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Small open economies in the vast ocean of global high finance*

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Abstract

Iceland has a long history of violent cycles of economic exuberance and hardship, of which the recent financial tsunami is only the latest example. We show that this boom-bust pattern is driven to an important extent by low-frequency co-movement of various financial variables; i.e., a common "financial cycle". This cycle is much longer than the typical business cycle, with significant differences in economic performance over its different phases. Indeed, almost all of the cycle's peaks coincide with some type of financial crisis. We find that Iceland is no island in the vast ocean of global high finance, as we uncover strikingly strong spillovers from fluctuations in global financial conditions.

Keywords: Financial cycle, financial crises, global financial spillovers, Iceland
JEL Classification: E32, E44, F44, G01

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"Macroeconomics without the financial cycle is like Hamlet without the Prince"
Claudio Borio (Borio, 2014, p. 183)

1 Introduction

Iceland has a long history of violent cycles of economic exuberance and hardship, of which the recent financial tsunami is only the latest example. We argue that this boom-bust pattern is driven to an important extent by low-frequency co-movement of various financial variables; i.e., a common "financial cycle". Our results suggest that this aggregate 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, as we uncover extremely strong global spillover effects.

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, Furfine & Lowe, Borio et al., and Daníelsson et al., 2004). 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 database which spans the period 1875-2013 and contains annual data on financial prices and volumes, as well as banking system balance sheet size and composition, to extract medium-term cyclical components for each variable and use principal component analysis to aggregate this information into a single composite measure of the financial cycle. The medium-term cyclical components are found to explain most of the movements in the financial variables included and the aggregate measure of the cycle is found to explain a large share of the total variability in these medium-term cycles.

We identify seven complete cycles in this aggregate measure of the financial cycle with a median duration of sixteen years, therefore closely matching the average period between the occurrences of serious financial crises in Iceland (see Einarsson et al., 2015). We also find evidence that the financial cycle has become longer and more intense over time. There is also a significant difference in economic performance over different phases of the financial cycle: the average growth rate of output is almost three times higher in the expansionary phase of the financial cycle than in its contractionary phase. 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 cycle, when balance sheets become overextended and asset price overvaluations peak, and the subsequent bust when these imbalances are unwound with potentially severe effects on economic activity. Indeed,

we find that almost all of the cyclical peaks coincide with some type of a financial distress within a window of three years.

In an influential paper, Rey (2013) shows that small open economies tend to be hostages to fluctuations in global financial conditions irrespective of their exchange rate regime. She argues that these global conditions reflect a common global financial cycle that is driven by financial conditions in the US and monetary policy set by the Federal Reserve. A key question in our context is therefore to what extent this financial boom-bust cycle in Iceland is driven by global factors. To address this question, we construct a simple measure of the global financial cycle using US data as a proxy and find strikingly strong ties between the Icelandic financial cycle and its global counterpart: over the whole sample period these two financial cycles spend close to 75% 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 cyclical peak lagging by a year or two. The spillover effects seem particularly strong in credit and wholesale bank funding and our results suggest that the effects have been growing stronger over time. As further evidence of these strong global contagion effects, we also find strong links between global financial crises and financial crises in Iceland: most crises in Iceland coincide with similar crises abroad and the most serious global episodes coincide with a two- to threefold increase in the probability of a financial crisis in Iceland.

The remainder of the paper is organised as follows. In Section 2 we discuss the data and analyse the key properties of medium-term cycles of individual financial variables. In Section 3 we construct a composite measure of the financial cycle in Iceland, discuss its main properties and how it interacts with economic activity and correlates with the incidence of financial crises in Iceland. In Section 4 we look at possible global spillover effects. Section 5 concludes the paper.

2 Cyclical behaviour of financial variables

2.1 The data and related literature

To estimate the financial cycle in Iceland and global spillover effects, we use a range of financial variables. The local variables include the three financial variables central to any analysis of financial cycles (cf. Borio & Lowe, 2004, Shin & Shin, 2011, Claessens et al., 2011, 2012, Drehmann et al., 2012, and Kim et al., 2013): credit (total lending and bond holdings of the credit system as data on credit to the non-financial private sector is not available over the whole sample period), broad money (M3), and real house prices. We also include data on the size and composition of the banking system balance sheet to capture its potentially important role in fuelling financial cycles (cf. Adrian & Shin, 2011, Brunnermeier et al., 2013, and the International Monetary Fund, 2013). First, we include the ratio of total banking system assets to GDP which can for example provide insights into how banks' risk appetite with regards to channelling funds to the real economy

evolves over the financial cycle (Schularick & Taylor, 2012, and Kim et al., 2013). Second, we include the ratio of banking system assets to bank equity to capture to what extent the expansion of banks' balance sheets is being financed with debt (cf. Drehmann et al., 2012). This leverage measure is more general than the credit-to-money ratio, also included, as it encompasses a greater number of assets and liabilities, and can therefore provide additional information for analysing the financial cycle. Finally, we include the ratio of non-core banking liabilities to total liabilities, which reflects the claims on domestic banks not held by the ultimate domestic creditors. This measure serves as 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, such as wholesale funding, as the traditional (monetary) ones are exhausted (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. Finally, to capture potential international spillover effects, we use data from the US to approximate the global financial cycle and the global financial crises dates from Reinhart & Rogoff (2011) to investigate the importance of global crises contagion. Appendix 1 provides the data sources.

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] The sample period therefore covers the period up to World War II (WWII) when the Icelandic economy was lagging behind other industrial economies in terms of income levels and financial deepening (Jónsson, 2004), and the post-WWII 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. We also look specifically at the second half of the post-WWII period (the period from 1980) which roughly coincides with the modernisation of the Icelandic financial system and liberalisation of domestic financial markets, 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).

2.2 Medium-term cycles in financial variables

The focus of this study is the medium-term variation in the data, which Claessens et al. (2011, 2012), Drehmann et al. (2012), and Aikman et al. (2015) find to dominate the overall

[1] Not all the series stretch back to 1875. For the domestic data the exceptions are broad money, credit and the two non-core bank liabilities variables which date back to 1886, while the US credit and house price data is only available from 1880 and 1890, respectively. Our analysis does not include domestic stock prices as stock market data does not extend further back than the mid-1980s.

fluctuations in financial data and to be a well-defined empirical regularity that has been operating over a long period of time. Their results also suggest that these lower-frequency cycles have interacted in an important way with the real economy and have an important role in the occurrence of financial crises.

Table 1 Key characteristics of medium-term cycles

	Duration			Amplitude		Slope	
	Expansion	Contraction	Full cycle	Expansion	Contraction	Expansion	Contraction
Real house prices	6.00	5.00	10.00	0.14	-0.12	0.03	-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
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
For. non-core liab.	6.00	5.50	11.00	0.04	-0.04	0.01	0.00
Total non-core liab.	5.50	6.00	11.50	0.07	-0.04	0.01	-0.01
Average	6.65	5.70	11.85	0.25	-0.22	0.03	-0.03
GDP	5.00	5.00	10.00	0.11	-0.14	0.02	-0.02

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. Duration, amplitude and slope are in all cases obtained using sample medians.

Source: Authors' calculations.

To identify the medium-term cycles, we follow Drehmann et al. (2012) and Aikman et al. (2015) and use the Christiano & Fitzgerald (2003) asymmetric band-pass filter to isolate cycles that have a duration between 8 and 30 years.[2] As has become standard (cf. Comin & 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.[3]

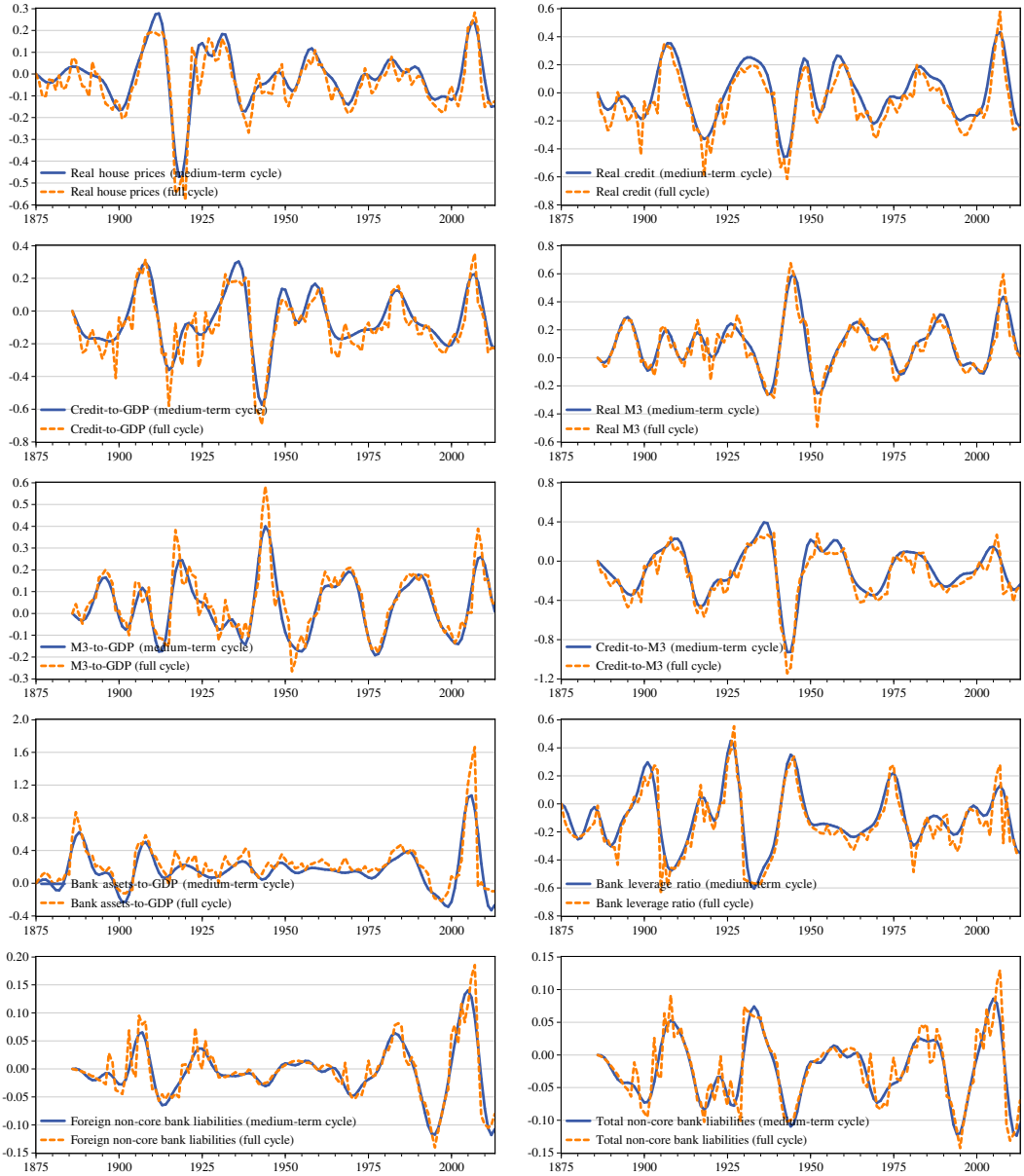
Table 1 shows that the medium-term cycles all have a cyclical phase lasting 5 years or more, with the expansionary phase lasting a year longer on average than the contractionary phase, and that a complete cycle has an average duration of almost 12 years. The table also shows that the medium-term cycles in financial variables tend to be longer and more intense

[2]Drehmann et al. (2012) also use an upper range of 30 years, while Aikman et al. (2015) use an upper range of 20 years. Comin & Gertler (2006), in a study of medium-term cycles in US macroeconomic variables, 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.

[3]For the two non-core bank liability measures (which equal zero for some years), we use the log-difference of one plus the variable.

than comparable cycles in real GDP, which is consistent with the findings of Claessens et al. (2011) and Drehmann et al. (2012).[4]

Figure 1 Medium-term and complete cycles in individual financial variables



Source: Authors' calculations.

Figure 1 shows how the financial variables are dominated by these medium-term cycles. The figure compares the medium-term cyclical components of each variables with all the components in the 2 to 30 year range. As the figures clearly show, the medium-term cycles capture a large part of the complete cycles in all of the series, suggesting that the business

[4]Also consistent with these papers, we find that medium-term cycles in the financial variables have lengthened over time, especially in the post-1980 period of increased domestic and global financial liberalisation and sophistication (details can be found in Einarsson et al., 2016).

cycle component (cycles between 2 and 8 years) play a smaller role in explaining the overall variation in the data: typically, the standard deviation of the medium-term component is found to be more than two times larger than the standard deviation of the business cycle frequency component.

The figure also highlights that the medium-term cycles in most of the financial variables tend to co-move, in particular in the post-WWII period.[5] A notable exception are the medium-term cycles in money and bank leverage, which seem to have different cyclical phases throughout most of the sample period. Overall, however, there is a tendency for the medium-term cycles in the financial variables to be highly synchronised, suggesting a presence of an aggregate financial cycle, which gradually becomes more prominent over time.

3 The aggregate financial cycle

The results from the previous section suggest that there exists an aggregate financial cycle in Iceland over a sample period spanning more than a century. Similar to Drehmann et al. (2012) and drawing on Borio's (2014) characterisation of the financial cycle as the inherent pro-cyclicality of the financial system, we define this aggregate cycle as the low-frequency cyclical co-movement of a set of financial variables including both quantities and prices. This definition is conceptually similar to the standard approach of defining the business cycle as the recurrent and broad-based co-movement of macroeconomic variables (cf. Burns & Mitchell, 1946).

To obtain the aggregate financial cycle, we use principal component analysis and identify the aggregate cycle as the first principal component, i.e. the linear combination of the medium-term cycles in the financial variables (all normalised to have a zero mean and a unit standard deviation) that explains most of the combined variability of the individual cycles. Our approach is therefore broader than, for example, Aikman et al. (2015) and Schularick & Taylor (2012) (who focus exclusively on the credit cycle) and Drehmann et al. (2012) (who focus on a cycle comprising credit and house prices), and provides additional insights into the potential feedback mechanisms among different parts of the financial system through the interaction between asset prices, borrower's collateral constraints, and banks' balance sheets.

3.1 Key properties of the financial cycle

Over the whole sample period we find that the cyclical components in individual variables contribute broadly equally to the aggregate cycle, except for the two money measures, and the bank leverage ratio which attain negative loadings which is not surprising given the

[5]The number of contemporaneous correlation coefficients exceeding 0.7 increases from seven in the 1875-1944 period to eleven (eighteen) in the post-WWII (post-1980) period (see Tables 3 and 4 in Einarsson et al., 2016). It is important to note that the increasingly strong co-movement of the cyclical components does not rely on the inclusion of the latest boom-bust cycle (i.e. the results continue to hold if we end the sample in 2003).

weak co-movement of these variables with the other financial variables mentioned above. Hence, the credit variables, the bank assets-to-GDP ratio and the two non-core liabilities measures seem to perform better at capturing the balance sheet overextension within the financial system than the two money measures and the bank leverage ratio.[6] Excluding these three variables gives broadly identical loadings for the seven remaining variables and raises the variability of the aggregate financial data explained by the first principal component from 50% to 65%. The factor loadings remain unchanged when estimating the aggregate cycle over the post-WWII period but the proportion of the total variability of the financial data captured by this aggregate measure rises to 75% in the post-WWII period and to 83% in the post-1980 period.[7] 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 typically ranges between one-third and a half.

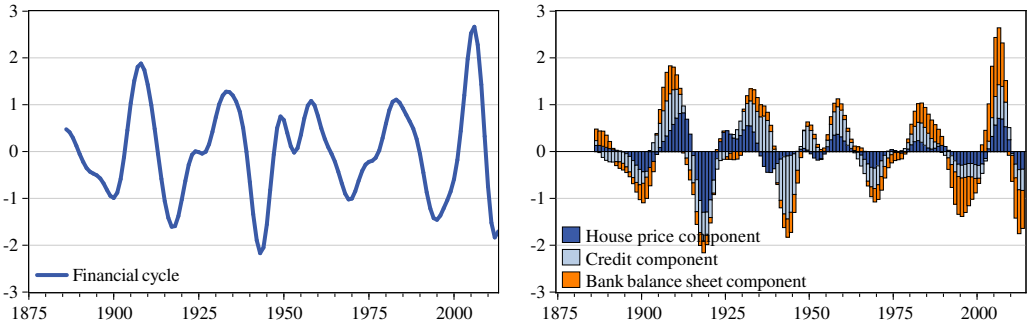
Figure 2 gives the full-sample estimate of the financial cycle and an approximation of the contribution of individual components to the aggregate cycle calculated using the whole-sample factor loadings. To ease the presentation, we summarise the seven individual components into three groups, one denoted the "credit cycle" which contains the contribution of the medium-term cycles in 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 contribution of the medium-term cycles in 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. There is an expansion around the turn of the century that peaks in 1908, which is mainly driven by credit during the early phase of the expansion, but with a rising contribution of bank balance sheets as the expansion matures, followed by house prices in the final years of the expansion (which in turn play a large role in the cycle's bust phase). There is another expansion that starts at the end of World War I (WWI), breaking off for a short period in the mid-1920s and expanding again until peaking in 1933 (therefore counting as two expansions). Here, house prices play a key role during the expansion's initial phase, followed by credit during the second stage of the expansion. The middle of the century is dominated by two rela-

[6]The relatively weak role of money in the financial cycle is consistent with the declining role of money in financial boom-bust cycles in the post-WWII period in other industrial countries found by Schularick & Taylor (2012) and Aikman et al. (2015). The weak role of bank leverage is perhaps more surprising but is likely to reflect the impact of financial repression in Iceland over a large part of the post-WWII period (with cyclical expansions typically reflecting 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) and measurement problems in the latest boom-bust cycle, where bank equity at book value has turned out to be significantly overestimated (Rannsóknarnefnd Althingis, 2010).

[7]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. 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.

Figure 2 The financial cycle and 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 component* refers to the contribution of the medium-term cycle in real house prices to the financial cycle, *Credit 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 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.

tively short financial expansions, one that peaks in 1949 and follows the large economic shock related to allied occupation in WWII (see Einarsson et al., 2015), and another one that starts in 1953 and peaks in 1958. Both are mainly credit driven, although house prices also play a role in the second cyclical expansion. The next expansionary phase lasts much longer, or fourteen years from 1969 to 1983, and is relatively broadly based. The final expansion is also long: starting in 1995 and lasting for eleven years before reversing sharply in 2006. This large expansion is mainly driven by expanding bank balance sheets during the cycle's birth phase, which coincides with the completion of the country's capital account liberalisation and a broad-sweeping privatisation of domestic financial institutes during the latter half of the decade and the first years of the new century. 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. During the bust phase of the cycle we see sizeable contributions from all components, but bank balance sheets again play a prominent role. The latest boom-bust cycle therefore highlights how the inclusion of bank balance sheet data in the estimation of the aggregate financial cycle can offer additional insights into its dynamics, due to the important role of financial institutions' balance sheets in driving economy-wide cyclical movements (cf. Adrian & Shin, 2011) by reinforcing the interactions between financing constraints and perceptions of value and risks, operating partly across borders.

Table 2 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 16 years on average and to have lengthened over time, as was typically found for individual financial variables. This is primarily due to the lengthening of the expansionary phase of the cycle, which gradually becomes longer than the contractionary phase. Both phases of

Table 2 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	9.50	9.50	8.50	9.00
Duration of complete cycle	16.00	16.00	19.50	24.00
Amplitude of expansions	2.14	1.61	2.53	3.13
Amplitude of contractions	-2.34	-2.46	-2.34	-3.54
Slope of expansions	0.23	0.23	0.30	0.26
Slope of contractions	-0.20	-0.22	-0.20	-0.48

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.

the cycle have also become more intense. Although caution is warranted given the relatively small number of cyclical episodes observed, these results are broadly in line with those found by Drehmann et al. (2012) for a sample of seven industrial countries. They also obtain financial cycles of 16 years that seem to have grown longer and more intense as liberalisation progressed since the mid-1980s and macroeconomic conditions became more stable during the run-up to the recent global financial crisis.

Table 3 gives the correlation coefficients of medium-term cycles in individual financial variables with the aggregate financial cycle. Medium-term cycles in most of the financial

Table 3 Co-movement 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	0.69	0.62	0.88	0.92	0.80	0.74	0.84	0.82
Real credit	0.91	0.95	0.89	0.92	0.84	0.78	0.90	0.88
Credit-to-GDP ratio	0.87	0.91	0.87	0.90	0.80	0.76	0.83	0.79
Real M3	-0.11	-0.39	-0.08	0.42	0.50	0.43	0.55	0.59
M3-to-GDP ratio	-0.33	-0.58	-0.15	0.11	0.43	0.48	0.39	0.47
Credit-to-M3 ratio	0.79	0.90	0.69	0.79	0.80	0.79	0.81	0.71
Assets-to-GDP ratio	0.71	0.47	0.87	0.95	0.74	0.69	0.78	0.76
Bank leverage ratio	-0.38	-0.70	0.10	0.54	0.35	0.16	0.51	0.62
Foreign non-core liab.	0.75	0.50	0.91	0.95	0.76	0.60	0.88	0.97
Total non-core liab.	0.91	0.90	0.91	0.93	0.87	0.91	0.83	0.88
Average	0.48	0.36	0.61	0.74	0.69	0.63	0.73	0.75
GDP	0.30	0.20	0.41	0.77	0.60	0.55	0.64	0.62

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.

variables remain highly correlated with the financial cycle throughout the sample period, with correlation coefficients around 0.7 or higher over the whole sample and close to 0.9 in the post-WWII period found for all the variables except the two money measures and the bank leverage ratio. This is also borne out by Harding & Pagan's (2006) concordance index reported in Table 3, which measures the fraction of time individual series are in the same cyclical phase as the aggregate financial cycle. The index is close to 0.8 for most of the variables over the whole sample period and rises even further in the post-WWII period.

3.2 The financial cycle, economic activity, and financial crises

Table 3 shows that there is strong and increasing co-movement between the aggregate financial cycle and the medium-term cycle in GDP.[8] Furthermore, as shown in Table 4, there is a marked difference in median output growth over the expansionary and contractionary phases of the financial cycle: over the whole sample period we find that GDP growth is almost three times higher on average during expansionary phases of the financial cycle than during its contractionary phases, rising to almost four times higher on average in the post-WWII period. The table also shows 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.

Table 4 GDP in different phases of the financial cycle

	Total sample	1875-1944	1945-2013	1980-2013
Growth in expansionary phase	0.049	0.049	0.049	0.043
Growth in contractionary phase	0.019	0.020	0.013	0.012
Relative duration in contractions	1.50	1.00	2.00	2.00

The table shows the median growth rate of GDP over the expansionary and contractionary phases of the financial cycle, and the relative duration (in years) of contractions in GDP 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 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.

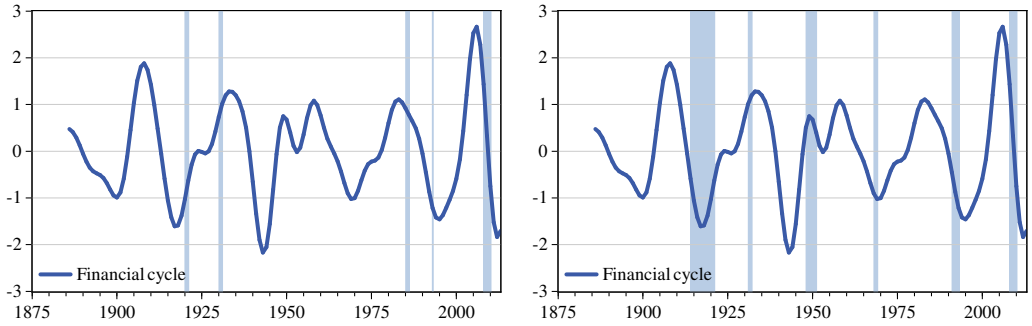
Source: Authors' calculations.

These results suggest an important role of the financial cycle in facilitating real economy expansions and triggering its subsequent downturns, where easier financial conditions during the cycle's boom phase boosts demand only to curtail it again when the cycle turns. One important manifestation of this co-movement is through possible financial disruptions during the final stages of the cycle's expansionary phase, for example when balance sheets

[8]The co-movement is even stronger when compared to the medium-term cycles in real domestic demand and the trade-to-GDP deficit: the correlation coefficients for these two variables rises from roughly 0.5 in the post-WWII period to roughly 0.9 in the post-1980 period, while the concordance index rises from more than 0.6 to 0.7 for domestic demand and from 0.7 to 0.85 for the trade deficit. Significant co-movement with the medium-term cycle in the real exchange rate is also found in the most recent period, with the correlation coefficient reaching almost 0.8 and the concordance index more than 0.6. Again, these results do not rely on the inclusion of the latest boom-bust cycle (i.e. the results continue to hold if we end the sample in 2003). See Einarsson et al. (2016) for details.

become overextended and asset price overvaluations peak. Indeed, as Figure 3 suggests, there seems to be a clear and systematic link between the financial cycle and the incidence of financial crises in Iceland (the crises dates are taken from Einarsson et al., 2015). The figure documents five banking crises, of which three are defined as systemic (in 1920-21, 1930-31, and 2008-10) and two non-systemic (in 1985-86 and 1993). To capture the typical clustering nature of different types of financial crises, Einarsson et al. (2015) also define "multiple" financial crises, using a version of Harding & Pagan's (2006) non-parametric common cycle algorithm to identify crisis episodes that involve a cluster of currency, inflation, and banking crises within a specified time window. This gives the six episodes (in 1914-21, 1931-32, 1948-51, 1968-69, 1991-93, and 2008-10) reported in the right panel of Figure 3 (for a detailed analysis of these episodes, see Einarsson et al., 2015). The figure clearly shows that financial crises, whether they are banking crises or full-blown multiple financial crises, are closely aligned with peaks in the financial cycle: about 80% of the peaks in the cycle have some type of a financial crisis within the three year window (using the same window size as Drehmann et al., 2012). Some of the crises occur soon after the cycle turns, but as in Drehmann et al. (2012) we also find cases where the cycle continues to expand for some time after the crisis occurs.[9]

Figure 3 The financial cycle and financial crises
Banking crises (left) and multiple financial crises (right) shown as shaded areas



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

4 Global spillovers

The analysis above suggests that a clearly defined financial cycle has been a key characteristic of the Icelandic economy over a period spanning more than a century, with major effects on the domestic business cycle and the incidence of financial crises. A key question is to what extent this cycle is driven by global factors (cf. Rey, 2013). Do the boom-bust

[9]The analysis in Einarsson et al. (2016) also suggests that the financial cycle contains useful early-warning information for ensuing crises and that the aggregate cycle outperforms individual financial variables, suggesting that by combining information from different financial variables and highlighting their important interaction in amplifying financial imbalances, the aggregate financial cycle can provide a better signal of future financial distresses than individual financial variable considered in isolation (see also Claessens et al., 2011, and Borio, 2014).

phases of the domestic financial cycle simply reflect similar movements in a financial cycle on a global level? And do financial crises in Iceland simply reflect contagion of similar crises from abroad? It is to these questions we now turn.

The transmission channels of such global spillovers are relatively well known: financial boom-busts frequently have an important international dimension of some kind, be that due to common sources 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 et al., 2014, Lane & 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 & Murshid, 2001).

4.1 Spillovers from the global financial cycle

We start by analysing the possibility of international spillover effects from the global financial cycle to its Icelandic counterpart. We use the US financial cycle as a proxy for the global cycle, given its international economic prominence and the fact that the US financial system has long served as a global financial centre. We use the data collected by Schularick & Taylor (2012), who study credit booms and leverage cycles over the period 1870-2008 (updated to 2011 by Jordà et al., 2014, with a further update to 2013 kindly made available by the authors). The dataset includes data on money and credit, total size of the banking system balance sheet, interest rates, and stock prices. To this we add Shiller's (2015) data on US house price. 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 & Fitzgerald (2003) band-pass filter to extract 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.

Table 5 shows the co-movement of our measure of the aggregate financial cycle in Iceland with the medium-term cycles in a number of US financial variables. 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 house prices, credit, and banking system size. 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 more than a century, an era covering a number of different policy regimes and varying degree of financial deepening and openness in Iceland, the domestic financial cycle has spent more than ninety years in the same phase as the US credit cycle.

We also construct a simple composite measure of the aggregate US financial cycle as

Table 5 Co-movement 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	0.67	0.47	0.82	0.90	0.57	0.45	0.67	0.74
Real credit	0.58	0.53	0.65	0.63	0.65	0.59	0.70	0.71
Credit-to-GDP ratio	0.67	0.70	0.65	0.63	0.72	0.67	0.75	0.74
Real M3	-0.26	-0.21	-0.32	-0.08	0.39	0.34	0.42	0.56
M3-to-GDP ratio	0.18	0.59	-0.17	-0.22	0.60	0.66	0.55	0.53
Credit-to-M3 ratio	0.66	0.66	0.66	0.81	0.67	0.62	0.72	0.62
Assets-to-GDP ratio	0.51	0.51	0.52	0.52	0.73	0.78	0.70	0.76
Real long-term rate	0.51	0.62	0.38	0.30	0.59	0.64	0.55	0.56
Real stock prices	0.13	0.45	-0.33	-0.33	0.46	0.59	0.36	0.38
US financial cycle	0.78	0.69	0.86	0.87	0.74	0.67	0.80	0.74

Dates of peaks in Icelandic (first line) and US (second line) financial cycles

1886	-	1908	-	1924	1933	-	1949	1958	-	1983	-	2006
1890	1896	1907	1913	-	1931	1937	1949	1956	1964	1980	1988	2006

Dates of troughs in Icelandic (first line) and US (second line) financial cycles

-	1900	-	1917	1926	-	1943	1953	-	1969	-	1995	2012
1892	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.

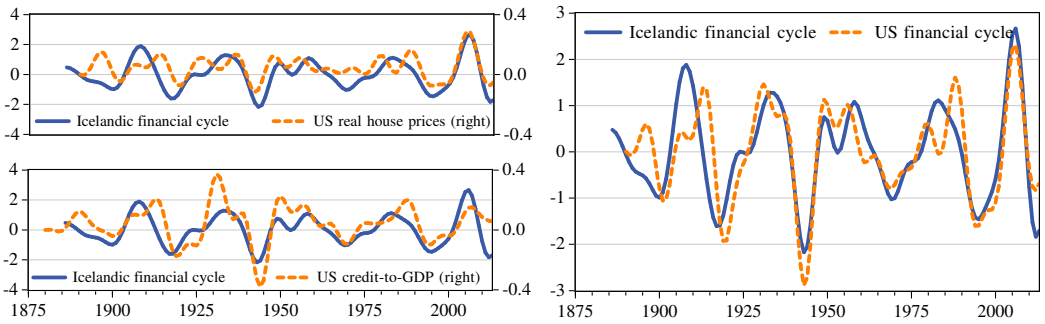
Source: Authors' calculations.

the 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.[10] 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 close to 0.75. Furthermore, both are rising over time: the correlation coefficient rises to almost 0.9 in the post-WWII period while the concordance index rises to 0.8. Thus, the two aggregate cycles are tightly aligned, in particular in the second half of the sample period where the two series spend 80% of the time in the same cyclical phase.[11]

[10]The aggregate measure 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).

[11]Both the aggregate cycles are found to be highly persistent but stationary and the strong correlation between the domestic and global cycles continues to hold for the growth rates of the cycles. We also tested for additional regional effects from Denmark and Norway (given their close political, economic, and cultural links with Iceland, especially in the earlier part of the sample period), and the UK (given the long-standing trade and financial links between the two countries and UKs leading role in global finance in

Figure 4 The US and Icelandic financial cycles



Sources: Authors' calculations.

The strong link between the two financial cycles can also be seen in the two lower panels of Table 5, which report the dates of the peaks and troughs in the domestic and US aggregate financial cycles, as well as in Figure 4 which compares the Icelandic aggregate cycle to the medium-term cycles in US credit and house prices on one hand and the composite US cycle on the other hand. There are eight peaks in the aggregate domestic cycle (seven if the first one which coincides with the first observation of the series is excluded) and eight troughs, while the aggregate US cycle has twelve peaks and troughs. Again, the correspondence between the two cycles is striking: six of the seven domestic peaks since the start of the 20$^{\text{th}}$ century correspond to peaks in the US cycle (with the Icelandic cyclical peak typically coinciding with the US peak or lagging it by a year or two). The troughs are also tightly linked, with seven of the eight domestic troughs occurring within a two-year window with troughs in the US.[12]

In Table 6 we take a closer look at the possible transmission channels through which the global financial cycle seems to work its way to Iceland. To do this we simply regress the medium-term cycle in each local financial variable on a constant and the composite US financial cycle measure. Again, the strong spillover effects to the aggregate Icelandic financial cycle are clear: the composite US financial cycle explains over 60% of the variation in the Icelandic financial cycle over the whole sample period, rising to almost 75% in the post-WWII period. The table suggests that credit and wholesale bank funding play an important role in channelling these spillover effects to the Icelandic economy, with rising importance of banks' balance sheets and house prices in the post-WWII period. This

the early part of our sample period). We find limited regional effects once we condition on the US financial cycle, although there is some evidence of additional spillover effects in the first half of the 20$^{\text{th}}$ century from the Danish credit cycle and, perhaps to some extent, the UK credit cycle. For the post-WWII period we see, however, that these additional regional effects all but disappear (see Einarsson et al., 2016, for more detail).

[12]There are four US cyclical peaks in the 20$^{\text{th}}$ century 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. Interestingly, the short and shallow domestic cyclical reversal in the mid-1920s (the only peak that does not have a corresponding peak in the US) does show up in the US data as a clear slow-down in the cyclical expansion but not enough to temporarily reverse the cycle as happens in the Icelandic case.

again highlights the benefits of looking also at the size and composition of the banks' balance sheets instead of just credit and house prices when attempting to capture the transmission of global financial spillovers to the domestic financial cycle and thereby to economic activity.[13]

Table 6 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	0.37	0.00	0.31	0.02	0.58	0.00	0.77	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
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 liab.	0.21	0.01	-0.02	0.89	0.53	0.00	0.58	0.00
Total non-core liab.	0.54	0.00	0.47	0.00	0.61	0.00	0.63	0.00
Aggregate fin. cycle	0.61	0.00	0.47	0.00	0.74	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.

4.2 Spillovers of global financial crises

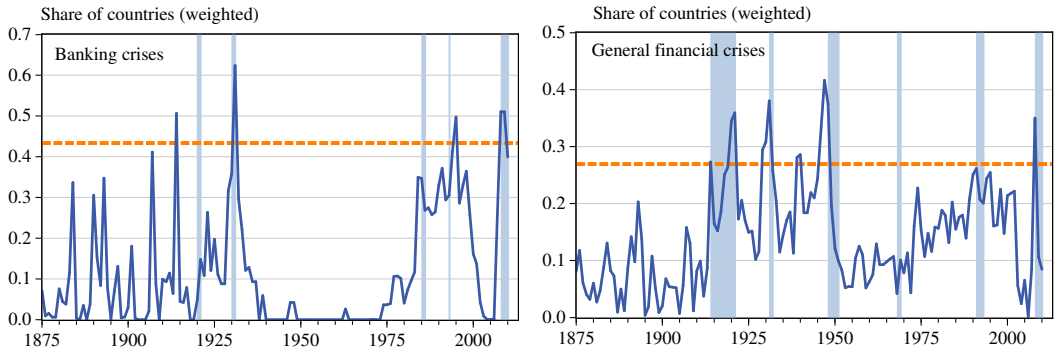
Not only do there appear to be strong spillover effects from the global financial cycle to its domestic counterpart, but also strong contagion effects from the incidence of global financial crises to domestic crisis episodes. To measure the global incidence of financial crises, we use the aggregate indices for 70 countries constructed by Reinhart & Rogoff (2011) for banking crises and for general financial crises which also include currency, inflation, debt, and stock market crises (with equal weights for each indicator). To reflect the fact that a crisis in a large economy is more likely to resonate on a global scale than a crisis in a small economy, we weigh each indicator using PPP-adjusted GDP weights.

Figure 5 shows the two crisis indicators for the period 1875-2010 (the last observation in Reinhart & Rogoff's sample). The figure also shows horizontal lines representing three standard deviations from the sample average of the country shares to capture the most serious global crises (see also Bordo & Landon-Lane, 2012). The three standard deviation cut-off point identifies four severe global bank-specific crises and six others of a more general nature, which coincide strikingly well with similar financial crisis episodes in Iceland.[14]

[13] Obstfeld (2015) also finds evidence of important spillover effects from long-term US interest rates to their Icelandic counterpart, with relatively fast adjustment.

[14] The dates are 1914, 1931, 1995, and 2008-9 for the banking crises and 1914, 1920-21, 1929-31, 1946-48, and 2008 for the more general financial crises. These dates are consistent with global crisis dates typically highlighted in the literature, cf. Kindleberger & Aliber (2011) and Reinhart & Rogoff (2009, 2011). See

Figure 5 International spillover of global financial crises to Iceland
Banking crises (left) and multiple financial crises (right) in Iceland shown as shaded areas



GDP weighted share of 70 countries in a given crisis from Reinhart & Rogoff (2011). The multiple global financial crisis measure is obtained as the sum of currency, inflation, sovereign external debt, banking, and stock market crises indicators. Horizontal lines denote 3 standard deviations from the whole-sample average country share.

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

This is further confirmed by a simple probit regression reported in Table 7, which shows that an increase in the ratio of countries in financial crises significantly raises the probability of a financial crisis in Iceland. The estimation results suggest that a three standard deviation increase in the share of countries in a financial crisis (the threshold for identifying global crises) raises the probability of a banking crisis in Iceland by 17 percentage points and the probability of a multiple financial crisis by more than 20 percentage points, thus leading to a two- to threefold increase in the probability of a financial crisis in Iceland.

Table 7 International financial crises and the probability of a financial crisis in Iceland

	Constant	Lagged depend. variable	Share of countries in crises	Marginal effects	Pseudo R^2	LR-test (p-value)
Banking crises	-2.49	0.96	4.48	0.056	0.394	0.000
	(0.37)	(0.53)	(1.32)	[0.167]		
Multiple financial crises	-2.83	2.39	6.69	0.069	0.528	0.000
	(0.60)	(0.42)	(2.51)	[0.207]		

The table reports the outcomes of probit regressions of an indicator of banking and multiple financial crises, respectively, on its own one-year lag (to capture the apparent persistence of financial crises) and the GDP-weighted share of countries in banking crises and general financial crises, respectively, from Reinhart & Rogoff (2011). The estimation period is 1875-2010 (135 observations). Numbers in parenthesis are robust (Hubert-White) standard errors. The LR test reports the p-value for the null hypothesis that the parameters (except the constant) in the probit regression equal zero. The table also reports the marginal effect of increasing the share of countries in crises by one standard deviation (three standard deviations in square brackets), evaluating the regressors at their sample mean.

Source: Authors' calculations.

Einarsson et al. (2015) for a more detailed discussion of these episodes.

5 Conclusions

Financial boom-bust cycles played an important role in macroeconomic analysis in the pre-WWII period, in particular in the analysis of the Great Depression, but its lessons somehow got lost in the post-war period (cf. Gertler, 1988). The recent global financial crisis has seen it return with a vengeance, however, with an increasing focus on the role of low-frequency cycles in the financial system in generating economic fluctuations and triggering financial crises. We contribute to this literature by analysing the financial boom-bust cycle in Iceland and the spillover effects from global financial conditions.

Our findings suggest that the variability in key financial variables in Iceland is dominated by low-frequency cycles with a duration of 8 to 30 years. We also find that over a period spanning more than a century that these cycles tend to move tightly together and that the co-movement has increased over time. This allows us to identify an aggregate financial cycle in the data, a cycle that is much longer than the typical business cycle. Our results suggest that there is a significant difference in economic performance over different phases of this cycle and that its peaks are strongly correlated with the incidence of financial crises in Iceland. We furthermore find strikingly strong ties between the Icelandic financial cycle and its global counterpart: over the whole sample period these two cycles spend close to 75% 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 cyclical peak lagging by a year or two. Our results suggest that these affects work their way to Iceland through a relatively broad set of financial channels, although the global effect seems particularly strong in the cyclical components of domestic credit and wholesale bank funding. As further evidence of these strong global contagion effects, we also find strong links between global financial crises and financial crises in Iceland: most crises in Iceland coincide with similar crises abroad and the most serious global episodes coincide with a two- to threefold increase in the probability of a financial crisis in Iceland.

These strong contagion effects surpass the whole spectrum of currency arrangement in Iceland; from membership in a currency union with Denmark, to different types of currency pegs, and to a flexible currency arrangement with an inflation target serving as the nominal anchor. The existence of these strong contagion effects also seem independent of how open the capital account is (although financial openness may affect the transmission channels through the financial system): they seem to survive long periods of capital controls, such as the period from the 1930s to the mid-1990s.

Our findings therefore suggest that the financial cycle plays a key role in fuelling the typical boom-bust behaviour of the Icelandic economy, while at the same time revealing 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 playing a further amplifying role by supporting a 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 to a contraction with a resulting economic recession, external adjustment, and, in many cases, a financial crisis.

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. (2015). 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 sample 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 the importance of contagion from global financial conditions. The key role of the global financial cycle in driving the financial boom-bust cycle in Iceland is consistent with the influential findings of Rey (2013) which suggest that local financial conditions are very much shaped globally, which in turn are heavily influenced by monetary policy in the US.

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 hand, raises some fundamental issues with important policy implications. We name only two. First, the 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. Second, while the existence of a clearly identified financial cycle highlights the need for macro-prudential instruments to curb the cycle, the evidence of strong global spillover effects further raises the question whether complimentary capital flow management measures are also needed to lean against financial flows. However, expectations should be kept in check with regard to what such measures can hope to accomplish as our results clearly demonstrate that international spillovers do not necessarily cease when the capital account is heavily controlled. Be that as it may, it is clear that efforts to understand and tame the financial cycle are likely to offer serious policy challenges in Iceland and other small open economies for years to come.

Appendix 1 Data sources

Icelandic data

Data on banking system assets is obtained from *Hagskinna: Icelandic Historical Statistics*, (Tables 13.2, 13.3, 13.6a-c, and 13.7), Björnsson (1961, p. 126-127), Björnsson (1981, p. 106, 119, and 129), Financial Supervisory Authority, and Central Bank of Iceland (*Annual Reports*, various years). Data on banking system equity is obtained from *Hagskinna: Icelandic Historical Statistics*, (Tables 13.2, 13.3, 13.6a-c, and 13.7), *Fjármálatíðindi* (p. 186), Gudnason (1972), Financial Supervisory Authority, and Central Bank of Iceland (*Annual Reports*, various years). Data on banking system non-core liabilities is obtained from *Hagskinna: Icelandic Historical Statistics*, (Tables 13.2, 13.3, 13.6a-c, and 13.7), Björnsson (1961, p. 126-127), Björnsson (1981, p. 106, 119, and 129), and Central Bank of Iceland. Data on M3 is obtained from *Hagskinna: Icelandic Historical Statistics*, (Table 13.1) and Central Bank of Iceland (Website and *Annual Report*, 2007). Data on total credit is obtained from *Hagskinna: Icelandic Historical Statistics* (Tables 13.9 and 13.12), and Central Bank of Iceland. Data on GDP is obtained from Jónsson (1999, Table V.14.6), and Statistics Iceland. The data on house prices is obtained from *Árbók Reykjavíkurbæjar 1940*, p. 38-39, and Statistics Iceland. Further detail on how the data was constructed can be found in Einarsson et al. (2015, 2016).

International data

The US financial data, except house prices, are obtained 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 version of the data from Schularick & 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).

The data on global financial crises is obtained using Reinhart & Rogoff's (2011) database on bank, currency, inflation, debt, and stock market crises in 70 countries from 1800-2010 (http://www.carmenreinhart.com/data/browse-by-topic/topics/7/). We use the bank crisis indicator and their measure of more general financial crises, which simply takes the sum of the individual crisis indicators. The two crisis indicators are then weighted using each country's average 1950-2010 share in PPP-adjusted nominal GDP in Geary-Khamis US dollars from the Penn World Tables. This is a slightly different weighting system from what Reinhart & Rogoff (2009, 2011) use but the difference should by minor. The index for overall global financial crises should therefore closely match the BCDI+ index constructed by Reinhart & Rogoff (2009).

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