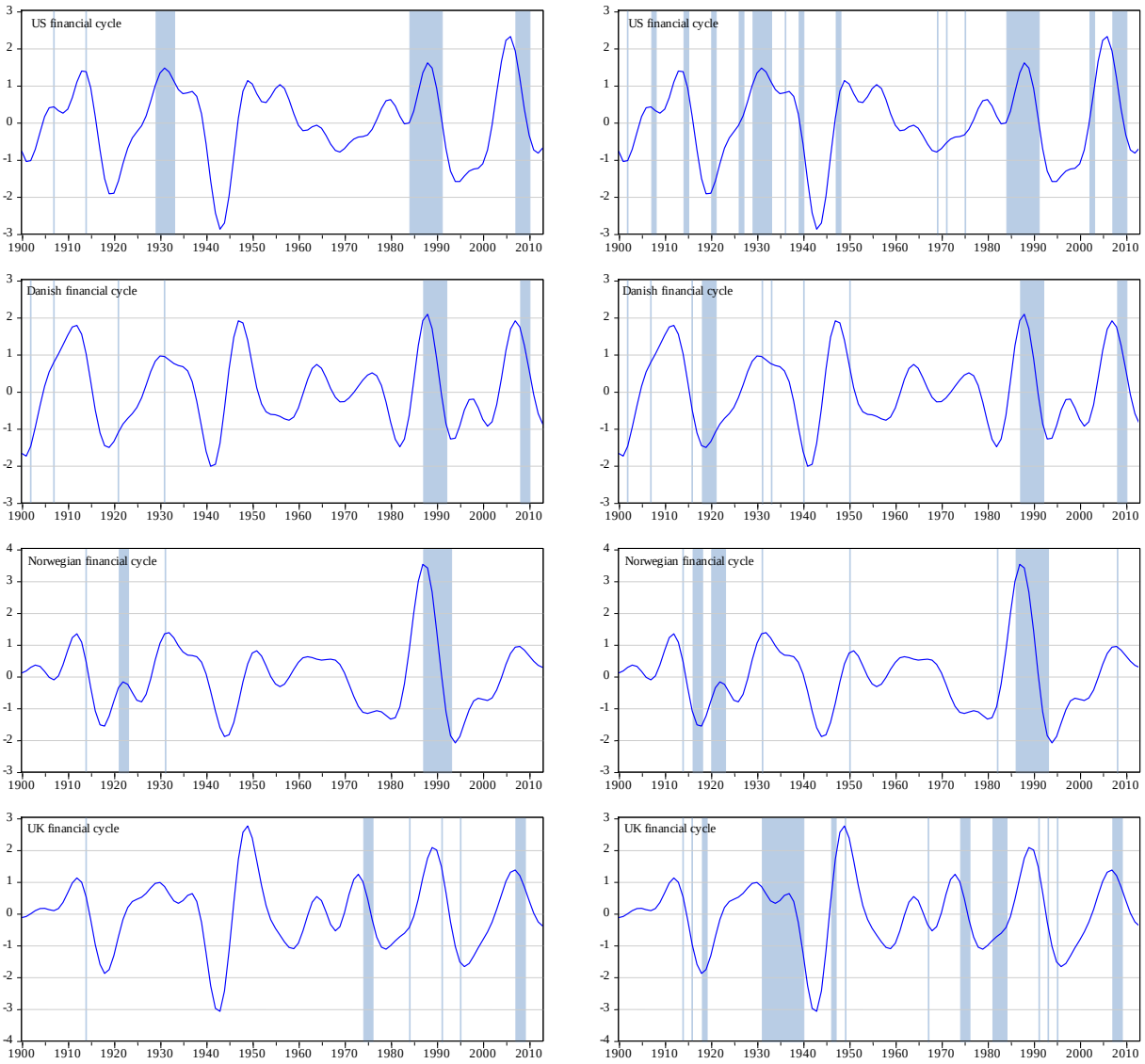
Inspection of the figure suggests that the cycles across these four countries tend to move together over time, with peaks and troughs more often than not coinciding. This visual perception is confirmed by the concordance index which suggests that the four cycles tend to be in the same phase from 60% to over 70% of the time. The financial crises identified here also show a strong common global component: the concordance index suggests that the four countries are 85% to over 90% of the time in the same financial state. Finally, panel probit regressions show that the composite financial cycle has a statistically significant predictive power for impending financial crises (with cyclical lags of up to four years significant at the 1% critical level). Furthermore, cyclical expansions significantly increase the probability of a financial crisis: for example a lagged binary indicator that equals unity at cyclical peaks and zero otherwise is found to be statistically significant (*p*-values equal to 0.001 and 0.012 for banking and general financial crises, respectively) and suggests that a peak in the financial cycle coincides with roughly two- to almost threefold increase in the probability of a financial crises two years after the cyclical peak.[33]

[32] General financial crises corresponds to dates when Reinhart and Rogoff's (2011) BCDI index signals two or more crisis episodes (i.e. at least two of banking, currency, external sovereign debt, or inflation crises).

[33] The regressions include a constant and time-invariant country-specific effects. Using cross-country averages, the empirical results suggest that the probability of a banking crisis rises from roughly 10% to 31%, whereas the probability of general financial crisis rises from 22% to 41%. The results for individual countries are very similar.

Figure A.4.1 Financial cycles and crises in the US, Denmark, Norway, and the UK

Banking crises (left) and general financial crises (right) shown as shaded areas



Financial cycle, estimated as the first principal component of the medium-term cycle of the credit-to-GDP ratio and real house prices for each country. Dates for financial crises are from Reinhart and Rogoff (2011). General financial crises are defined as years when there are two or more crisis episodes involving either a banking, currency, external sovereign debt or inflation crises identified by Reinhart and Rogoff (2011).

Sources: Reinhart and Rogoff (2011) and authors' calculations.

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