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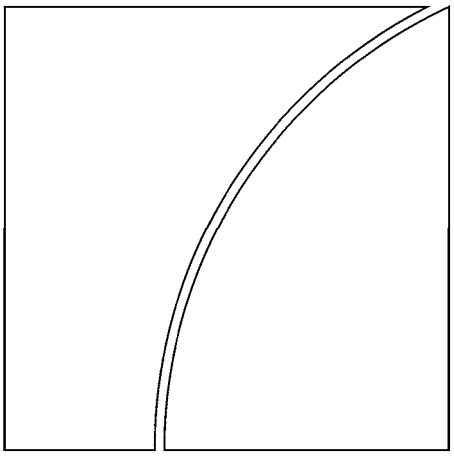

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Monetary and Economic Department

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Keywords: financial cycle, business cycle, credit, asset prices, financial crises, medium-term

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Characterising the financial cycle: don't lose sight of the medium term!

Mathias Drehmann, Claudio Borio and Kostas Tsatsaronis [1]

Abstract

We characterise empirically the financial cycle using two approaches: analysis of turning points and frequency-based filters. We identify the financial cycle with the *medium-term* component in the joint fluctuations of credit and property prices; equity prices do not fit this picture well. We show that financial cycle peaks are very closely associated with financial crises and that the length and amplitude of the financial cycle have increased markedly since the mid-1980s. We argue that this reflects, in particular, financial liberalisation and changes in monetary policy frameworks. So defined, the financial cycle is much longer than the traditional business cycle. Business cycle recessions are much deeper when they coincide with the contraction phase of the financial cycle. We also draw attention to the "unfinished recession" phenomenon: policy responses that fail to take into account the length of the financial cycle may help contain recessions in the short run but at the expense of larger recessions down the road.

JEL classification: E44, E61, G21.

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Introduction

The financial crisis has triggered a major rethink in macroeconomics. The dominant pre-crisis paradigms viewed finance largely as a sideshow to macroeconomic fluctuations.[2] The crisis demonstrated that this presumption was dangerously wrong. In contrast to what much of the literature assumed, interest rates could not capture all the interactions between the financial and real sides of the economy. And even strands of work that incorporated richer elements of those interactions, such as the role of collateral (eg, Bernanke et al (1999)), fell way short of replicating the strength and occasional virulence of the processes at work. After all, they could not account for financial crises. A rapidly growing literature is now seeking to remedy these shortcomings. The prevailing approach is to incorporate richer financial sectors into dynamic stochastic general equilibrium (DSGE) models.[3] Whether this line of enquiry will ultimately prove fruitful is a legitimate subject of debate.[4]

Regardless of the specific approach, however, *any* future work to model financial factors requires a better understanding of the stylised empirical regularities of the "financial cycle", with its booms and busts possibly leading to serious financial and macroeconomic strains. And yet, the meaning and characterisation of the financial cycle remain elusive.

Against this backdrop, the objective of our paper is to contribute to a budding literature that seeks to characterise the financial cycle. Some of this work has shed only indirect light on the question. It has done so in various ways: by documenting empirically the behaviour of the relationship between credit, asset prices and real economic activity (eg, Borio et al (1994), Detken and Smets (2004), Goodhart and Hoffman (2008), Schularick and Taylor (2009)); by developing leading indicators of financial distress (eg, Borio and Lowe (2002), Alessi and Detken (2009), Gerdesmeier et al (2010)); and by examining the forecasting properties for economic activity of various financial indicators beyond interest rates (eg, English et al (2005), Borio and Lowe (2004), Ng (2011), Hatzius et al (2010)).

More recently, other work has addressed the issue head-on. In particular, Claessens et al (2011a,b) employ traditional cycle-dating methods (turning-point analysis) for a large number of countries to identify peaks and troughs in credit, property prices and equity prices – the three series that they relate to the financial cycle. They find that cycles in these series, considered individually, tend to be long and severe, that the cyclical behaviour of credit and house prices is highly synchronised, and that there is a strong relationship between the financial and the business cycle. For their part, Aikman et al (2011) rely on frequency-based filters to document the relationship between the credit cycle and the business cycle. They find that there is a distinct credit cycle, whose length and amplitude exceed those of the business cycle, and that credit booms are closely related to banking crises.

Our study complements and extends this line of enquiry in several ways. We combine the two analytical approaches – turning-point analysis and frequency-based filters – to draw sharper and more robust conclusions. We explore a broader range of variables that could characterise the financial cycle: credit, the credit-to-GDP ratio, property prices, equity prices and an aggregate asset price index, which combines property and equity prices.[5] We compare short-term cycles, which last between 1 to 8 years and correspond to traditional

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[2] For a representative such analysis, see Woodford (2003).

[3] See, for instance, Angeloni and Faia (2009), Christensen et al (2010), Christiano et al (2010), Meh and Moran (2010), Cúrdia and Woodford (2010), Gerali et al (2011) and Gertler and Kiyotaki (2011). For an alternative strategy, see Adrian and Shin (2010).

[4] For a review and critique, see eg, Borio (2011); and for other critical perspectives, Laidler (2004), Goodhart (2004), Buiter (2009) and Caballero (2010).

[5] Many other variables could be considered, but data availability constrains our choice.

business cycle frequencies, with medium-term cycles, lasting between 8 and 30 years. We consider not only individual variables but also combinations thereof, so as to identify a proxy that captures more fully the financial cycle. And we begin to explore the relationship between the financial cycle, on the one hand, and financial and monetary regimes, on the other. Our analysis covers seven countries and the period 1960-2011.

In identifying the financial cycle, we pay special attention to *medium-term* frequencies. This is because we are particularly interested in financial crises, which in turn often result in major and long-lasting, if not permanent, output losses. Such crises are rare, pointing to the relevance of low-frequency analysis.

We highlight four empirical findings.

First, it is possible to identify a well defined financial cycle that is best characterised by the *co-movement* of medium-term cycles in credit and property prices. Equity prices, and by implication aggregate asset prices, do not fit this picture well: they exhibit a comparatively higher volatility at short-term frequencies and co-move far less with the other two series. The importance of the medium-term component of the financial variables is so high compared with the short-term component that, in what follows, unless otherwise stated, we will use the term "financial cycle" to refer to this *medium-term* cycle.

Second, the duration and amplitude of the financial cycle has increased since the mid-1980s. Over the whole sample, financial cycles last, on average, around 16 years. But when considering only cycles that peaked after 1998, the average duration is nearly 20 years, compared with 11 for previous ones.

Third, peaks in the financial cycle are closely associated with systemic banking crises, (henceforth "financial crises" for short). More specifically, *all* the financial crises with domestic origin (ie, those not arising from losses on cross-border exposures) occur at, or close to, the *peak* of the financial cycle. Conversely, most peaks coincide with financial crises. In fact, there are only three instances post-1985 for which the peak is not close to a crisis and these correspond to periods when the financial system came under considerable stress (Germany in early 2000s, Australia and Norway in 2008/2009). The correspondence between crises and peaks in the financial cycle is a key result, highlighting the importance of medium-term developments in the run-up to financial crises.

Fourth, while the financial cycle and the business cycle are different phenomena, they are related. Admittedly, also for GDP the importance of the medium-term component of fluctuations exceeds the short-term component, as already shown by Comin and Gertler (2006). But the business cycle is still identified in the macroeconomic literature with short-term fluctuations (up to 8 years). Moreover, the relative importance and amplitude of the medium-term component is considerably larger for the joint behaviour of credit and property prices than for GDP. Individual phases also differ between both cycles. The contraction phase of the financial cycle lasts several years, while business cycle recessions generally do not exceed one year. That said, recessions coinciding with the contraction phase of the financial cycle are especially severe, as GDP drops by around 50% more than otherwise.

Our evidence is consistent with the view that the amplitude, length and potential disruptive force of the financial cycle are closely related to the financial, and possibly also monetary, regimes in place (eg, Borio and Lowe (2002)). The mid-1980s are a rough proxy for financial liberalisation and, to a lesser extent, for the establishment of credible anti-inflation regimes. And it is precisely since then that the length and amplitude of the financial cycle have increased. Moreover, it is since then that the relationship with financial crises has become tighter. In fact, in our sample the only financial crisis pre-1985 occurs in the United Kingdom in the early 1970s, following a financial deregulation phase specific to that country.

Finally, we draw attention to what we call the "unfinished recession" phenomenon. This refers to episodes in which policy responses that fail to take medium-term financial cycles into account can contain recessions in the short run but at the cost of larger recessions down

the road. In these cases, policymakers may focus too much on equity prices and standard business cycle measures and lose sight of the continued build-up of the financial cycle, characterised by further increases in the ratio of credit to GDP and in property prices. The bust that follows an unchecked financial boom brings about large economic disruptions.

The rest of the paper is organised as follows. The first section describes the data and methodologies. The second presents the results of the turning-point and the frequency-based filter approaches as applied to *individual* series. By examining the relative importance of the short-term and medium-term components in the fluctuations of the series and their relationship with financial crises, it lays the basis for the choice of the variables to be combined into a financial cycle. The third section develops the multivariate analysis, identifying the financial cycle with the *joint* behaviour of credit and property prices and highlighting its tight link with financial crises. The fourth discusses in more depth the nexus between the financial cycle and the business cycle. The fifth explores the link of the financial cycle with policy regimes and illustrates the "unfinished recession" phenomenon.

1. Data and methodology

1.1 Data

We analyse the behaviour of six variables for seven countries (Australia, Germany, Japan, Norway, Sweden, the United Kingdom and the United States) over the period 1960-2011 with quarterly data. We select the variables and countries based on relevance and availability.

We take GDP as the representative variable for the business cycle. We do recognise that a multivariate approach would be preferable. To this day, for instance, the NBER examines a range of indicators when identifying the US business cycle. That said, for the sake of simplicity, and following common practice in the empirical literature, we opt for a univariate representation.

The financial cycle has been far less researched and is less well-defined than the business cycle. Therefore, in the style of Burns and Mitchell (1946), we look at a number of series to characterise it. The choice of variables is not obvious, but it is hard to imagine that one could do without credit and asset prices (eg, Kindleberger (2000), Minsky (1982)). Overall, we consider five financial variables: (i) credit to the private, non-financial sector; (ii) the ratio of credit to GDP; (iii) equity prices; (iv) residential property prices; and (v) an index of aggregate asset prices, which combines residential property, commercial property and equity prices (Borio et al (1994)).[6]

Given our focus on longer cycles, we require that variables be available for at least 40 years in all countries. This rules out a number of other financial variables that are obvious candidates for inclusion: measures of credit quality, such as spreads between high- and low-risk debt, measures of performance of financial firms (eg profits, write-offs, non-performing loans), and measures of leverage and default rates.

All series are in real terms (deflated by CPI) and in logs. The only exception is the credit-to-GDP ratio, which is expressed in percentage points. All series are normalised by their respective value in 1985Q1 to ensure comparability of the units.

[6] Ideally, credit to the private, non-financial sector should cover credit from all sources. Unfortunately, reliable data covering a sufficiently long period are only available for the United States. For all other countries, we are constrained to using bank credit. However, this is a less significant restriction than it first appears, as the financial systems in these countries are much more bank-centric.

The period of our analysis includes eleven systemic banking crises (henceforth referred to also as "financial crises"). We follow the dating of crises in Laeven and Valencia (2008 and 2010) and Reinhart and Rogoff (2008). In addition, we use judgement and draw on correspondence with central banks to determine some of the dates more precisely.[7]

Our analysis relies on two different methodologies. The first uses statistical filters to isolate fluctuations at different frequencies in the data, notably distinguishing between short- and medium-term fluctuations ("frequency-based filter analysis"). The second identifies peaks and troughs in the series and summarises their behaviour between those dates ("turning-point analysis").

1.2 Frequency-based filter analysis

Historically, the study of the business cycle has focused on the behaviour of macroeconomic data with cycles lasting between one and eight years. In our study we want to focus on two types of cyclical patterns, namely those that have the same periodicity as the business cycle and those that have considerably longer periodicity (ie lower frequency).

This approach is in the spirit of Comin and Gertler (2006), who study the behaviour of medium-term macroeconomic cycles for the US economy. Similarly to their work, we employ a band-pass filter to isolate short-term cycles, with a duration between 5 and 32 quarters (the typical business-cycle length), and medium-term cycles, with a duration between 8 and 30 years (or 32 and 120 quarters).[8]

We use the band-pass filter suggested by Christiano and Fitzgerald (2003) to isolate the component of each series that corresponds to the chosen frequency interval. Like Comin and Gertler (2006), we filter the data in annual growth rates (ie four-quarter differences in log-levels). On the reasonable, and commonly used, assumption that the growth rates of macroeconomic series are stationary, the filter implies a zero trend (or drift). To facilitate comparison with the turning-point analysis, we then convert the resulting series into log-levels by cumulating growth rates from zero, starting at the beginning of the observation period.[9]

1.3 Turning-point analysis

Our second approach, turning-point analysis, has a much longer tradition than frequency-based filters. The approach seeks to identify cyclical peaks and troughs in the series and was originally proposed by Burns and Mitchell (1946) to date the business cycle. Bry and Boschan (1971) provided a computerised algorithm for monthly series, subsequently adapted to deal with quarterly series by Harding and Pagan (2002).

The algorithm involves two key steps: (1) the identification of local maxima and minima over a specific window; (2) the imposition of censoring rules to guarantee a minimum length of the cycle (ie the distance between two consecutive peaks or troughs) as well as a minimum length of each phase (ie from peak to trough or trough to peak). In addition, the algorithm

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[7] The second column in Table 5 below lists all the crisis dates.

[8] The choice of 30 years as an upper bound is partly dictated by data availability. It is technically impossible to estimate cycles that are longer than the span of the available data. Given that some series start after 1960 and a few as late as 1970, we examine cycles that are up to 30 years long. This also ensures that the medium-term cyclical components do not include long-term secular trends.

[9] Given that we focus on the cyclical patterns, rather than the exact level, of the filtered series, the starting level is of minor importance, as it amounts to a shift parameter.

requires peaks and troughs to alternate and a trough (peak) to be lower (higher) than the preceding peak (trough).

Different calibrations of these parameters result in different sets of peak and trough dates. We are interested in comparing short- and medium-term cycles. Hence, we employ two alternative calibrations, as explained in more detail in the Annex.

For the shorter (business-cycle) horizon we follow the suggestions of Harding and Pagan (2002). We define local maxima (minima) at time *t* if the value of the series is the highest (lowest) within the five-quarter window centred at *t*. These are peaks (troughs) of the cycle if they fulfil two conditions: (i) each cycle has a minimum length of 5 quarters; and (ii) each phase (expansion or contraction) is at least two-quarters long. We label this the *short-term* algorithm.

To capture cycles that are longer than those typically considered in business cycle analysis, we also implement what we call the *medium-term* algorithm. This determines local maxima and minima over a nine-quarter window, and sets the minimum cycle length equal to 5 years (40 quarters). Arguably, 5 years are still at the low end for a medium-term cycle. In fact, the lower bound for the medium-term cycle length we use for the band-pass filters is 8 years. We chose it nonetheless because the minimum distance between two financial crises in a given country in a much broader sample than that employed here is 5 years (Drehmann et al (2011)). If anything, this choice will bias the algorithm towards identifying shorter rather than longer cycles. But, as we show below, it still allows the approach to identify the key medium-term peaks and troughs.[10]

We implement both methods as computer algorithms. This approach identifies the vast majority of peaks and troughs. That said, some manual cross-checking is also necessary.[11]

2. Characterising cycles in individual series

In this section we compare the behaviour of the short- and medium-term cycles in *individual* variables. We discuss sequentially the results of the frequency-based filter and turning-point methods. We also explore the relationship between the resulting medium-term cycles and financial crises. The messages from this analysis will inform our choices in building a measure of the financial cycle that combines *several* variables in the following section.

2.1 Frequency-based filter analysis: short-term and medium-term cycles

What is the relative importance of the short- and medium-term cyclical components of the different series? To compare the two we calculate the standard deviation (volatility) of each cyclical component for each variable.

Table 1 reports the ratio of the standard deviation of the medium-term cyclical component to the short-term cyclical component for the six series across countries. A ratio higher than unity means that the medium-term component is more volatile (ie has greater amplitude) than the short-term one. By construction, the two components are independent of each other. This

[10] Extending the minimum length to 8 years for the medium-term cycle would only strengthen our results, because it would reduce the number of cycles in the individual series, eliminating possible "noise". However, the algorithm would still identify all the main peaks and troughs associated with crises.

[11] A key problem is that cycles that do not fit the constraints are eliminated sequentially in the code. This leads in a few cases to ambiguities, which we resolve manually.

means that the ratio can also be interpreted as their relative importance in shaping the dynamics of each variable.

Table 1

Relative volatility of short- and medium-term cycles: individual series[1]

(Frequency-based analysis)

	AU	DE	GB	JP	NO	SE	US
Credit	**4.52**	**1.80**	**3.73**	**4.34**	**6.28**	**6.78**	**3.87**
Credit/GDP	**7.36**	**2.83**	**5.28**	**3.39**	**4.99**	**5.98**	**4.92**
House prices	1.75	**2.19**	**2.42**	3.05	2.21	**4.91**	**3.91**
Equity prices	1.72	1.40	1.77	2.14	1.30	1.42	1.41
AAP[2]	1.95	**3.94**	**2.56**	**3.36**	1.60	1.48	**1.75**
GDP	3.25	1.73	1.93	3.06	2.55	1.84	1.51

[1] The figures refer to the ratio of the standard deviation of the medium-term cyclical component to that of the short-term component over the entire sample period. A number greater (smaller) than 1.0 means that the medium-term cyclical component is more (less) volatile than the short-term component. Cells shown in bold denote cases where the ratio of medium- to short-term component volatility for the corresponding series is higher that the corresponding ratio for GDP. Acronyms used here and in subsequent tables and graphs: AU = Australia; DE= Germany; GB= United Kingdom; JP = Japan; NO = Norway; SE = Sweden; US = United States. [2] Aggregate asset price index.

In all cases the volatility of the medium-term cyclical component exceeds that of the shorter-term one. Put differently, the cycles of periodicities between 8 and 30 years are more important in shaping the behaviour of these series than those with shorter duration. This confirms and extends the finding of Comin and Gertler (2006) for US real variables to more countries and to financial variables.

This pattern is especially pronounced for credit and, to a lesser extent, property prices. The volatility of their medium-term component is much higher than that of the short-term component, almost invariably by a factor of two or greater. And the ratio of the two components often exceeds the corresponding one for GDP (entries shown in bold). This is the case for all countries for the two credit variables (credit and the credit-to-GDP ratio) and for four out of seven countries for house prices, with one other country being effectively a tie. By contrast, the ratio of the medium- to the short-term component is considerably lower for equity prices, for which it actually never exceeds that for GDP. Naturally, the performance of the aggregate asset price index is somewhere in between.

Are the cycles in the financial variables different in the more recent period of financial liberalisation? In a rough attempt to capture the financial liberalisation wave, we split the period into two halves (pre-1985 and post-1985). We find that the amplitude of the medium-term cyclical component has tended to increase in the second half of the period. This has been especially true for credit and property prices). Table 2 presents the ratio of the volatility of the medium-term component during the post-1985 period to its volatility during the first period. A ratio that is larger than unity indicates that the medium-term component gained in importance in the second half of the sample.[12] For almost all countries the medium-term

[12] A comparison of the ratio of volatilities (medium-term over short-term component) between the two sub-periods paints a similar picture for all variables. Results are available on request.

cyclical component of the credit and the residential price series increased in the post-1985 period. The increase in volatility post-1985 is smaller in the case of equity prices and GDP, and it is less widespread among the seven countries. Japan is an exception to these patterns: ostensibly, the fact that the country never recovered from the financial bust cycle that started in the early 1990s muddies the waters.

Table 2

Relative volatility of medium-term cycles pre- and post-1985:[1] individual series

(Frequency-based analysis)

	AU	DE	GB	JP	NO	SE	US
Credit	**2.75**	**1.53**	**1.49**	0.85	**2.09**	**1.12**	**2.66**
Credit/GDP	**5.86**	**2.27**	**3.88**	0.99	**2.05**	**1.26**	**4.91**
House prices	**2.27**	**1.16**	**1.94**	0.49	**1.90**	**1.04**	**3.96**
Equity prices	0.43	**1.14**	0.51	**1.45**	0.65	**1.36**	**1.78**
AAP[2]	**2.97**	0.68	0.48	0.56	**1.88**	**2.25**	**1.86**
GDP	0.34	**1.14**	**1.26**	0.84	**1.25**	**2.16**	0.93

[1] For each variable, the figures refer to the ratio of the volatility of the medium-term cyclical component post-1985 to that pre-1985. A number greater than 1.0 (shown in bold) means that the medium-term cyclical component of the corresponding series was more volatile in the post-1985 period than in the pre-1985 period.
[2] Aggregate asset price index.

2.2 Turning-point analysis: short-term and medium-term cycles

By applying the turning-point dating algorithm we obtain a set of peaks and troughs for each variable. A subset of those turning points refers to the medium-term cycle of the series. Graph 1 illustrates the results of the algorithm for the case of the United States (the graphs for the other countries are in the Annex). Green circles denote the peaks and troughs of the short-term cycle and red diamonds those that are also turning points of the medium-term cycle. Shaded areas indicate NBER recessions, and orange lines the beginning of financial crises.

Looking at GDP (upper left-hand panel), our short-term dating algorithm captures NBER recessions well. In many cases the dating of a peak and subsequent trough coincide exactly with the onset of a recession and the beginning of the recovery. A significant exception is the mild recession in the early 2000s: GDP just stagnated while the NBER recorded a recession because broader measures of macroeconomic activity pointed to a contraction.[13]

The dating algorithm also performs well with reference to the medium-term cycle. It captures *all* major peaks and troughs in the data (red dots) and it eliminates most of the short-lived ones, such as the mini drop in the credit-to-GDP ratio in 1996 (middle left-hand panel). It also eliminates the short-run equity price cycles in the early 1970s (lower right-hand panel), because they violate the five-year minimum-cycle-length constraint.

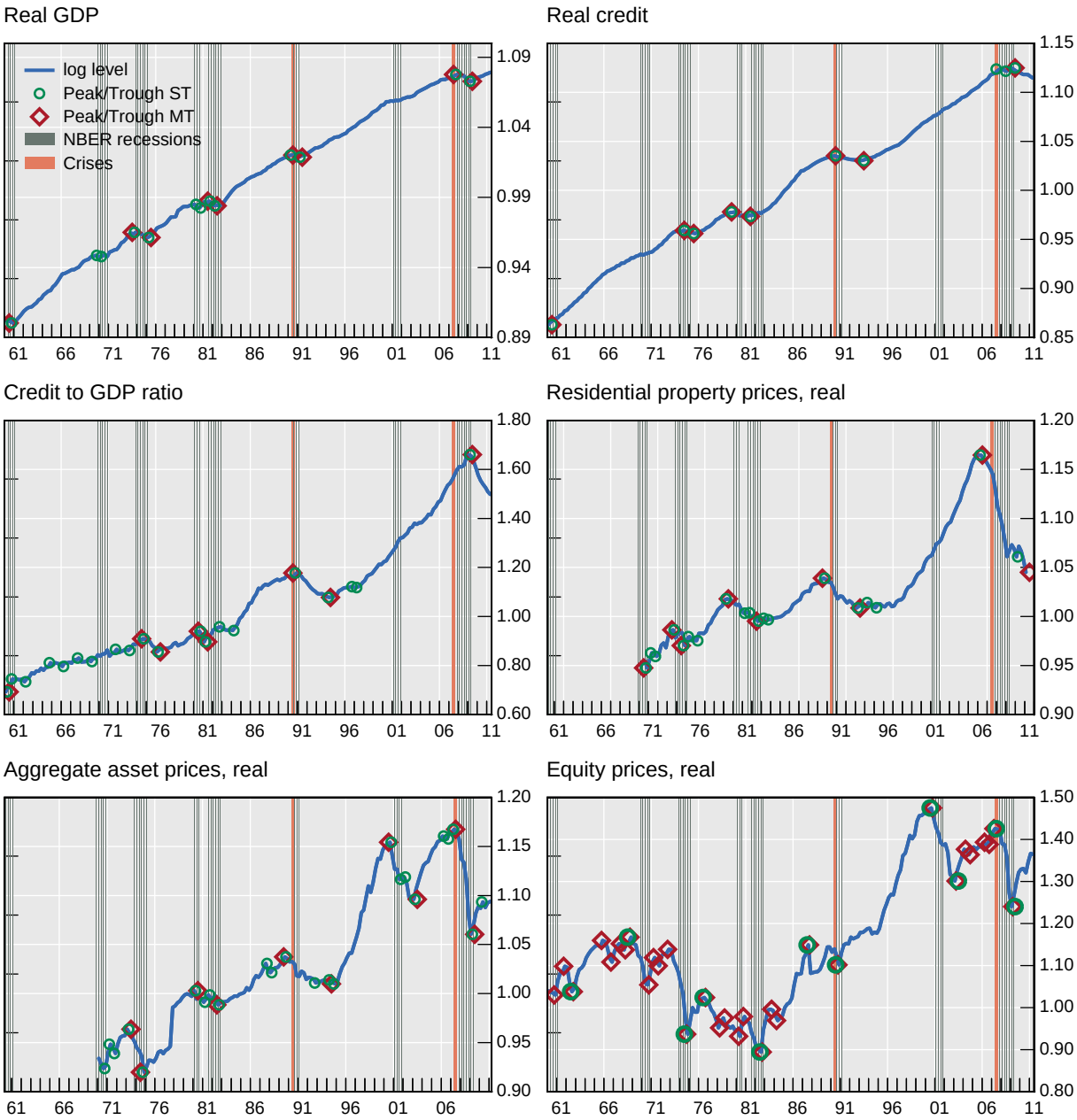
Casting the net more widely, and looking across all countries and series, the following results deserve highlighting (Table 3).

[13] Indeed, if one combines the messages from turning-point analysis of different macroeconomic series (GDP, unemployment, industrial production, investment and consumption), the turning-point method would classify this period as a recession.

Graph 1

Peaks and troughs in short-term and medium-term cycles

Individual series for the United States



Note: Series are in log levels and normalised by their respective value in 1985Q1.

Sources: national data; OECD; IMF.

Medium-term cycles last between 8 to 18 years, with their length varying across variables (last column, upper panel, Table 3).[14] Credit has the longest medium-term cycle (18 years), and equity prices the shortest (9 years). The medium-term cycle in GDP has an intermediate

[14] Durations of the full cycle differ slightly depending on whether they are measured peak-to-peak or trough-to-trough or with means or medians, but the main insights are robust. Full results are presented in Table A1 in the Annex.

length of around 11 years. By contrast, there are no large differences in the duration of short-term cycles across the different variables. These cycles last between 3 and 5 years, very much in line with the duration of the traditional business cycle (last column, lower panel, Table 3).

Table 3

Characteristics of medium-term and short-term cycles: individual series[1] (Turning-point analysis)

	Amplitude[2]		Duration		
	Expansion	Contraction	Expansion	Contraction	Cycle[3]
Medium-term cycles	*In per cent*		*Number of quarters*		
Credit	140	–7	53	8	72
Credit/GDP	31	–8	27	13	41
House prices	48	–16	19	15	42
Equity prices	121	–48	20	12	38
AAP	57	–26	22	11	37
GDP	38	–3	48	5	44
Short-term cycles					
Credit	18	–3	10	3	13
Credit/GDP	8	–4	7	5	15
House prices	12	–6	7	6	16
Equity prices	36	–22	5	5	11
AAP	15	–11	6	5	13
GDP	15	–2	20	3	22

Note: [1] Results based on the median of the distribution. Those based on the mean are shown in Table A1 in the Annex. [2] Percentage change from trough to peak (expansion) or peak to trough (contraction). [3] The duration of the full cycle is measured from peak to peak. Durations measured from trough to trough are shown in Table A1 in the Annex.

In general, the contraction phase in the medium-term cycle is significantly shorter than the expansion phase (columns three and four, Table 3). This is particularly true for GDP, for which the typical contraction lasts only 5 quarters while expansions are nearly ten times longer. Financial variables contract for 2 to 4 years and their expansions are about twice as long, with the exception of credit, which has the longest expansion phase of all variables (around 13 years). Contractions in residential property prices are especially drawn out and typically last around 4 years, making the average upswing and downturn phases of their cycle more evenly balanced in length.

Post 1985, medium-term cycles in all variables become longer and their amplitude increases (Table 4). This pattern is particularly pronounced for residential property prices, for which cycles are more than twice as long (14 instead of 6 years) and the trough-to-peak amplitude almost triples (from 36% to 94%). The length of credit cycles increases by a factor close to four, from around 5 to nearly 19 years.[15]

[15] In the majority of countries, there are no short- or medium-term cycles in the first 10-15 years in credit or GDP as both variables expand continuously. Therefore, there are very few data points to measure the length of the cycle – in particular from peak to peak - prior to 1985.

A question that arises at this point relates to how the cycles identified by the two methods (ie the dating algorithm and the band-pass filter) compare with each other. The answer is that, while related, they are not identical. We assess this issue in some detail in Section 3, where we identify the financial cycle as the common movement in credit and property prices. In addition, the graphs in the Annex juxtapose the filtered component of individual series with peaks and troughs, allowing a visual inspection: this indicates that the two sets of points broadly correspond to each other, although the coincidence is not perfect.

Table 4

Characteristics of medium-term cycles pre- and post-1985: individual series[1]
(Turning-point analysis)

	Amplitude[2]		**Duration**		
	Expansion	Contraction	Expansion	Contraction	Cycle[3]
Pre-1985	*In per cent*		*Number of quarters*		
Credit	132	–7	48	6	22
Credit/GDP	31	–8	39	9	31
House prices	36	–14	17	14	25
Equity prices	86	–44	21	20	34
AAP	50	–19	21	12	28
GDP	37	–3	41	4	27
Post-1985					
Credit	149	–8	64	18	74
Credit/GDP	41	–9	20	16	49
House prices	94	–16	37	20	57
Equity prices	171	–49	19	10	40
AAP	74	–29	23	10	42
GDP	60	–3	63	5	48

Note: [1] Results based on the median of the distribution. Those based on the mean are shown in Table A2 in the Annex. [2] Percentage change from trough to peak (expansion) or peak to trough (contraction). [3] The duration of the full cycle is measured from peak to peak. Durations measured from trough to trough are shown in Table A2 in the Annex.

2.3 What happens around financial crises?

Crises represent acute episodes of distress in the financial sector closely linked to severe losses in output and employment. It is thus interesting to examine the relationship between the cyclical phases in the financial variables and the timing and incidence of crises. A priori it seems intuitive that financial crises should be associated with the onset of the contraction phase of the cycle in financial variables. The two parts of Table 5 summarise the relationship between crises and the medium-term cycle peaks identified by the two statistical methods.

The table shows the time distance between the date marking the onset of a financial crisis and the nearest peak in GDP or the financial series in our dataset. The upper panel refers to the peaks in the filtered series and the lower panel to those generated by the turning-point algorithm. All figures are reported in quarters, with a negative (positive) number indicating that the peak in the series occurs prior to (after) the quarter in which the crisis begins.

Table 5
Financial crises and peaks in medium-term cycles: individual series

	Crisis date	Credit	Credit to GDP	House prices	Equity prices	AAP	GDP
Frequency-based filters		*Number of quarters*					
AU	1989 Q4	–2	–1	5	–4	–2	–2
DE	2007 Q3	–29	12	–	6	–38	–34
GB	1973 Q4	–1	–1	4	–13	–9	3
	1990 Q2	–1	3	–3	–9	–3	–6
	2007 Q3	9	11	0	–37	–3	–7
JP	1992 Q4	–7	–6	–6	–16	–10	–9
NO	1990 Q4	–9	–6	–10	–8	–31	–18
SE	1991 Q3	–3	–2	–5	–16	–8	–11
	2008 Q3	8	9	2	2	–34	–11
US	1990 Q4	–5	–5	–7	–5	–6	–4
	2007 Q3	5	6	–2	–1	–7	–12
Average	*(excl DE)*	*–1*	*1*	*–2*	*–11*	*–11*	*–8*
Turning-point method		*Number of quarters*					
AU	1989 Q4	3	5	–3	–9	–3	2
DE	2007 Q3	7	6	–47	1	–1	2
GB	1973 Q4	0	1	–1	–21	–1	–2
	1990 Q2	3	5	–3	–11	–3	0
	2007 Q3	10	10	0	–1	–1	2
JP	1992 Q4	0	0	–8	–12	–12	17
NO	1990 Q4	–3	–2	–11	–2	–13	–14
SE	1991 Q3	–5	–5	–6	–8	–8	–5
	2008 Q3	2	3	–4	–5	–5	–3
US	1990 Q1	1	3	–2	–10	–2	1
	2007 Q3	6	6	–6	–1	–1	1
Average	*(excl DE)*	*1.7*	*2.6*	*–4.4*	*–8.0*	*–4.9*	*–0.1*

Note: The figures refer to the distance (in quarters) between a financial crisis date and the nearest peak in the medium-term cyclical component of the corresponding variable. Negative (positive) numbers indicate that the nearest peak precedes (follows) the crisis date.

On average, financial crises tend to occur close to the peaks of the medium-term cycles in credit, credit-to-GDP and residential property prices. The only exception is the recent crisis in Germany, which was admittedly driven by banks' exposures to the financial cycle in *other* countries. This case aside, the peaks identified by both methods are, in most cases, less

than one year away from the actual crisis dates.[16] The peaks in the other series occur further away from crises. On average, equity prices and the aggregate asset price index peak 11 quarters prior to a crisis. The GDP peaks also precede crises but are somewhat closer to them.[17]

Table 6

Financial crises and peaks in all cycles: individual series

	Peaks close to crises[1]				Amplitude[2]		Duration[3]	
	Entire sample		Post-1985		Close to crises	Not close to crises	Close to crises	Not close to crises
	Yes/No		Yes/No					
Medium-term cycle								
Credit	10/11	48%	9/5	64%	197	120	59	45
Credit/GDP	10/21	32%	9/9	50%	74	26	43	26
HP[4]	10/15	40%	9/4	69%	81	44	33	20
EqP[5]	8/29	22%	8/12	40%	210	145	26	22
AAP[6]	9/20	31%	8/10	44%	70	68	23	24
GDP	8/16	33%	7/8	47%	48	96	49	54
Short-term cycle								
Credit	14/36	28%	12/14	46%	82	42	28	19
Credit/GDP	14/60	19%	12/24	33%	50	10	24	9
HP[4]	15/43	26%	22/51	30%	46	17	18	9
EqP[5]	14/109	18%	14/22	39%	40	45	5	6
AAP[6]	20/50	29%	18/30	38%	34	26	11	9
GDP	11/33	25%	9/13	41%	38	21	39	20

Note: [1] A peak in a series is close to a crisis if it occurs within a three-year window around the crisis date. The percentage refers to the ratio of the number of peaks close to crises compared to all peaks in the series. [2] Percentage change from trough to peak. [3] In quarters. [4] HP house prices [7] EqP equity prices [7] AAP aggregate asset price index.

Table 6 elaborates further on the relationship between cyclical peaks and crises. Rather than focusing only on peaks in the medium-term cycle, it examines also peaks in the short-term cycle. Here we classify a peak as "close" to a financial crisis if it occurs within a twelve-quarter window. Three points stand out.

First, all the crises arising from losses on *domestic* exposures are associated with peaks in the medium-term cycles of credit and property prices.[18] The left-hand side columns of Table 6 show that all ten crises with domestic origin occurred near the peak in credit and house

[16] In fact, the average distance of the peaks in the frequency-based filtered series is 1 to 2 quarters from the crisis date. The maximum distance between a peak and the crisis date is two-and-a-half years, with most cases falling within a six-quarter window.

[17] For the turning-point method, GDP peaks almost coincide with systemic crises.

[18] The only crisis linked to losses on foreign exposures is Germany in 2007, as discussed above.

price cycle. This number is reduced by one or two crises for the other variables. Conversely, around 40-50% of these peaks are close to crises (ie within a three-year window). This link is much weaker for the other series. Indeed, for equity prices only about 20% of the peaks are close to crises.

The link between the components of the medium-term cycles in financial series and crises becomes tighter in the post-1985 period. Here, around 65-70% of cyclical peaks in credit and property prices occur close to crises. One reason is that there is only one crisis in the pre-1985 period among the countries we examine, in the United Kingdom (see above).[19]

Second, cycles that peak close to crises tend to be longer and have a greater amplitude. For example, the credit cycle associated with crises is on average four years longer (15 instead of 11 years) and its trough-to-peak amplitude is almost 200%, compared with 120% for other cycles. The findings for the property price cycle are qualitatively similar.

Finally, the results in the Table 6 caution against relying on higher-frequency cycles in characterising the financial cycle, at least if one is interested in crises. The lower panel of the table compares the turning points of the short-term cycles with crises. Only 20-30% of identified peaks are close to a crisis. This is true even for credit and house prices, series for which the medium-term cycle peaks are often close to crises. This result is not surprising if one considers that there are (by construction) more cycles of lower periodicity in a given variable, but it does highlight that these higher-frequency cycles are less important from a systemic point of view.

3. Towards a measure of the financial cycle

In this section we put together the messages from the analysis of cyclical patterns in individual variables to construct a *multivariate* measure of the financial cycle in each country. We first describe the methodologies to aggregate the information derived from individual series and then we discuss the selection of the individual variables that are included in the composite measure of the financial cycle. Given the previous findings, we focus exclusively on *medium-term* cycles.

3.1 Methodology for the combination of series

We use two different methodologies to combine information from individual variables into an aggregate measure of the financial cycle. For cycles derived from the frequency-based filters, we aggregate by taking the average of the filtered series, since the components are continuous series of comparable units of measurement.[20] Aggregating the peaks and troughs identified by the turning-point methodology is slightly more involved. Here we follow Harding and Pagan (2006) and rely on a measure of the median distance of individual series from a turning point. We discuss the procedure below in general terms and provide more detail in the Annex.

In essence, the procedure identifies a turning point in the common cycle if two conditions are satisfied. We describe the conditions for peaks; those for troughs are equivalent. The first condition is that the date corresponds to a local minimum for the median distance of all

[19] This is the secondary banking crisis in the United Kingdom in the early 1970s, which followed on the heels of an early period of liberalisation.

[20] To ensure comparability of different series at this point, it is important that the log level of all individual series is normalised, for which we use the respective (log) level in 1985Q1.

component series from their closest (own) peak. The second condition requires that all individual series have an individual peak within a pre-specified window around that date. In addition, the procedure imposes the same constraints on the common cycle as those imposed when dating the cycles in individual series: peaks and troughs need to alternate, and the length of the cycle and each phase need to satisfy certain restrictions.

In order to adjust the Harding and Pagan procedure to the task at hand, we make one modification. Harding and Pagan (2006) suggest that, when analysing the business cycle at traditional frequencies, a turning point for the combined cycle should occur within a two-year window of the turning points in the individual series. This is too restrictive for the medium-term financial cycle because of the very different average length of the cycles in the component series. We adopt two different values for the width of this window and identify what we call "regular" and "weak" turning points, respectively. We identify a *regular turning point* in the common cycle if peaks/troughs of the individual series are within 6 quarters on either side of the turning points in the combined cycle (ie we adopt a window of 3 years). We identify *weak turning points* if peaks/troughs of the individual series are further than 6 but no fewer than 12 quarters away from the specific date (ie we adopt a window of 3 to 6 years centred on the specific date).

3.2 Selection of series

We consider the medium-term cyclical components of credit, the credit-to-GDP ratio and property prices as the components of the financial cycle. We therefore omit aggregate asset prices and equity prices, because they behave differently from residential property prices and the credit variables. They tend to exhibit far greater short-term volatility and their medium-term cycle peaks are less often associated with crises (Tables 1 and 5).

That equity prices have different cyclical characteristics from the series we selected is confirmed by the concordance index, originally proposed by Harding and Pagan (2006). This simple statistic measures the fraction of time two series are in the same phase (expansion or contraction). If two series expand and contract at the same time, the concordance between them is 100%. If they are always in different phases, their concordance is zero. If two series have fully independent cycles, their concordance is 50%. Table 7 shows the concordance indices for various pairs of series (columns) in each country (rows). The phases in the credit and property price cycles are well aligned (concordance around 70%). The medium-term cycle in equity prices is not very closely synchronised with those of the other financial variables: the concordance measures range from 53% to 59%. Given that the aggregate asset price index is a weighted average of both series (as well as of commercial property prices), its synchronicity with the credit cycle is somewhere in between those for equity and property prices.

The co-movement of the cyclical components derived from the frequency-based filters paints a similar picture. Given that the medium-term cyclical components of these variables are continuous time series we can look at their correlation pattern. The cross-country average contemporaneous correlation between the medium-term components of the house price and credit series is 60% and between house prices and the credit-to-GDP ratio 42%. By contrast, the average correlation between the medium-term component of equity prices and credit is 37%; between equity prices and the credit-to-GDP ratio is 15%; and between equity and property prices is 12%. Interestingly, for the United States the filtered equity price series is negatively correlated with those for credit (-10% with credit and -36% with the credit-to-GDP ratio) and property prices (-35%).

On the basis of these findings and the messages from the analysis in the previous section we construct the financial cycle from three variables: residential property prices, real credit and the credit-to-GDP ratio.

Table 7

Concordance between financial variables: medium-term cycles[1]

	Credit				Credit/GDP			House prices		Equity
	Credit/ GDP	**HP**	**EQ**	**AAP**	**HP**	**EQ**	**AAP**	**EQ**	**AAP**	**AAP**
AU	91	56	57	84	54	60	76	42	66	75
DE	89	59	49	62	63	42	54	29	58	67
GB	93	80	53	75	85	48	68	55	75	71
JP	77	86	80	81	77	59	76	78	96	82
NO	72	72	56	69	52	59	53	72	75	81
SE	73	76	62	51	72	58	46	57	66	78
US	93	79	54	73	71	47	73	66	80	68
Mean	*84*	*73*	*59*	*71*	*68*	*53*	*64*	*57*	*73*	*74*

Note: [1] Fraction of time for which two series are in the same phase, in percent. HP: house price, EQ: equity prices, AAP: aggregate asset prices.

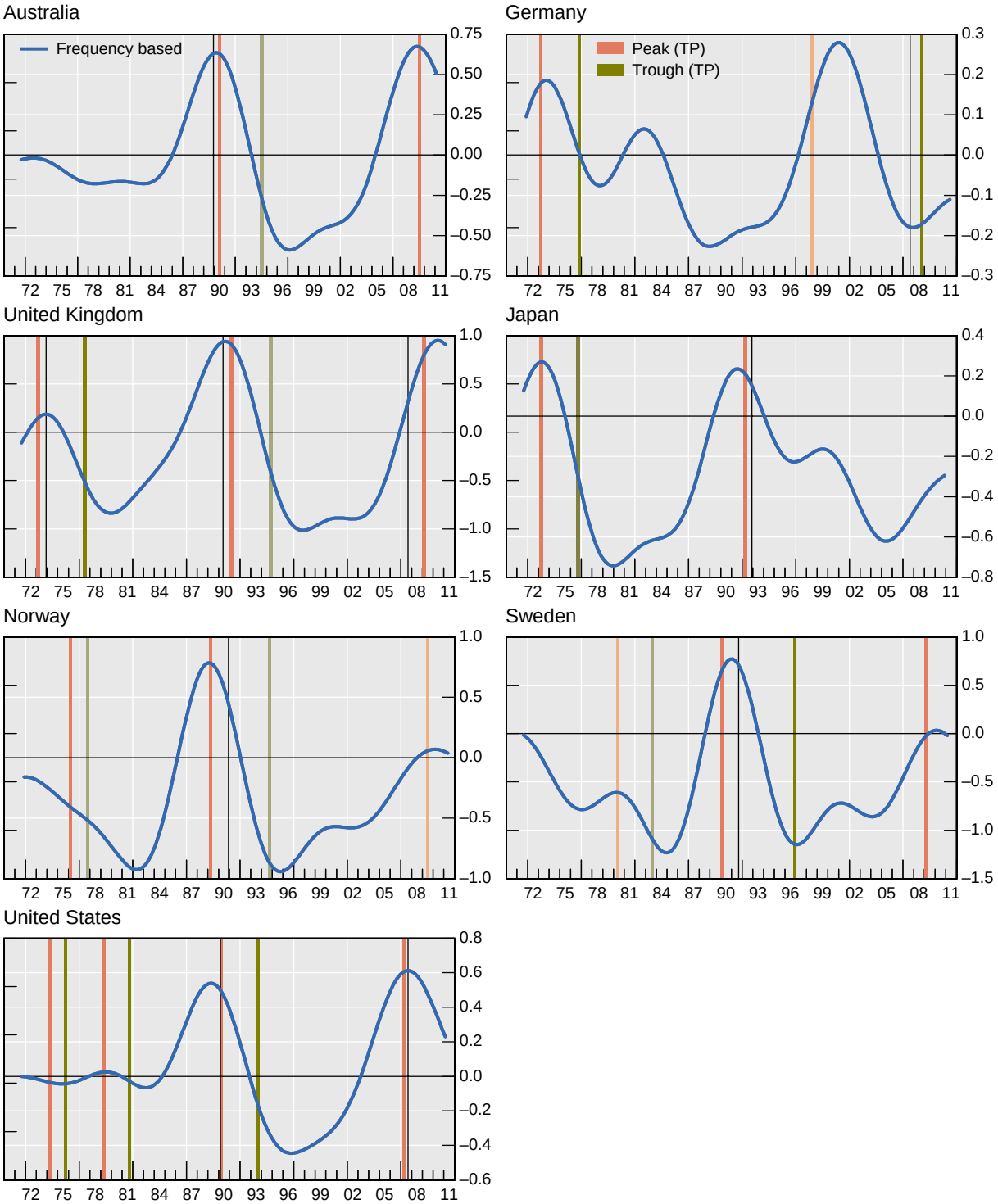
3.3 Results

Graph 2 summarises the results of the two methodologies for constructing a composite measure of the financial cycle. The blue line represents the financial cycle derived from frequency-based filters and the vertical lines show peaks (orange) and troughs (green) identified by the turning-point method. The outcomes of both aggregation methods provide a very consistent picture. The identified peaks align well and tend to occur around major financial crises (black vertical lines). Given the discussion in the previous section, this should not come as a surprise, but the alignment is remarkable nonetheless.

Table 8 provides more detail. It summarises the information of all 24 peaks in the financial cycle identified by either method. The table is organised in panels structured to show, in sequence and starting from the top: a) the peaks identified by both methods that coincide with a crisis; b) the peaks identified by both methods that do not coincide with a crisis; c) the peaks identified only by the turning-point method; and d) the peaks identified only by the filtered-series method. The date shown in the left-hand side column is the one that corresponds to the turning-point method except, naturally, for the bottom panel, for which it corresponds to the peak in the filtered series. Taking these dates as a benchmark, the table provides information about the distance (in quarters) to the nearest crisis date, to the nearest peak identified in the filtered series or to the nearest peak identified by the turning-point method. Negative (positive) numbers in these columns indicate that the peak or crisis occurs before (after) the specified date. For the turning-point method, we also show the maximum distance between the peaks in the individual series (labelled “cluster width”), which indicates whether the peak could only be identified weakly (ie whenever the cluster width is in the range of 3 or 6 years).

Graph 2

The financial cycle: frequency and turning-point based methods



Note: Orange and green bars indicate peaks and troughs in the combined cycle using the turning-point (TP) method. Peaks and troughs are only weakly identified (light orange and light green) if turning points for credit, the credit-to-GDP ratio and house prices are further than 6 quarters but no more than 12 quarters apart from the turning point in the common cycle. The frequency-based cycle (blue line) is the average of the medium-term cycle in credit, the credit to GDP ratio and house prices (frequency based filters). Black vertical lines indicate the starting point for banking crises, which in some cases (GB 1976 and US 2007) are hardly visible, as they coincide with a peak in the cycle.

Source: authors' estimates.

Table 8
Financial crises and peaks in the financial cycle

	Date	Time to closest[1]			Cluster width[3]	Duration[4]
		Crises	Peak (filters)	Peak (TP)		
		Number of quarters				
Peaks identified by both methods that are close to a crisis[5]						
GB	2009 Q1	–6	5	0	10	72
SE	2009 Q1	–2	4	0	7	75
US	2007 Q3	0	0	0	12	68
JP	1992 Q2	2	–3	0	8	74
GB	1991 Q1	–3	–2	0	8	69
AU	1990 Q3	–3	–2	0	8	..
US	1990 Q3	–2	–5	0	5	44
SE	1990 Q2	5	3	0	1	38
NO	1989 Q3	5	–2	0	9	53
GB	1973 Q4	0	0	0	2	..
Peaks identified by both methods that are not close to a crisis[5]						
NO[2]	2009 Q2	–74	3	0	16	79
AU	2009 Q1	–77	1	0	6	74
DE[2]	1998 Q4	35	9	0	21	100
SE[2]	1980 Q4	43	–2	0	13	..
US	1979 Q3	42	–1	0	5	21
DE	1973 Q4	135	–1	0	0	..
JP	1973 Q4	76	–2	0	4	..
Peaks in the financial cycle identified only by turning-point analysis[6]						
NO	1976 Q2	58	51	0	7	
US	1974 Q2	63	20	0	4	
Peaks in the financial cycle identified only by filtered–series analysis[6]						
SE	2001 Q1		0	32		
JP	1999 Q3	–27	0	–29		
DE	1982 Q2	99	0	–36		
AU	1972 Q4	68	0	71		
Average durations						
					All cycles	64
					Cycles peaking before 1998	50
					Cycles peaking after 1998	78

Note: [1] Distance (in quarters) between the date and closest crisis or closest peak using either frequency based filters or the turning-point method. Negative (positive) numbers indicate that the nearest peak/crisis precedes (follows) the peak date. Except for the last section of the table, the date is based on the peak of the turning-point method. [2] The (combined) financial cycle is only weakly identified, as the turning points for credit, the credit-to-GDP ratio and house prices are further than 6 quarters but no more than 12 quarters apart from the turning point in the common cycle. [3] Maximum distance (in quarters) between two peaks of the individual series within one cluster. [4] Number of quarters from previous peak. [5] Peaks are close to crises if both occur within a twelve-quarter window. [6] Peaks are identified by only one method if peaks identified by the other method are more than 12 quarters apart.

Both the turning-point and frequency-based methodologies provide a very consistent picture about the peaks in the financial cycle. No fewer than 17 out of 23 peaks are identified by both methods. With the exception of Germany in the late 1990s, for each of those 17 cases (top two panels of Table 8) the two methods identify peaks that lie within 5 quarters of each other.

Even more surprising given the difference in the methodological approaches, the coincidence is so tight that for 10 out of 17 cases both methods identify a peak within 2 quarters of each other. Visual inspection of the peaks identified only by the filtered series (bottom panel) suggests that they represent minor reversals: they can be detected statistically but they are not very meaningful economically. Interestingly, many of these less important peaks, as well as the two peaks identified only by the turning-point approach (third panel), occur in the pre-1985 period. Given these observations, the rest of the section focuses exclusively on the peaks that are identified by both methods.

The last column of Table 8 provides a rough measure of the duration of the financial cycle, measured by number of quarters from the previous peak. It highlights that the medium-term financial cycle is quite long and that its length has increased over time. Over the whole sample, the duration of the financial cycle is, on average, around 16 years (64 quarters). When considering only cycles that peaked after 1998, it is nearly 20 years, compared with 11 for previous ones.

The most striking result shown in Table 8 is the high coincidence of financial cycle peaks with crises after 1985, our rough date for financial liberalisation. This coincidence is so strong that it almost invites the question of why there are peaks in the financial cycle that are *not* associated with crises (shown in the second panel from the top). Only three out of twelve such peaks do not coincide with a banking crisis: Germany in 1998, Australia and Norway in 2009. In each of these cases banks still experienced serious financial strains. The German banking system, and in particular the cooperative banking sector, came under strong pressure in the early 2000s after the post-unification boom. In Norway in 2009 the authorities injected NOK 4.1bn of capital into twenty-eight Norwegian banks to help ease the strains from the recent crisis.[21] Similarly, in late 2008 Australian authorities took measures to stabilise the banking system, although their interventions did not involve recapitalisation and were framed as a response to international funding pressures.[22]

4. The financial cycle and the business cycle

The analysis so far clearly indicates that the medium-term financial cycle is a different phenomenon from the business cycle that is generally discussed in the macroeconomic literature. This can be seen from Graph 3, which shows for the United States the medium-term financial cycle (orange and green lines: peaks and troughs identified by the turning-point method; blue line: frequency-based filters), NBER recessions (grey bars), and the cycle in real GDP identified by the short-term frequency based filter (red line).

The graph illustrates that the two cycles differ in several respects. The financial cycle is visibly longer and has a larger amplitude. This is particularly the case after financial liberalisation. Consistent with this, not all recessions coincide with troughs in the financial cycle. This is most obvious for the recession in the early 2000s, during which the financial cycle was expanding. It is also evident that business cycle recessions are also much shorter than contraction phases in the financial cycle.

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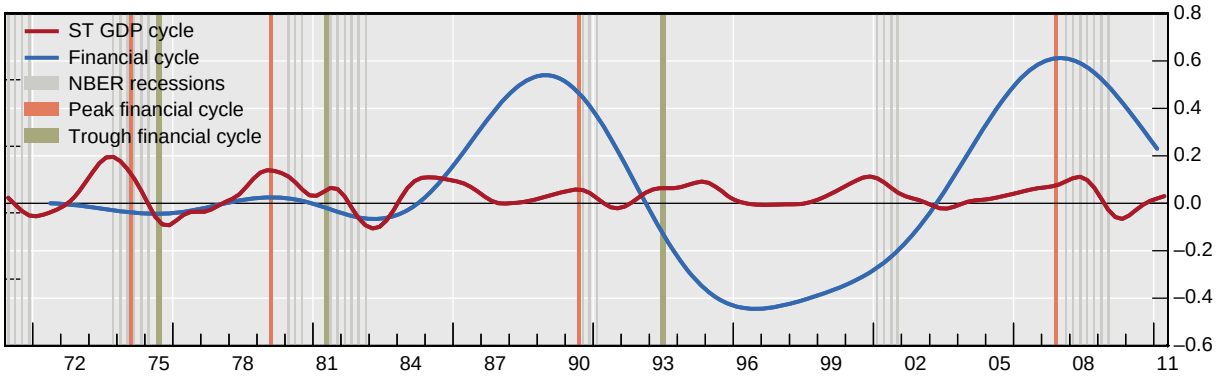
[21] Interestingly, the German and the Norwegian booms are only weakly identified by the turning-point method, as credit and property price series did peak less closely together, only within a window of 4 to 5 years. In both cases the reversal in property prices started much earlier than the fall in credit. This may suggest that other offsetting factors held losses in check, providing one reason why full-blown crises did not materialise.

[22] In particular, the Australian authorities enhanced the deposit insurance scheme, introduced debt guarantees and intervened in the capital markets to buy residential mortgage-backed securities.

Graph 3

The financial and business cycles in the United States



Note: Orange and green bars indicate peaks and troughs of the combined cycle using the turning-point (TP) method. The frequency-based cycle (blue line) is the average of the medium-term cycle in credit, the credit to GDP ratio and house prices (frequency based filters). The short term GDP cycle (red line) is the cycle identified by the short-term frequency filter.

Source: authors' estimates.

These results hold more generally. Across the sample, financial cycles have a longer duration than business cycles. The standard business-cycle length is between 6 quarters to 8 years;[23] the financial cycle lasts between 10 and 20 years, depending on whether the economy was liberalised or not. To be sure, this is not surprising: it is a corollary of identifying the financial cycle with medium-term cycles in credit and property prices. Yet, the financial cycle is also longer than the medium-term cycle in output. Depending on the sample period, the duration of the latter ranges from around 7 to 12 years (Table 4).

Swings in the financial cycle are also more pronounced than those in the business cycle. On average, the standard deviation of the frequency-based financial cycle is more than seven times larger than that for the cycle in output at business cycle frequencies. Even when compared to the medium-term cycle in output, the standard deviation is two and a half times larger. The turning-point method paints a similar picture.[24] In particular, the data suggest that medium-term expansions in credit and property prices include periods of particularly strong growth (Annex Table 1). For variables exhibiting a relatively steady growth pattern, one can expect the product of the average quarterly growth rate times the average duration of each phase to roughly match the average amplitude. This is the case for GDP. By contrast, for all financial variables this calculation underestimates the observed amplitudes during expansions, implying that this should also the case for the financial cycle.

Contractions phases for the financial cycle are much more drawn out than those for the business cycle. Business cycle recessions last on average around a year, regardless of whether cycles are dated by the short- or medium-term turning point method (Table 3). By contrast, the financial cycle contracts for more than 3 years on average. And it is not uncommon for this phase to last more than 5 years (e.g. Norway and Sweden in the early 1990s, Germany in the early 2000s). In fact, according to the turning-point method, the financial cycle in Japan is still contracting after its peak in 1992, some 20 years ago!

[23] When talking about the length of the cycle, we only refer to results based on the turning-point method. For the frequency based filters, the length is determined by the choice of the frequency bands.

[24] To be precise, we can only identify dates of peaks and troughs of the aggregate cycle when combining series with the turning-point method. The statements about the amplitude are therefore based on the results of the turning-point method for the individual series that make up the financial cycle.

Given that business cycles, as normally measured, are much shorter than financial cycles, only some business cycle recessions coincide with downturns in the financial cycle. This raises the question of whether they are more severe. Table 9 summarises the results. It shows the average amplitude and length of recessions (based on the short-term turning point method for GDP) for expansions and contractions of the financial cycle and various sub-samples.[25] As our sample is not particularly large, the following results should be seen as indicative, even though the main insights are in line with Claessens et al (2011b).[26]

Table 9

Business cycle contractions and the phase of the financial cycle

	Full sample		Pre-1985		Post-1985		Contractions[2]	
	Exp.[1]	Cont.[1]	Exp.[1]	Cont.[1]	Exp.[1]	Cont.[1]	Without crisis	With crisis
Amplitude[3]	-2.2	-3.4	-2.4	-2.5	-1.8	-3.6	-3.0	-3.7
Length[4]	3.5	4.3	3.5	3.2	3.5	4.6	3.9	4.6
Obs.	17	21	13	5	4	16	9	12

Note: [1] Ex and Co refer to the expansionary and contractionary phases of the financial cycle, respectively. [2] Full sample. [3] Average percentage change in real GDP from peak to trough. [4] Average duration from peak to trough, in quarters.

We find that recessions are deeper when they coincide with the contraction phase of the financial cycle. And the magnitudes are substantial: on average real GDP drops by around 50% more (-3.4% versus -2.2%). This is true even though recessions take on average only less than one quarter longer in these cases. And financial liberalisation matters: while there are no clear differences prior to 1985 (third and fourth columns in Table 9), the contrast is particularly stark since then (-1.8 vs -3.6; fifth and sixth columns in the Table).

The last two columns of Table 9 highlight that the depth of the recession is not merely driven by banking crises, which – as we have shown – are closely aligned with peaks in the financial cycle. Even when no banking crisis takes place, recessions are deeper than in the expansionary phases of the financial cycle (-3% versus -2.2%).[27] That said, they are even more severe when a banking crisis occurs: real GDP drops on average by nearly 4% in these cases.

5. Policy context: regime-dependence and "unfinished recessions"

We next look beyond the stylised empirical regularities and consider in more depth the policy context that may lie behind them. We explore, sequentially, how the nature of the financial cycle and its interaction with the business cycle may depend on the policy regimes in place

[25] As long as there is a partial overlap with a downturn in the financial cycle, we classify a recession as coinciding with a contraction.

[26] Using different methods Jorda et al (2011) show that recessions are deeper and longer when they are preceded by periods of strong credit expansion.

[27] Recessions are classified as coinciding with crises if they take place in a two-year window around a crisis date.

("regime-dependence") and how policy responses that fail to take medium-term financial cycles into account may contain recessions in the short run but at the cost of larger recessions down the road (we label this the "unfinished recession" phenomenon).

Our results indicate that the length and amplitude of the financial cycle (and the associated medium-term business cycle), have increased since the early 1980s. To our mind, as suggested in our analysis, a key factor behind this development is the conjunction of changes in the financial and monetary regimes (Borio and Lowe (2002)). The wave of financial liberalisation that took place in the early-mid 1980s allowed financial forces to have full play, reinforcing the procyclicality of the financial system. At the same time, more subdued inflation progressively removed the need to tighten monetary policy as the economy expanded. The stop-go policies of the 1960s-early 1970s naturally prevented financial cycles from gaining strength; the change in regimes in effect loosened the anchors of the financial system, increasing its "elasticity".

The role of changes in the financial and monetary regimes is complementary. In and of itself, financial liberalisation is capable of amplifying the financial cycle, as highlighted by the experience of the United Kingdom with Competition and Credit Control in the early 1970s, a period of high inflation. But in those days the rise in inflation, and/or the deterioration of the balance of payments, that accompanied economic expansions would inevitably quickly call for a policy tightening.

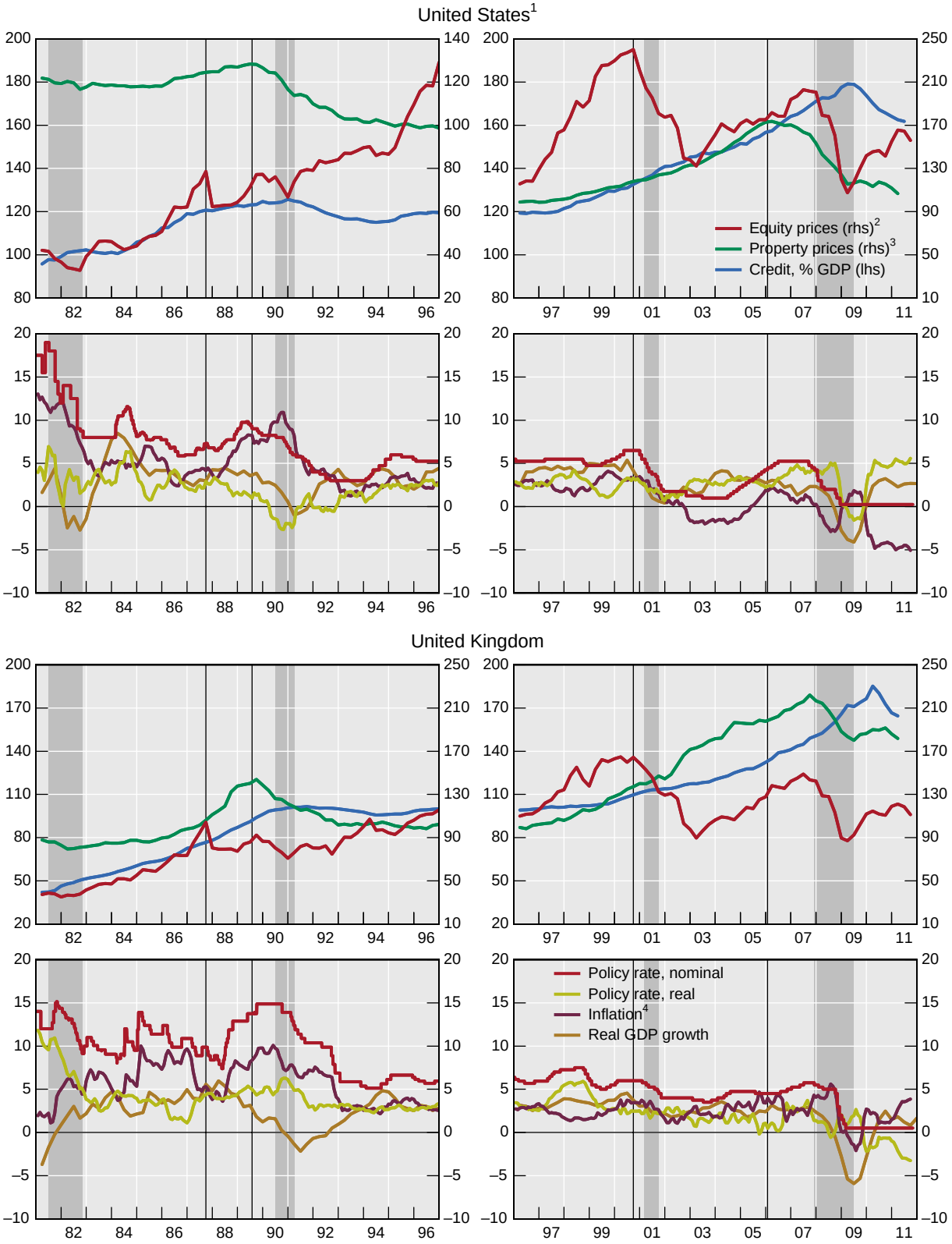
In addition, the amplitude of recent financial and business cycles has been boosted by positive supply-side developments (Borio (2007)). Just think of those associated with the globalisation of the real economy or the information technology revolution of the 1990s. These developments amount to a string of positive supply shocks. The combination of higher growth potential and downward pressure on prices turbo-charged the cycle.

Against this backdrop, if the policymakers "overreact" to short-term developments and lose sight of the (medium-term) financial cycle that may lie behind them, they can store up bigger trouble down the road. Arguably, this is what happened both in the mid-1980s/early 1990s and in the period 2001-2007. In both cases, policymakers reacted strongly to collapses in equity prices – the global stock market crashes of 1987 and 2001, which ushered in slowdowns in economic growth and/or actual recessions. As we have seen, however, equity prices are not a reliable indicator of the medium-term financial cycle. In fact, in both episodes credit and property prices continued to increase, benefiting from a second breath of life. A few years later, the credit and property price booms in turn collapsed, causing serious financial disruptions and dragging down the economy with them.[28] From the perspective of the medium-term financial and business cycles, the slowdowns or contractions in 1987 and 2001 can thus be regarded as "unfinished recessions".

[28] The main difference between the two episodes is that the interval between the peaks in equity and property prices was considerably longer in the more recent one, as already conjectured in Borio and McGuire (2004). This, in turn, largely reflects the more delayed emergence of incipient, if any, inflationary pressures in the past decade.

Graph 4

Unfinished recessions



Note: the vertical lines denote stock and real estate market peaks in each sub-period.

[1] The shaded areas represent the NBER business cycle reference dates. [2] 1995=100; in real terms. [3] Weighted average of residential and commercial property prices; 1995=100; in real terms. [4] For the United States, CPI; for the United Kingdom, RPI.

Sources: Datastream; national data; BIS estimates.

These stylised patterns are evident in Graph 4, which for illustrative purposes shows the experience of the United States (top panels) and United Kingdom (bottom panels). Monetary policy eased strongly in the wake of the stock market crashes and the weakening in economic activity. At the same time, the credit-to-GDP ratio and property prices continued their ascent, soon followed by GDP, only to collapse a few years later. Partly because inflation remained rather subdued in the second episode, the authorities raised policy rates much more gradually. And the interval between the peak in equity prices and property prices (vertical lines) was considerably longer, roughly 5 rather than 2 years.

Conclusion

In the early 1940s Burns and Mitchell began to characterise empirically the business cycle. They thus provided a more systematic set of empirical regularities to confront theories of the business cycle that had already been developing for much longer (eg, Zarnovitz (1992), Laidler (1999) and Besomi (2006)). That work proved hugely influential.

By comparison, empirical work on the financial cycle is more limited. From one perspective, this is puzzling. After all, notions of the financial cycle, or at least of booms followed by busts, had even predated those of the business cycle. And the idea that financial and business fluctuations were closely intertwined has an equally long history. From another perspective, this state of affairs is entirely natural. Most of the work that followed that of Burns and Mitchell focused on interest rates and, at most, monetary aggregates. And it developed within analytical frameworks that, over time, moved increasingly away from notions of well-defined, endogenous cycles, in which booms did not just precede, but caused, the busts. Moreover, the post-war phase of financial repression reinforced this tendency, by keeping financial forces on a tight leash.

The recent financial crisis has shown just how untenable this state of affairs is. Our paper is intended as a small contribution to what we hope will be a growing literature that seeks to characterise empirically the financial cycle and its relationship with the business cycle. The paper does this by combining turning-point and frequency-based statistical methods and by considering series both individually and jointly for several advanced countries since the 1960s.

With this in mind we highlight four key conclusions. First, when seeking to identify financial cycles most relevant for macroeconomic disruptions, it is critical to focus on the *medium-term*, not on traditional business cycle frequencies, ie, on cycle lengths of sixteen years on average, or even longer. Second, it is possible to identify well-defined (medium-term) financial cycles, whose peaks tend to coincide very closely with financial crises and, hence, with serious damage to economic activity. Third, those cycles are best captured by combinations of credit and property prices; equity prices do not fit the picture well. Fourth, the length, amplitude and virulence of these cycles have increased since the mid-1980s.

These findings have significant policy implications. We argue that they are consistent with the view that the greater prominence of these cycles is regime-dependent, ie that it reflects the conjunction of financial liberalisation with monetary policy frameworks that have, over time, become focused on, and quite successful at, delivering near-term price stability. And we note that the authorities should watch out for what we call the “unfinished recession” phenomenon. Policy responses that fail to take (medium-term) financial cycles into account can help contain recessions in the short run but at the expense of larger recessions down the road.

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Annex: The turning-point algorithm

Dating individual series

As discussed in Section 1.3, the turning-point algorithm proposed by Harding and Pagan (2002) involves two key steps: (1) identifying local maxima and minima over a specific window; (2) imposing censoring rules, so as to guarantee a minimum length of the cycle (ie the distance between two consecutive peaks or troughs) as well as a minimum length of each phase (ie from peak to trough or trough to peak). In addition, the algorithm requires peaks and troughs to alternate. We also impose the restriction that a trough (peak) has to be lower (higher) than the preceding peak (trough).

For the short-term algorithm (ST) we follow Harding and Pagan (2002). More formally, the conditions to identify peaks and troughs for a series Y are:

- ST window length 5 quarters, or
    1. ST peak in Y_t if $\Delta Y_{t,t-i}>0$ for $\forall i \in [-2,-2,1,2]$
    2. ST trough in Y_t if $\Delta Y_{t,t-i}<0$ for $\forall i \in [-2,-2,1,2]$
- ST censoring rules:
    1. Minimum length of the cycle: 5 quarters
    2. Minimum length of each phase: 2 quarters

The formal conditions for the medium-term algorithm (MT) are:

- MT window length 9 quarters, or
    1. MT peak in Y_t if $\Delta Y_{t,t-i}>0$ for $\forall i \in [-4,-3,-2,-1,1,2,3,4]$
    2. MT trough in Y_t if $\Delta Y_{t,t-i}<0$ for $\forall i \in [-4,-3,-2,-1,1,2,3,4]$
- MT censoring rules:
    1. Minimum length of the cycle: 5 years (40 quarters)
    2. Minimum length of each phase: 2 quarters

While we adopt the second censoring rule for reasons of symmetry with the ST algorithm, it is never binding.

Combining series

To identify the financial cycle non-parametrically based on developments in real credit, real property prices and the credit-to-GDP ratio, we follow Harding and Pagan (2006). More generally, the algorithm identifies the common cycle based on N variables Y_1-Y_N. After identifying turning points in the individual series, the algorithm then identifies peaks and troughs in the common cycle through the following steps:

1. For each series Y_i and each point in time t, calculate the minimum number of quarters to the next peak (trough) to obtain $DP_t^{Y_i}$ ($DT_t^{Y_i}$).

2. Take the median across all $DP_t^{Y_i}$ ($DT_t^{Y_i}$) to obtain MP_t (MT_t).

3. Look for local minima in MP_t (MT_t). These are turning points of the common cycle if

    a) there is a cluster of peaks (troughs), i.e. peaks (troughs) of all individual series are no further away than 6 quarters from the peak (trough) of the common cycle (maximum cluster width = 3 years). A peak (trough) of the common cycle is weakly

identified if peaks (troughs) of the individual series are more than 6 but less than 12 quarters away (cluster width ranges from 3 to 6 years);

b) the common cycle satisfies the same censoring rules as the medium-term cycle and peaks and troughs alternate.

After running steps 1 to 3, it may still be possible that peaks and troughs of the common cycle are not uniquely identified. For example, there may be three consecutive quarters of potential peaks in the common cycle. If this is the case, we choose the turning point that has the lowest average distance from the turning points in the individual series, in line with Harding and Pagan (2006).[29] Note that in our case the conditions of step 3b) are never binding.

We depart from Harding and Pagan (2006) in two respects. First, we use different cluster widths. This is more appropriate for medium-term cycles, as their suggested maximum cluster width of 2 years is too short. Second, we require that *all* individual series should have a turning point within a particular cluster, whereas Harding and Pagan (2006) do not impose such a condition. In their empirical implementation, they identify, say, a trough in the common cycle, when at least 2 out of 5 series have a trough. However, as we only have three series, two of which relate to credit developments, our approach provides a tighter identification.

[29] This additional condition is sufficient to identify all peaks and troughs of the common cycle uniquely, except the through in Germany in 1975/76, where we chose 1976Q1 as the mid-point of the identified possible troughs.

Annex Tables

Annex Table 1: Characteristics of the medium-term and short-term cycles

Name	State	Mean					Median					Obs
		Quarterly growth rate[1]	Ampli-tude[2]	Duration[3]			Quarterly growth rate[1]	Ampli-tude[2]	Duration[3]			
				Peak to peak	Trough to trough	Phase duration			Peak to peak	Trough to trough	Phase duration	
Medium term												
Credit	Expansion	1.66	156.48		68	52	1.64	139.55		60	53	21
Credit	Contraction	–1.08	–10.45	63		13	–0.62	–7.28	72		8	14
Credit/GDP	Expansion	1.17	42.91		45	32	0.97	31.09		41	27	29
Credit/GDP	Contraction	–1.00	–11.35	45		14	–0.91	–8.06	41		13	24
House prices	Expansion	1.98	59.32		45	25	1.79	47.93		40	19	24
House prices	Contraction	–1.50	–19.40	46		19	–1.36	–15.74	42		15	25
Equity prices	Expansion	4.50	160.06		36	23	4.33	121.05		32	20	34
Equity prices	Contraction	–5.43	–46.62	40		15	–4.94	–47.75	38		12	37
AAP	Expansion	2.32	68.57		38	24	1.90	56.93		33	22	26
AAP	Contraction	–2.89	–26.27	40		14	–2.55	–26.13	37		11	29
GDP	Expansion	0.86	79.59		56	53	0.84	37.52		49	48	24
GDP	Contraction	–0.85	–3.77	48		5	–0.64	–3.19	44		5	23
Short term												
Credit	Expansion	1.47	55.27		26	22	1.36	17.61		19	10	47
Credit	Contraction	–1.06	–4.96	26		5	–0.82	–3.07	13		3	43
Credit/GDP	Expansion	1.30	18.74		18	12	1.10	7.58		15	7	71
Credit/GDP	Contraction	–1.11	–5.83	19		6	–0.84	–4.46	15		5	67
House prices	Expansion	1.78	24.90		20	11	1.72	12.43		15	7	58
House prices	Contraction	–1.21	–10.34	20		9	–0.91	–5.86	16		6	54
Equity prices	Expansion	6.15	52.27		12	7	5.68	35.87		11	5	110
Equity prices	Contraction	–5.55	–25.12	12		5	–4.94	–21.69	11		5	113
AAP	Expansion	2.34	28.58		16	10	1.87	15.45		14	6	69
AAP	Contraction	–2.64	–14.41	16		6	–2.05	–11.12	13		5	68
GDP	Expansion	0.86	25.66		28	25	0.86	14.51		23	20	38
GDP	Contraction	–0.75	–2.73	28		4	–0.61	–2.25	22		3	42

Note: [1] In percent. [2] Percentage change from trough to peak (expansion) or peak to trough (contraction). [3] In quarters.

Annex Table 2: Characteristics of the medium-term cycle pre- and post-1985

	State	Mean					Median					Obs
		Quarterly growth rate[1]	Ampli-tude[2]	Duration[3]			Quarterly growth rate[1]	Ampli-tude[2]	Duration[3]			
				Peak to peak	Trough to trough	Phase duration			Peak to peak	Trough to trough	Phase duration	
Pre 1985												
Credit	Expansion	1.66	169.86		49	54	1.57	131.80		49	48	14
Credit	Contraction	–1.48	–8.18	22		6	–1.21	–7.11	22		6	7
Credit/GDP	Expansion	1.02	42.83		38	34	0.71	31.09		35	39	17
Credit/GDP	Contraction	–1.19	–9.57	33		10	–1.07	–7.60	31		9	13
House prices	Expansion	1.86	43.86		27	21	1.62	35.69		30	17	15
House prices	Contraction	–1.50	–17.00	26		15	–1.15	–14.29	25		14	12
Equity prices	Expansion	4.38	135.09		34	21	4.33	86.15		32	21	20
Equity prices	Contraction	–4.25	–46.27	36		18	–3.43	–43.99	34		20	17
AAP	Expansion	2.11	54.37		28	22	1.82	49.72		29	21	13
AAP	Contraction	–2.06	–22.04	28		14	–2.11	–19.12	28		12	11
GDP	Expansion	0.96	93.89		45	51	0.97	36.97		32	41	16
GDP	Contraction	–0.88	–3.29	27		4	–0.86	–3.19	27		4	9
Post 1985												
Credit	Expansion	**1.68**	129.72		**86**	47	**1.64**	**149.23**		**70**	**64**	7
Credit	Contraction	–0.68	**–12.72**	**66**		**20**	–0.41	**–8.24**	**74**		**18**	7
Credit/GDP	Expansion	**1.38**	**43.02**		**51**	29	**1.06**	**40.58**		**49**	20	12
Credit/GDP	Contraction	–0.77	**–13.46**	**49**		**18**	–0.56	**–8.52**	**49**		**16**	11
House prices	Expansion	**2.18**	**85.08**		**54**	**33**	**2.05**	**94.29**		**48**	**37**	9
House prices	Contraction	–1.49	**–21.61**	**53**		**23**	**–1.52**	**–16.25**	**57**		**20**	**13**
Equity prices	Expansion	**4.68**	**195.72**		**38**	**24**	**4.51**	**171.46**		**33**	19	14
Equity prices	Contraction	**–6.43**	**–46.92**	**42**		12	**–6.76**	**–49.16**	**40**		10	**20**
AAP	Expansion	**2.53**	**82.76**		**42**	**25**	**2.38**	**73.57**		**40**	**23**	13
AAP	Contraction	**–3.40**	**–28.86**	**42**		**14**	**–3.02**	**–28.81**	**42**		10	**18**
GDP	Expansion	0.67	51.00		**63**	**55**	0.73	**59.60**		**56**	**63**	8
GDP	Contraction	–0.83	**–4.07**	**54**		**5**	–0.49	–3.15	**48**		**5**	**14**

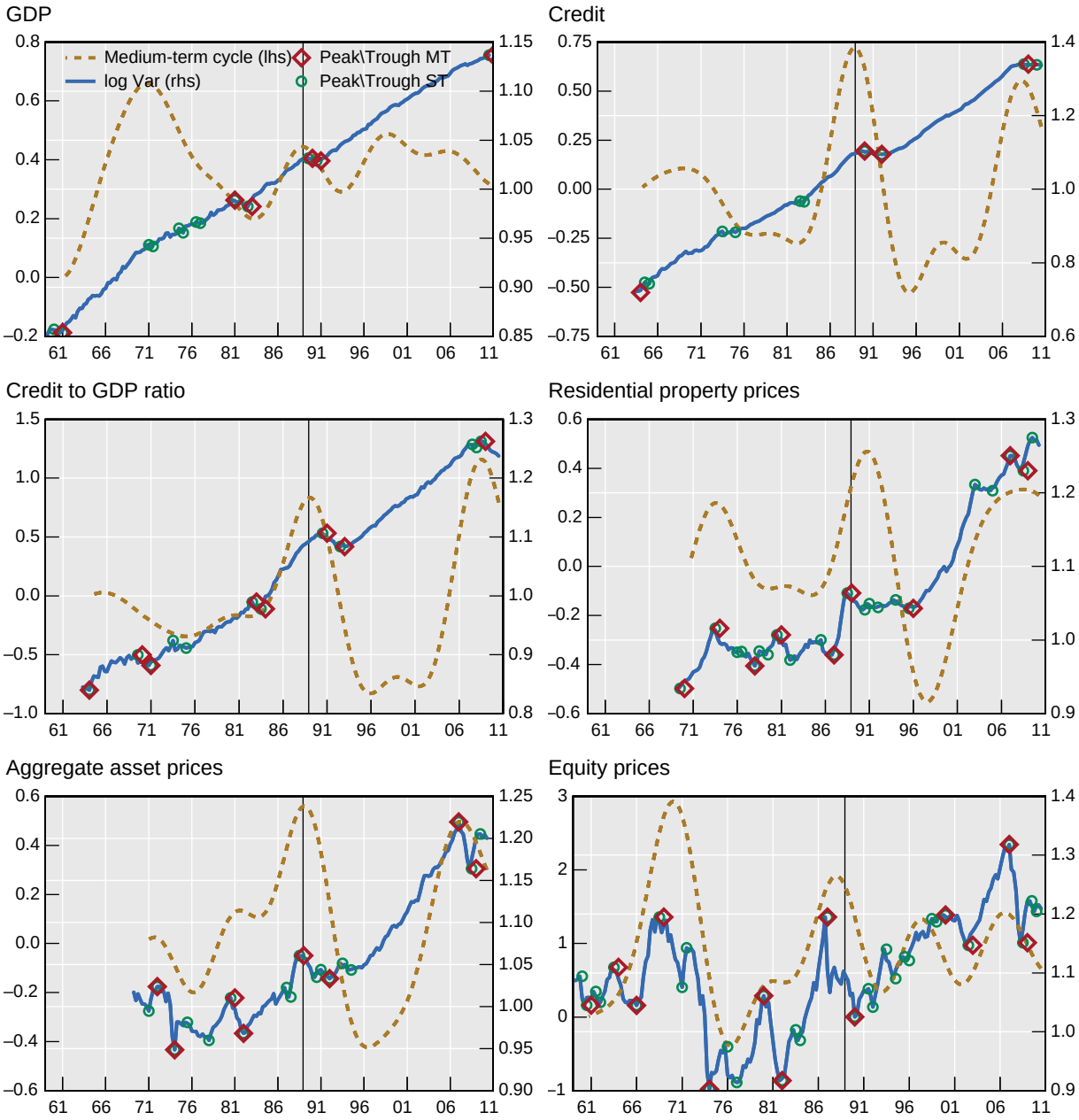
Note: [1] In percent. [2] Percentage change from trough to peak (expansion) or peak to trough (contraction). [3] In quarters. Bold cells in the post 1985 section indicate that these values are larger (in absolute terms) than pre 1985 values.

Annex Graphs

Annex Graph

Peaks and troughs of short- and medium-term cycles: individual series

Australia



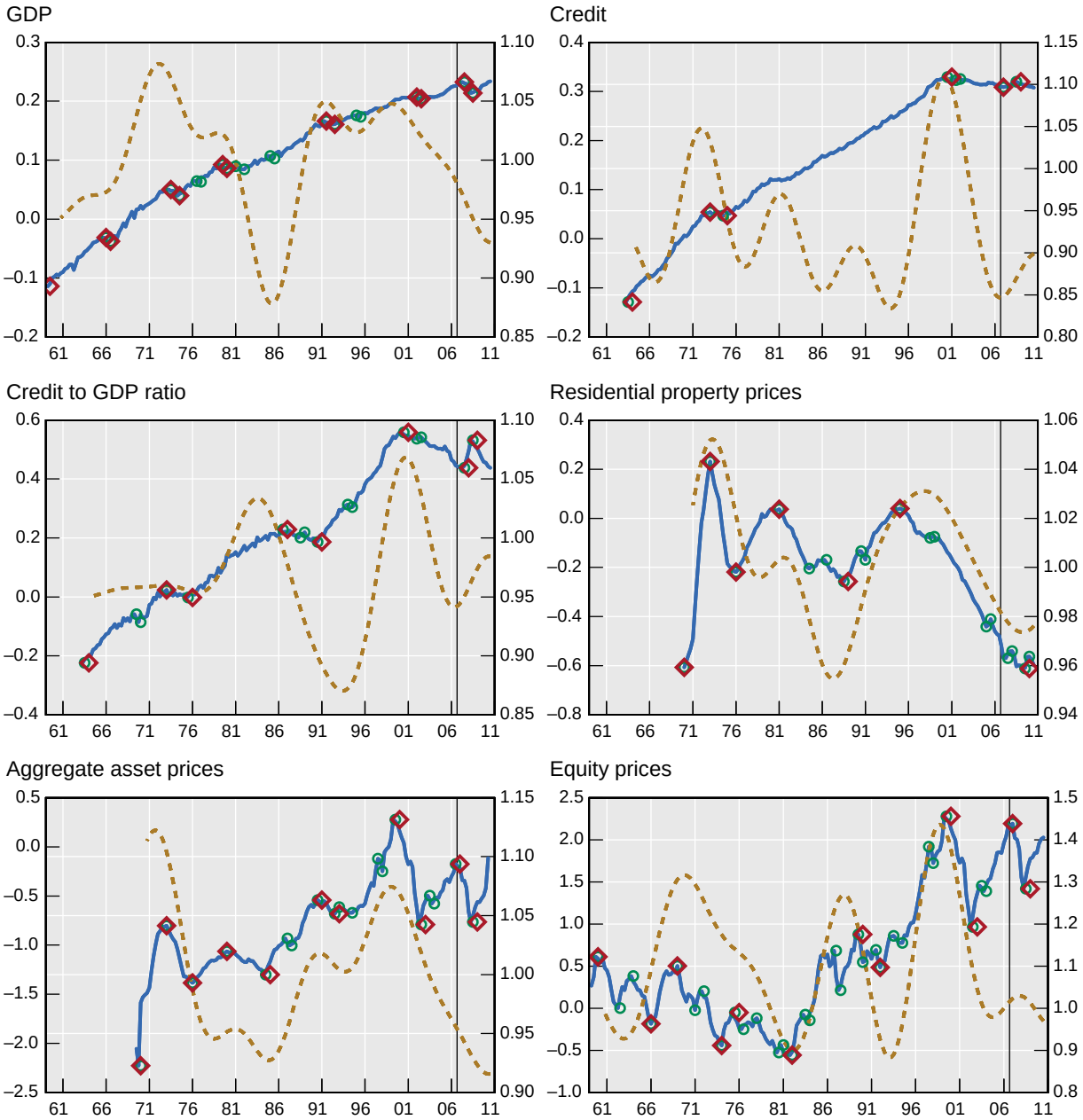
Note: Unfiltered series are in log levels and normalised by their respective value in 1985Q1. Vertical lines indicate the starting point for banking crises.

Sources: national data; OECD; IMF; BIS estimates; author's estimates.

Annex Graph

Peaks and troughs in short- and medium-term cycles: individual series

Germany



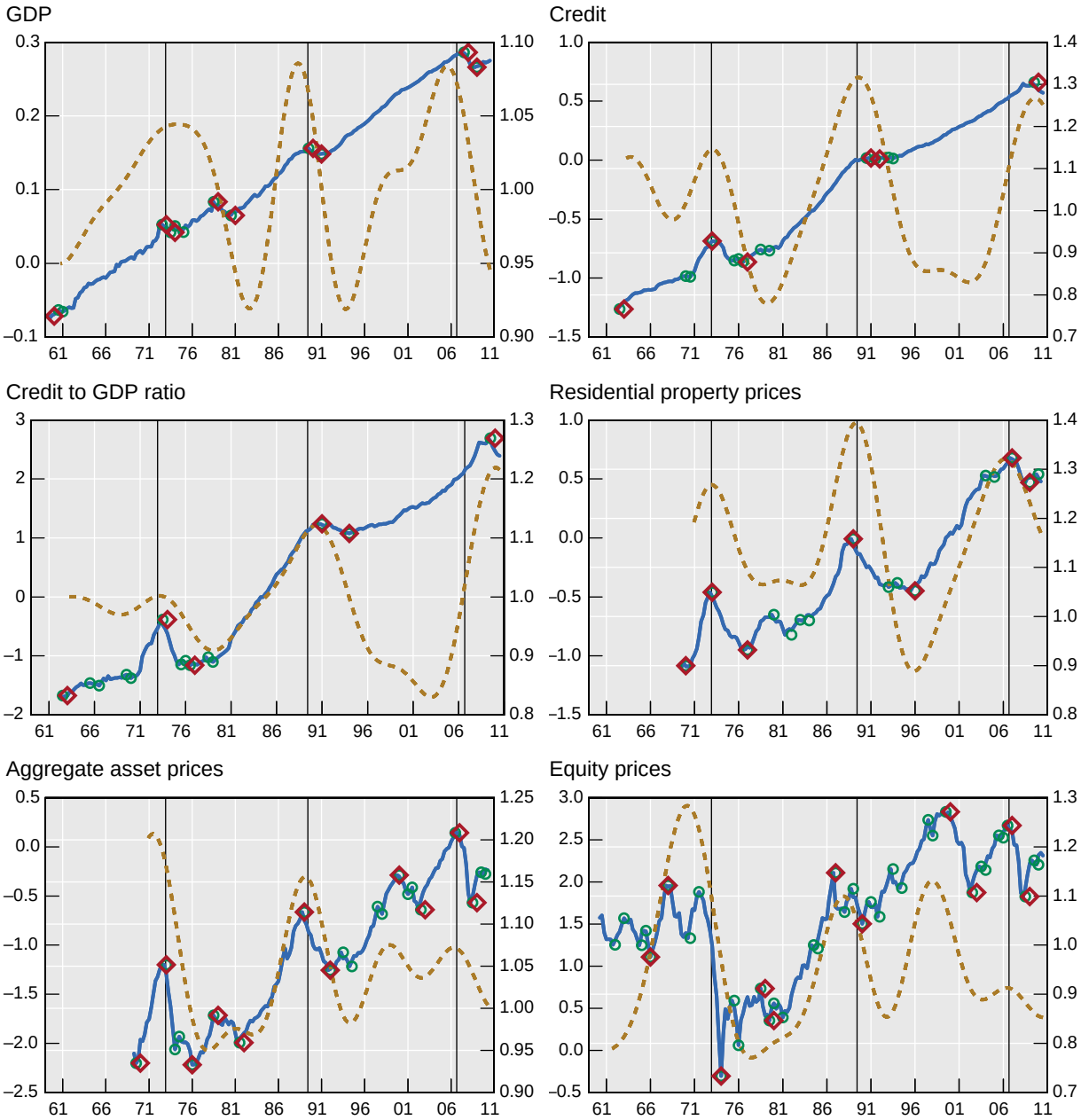
Note: Unfiltered series are in log levels and normalised by their respective value in 1985Q1. Vertical lines indicate the starting point for banking crises.

Sources: national data; OECD; IMF; BIS estimates; author's estimates.

Annex Graph

Peaks and troughs in short- and medium-term cycles: individual series

United Kingdom



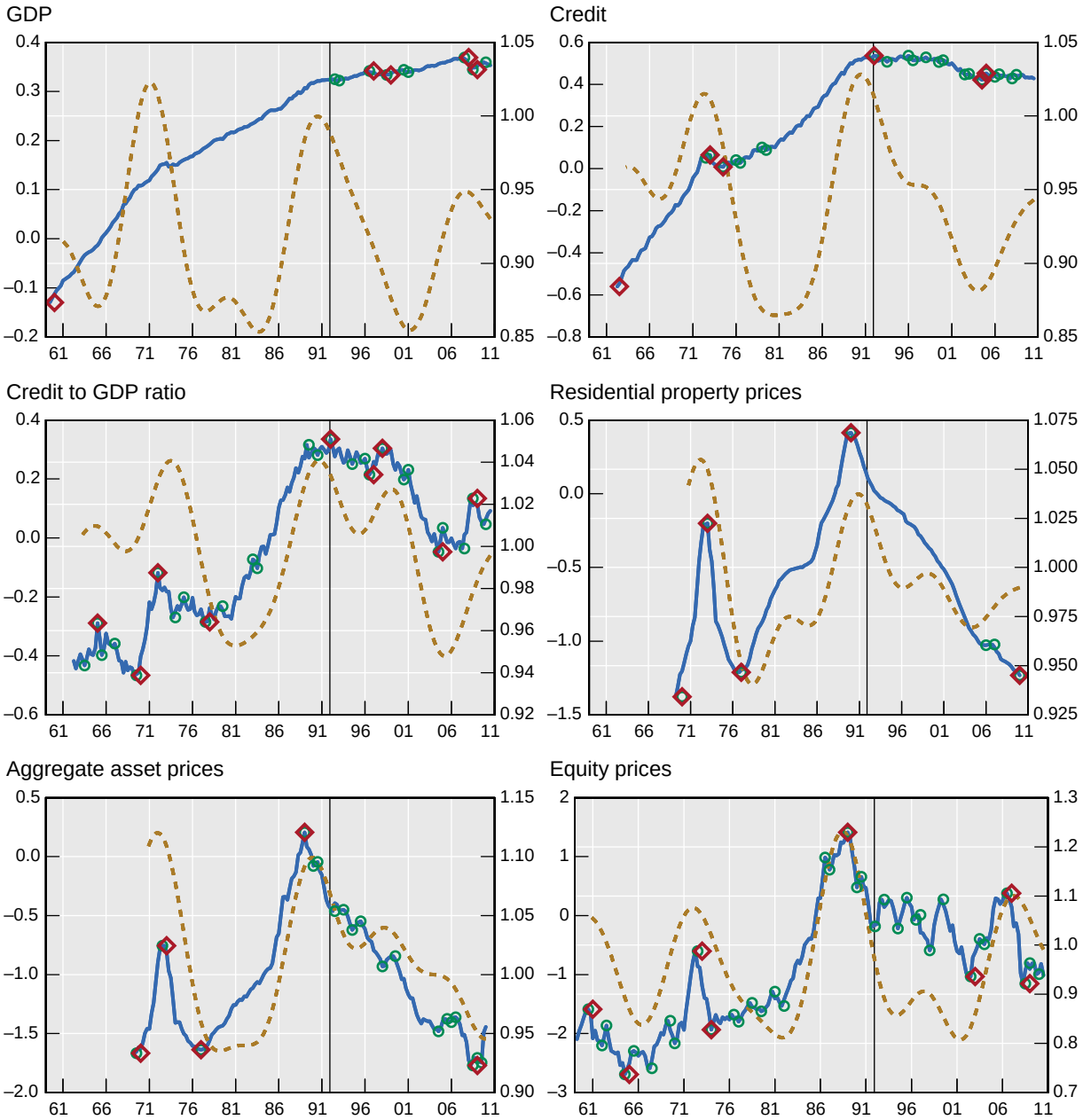
Note: Unfiltered series are in log levels and normalised by their respective value in 1985Q1. Vertical lines indicate the starting point for banking crises.

Sources: national data; OECD; IMF; BIS estimates; author's estimates.

Annex Graph

Peaks and troughs in short- and medium-term cycles: individual series

Japan



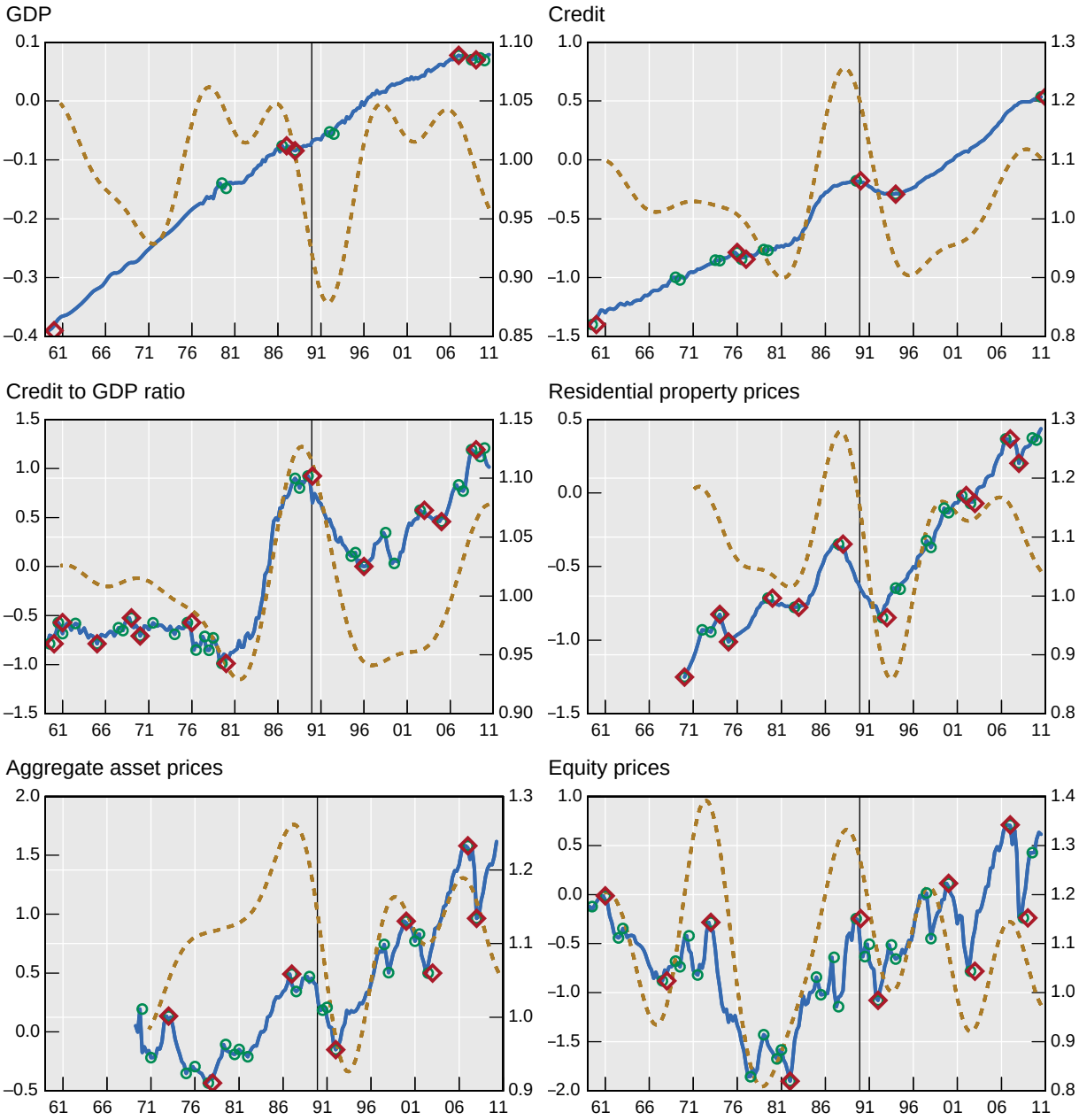
Note: Unfiltered series are in log levels and normalised by their respective value in 1985Q1. Vertical lines indicate the starting point for banking crises.

Sources: national data; OECD; IMF; BIS estimates; author's estimates.

Annex Graph

Peaks and troughs in short- and medium-term cycles: individual series

Norway



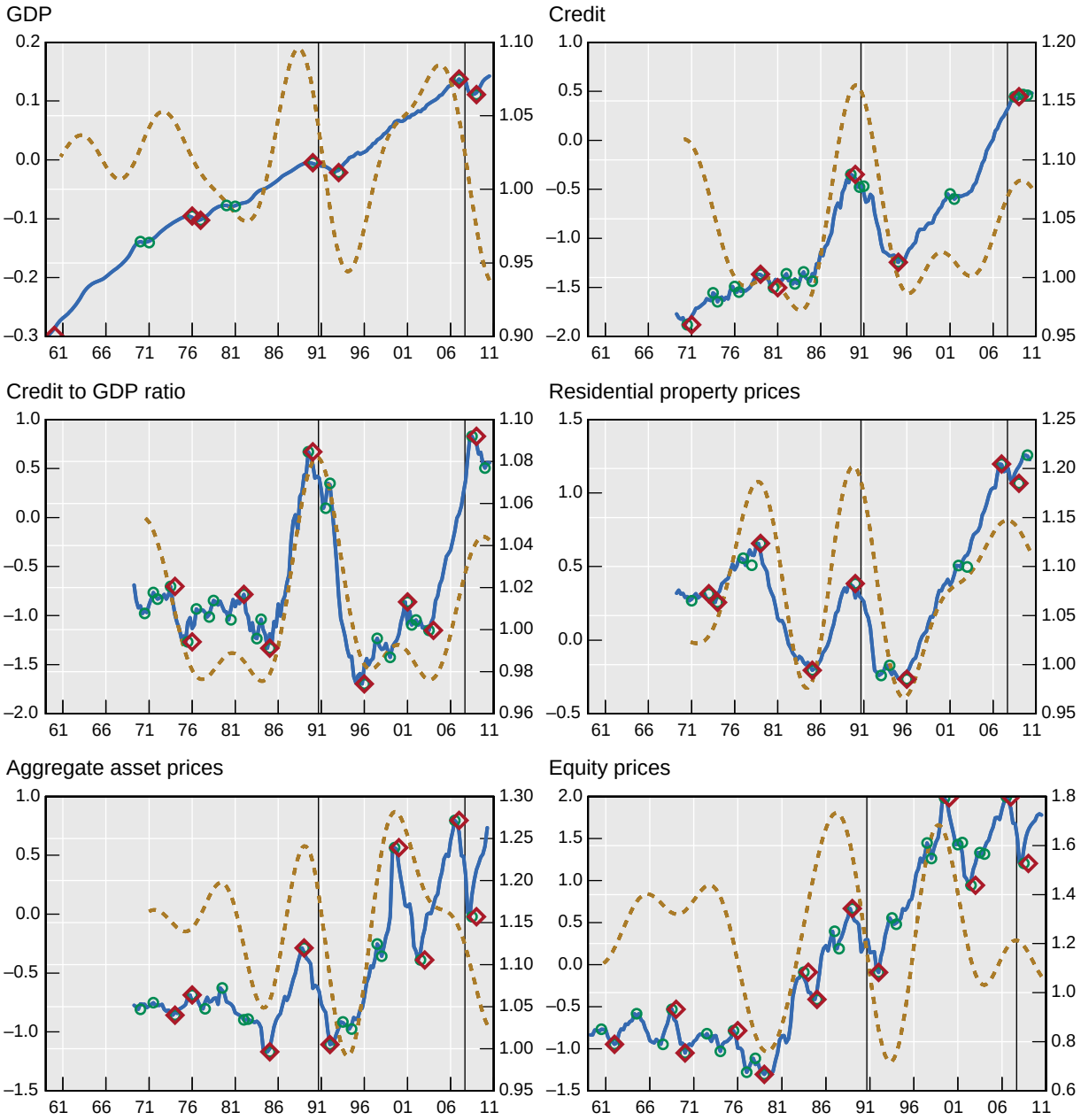
Note: Unfiltered series are in log levels and normalised by their respective value in 1985Q1. Vertical lines indicate the starting point for banking crises.

Sources: national data; OECD; IMF; BIS estimates; author's estimates.

Annex Graph

Peaks and troughs in short- and medium-term cycles: individual series

Sweden



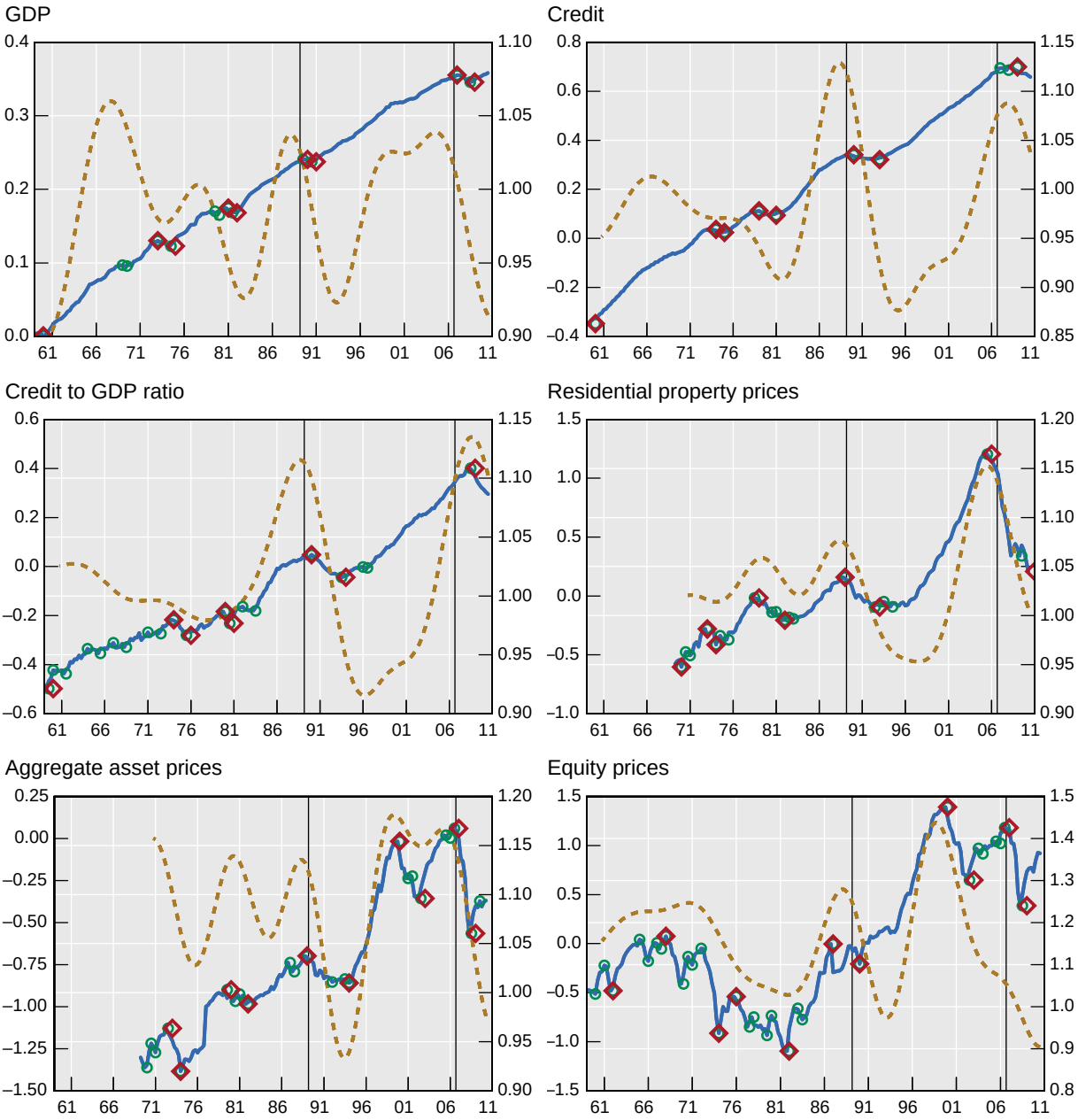
Note: Unfiltered series are in log levels and normalised by their respective value in 1985Q1. Vertical lines indicate the starting point for banking crises.

Sources: national data; OECD; IMF; BIS estimates; author's estimates.

Annex Graph

Peaks and troughs in short- and medium-term cycles: individual series

United States



Note: Unfiltered series are in log levels and normalised by their respective value in 1985Q1. Vertical lines indicate the starting point for banking crises.

Sources: national data; OECD; IMF; BIS estimates; author's estimates.