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2016

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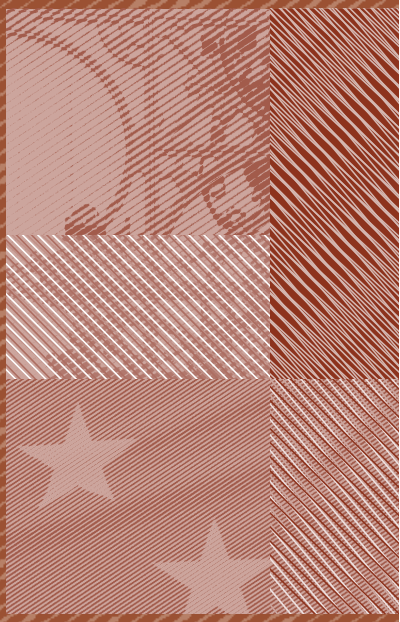

Documentos de Trabajo
N.º 1601

BANCO DE **ESPAÑA**
Eurosistema

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BANCO DE ESPAÑA

(*) This paper is the sole responsibility of its authors. The views represented here do not necessarily reflect those of the Banco de España or the Eurosystem. The authors would like to thank Rafael Repullo and an anonymous referee for their valuable comments and suggestions. They would also like to thank Roberto Blanco, Oliver Bush, Jorge Galán, Daniel Pérez and Jesús Saurina for useful discussions and contributions.
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Documentos de Trabajo. N.º 1601
2016

ISSN: 1579-8666 (on line)

Abstract

This paper analyses a group of quantitative indicators to guide the Basel III countercyclical capital buffer (CCB) in Spain. Using data covering three stress events in the Spanish banking system since the early 1960s, we describe a number of conceptual and practical issues that may arise with the Basel benchmark buffer guide (i.e. the credit-to-GDP gap) and study alternative specifications plus a number of complementary indicators. In this connection, we explore ways to deal with structural changes that may lead to some shortcomings in the indicators. Overall, we find that indicators of credit 'intensity' (where we propose the ratio of changes in credit to GDP), private sector debt sustainability, real estate prices and external imbalances can usefully complement the credit-to-GDP gap when taking CCB decisions in Spain.

Keywords: countercyclical capital buffer, credit-to-GDP gap, guiding indicators, build-up phase, credit intensity, real estate prices, external imbalances, private sector debt sustainability, macroprudential policy.

JEL Classification: E58, G01, G21, G28, G32.

Resumen

Este trabajo analiza potenciales indicadores cuantitativos que sirvan para ayudar a determinar el nivel óptimo del colchón de capital anticíclico (CCA) en la economía española. Utilizando datos a partir de principios de la década de los sesenta del siglo pasado, período que cubre tres episodios de tensión en el sistema bancario español, analizamos los distintos problemas, prácticos y conceptuales, que resultan de la aplicación estricta del indicador de referencia establecido en la regulación de Basilea III (es decir, la brecha entre crédito y PIB) y estudiamos especificaciones alternativas, así como indicadores complementarios. Se explora, en particular, la forma de tratar los problemas de cambios estructurales en el comportamiento de los indicadores que afectan a su validez. En conjunto, encontramos que indicadores de intensidad en el crecimiento del crédito (la ratio entre variación del crédito y nivel del PIB), sostenibilidad de la deuda privada, precios de inmuebles y desequilibrios de balanza de pagos pueden ayudar a complementar a la brecha entre crédito y PIB en la toma de decisiones sobre el CCA en España.

Palabras clave: colchón de capital anticíclico, brecha entre crédito y PIB, indicadores, fase de acumulación, crédito, precios de inmuebles, desequilibrios externos, sostenibilidad de la deuda privada, política macroprudencial.

Códigos JEL: E58, G01, G21, G28, G32.

1 Introduction

A number of macroprudential instruments have been proposed in the last few years. Most instruments thus far are based on banks' balance sheets, build on microprudential standards and are usually classified as structural or cyclical (time-varying). Among the latter, the countercyclical capital buffer (CCB) is perhaps the best-known and one at a more advanced stage of operationalisation. The capital buffer for systemically important financial institutions, on the other hand, is an example of a structural instrument.

The CCB's primary objective is to ensure that the banking sector as a whole has an extra capital buffer which could be used to absorb losses in a downturn preceded by a period of excessive credit growth associated with the build-up of systemic risks. As such, the CCB aims to contribute to the broader objective of increasing resilience in the banking system and, in this manner, help sustain the supply of credit to the economy in bad times.[1,2]

To work counter-cyclically, the CCB should increase at the pace that risks to financial stability stemming from excessive credit growth accumulate. This occurs during what is known as the activation, accumulation or build-up phase. Following this first phase the CCB should be promptly reduced in the event of a banking crisis, or be progressively released as risks to financial stability recede. This is the deactivation, disaccumulation or release phase. Failing to use the buffer when systemic risk due to excessive credit growth materialises would hamper its effectiveness and increase procyclicality. Naturally, the release of the CCB would only be possible if it were adequately accumulated in the first place.

In Europe, the new legislation on banking regulation (CRR/CRDIV) introduces the CCB along the lines suggested by the Basel Committee on Banking Supervision (BCBS).[3] In addition, a 2014 recommendation by the European Systemic Risk Board (ESRB) provides further guidance for operationalising the CCB.[4] In accordance with these provisions, decisions on the CCB's activation and release follow what is known as a 'constrained' or 'guided discretion' approach, a middle-ground route between rules and discretion.[5] This approach comprises a common standardised quantitative indicator to be used as a benchmark or starting point: the credit-to-GDP gap (hereafter the 'Basel gap'). It also lays down a set of principles to guide judgement when taking buffer decisions. Further to the Basel gap, the ESRB recommendation also suggests a number of other quantitative indicators which can also inform CCB decisions.

Against this background, we focus in this paper on exploring the informative value of a group of quantitative indicators (or 'signposts') – including the Basel gap – to help guide the

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1. The possible dampening of the build-up of excessive credit in boom times or the containment of exuberance are seen as potential positive side-effects but are not primary goals. In particular, the CCB has not been conceived as an instrument to manage business cycles or asset prices. The entire focus is on the credit cycle, and all emphasis on resilience. In this connection, Jiménez et al. (2013) provide empirical insights into the effects of countercyclical buffers on credit cycles both in good and in bad times.

2. Drehmann et al. (2010) study different options for the design of countercyclical capital buffers, also drawing on the experience with dynamic provisions (i.e. the general loan loss provisions applied in Spain since 2000). Saurina (2009a, 2009b) and Trucharte and Saurina (2013) describe the Spanish dynamic provisions in detail and discuss their use for macroprudential policy.

3. See BCBS (2010, 2011).

4. ESRB Recommendation on "Guidance to EU Member States for setting countercyclical buffer rates".

5. Libertucci and Quagliarello (2010) discuss the usage of rules and discretion in macroprudential policy.

CCB's activation in Spain during those periods when systemic risks stemming from excessive credit growth are building up (i.e. the moment when the CCB should accumulate).[6]

There are conceptual reasons for thinking that the best indicators for the activation and release phases of the CCB may be different. Risks from excessive credit growth tend to accumulate following a "slow-moving" process. The CCB is thus expected to be better guided in this phase by indicators able to send stable and consistent signals, i.e. showing low volatility. In contrast, the CCB should be promptly released when a crisis arises to allow banks to absorb losses, thereby contributing to head off abrupt credit contractions. Indicators to guide the CCB in this case should thus be able to quickly capture changes in market conditions, which typically translate into higher volatility for the indicator.

In keeping with this idea, empirical studies also suggest that the best-performing indicators to signal the CCB accumulation are not necessarily the best ones to signal its release. For example, market-based or near-coincident indicators tend to outperform other indicators when signalling a prompt release of the CCB. In addition, 'momentum' indicators capturing changes in credit growth may help guide CCB decisions in a gradual release context [Detken et al. (2014), Giese et al. (2014)]. It is also worth noting that, given practical difficulties in disentangling both scenarios – prompt vs. gradual release – in real time, expert judgement is expected to play a greater role during the release phase than in the build-up phase [Detken et al. (2014)]. Consequently, and apart from a few specific observations we make in the paper on the release phase, we simply focus on assessing prospective indicators for guiding the build-up phase.

Our first finding is that the Basel gap would have faced some challenges in anticipating the stress periods identified in the Spanish banking sector in the last 50 years. This occurs due to specific features in the historical series for Spain. We analyse these features in detail and suggest improvements in two not mutually exclusive directions: structural estimates for the gap-based indicators and complementary indicators. Concerning the latter, we find that indicators of credit 'intensity' (where we propose the ratio of changes in credit to GDP), private sector debt sustainability, real estate prices and external imbalances can usefully complement the credit-to-GDP gap in taking CCB decisions in Spain. These insights may also be useful for other countries with similar historical characteristics.

The paper is organised as follows. In the next section we describe the three periods of banking stress preceded by excessive credit growth that we have identified in Spain over the past 50 years. Section 3 analyses the behaviour of the Basel gap ahead of those three events. Section 4 introduces the methodology to assess complementary indicators for guiding the CCB activation. All these complementary indicators along with 'structural' estimates for the gap-based indicators (i.e. indicators calculated as deviations from their long-run trends) are assessed empirically in Sections 5 and 6. Section 7 concludes.

6. A prolific stream of literature assessing the performance of the Basel gap and other indicators both at the country and EU levels has emerged since the CCB was announced. For example, the analysis in Detken et al. (2014) underpins the ESRB Recommendation on guidance for setting CCB rates (ESRB 2014/1) and assesses a set of guiding indicators for the EU; Kelly et al. (2013) examine the performance of the gap in Ireland; Kauko (2012) provides empirical analysis for Finland and a cross-section of EU countries; Bonfim and Monteiro (2013) for Portugal; Gerdrup et al. (2013) for Norway; Giese et al. (2014) for the UK; and Geršl and Seidler (2011) for a sample of central and eastern European countries, including the Czech Republic.

2 Stress events: the late 70s, Banesto and the recent crisis

The empirical analysis in this paper broadly follows what is commonly known as an 'early warning' approach [see, for example, Detken et al. (2014) in the CCB context]. The first step under this approach consists of identifying those relevant episodes of systemic banking crises in Spanish history. As suggested by Davis and Karim (2008), there is no single way to define banking crises and a degree of subjectivity is usually needed.[7] To do this we start by applying the criteria set out in Laeven and Valencia (2012), who broadly identify a banking crisis period as one in which there are significant signs of financial distress (e.g. bank runs, large losses and/or bank liquidations) and significant banking policy intervention measures in response to losses in the banking sector (e.g. extensive liquidity support, bank restructuring, nationalisations, public guarantees, deposit freezes).[8] As a result, two periods of systemic banking crises since 1960 were identified (1978Q1–1985Q3 and 2009Q2–2013Q4). Secondly, for the purpose of this paper, we add a third event (1993Q3 –1994Q3) which, despite not being a truly systemic event according to the criteria above, was still a significant idiosyncratic event coinciding with the intervention and subsequent resolution of a large Spanish bank.[9]

The 1978-1985 crisis (the 'late 70s crisis') was the longest banking crisis and that with the highest costs in terms of forgone GDP in Spanish history so far. It followed the collapse of the Bretton Woods monetary system, the oil shock and the deep recessionary period which characterised the early 1970s in western economies. In Spain, the crisis affected a very large part of its banking system, including both small and large institutions. As an illustration, Martín-Aceña et al. (2013) estimate that around 52% of Spanish banking institutions were affected by the crisis.

The second event (the 'Banesto crisis') is a relatively short stress period between 1993 and 1994 when one of the oldest and largest Spanish banks – Banco Español de Crédito (Banesto) – went into resolution, was recapitalised and was then sold in a public offering. Though this episode cannot be considered strictly a systemic banking crisis, we still include the Banesto crisis in the exercise as we considered it would be useful to assess the performance of the indicators against different types of stress events and severities.

Finally, the third stress event (the "recent crisis") corresponds to the latest financial crisis which affected most financial systems around the world. As is now well known, this financial crisis has been one of the deepest and most widespread in history. We date the beginning of this third stress period in Spain at mid-2009, coinciding with the intervention of Caja de Ahorros de Castilla La Mancha (CCM) by the Banco de España. The end-2013 reference point coincides with the conclusion of the financial assistance programme agreed with the European authorities in 2012 for the recapitalisation of a portion of Spanish banks.[10]

Having identified these three stress events, we explore in what follows the performance of a number of indicators to help guide the buffer decisions. We start by analysing the Basel gap.

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7. Some conventional crisis classifications widely used in the literature on early warning systems include Caprio and Klingebiel (1996), Demirgüç-Kunt and Detragiache (1998) and Kaminsky and Reinhart (1999).

8. The European System of Central Banks (ESCB) Macroprudential Research Network followed the same approach to construct the Heads of Research Group's banking crises database.

9. For further details on the stress events considered see Martín-Aceña et al. (2013) and Malo de Molina and Martín-Aceña (2011).

10. Banco de España (2013).

3 Basel gap

As explained above, while authorities in the EU are recommended to also consider other quantitative indicators and qualitative information, the baseline (or 'standardised') credit-to-GDP gap proposed in Basel III is the common starting point for guiding decisions on the CCB. The Basel gap is defined as the difference between the ratio of credit to nominal GDP and its long-term value. The BCBS and the ESRB propose a broad definition of credit for the numerator of the ratio. On that basis, we construct a long time series of households and non-financial corporations' total credit in Spain covering the period since 1962.[11] This measure includes both loans and securities and hereafter it will be interchangeably referred as credit or debt. For the denominator, we extend the most recent GDP backwards using historical growth rates from previous statistical GDP bases (see details in Appendix 1). Both the BCBS and the ESRB also propose using the on-sided Hodrick-Prescott filter (also known as recursive or real-time HP trend) as the method to calculate the long-term value of the credit-to-GDP ratio in the baseline indicator.[12]

Chart 1 shows the resulting credit-to-GDP ratio for Spain and its trend. The three stress events identified above (the two systemic crises and the idiosyncratic event) are also shown as shaded areas.

The credit-to-GDP ratio shows an upward trend before the three stress events. The Basel gap, however, would have missed the first two events and would have signalled the third one around ten years ahead of the actual event. This is clearer in Chart 2, which shows the Basel gap and the baseline lower and upper thresholds (2% and 10%, respectively) suggested by the BCBS to activate and gradually increase the CCB from 0% to 2.5%.[13] The CCB would have been zero (the Basel gap is below the 2% lower threshold) both in the run-up to the late 70s crisis and in the Banesto crisis. This means that, in the hypothetical case that the CCB were *exclusively* guided by the Basel gap, the CCB would have not accumulated ahead of these events. Alternative definitions of the credit-to-GDP gap do not alter this outcome substantially (see Appendix 2).

One of the main reasons for the observed features in the Basel gap lies in the calculation of the long-run trend for the credit-to-GDP ratio**.** The HP filter used to calculate this trend is a univariate statistical procedure designed to estimate long-run trends in data series. Two key decisions should be made when applying the HP filter: a) on the smoothing parameter (lambda in the literature) to be used; and b) on whether to use a 'one-sided' (also named 'recursive') or a 'two-sided' filter. Choosing the lambda parameter is equivalent to defining the average duration of a full cycle for the variable being studied. A higher parameter implies a longer cycle. Second, the decision on using a one- or two-sided HP filter depends on whether the aim is that, at any point in time and recursively, the filter should use only past

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11. Although there is some debate on whether inter-company loans should be included or not, here we decided to include them. We did this in an attempt to simplify calculations and make the results more comparable across countries, as separate data on inter-company loans are not always available in other countries.

12. The HP filter is a statistical technique widely used by researchers and analysts to separate cyclical from long-run behaviour in economic series. For further details on the calculation of HP trends, see Hodrick and Prescott (1980) and Stock and Watson (1999). Edge and Meisenzahl (2011) analyse the implications of using the HP filter for the calculation of the credit-to-GDP gap in real time.

13. The BCBS guidance for operating the CCB (BCBS, 2010) suggests, based on empirical analysis of past banking crises, that relevant national authorities use as a starting guide a lower threshold of 2% and an upper one of 10% to transform the Basel gap into CCB rates (pp 13-14).

information to estimate the trend (one-sided), or both past and 'future' information (two-sided).[14] The Basel gap uses quite a high lambda (400,000) to capture the longer duration of financial cycles compared to business cycles. Besides, the filter is one-sided to emulate CCB decisions in real time.

These two elements imply that sufficiently long data series should be available for the HP filter to work properly (Drehmann and Tsatsaronis [2014] suggest at least 10 years of available data for the credit-to-GDP ratio. The high lambda also generates substantial persistence in the estimated trend. This has two direct implications for the gap estimations. First, the gap will tend to remain constantly positive over several years for countries transiting from a period of low or falling credit-to-GDP ratios to a period of increasing ones. By the same token, the gap will tend to remain negative in countries which have experienced a strong and prolonged credit growth process followed by a sharp adjustment.

More generally, in cases when there are sharp and long-lasting movements in the trend – for example, as a result of structural changes – it is expected to take some time for the filter to react and accommodate to those movements. Arguably, this issue may be less acute in the two-sided filter.[15] But a two-sided filter in 'real time' requires forecasts, so the resulting reliability will depend largely on the projection's accuracy and its ability to anticipate changes in trends. We consider alternative (structural) estimates of equilibrium for the gap-based indicators later in this paper.

Bearing these issues in mind, we observe that in Spain, even using data since 1962 – a fairly long data series by common standards – it would have been necessary to wait until around the mid-1980s to describe a full credit cycle. In the meantime, the credit-to-GDP ratio almost doubled over the years before the late-1970s banking crisis, suggesting a very fast pace of credit growth. The lack of historical data covering at least a full credit cycle explains why the one-sided HP gap does not signal this period as one of excessive credit growth.

Following this initial period, the credit-to-GDP ratio stopped growing in Spain and even declined somewhat during the 1980s and 1990s. As a consequence of the high persistence in the trend, the one-sided HP gap remained negative for a long period after the 1978-1985 crisis. Consequently, by the time of the next stress event (1993-1994), the trend was still too high, which helps to explain the absence of activation signals.

The opposite occurred by the end of the 1990s. The credit-to-GDP ratio started to increase again steadily, with the estimated trend taking time to catch up. As a result, the Basel gap would have started sending signals of excessive credit growth from mid-1998 and, following the baseline Basel rule, the CCB would have reached a level of 2.5% by end-1999 (see Chart 2). This is ten years in advance of the 2009-2013 banking crisis. Also, from mid-2004 the gap became ostensibly high (above 25%), suggesting considerably higher CCB rates in the years immediately before the crisis.[16]

As result of Spain joining the euro area in 1999, at least part of the credit growth observed from the mid-1990s to 2007 may be judged to be not excessive, but rather the result of the banking system adjusting to a new equilibrium (a structural change). Some support for

14. Economic forecasts are commonly used to feed the 'future' information into the two-sided HP filter.
15. See Gerdrup, Kvinlog and Schaaning, 2013.
16. This potential 'overshooting' seems to be less acute when a gap calculated as the ratio between the credit-to-GDP level and its trend (a 'percentage' gap) is used instead (see Appendix 2, chart A.2.1).

this hypothesis can be found in the fact that the level of credit-to-GDP in Spain during the 1980s and 1990s (around 90%) was relatively low when compared to the level of financial intermediation in other advanced economies, suggesting that the Spanish system was at a different stage of development. Logically, the HP trend, being a purely statistical tool, has some limitations when having to address this kind of structural change.

On the other hand, it should also be acknowledged that structural changes are not always easy to assess. In particular, detecting in real time the precise moment when excessive credit growth processes start to unfold is quite challenging and, when trying to do so, there is a need to avoid the inherit leaning towards inaction in macroprudential policy. As a result, given the perils of underestimating risks from excessive credit growth during expansionary periods and without a better understanding of the structural determinants of credit-to-GDP levels, a carefully balanced policy is warranted.

Similar situations related to the trend persistence in the Basel gap may also occur in the coming years. Two arbitrary simulations of the credit-to-GDP ratio serve to illustrate these issues (Chart 3). Both simulations assume that part of the large increase observed in the first decade of this century was unsustainable and, consequently, the credit-to-GDP ratio will fluctuate in the future around a somewhat lower level than in the recent past (note that the ratio has fallen by 50 percentage points from its peak to 2014Q4). We also assume in both cases that a new credit boom unfolds, with a strong increase in the credit-to-GDP ratio (by more than 60 percentage points) in four and six years, respectively. As before, due to its high persistence, it takes time for the one-sided HP trend to adjust to the new equilibrium level, making it more difficult for the gap to send timely activation signals.

Solving these issues is challenging, but they are not completely new. There are at least three strategies which can be followed. The first strategy is to use a broader set of complementary indicators, as mentioned before. Second, econometric estimations of the long-term credit-to-GDP equilibrium level can provide information on those structural factors explaining credit developments. Finally, other methodologies and approaches, such as stress tests, for example, may also help to identify relevant endogenous and exogenous factors for guiding buffer decisions. We focus in this paper on the first and second approach only.

4 Methodology for assessing the performance of indicators

Generally speaking, the main broad features ideally required of an indicator, when guiding CCB decisions for the build-up phase, are twofold: i) the indicator should peak in advance of the stress events identified and should remain mute otherwise – i.e. this means avoiding missing crises or sending false signals; ii) the peaks should occur several quarters ahead of the stress event, to give enough time for the CCB to accumulate.

In line with this, we use an 'evaluation window' spanning from four years to one year ahead of the beginning of each stress event as the reference timeframe to assess the indicators' performance. Best indicators should consistently send 'alarm signals' (i.e. with the indicator showing high values) over those 3-year windows, while they should send no alarms (i.e. show low values) outside them. Crisis periods and the year before are excluded from the analysis since, as explained, our interest is confined to the build-up phase.[17]

We begin the empirical assessment by describing, in Section 5, each of the selected indicators, their conceptual properties and their expected functioning as potential guiding indicators for the CCB activation. We also comment on their advantages, disadvantages and challenges in their practical operationalisation in each case. Whenever possible, we propose solutions to the issues we observe. Next, we assess, in Section 6, each of the selected indicators quantitatively following a non-parametric approach (based on the area under the received operator characteristic curve, AUROC) and a parametric one (based on logit regressions).

The AUROC approach extracts 'signals' from each indicator depending on whether this is above or below a specific threshold. Based on those signals, the statistical procedure assesses the indicator performance in terms of the number of correct signals (i.e. hits and good silence) or incorrect signals (i.e. false alarms and missed crises) it sends ahead of the identified stress periods. As such, the AUROC value is an encompassing measure which takes into account the indicator's accuracy for each possible threshold value. An AUROC value of 0.5 means that the indicator is uninformative, whereas a value of 1 means that the indicator sends no wrong signal for any possible threshold (a perfect indicator).

Further to the AUROC measure we also calculate the psAUROC (partial standardised AUROC). The psAUROC is a refinement of the AUROC metric. The psAUROC takes into account policy-makers' preferences over type I errors (missing crises) and type II errors (false alarms). These preferences can be represented by a policy-maker loss function. For each loss function and each indicator there is an optimal threshold minimising the loss function. But not all thresholds are equally reasonable. For instance, thresholds that are too high can only be optimal when policy-makers are more concerned about false alarms than about missing crises, which is typically not the case. As a result, one may want to exclude this kind of option from the analysis. Reflecting this reasoning, the partial AUROC allows the area under the ROC curve to be calculated for a narrow range of thresholds. For the purpose of this paper – and as in Detken et al. (2014) – we only consider those cases in which policy-makers are at least as concerned about missing crises as about receiving false alarms. In other words, this means calculating the area under the ROC curve starting from a 0.5 weight between type 1 and 2

17. One-year-before crisis observations are excluded because increases in the CCB have to be announced 12 months in advance in order to give banks appropriate time to meet the additional capital requirements.

errors up to a weight of 1 (i.e. fully weighted towards type 1 errors). Finally, to allow comparisons between the partial AUROCs we report their standardised values following the transformation suggested by McClish (1989).

The second quantitative approach we use is parametric and based on logit regressions. This approach assesses the indicators' capacity to explain the probability of being in one of the 4-to-1-year ahead-of-crisis periods that we have identified.

5 Complementary indicators to guide the CCB in Spain

Our initial selection of potential complementary indicators was steered by conceptual analysis, detailed guidance from international bodies (e.g. BIS 2010; ESRB 2014), specific considerations related to our exercise and a growing empirical literature on the subject. On the latter, Appendix 3 summarises the main categories of indicators suggested in the recent literature.

Two observations on the empirical strategy we follow should be made at this point. First, since our focus is on the Spanish case, we have a limited number of stress observations. As a consequence, running a 'simultaneous horse race' with a long and wide-ranging list of potential indicators will lead to small-sample over-fitting problems. We have thus preferred to avoid this route.[18] Second, we only use indicators for which sufficiently long-dated data are available (i.e. the data cover the three stress events identified) in order to be able to assess them empirically on an equal footing.

The initial set of selected indicators cover those key dimensions of risks highlighted in the relevant empirical literature and which have been conceptually associated with the build-up of system-wide risks due to excessive credit growth. While each new crisis arguably introduces some distinctive features, there appears to be no systemic crisis without at least some of the following factors at play to some extent: a) relaxation of credit standards and/or (ex-post) excessive income/wealth expectations both on the borrowers' and lenders' sides, typically leading to strong credit growth; b) increases in households' and non-financial corporations' leverage; c) appreciation of credit-financed assets; and d) aggregate investment exceeding internal savings. Experience shows that these factors are frequently related and can mutually reinforce one another, although they do not always send 'warning signals' simultaneously in all cases.

Against this background, we analyse in what follows a set of potential complementary indicators of credit developments, debt burden, real estate prices and external imbalances.

5.1 Credit developments

Excessive credit growth is one of the clearest early warning signs of future banks' loan losses. Yet the challenge lies in disentangling what 'excessive' is. The credit-to-GDP gap is intended to work, in fact, as a proxy measure of this excess. The gap links credit volumes to GDP levels, so total credit in a given country can be considered excessive when its level deviates too much from GDP, taking as a reference value the long-run trend of the credit-to-GDP ratio. This is intuitive, as borrowers' income - used to repay debt - is closely linked to GDP.

However, as was shown in Section 3 for the Spanish case, structural changes in the 'equilibrium' level of the credit-to-GDP ratio may suggest a need to introduce some refinements. One way to deal with structural changes is to estimate the 'equilibrium'

18. Regarding this discussion, some trade-offs between multi-country and country-specific analyses have been made clear when trying to find and calibrate suitable indicators and rules for guiding macroprudential instruments. Multi-country analysis permits a more robust analysis of alternative indicators owing to the higher number of crisis episodes available. On the other hand, analysis at the country level allows a better reflection of national specificities. These trade-offs also apply to the CCB. For example, the role of the Basel gap as a common international benchmark is consistent with its superior performance in cross-country analyses. Yet, as also provided in the BCBS guidance for operating the CCB, decisions at the country level may further be improved by using complementary quantitative and qualitative information. This may occur, for instance, in cases like Spain's, where there were significant structural changes to the macro-financial environment.

credit-to-GDP ratio in a given country. This can be done, for example, by using cross-country data on credit and its determinants. As for the rest of the indicators, these estimations should be assessed in real time to still be relevant for policy consideration. In other words, the empirical models proposed should be estimated only using the information available at each point in time.

Following this approach also means that the model should be able to identify and assess structural changes before they actually happen, mostly based on other countries' experience. As can be expected, this is not an easy exercise and, consequently, it may be difficult and potentially unsafe to rely exclusively on this approach to set the CCB. Using information from other complementary indicators, linked to different dimensions of systemic risks associated with excessive credit growth, is thus also advisable.

Chart 4 shows the different indicators on credit developments that we explore, which can be grouped in two categories: a) indicators on credit flow; and b) the 'structural credit-to-GDP gap'. The vertical lines in the various panels define the starting dates for the three stress events identified in our sample, with the grey-shaded areas capturing the stress episodes and the year ahead. The orange-shaded areas show the time windows (four years to one year ahead of each stress event) in which the CCB should ideally be accumulated. All other quarters represent 'tranquil' times (i.e. periods in which a crisis is neither unfolding nor system-wide risks from excessive credit growth accumulating), meaning the CCB should not be activated. We discuss each indicator in detail.

5.1.1 CREDIT FLOW

Indicators of the '*intensity'* (or velocity) in the build-up of credit – i.e. credit flow indicators for a given period, as for example the annual real credit growth proposed in Repullo and Saurina (2011) – stand out as potentially useful complements to the Basel gap in at least two respects. First, they can provide more timely signals of rapid credit growth processes which the Basel gap may take time to capture. This may occur, for instance, in situations following a strong period of credit growth such as that experienced in Spain before the recent crisis (see discussion at the end of Section 3). Second, periods of very rapid growth may bring about risks to financial stability even though the 'credit excess limit' set by the Basel gap is not crossed. This may be relevant, for example, in developing financial markets.

More generally, real credit growth should be a good signal of when lenders are underestimating risks and consequently credit is growing steadily and rapidly over time. In fact, in the three crisis periods identified in Spain, the annual growth rate of credit was above its long-term average for at least some quarters prior to the crises (see Chart 4, Panel 1). And this was more so in the case of the two (the first and third) most serious ones.

However, and despite these commendable features, real credit growth alone did not seem to be sending sufficiently timely signals for activating the CCB. Credit growth peaks too early ahead of the stress events identified – actually earlier than the start of the evaluation window we use – and it declines significantly during these time windows. Besides, owing to its relatively high volatility it tends to generate less stable signals in comparison with other possible indicators.

A promising refinement is what we have called the 'credit intensity' indicator, defined as the annual change in non-financial private-sector credit divided by four-quarter cumulated GDP. This indicator can be considered a proxy for new credit, so it gives an idea

of the extent to which expenditure is being supported by new credit, and therefore of whether that level of expenditure is sustainable or not. As such, a high value of the indicator should point to unsustainable expenditure levels. Further, both the numerator and the denominator of the ratio are capturing annual flows, which is conceptually appealing. The importance of credit flows for GDP growth has also been emphasised in Biggs el al. (2009) when analysing credit-less recoveries. These authors find that GDP growth is more strongly correlated with changes in credit flows than with changes in credit levels. Finally, the proposed 'credit intensity' indicator has also been one of the indicators chosen for the EU Macroeconomic Imbalance Procedure (MIP).

Chart 4 shows that the 'credit intensity' indicator peaks well ahead of the three identified events and it remains high for most of the build-up periods, particularly in the two systemic ones. Also of relevance is the fact that this indicator is not subject to the high inertia observed in the credit-to-GDP gap, which makes it more likely to capture in a timely fashion potential future episodes of excessive credit growth.[19]

5.1.2 STRUCTURAL BASEL GAP

As earlier discussed, the Spanish data illustrate some limitations which may arise with the Basel gap in practice. This is shown, for example, by the fact that the gap values in the first two build-up periods (orange-shaded) in Spain are generally not higher than in tranquil periods (see Chart 4, Panel 3), suggesting no need to accumulate the CCB on those occasions. On the other hand, the gap values increase very rapidly at the end of the 1990s without an imminent crisis ahead.

As stated, most of these problems are due to limitations in the HP filter used to calculate the long-run trend. Results tend to improve when we use a real-time structural estimate of the equilibrium credit-to-GDP ratio, rather than the HP filter.

We constructed a database of quarterly variables (1970Q4-2014Q2) for 20 developed countries to estimate credit-to-GDP equilibrium values.[20] This database includes the following variables: credit-to-GDP ratio (from the BIS), per capita GDP in PPP, 10-year nominal interest rates, inflation rate (GDP deflator) and an indicator of financial liberalisation obtained from the IMF.[21] Other potential explanatory variables such as wealth, financial development, tax treatment of credit, and the presence of safety networks were not available for the time span needed, but the variables included should still capture at least part of their effects. We also use country-specific dummies to control for time-invariant characteristics in each country.

We estimate a panel regression in levels of the (log of) credit-to-GDP ratio over per capita GDP, a nominal interest rate, the inflation rate and the indicator of financial liberalisation. All these variables can be considered non-stationary, so if the residuals of the regression are stationary, the estimators are super-consistent, thus relieving the usual endogeneity problems in this kind of exercise.

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19. Simplicity is also a plus. The indicator appears to show no long-term trend (i.e. it is stationary) and therefore threshold values for guiding the CCB accumulation could eventually be calibrated without using any statistical filter. As put by Calomiris (2012): "Only simple rules can avoid dependence on regulatory discretion, which is subject to political manipulation; automatically enforced, transparent rules are incentive-robust for regulators".

20. The countries are: Austria, Australia, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, UK, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Sweden and US.

21. See Abiad, Detragiache and Tressel (2008).

The estimated equation with the best fit was the following:

$$\left(\frac{cr}{y}\right)_{it} = -\underset{(0.16)}{0.36} + d_i + \underset{(0.01)}{0.26} euro_{it} + \underset{(0.02)}{0.55} yc_{it} - \underset{(0.09)}{1.83} ic_{it} \qquad [1]$$

$$R^2 = 0.87;\ RMSE = 0.16;\ N = 3500;\ DF = 0.31$$

As expected, the per capita income (yc) has a positive impact on the credit-to-GDP-ratio (cr/gdp). Richer individuals are able to obtain more credit (they have higher collateral and they can assume higher debt service) and they tend to consume more credit goods (durables and housing). The nominal interest rate (ic) captures both the traditional price effect and the impact of inflation on the affordability of new debt. The estimates also confirm the expected negative effect of the nominal interest rates on the credit-to-GDP ratio. Besides, the regression includes a dummy capturing the creation of the monetary union. Neither inflation nor the financial liberalisation index were found to be significant. The model has a good fit and unit root tests (DF-type) suggest there are no major problems with non-stationarity of the residuals.

Nonetheless, as explained, this exercise should be conducted in real time to be valid for policy purposes. To study this aspect we explore how the proposed empirical model to estimate equilibrium values of the credit-to-GDP ratio would have performed in the past if estimated recursively with different information sets at different points in time (Chart 5). As can be seen, despite using an international panel dataset, the parameter estimates are not completely stable. Joining the euro area, for example, implies a jump in the 'equilibrium' ratio. This can be interpreted as a consequence of the perceived gains in terms of macroeconomic stability and credibility that joining the euro area meant to some countries, together with increasing financial integration among members. In any case, a point worth noting is that parameters are estimated with a substantial amount of uncertainty as reflected in the difference between 2010 and 2014 estimates.

Without losing sight of the aforementioned instability, Chart 4 shows the resulting gap ('structural credit to GDP gap') between headline and equilibrium values of the credit-to-GDP ratio calculated in real time. The indicator shows an upward trend and was significantly positive in anticipation of the two crises identified as systemic. On the contrary, it was negatively signed in the 1990s crisis although it increased by 10 percentage points in 1990. It is interesting to note that while in 1989 and 1990 the Banco de España introduced administrative limits to banks' credit growth, this indicator alone would not have shown that need.

5.2 Debt burden

Indicators capturing excessive debt service ratios by households and corporations have been widely supported in the recent literature on guiding indicators for the CCB [see, for example, Drehmann and Juselius (2012, 2014), Detken et al. (2014), Giese et al. (2014)]. These indicators focus on the borrowers' side, providing information on the level of private sector indebtedness and its sustainability.

In general, debt service indicators capture the fraction of income devoted to debt reimbursements. The latter can be split into two parts: accrued interest payments and principal payments. The indicators thus incorporate information not only on the debt level but also on interest rates and maturity. This is valuable information, as both aspects have an effect on debt sustainability.

Following Drehmann and Juselius (2012) we construct the debt burden indicators based on available data inputs for Spain. In particular, we calculate a debt burden (*db*) according to the following expression:[22]

$$db_t = \frac{i_t}{[1-(1+i_t)^{-m_t}]} \frac{D_t}{(Y_t + i_t D_t)} \quad [2]$$

Where *i* is the outstanding debt interest rate, *D* is the total debt analysed earlier, *m* is the debt maturity and *Y* is private agents' disposable income. We calculate the debt burden ratio both for the aggregate of households and non-financial corporations, using GDP as the measure of disposable income.[23] As Panel 1 of Chart 6 shows, the debt burden for the non-financial private sector hovers around 14% of GDP until the mid-2000s. It then increases considerably before the recent banking crisis and diminishes afterwards, although it is still above the previous levels. Note that this indicator increases before the three stress periods, although it is also relatively high during the 70s crisis – a period in which it even rose further – and the quiet period that followed.

A difficulty with this indicator is that it is influenced by the business cycle through its effects on disposable income and interest rates. And there is some evidence suggesting that business and credit cycles interact [see, for example, Claessens, Kose and Terrones (2011)]. One way to tackle this interaction effect is by calculating a debt service ratio based on cycle-free inputs, i.e. potential disposable income (derived from potential GDP)[24] and the natural interest rate.[25] Panel 2 of Chart 6 shows the results when using these inputs.

The indicator now is similar but shows a declining trend during the 70s crisis. Thus, it reached a peak before each of the three stress events identified in Spain, with the second event signalled as a minor one, consistent with its non-systemic nature.

5.3 Real estate prices

Risks from excessive credit growth and rising property prices can often reinforce each other in anticipation of systemic banking crises [see, for example, Borio and Drehmann (2009), Barrel et al. (2010) and Behn et al. (2013)]. The two variables tend to move in tandem because of the role of credit in supporting housing purchases and the role of housing wealth (as collateral) in decisions on loan supply. As a result, unusually high or rapid increases in property prices can provide useful information to identify an excessive credit growth process. Further, unsustainably high real estate prices may also act as an additional source of systemic risk themselves.

As with credit, growth rates and levels (including deviations from 'equilibrium' levels) of real estate prices are possible candidates. Accordingly, we consider annual growth rates of real house prices and four additional indicators for the sector: price-to-income ratio, price-to-rent ratio, a HP-based house price gap and a structural house price gap (Chart 7).

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22. This expression is slightly different from that of Drehmann and Juselius (2012) as the denominator of this expression also includes interest payments. Note that disposable income of households and nonfinancial corporations is net of these payments.

23. Separate ratios for households and non-financial corporations do not lead to better results than the aggregate ratio.

24. Potential disposable income is obtained by smoothing the observed ratio of disposable income over GDP and multiplying it by potential GDP.

25. The natural interest rate is obtained by adding potential growth to target inflation, as in Hofmann and Bogdanova (2012).

Real house prices grew strongly ahead of all the identified stress events. However, as was the case with real credit growth, the annual growth rate tends to peak too early and is already declining during the buffer build-up periods, making it less suitable as a guide for CCB activation but probably more useful for its release.

Turning to house price indicators, when we normalise by income (i.e. price-to-income ratio) we see distinct local peaks during the build-up periods, suggesting that this may be an informative indicator to guide CCB activation. However, each new peak tends to be higher than the previous one, with the ratio showing an implicit long-run upward trend. This pattern is even clearer for the price-to-rent ratio, probably due to the characteristics of the Spanish rental market which is rather small and has traditionally been subject to considerable regulatory constraints. As a result, housing rents appear to be a relatively weak indicator of trends in housing prices.

Selecting reference values or thresholds to guide CCB activation is harder in the presence of implicit trends. As in other cases, for real estate prices, this problem may be tackled by applying the HP filter to separate the trend and calculate the indicator in 'gap format' as in the Basel gap, or alternatively by using a structural model of house prices to estimate the long-term trend. We study both options.

The one-sided HP gap (i.e. the 'real time' gap) for housing prices works well ahead of the second and third stress event. But it does not work in the first event as there is insufficient historical data for that period.[26] Unlike the credit-to-GDP gap, the one-sided HP gap for house prices does not show abrupt changes, making it more useful as a complementary guiding indicator for the CCB.

Although the HP trend to calculate the house price gap worked in our sample, structural changes may still occur. To illustrate how a structural house price indicator may work in practice, we use an empirical model to estimate changes in the sustainable level of house prices based exclusively on Spanish data. While not free from trade-offs, this would allow us to better capture specificities in the Spanish housing market.[27]

The model has two explanatory variables. First, according to historical evidence in Spain, we assume that 'equilibrium' prices increase one-to-one with income. Second, we estimate the impact on long-term price-to-income values of the first principal component computed on three variables: nominal mortgage interest rates, banks' intermediation margin (spread between loan rates and deposit rates) and credit-to-GDP gap. This first component aims to capture the effects from diverse factors occurring in Spain – such as credit market liberalisation, greater macroeconomic stability and deepening of mortgage markets – which have helped to increase credit availability for house purchasers, pushing up both demand and prices.

As we did for the structural credit-to-GDP gap, we perform a real-time exercise, meaning that both the credit factor and its impact on 'equilibrium' house prices are estimated at each point in time only with information available at that point.[28] We then calculate the gap between actual and equilibrium prices. The resulting structural indicator is shown in Chart 7.

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26. This is confirmed when a two-sided HP filter is applied instead of the one-sided one in the gap calculation. The gap using a two-sided filter with actual future values would also pick up the first stress event.

27. In this connection, Muellbauer (2012) argues against simple panel analysis of house prices across countries, due to the omission of important institutional differences.

28. Before 1986, due to the lack of sufficient data to estimate the credit factor, the equilibrium price is assumed to be the average value of house price to income.

The gap is both clearly positive and high ahead of the three stress events identified. A possible caveat is that the house price gap seems unable to identify differences in the severity of crises. Its maximum level ahead of the non-systemic 1993-1994 crisis is similar to those ahead of the two other systemic crises, whose consequences for the financial sector and the real economy were significantly higher.

5.4 External imbalances

The indicators analysed above directly capture, or are closely linked to, credit behaviour. Other promising indicators for the purpose of signalling excessive credit growth periods are those that indirectly react to it. In that respect, it has been generally observed that when credit grows well above GDP, consumption and investment increase, and domestically generated savings are insufficient to finance the credit expansion. As a result, resources have to be 'imported' from abroad and this is recorded in the balance of payments as a deficit on the current account.[29] For this reason, the current account balance of the economy as a whole can be a useful leading indicator of financial distress, notably when deficits of a certain size are recorded over a sustained time period.

As before, we consider a headline indicator calculated as the current account over GDP ratio (the current account balance), and a structural gap version (a measure of the ratio in deviations from its structural level).

Panels 1 and 2 of Chart 8 show, respectively, the headline and the structural gap versions. The latter is derived from the results obtained by the International Monetary Fund in the External Balance Assessment (EBA) Methodology.[30] The EBA is the tool developed by the IMF to analyse the nature of countries' external imbalances. In the case of the current account, this tool is based on panel regression techniques which allow its main determinants to be identified. As we are borrowing the results from the IMF we preferred not to perform the exercise in 'real-time', thus the results presented here should be interpreted as indicative of its potentiality.

The explanatory variables include non-policy variables (relative productivity, relative expected GDP growth, net foreign assets position, exhaustible resources, relative demographic factors, financial centre and relative institutional environment), financial variables (relative reserve currency status, global capital market conditions, relative private credit to GDP), cyclical variables (relative output gap and commodities terms of trade) and policy variables (relative public balance cyclically adjusted, relative public health expenditure over GDP, exchange rate interventions and capital controls.) In our case, we obtain the structural level of the current account by dropping the effects of the variables that are most closely related to the business or the financial cycle (relative expected GDP growth, global capital market conditions, relative output gap and commodities terms of trade).[31]

As the chart shows, both series have a very similar profile, especially before the 1990s. Afterwards, differences between them seem to be greater. From this perspective,

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29. Alternatively, an increase in the supply of external funding can itself contribute to the excessive growth of domestic credit and expenditure.

30. For both the methodology and the dataset, see: https://www.imf.org/external/np/res/eba/.

31. The IMF database is annual and only covers the period 1986-2013. In the case of the Spanish data, we have extended it backwards to 1970 using different domestic sources. In order to calculate the variables in relative terms, we have aggregated data for the countries where those variables were available; therefore, the results before 1986 are purely illustrative. We have also interpolated the annual results obtained with the EBA methodology to quarterly frequency using the current account balance figures.

the stress events identified seem to be preceded by a deficit of around 4% of GDP in the headline current account or in its deviation from the estimated structural level. It is noteworthy, besides, that both ratios fluctuate around a stable level (more so in the case of the deviations).

It should also be noted that the sources of the observed current account deficits were very different in the three episodes. In the 1970s the oil price shocks played a leading role; in the 1990s insufficient savings were the key; and in the 2000s excessive investment in the real estate sector was at the heart of the observed events. According to the structural approach, the current account deficit recorded in the 2000s can be explained by two main factors: first, demographic developments related to the immigration flows which inverted the ageing trend, and second the adoption of a currency, the euro, in which a significant part of world reserves are denominated. The second factor, unlike the first, is permanent. Note also that commercial and financial openness in Spain was very different in each period. However, in all the cases considered a stress event was recorded some time later.

As a result, the current account balance sent informative signals ahead of the three stress events identified and its dynamics are also consistent with the concepts underlying this indicator. The indicator seems to work even better when it is calculated as deviations from its structural level.

6 A quantitative assessment of the various indicators

In this section we assess each complementary indicator and the Basel gap on a standalone basis, using the non-parametric (AUROC and psAUROC) and parametric (logit) procedures introduced in section 4.

The upper panel in Table 1 shows the results when using the three stress events identified in Spain. Indicators are ordered by their AUROC. The first point to note is that there is a clear correlation in the results for the parametric and non-parametric approaches, although with higher variation in the psAUROC measure.[32]

The indicators with the highest AUROC are the structural house price gap and the two current account balance measures. The two indicators of non-financial private sector debt service, house price overvaluation measures (house price to income ratio and real house price gap), structural credit to GDP gap and credit intensity (net change in credit divided by GDP) also appear as useful complementary indicators. Given the specificities in the Spanish data commented in previous sections, the Basel gap presents lower statistics' value and significance than other indicators. Real credit and house price annual growth rates are uninformative, as is real GDP annual growth, included here only for comparison.

We also find that the gaps obtained with the structural exercises can substantially improve the results when compared to the non-structural specifications. When considering the three stress events, this is particularly the case for the house price gap and somewhat less so for the credit to GDP gap, which may be suggesting – once again – the difficulties in estimating structural levels of sustainable aggregate credit in real time.

The lower panel of Table 1 shows the results when we focus only on the two systemic stress events, not taking into account the 1993Q3-1994Q3 event (the Banesto crisis). The Basel gap performs much better this time, though still behind other indicators. In keeping with this, the proposed structural (real-time) estimate of the credit to GDP gap now shows very good statistical properties, with an appreciable improvement compared to its non-structural specification.

Overall, the complementary indicators that perform best in our sample are the structural current account balance, the structural house price gap, the alternative non-financial private sector debt service and credit intensity. Note that those four indicators include at least one for each of the four categories discussed in Section 5 (i.e. credit developments, debt burden, real estate prices and external imbalances). And, in the case of credit developments, they include both a measure of 'excess' credit and a measure of the 'intensity' (or velocity) at which credit excesses are building up.

A natural extension of these results would be to explore a multivariate approach, looking for the best performing combinations of the above-mentioned indicators.

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32. When starting from a sufficiently low (prudent) threshold, which implies zero missed crises, the number of false alarms cannot be reduced without necessarily increasing the number of missed crises by more than the reduction in false alarms; the psAUROC procedure ignores higher thresholds. If the number of crisis periods is relatively limited, as in our database, the resulting number of false alarms at that maximum threshold can be relatively high, which explains why a psAUROC of 100% may sometimes correspond to a relatively low AUROC.

Unfortunately, this approach proves to be not very useful in our case. As the charts and Table 1 show, several indicators already have very good early-warning properties to anticipate the events we have identified. This means that not only are they highly correlated among themselves, but also that the margin for improvement in predicting crises is limited, leading to serious risks of over-fitting in a multivariate analysis. In fact, when we combine the single best-performing indicator for the 3-crises case (the structural house price gap) with all the others in a logit regression, the additional indicator is non-significant in all but four cases and, of these, only one shows the expected sign (the structural current account), with the pseudo-R^2 increasing from 69.4% to 80.5%.

We interpret this as suggesting that the country-specific data we use does not allow us to extract more detailed inference on the predictive capacity of selected indicators of systemic banking crises, beyond what we can obtain on a standalone basis. This problem may be overcome in a cross-country analysis, with a higher number of crisis episodes, but this also entails a trade-off between data availability and comparability. Finally, given the multidimensional nature of systemic financial crises, the advantages and disadvantages from combining different indicators should be carefully considered.

7 Conclusions

Sound policy rules are very much needed to ensure predictability and avoid time inconsistency problems. Yet designing and implementing simple, comparable and effective countercyclical policy rules is not an easy task. This has been the case for fiscal and monetary policy, for example, and macroprudential policy is no exception. That is why a sound analysis of the historical behaviour and theoretical underpinnings of potential guiding indicators for the accumulation of the CCB is an important exercise and this paper aims to provide some insights on this.

EU legislation requires that a countercyclical capital buffer be set starting on the basis of the credit-to-GDP gap (as defined in Basel) and possibly complementing it with other specifications or indicators if needed, besides qualitative information. Drawing on empirical evidence in Spain, we suggest a number of issues to be considered when applying this benchmark guide. We find that the credit-to-GDP gap has important limitations when dealing with incomplete credit cycles and in the presence of structural changes in the data. The consequences of these issues can be observed when analysing how well the gap would have performed in Spain in the past. But these insights are also relevant for the future, as illustrated with some simple simulations.

We find that a relatively small set of indicators, comprising economic developments typically associated with excessive credit growth periods – namely, strong credit growth, increased debt service in the private sector, house price appreciation and external imbalances – would have been useful complements to the credit-to-GDP gap in setting the CCB in Spain in the past, thus suggesting their possible value for the future or even for other countries. We also find that structural estimates of the long-run trend for the indicators in 'gap format', including the credit-to-GDP gap, can be helpful to overcome some of the issues observed with the one-sided HP filter and to improve the performance of the indicators.

Specifically, we find that indicators of 'credit intensity' (the ratio of changes in credit to GDP), property prices (structural house price gap), external imbalances (headline or structural current account as a percentage of GDP) and private sector debt sustainability (cyclically-adjusted debt burden ratio for the non-financial private sector) can help to identify periods of excess credit growth associated with an increase in systemic risks. In the quest for simplicity it is also worth noting that no statistical transformation was needed for the credit intensity and current account balance indicators.

At this stage we do not assess any possible rules for combining or aggregating information from different indicators. There are two main reasons for this. First, systemic risks are multidimensional, so it is difficult to anticipate what exactly the trigger for the next crisis will be. This means that information from indicators on a standalone basis is still useful for CCB purposes. Second, given the non-mutually independent dynamics of the indicators we consider, there are practical difficulties in disentangling their relative informative value by using a limited number of crisis observations, as is typically the case in country-specific analyses such as ours.

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APPENDIX 1: Database and sources

Total debt of households and non-financial corporations.

Since December 1994, this consists of all the loans and debt securities of households and non-financial corporations, including inter-company loans, according to the Financial Accounts of the Spanish Economy based on the ESA 2010. These data are extended back to March 1980, using growth rates taken from the Financial Accounts based on the ESA 1995, and to March 1962, using the growth rates of total bank loans to "other resident sectors".[33]

Gross Domestic Product.

We first construct annual series for nominal and real GDP compatible with the new definition of ESA 2010. The official series from the National Statistics Institute (INE) (1995-2013) are extended backwards using growth rates for GDP Base 2000.[34] Data for the years before 1970 are taken from the BDMACRO database of the Ministry of Finance.

Subsequently, quarterly series are obtained by interpolating the annual data using quarterly GDP Base 2000 data, for the period from 1970, and electric energy consumption and CPI, for the period before 1970.

Potential GDP is calculated as the simple average of: a two-sided HP filter with lambda equal to 1,600, a two-sided HP filter with lambda equal to 20,000, the European Commission's output gap indicator and the IMF's output gap indicator. The latter two indicators are interpolated to obtain quarterly data using a two-sided HP filter with lambda equal to 20,000.

House prices.

Since 2007, these are based on the Housing Price Index produced by the INE.[35] These data are extended backwards using growth rates obtained from Ministerio de Fomento housing price statistics (to 1987), house prices in the capital from Tecnigrama (to 1977) and the residential investment deflator (to 1970). Annual data series were interpolated and adjustments were made to take into account the different variability of the various series considered.

Housing rents.

An index based on the housing rent component of the CPI.

Current account balance.

Since 1989 it is obtained from the Spanish Balance of Payments (2000-2014, based on the sixth edition of the IMF's Balance of Payments Manual; 1989-1999, based on the fifth edition of the IMF's Balance of Payments Manual) and, between 1970 and 1988, based on the previous balance of payments methodology.

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33. "Other resident sectors" includes all residents other than credit institutions and general government.
34. Investment in R&D is estimated and added separately.
35. This is a hedonic index that adjusts for changes in housing quality.

Average interest rate on households' and non-financial corporations' debt.

For the period since 2003, interest rates on outstanding amounts are taken from harmonised Eurosystem statistics (Table 19.12 of the Statistical Bulletin of the Banco de España). For the period before 2003, they are derived from internal estimates of the interest rates applied by banks to new loans.

Average maturity of the debt of households and non-financial corporations.

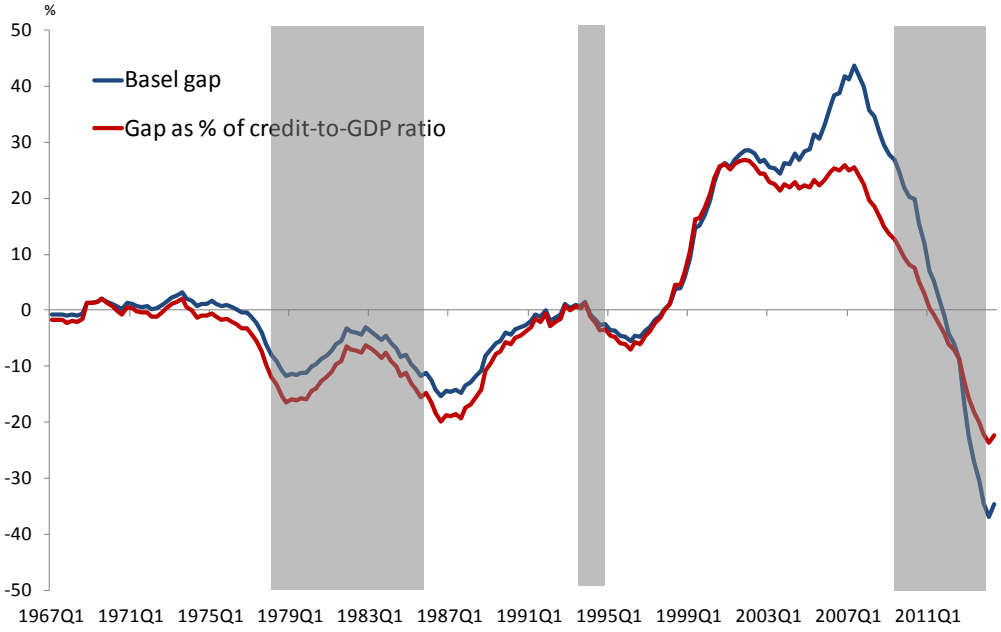
The average maturity of the debt of households and non-financial corporations is obtained from the breakdown of debt levels by maturity in the Spanish Financial Accounts. It is assumed that the average maturity of short-term debt is two quarters and in the case of long-term debt, 58 quarters for households and 46 quarters for non-financial corporations. The latter difference reflects the fact that most long-term household debt has a maturity of more than 5 years, whereas most long-term debt of non-financial corporations has a maturity of 1-5 years. Prior to 1980, the average maturity is kept at the level of 1980.

Disposable income of households and non-financial corporations.

For the period since 1980, these variables are taken from the database of the Banco de España's Quarterly Macroeconometric Model of the Spanish Economy. The data are extended back to 1970 using, interpolated National Accounts annual data.

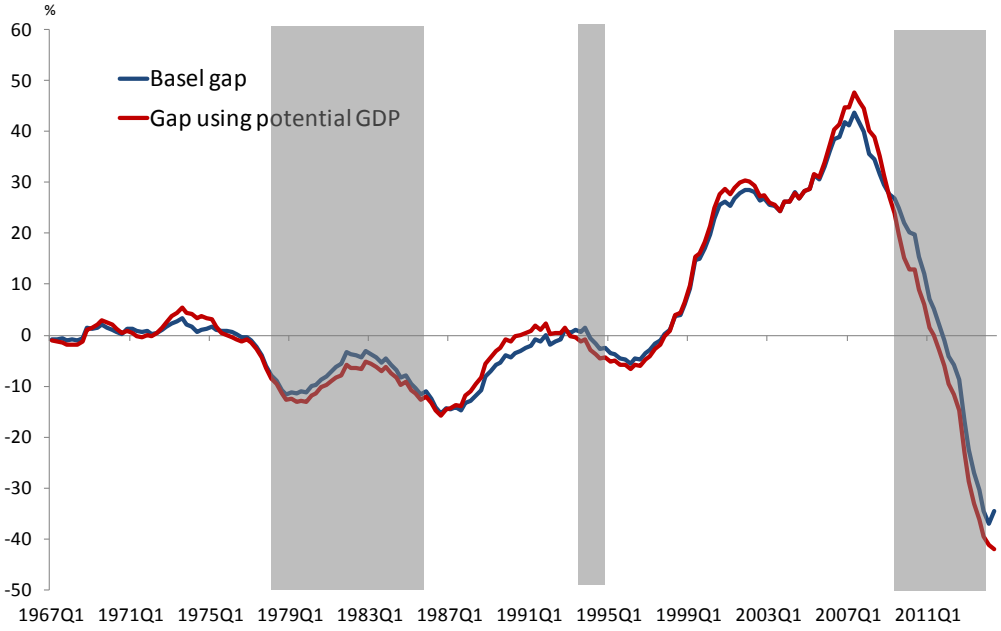
APPENDIX 2: Alternative definitions of the credit-to-GDP gap

Chart A.2.1: Gap as percentage of credit-to-GDP ratio



Sources: BdE, INE and own calculations.

Chart A.2.2: Gap using potential GDP



Sources: BdE, INE and own calculations.

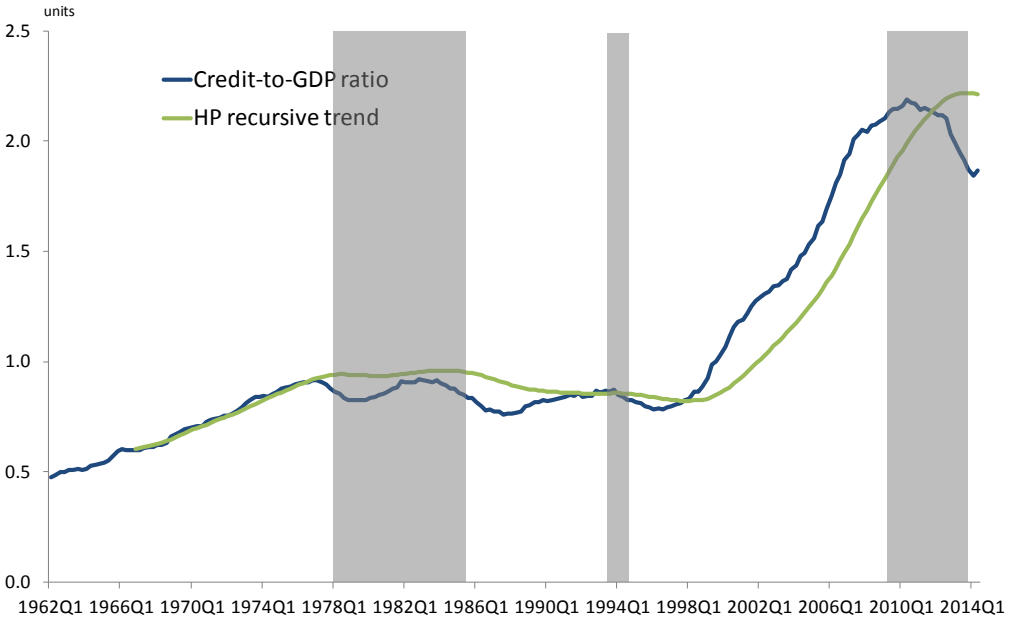
APPENDIX 3: Guiding indicators for the CCB explored in recent literature

Papers	Credit gaps (e.g. credit-to-GDP gap)	Credit growth (e.g. real total credit growth)	Real estate prices (e.g. real residential prices/over-valuation)	External imbalances (e.g. current account)	Private sector debt burden (e.g. debt service ratio)	Balance sheet (e.g. loan-to-deposits ratio)	Market-based (e.g. equity prices)	Macro-economic (e.g. GDP growth)	Other
Alessandri et al. (2015)	X	X	X			X		X	
Alessi and Detken (2014)	X	X	X	X	X		X	X	
Bank of England (2013)	X	X		X		X	X		
Behn et al. (2013)	X	X	X				X		
Bonfim and Monteiro (2013)	X	X	X	X*			X	X	
Denmark SRC (2014)	X		X		X	X			
Detken et al. (2014)	X	X	X	X	X		X	X	
Drehmann and Juselius (2014)	X	X*	X*		X	X	X*		
Gerdrup et al. (2013)	X		X			X			
Gersl and Seidler (2011)	X	X							
Giese et al. (2014)	X	X	X		X	X	X		Mortgage and bank funding spreads
Jokivuolle et al. (2015)	X							X	
Kalatie et al. (2015)	X	X	X	X	X	X	X		
Kauko (2012)	X		X	X					
Kelly et al. (2013)	X								
Rychtárik (2014)	X	X	X		X	X		X	
Valinskytė and Rupeika (2015)	X		X	X	X	X	X		

*Low predictive power.

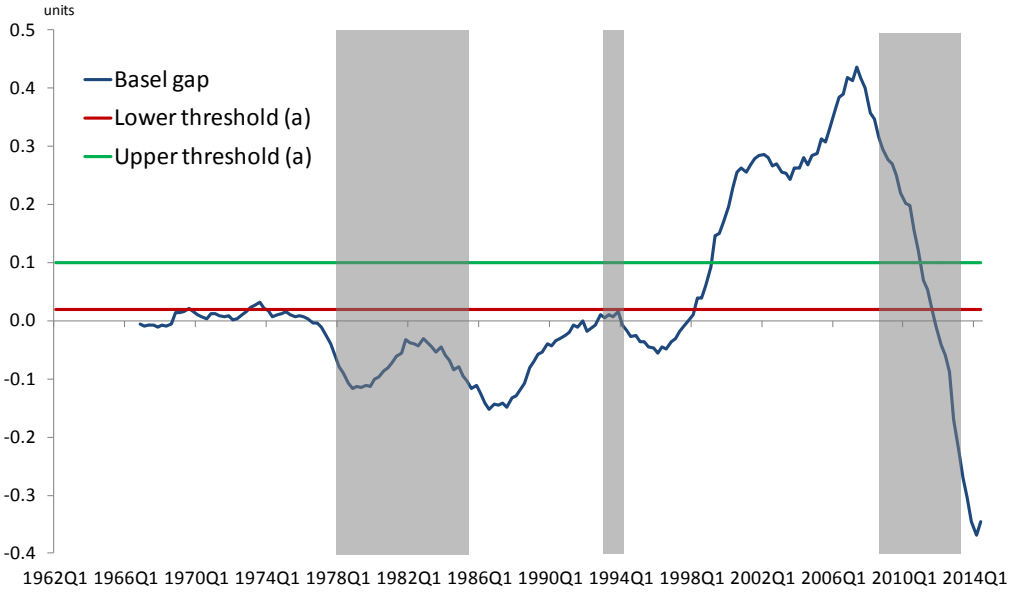
CHARTS

Chart 1: Credit-to-GDP ratio in Spain



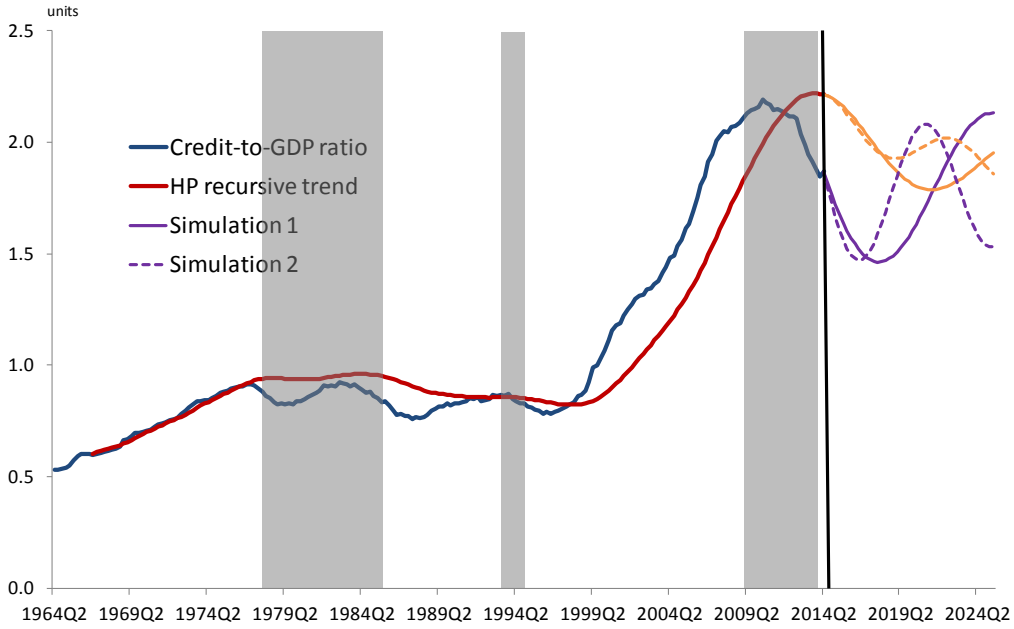
Sources: BdE, INE and own calculations.

Chart 2: Baseline Basel gap and thresholds. Application to Spain



Sources: BdE, INE and own calculations.
a. Banks have a year to comply with the required CCB when the gap exceeds the threshold.

Chart 3: Arbitrary example of simulated credit-to-GDP ratio in Spain



Sources: BdE, INE and own calculations.

Chart 4: Credit development indicators

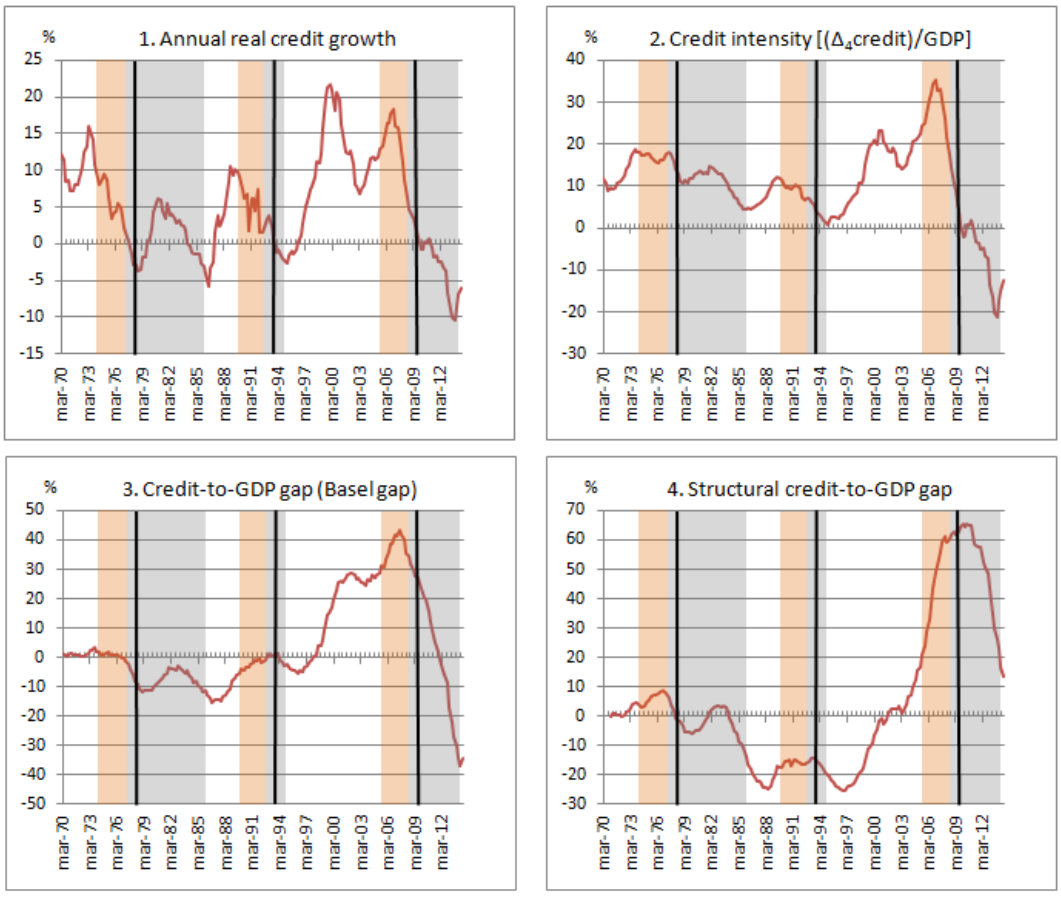
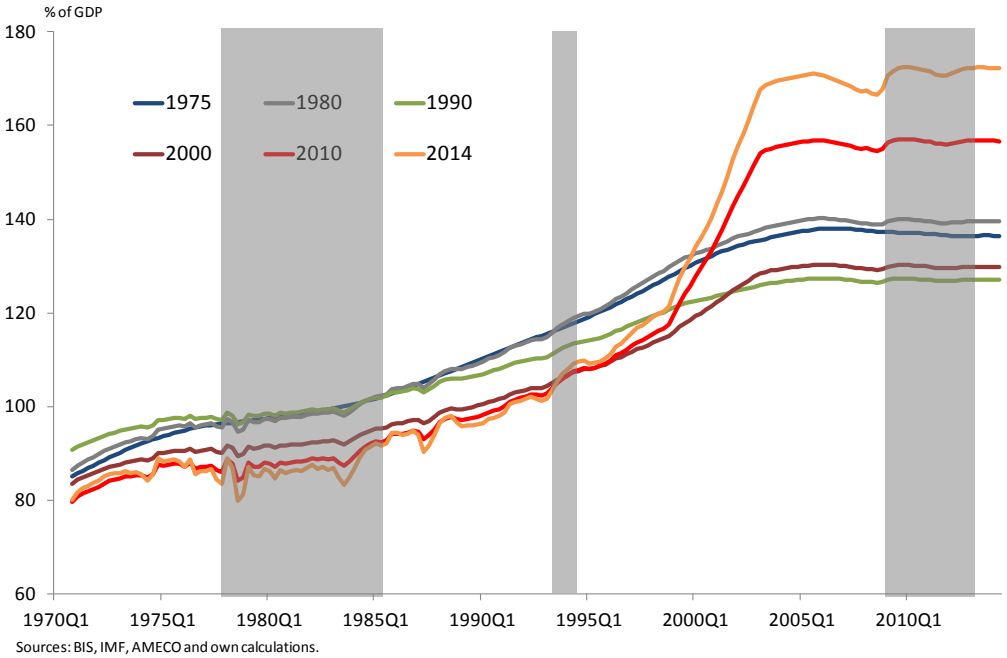


Chart 5: "Equilibrium" estimates of the credit-to-GDP ratio



Sources: BIS, IMF, AMECO and own calculations.

Chart 6: Debt service burden indicators

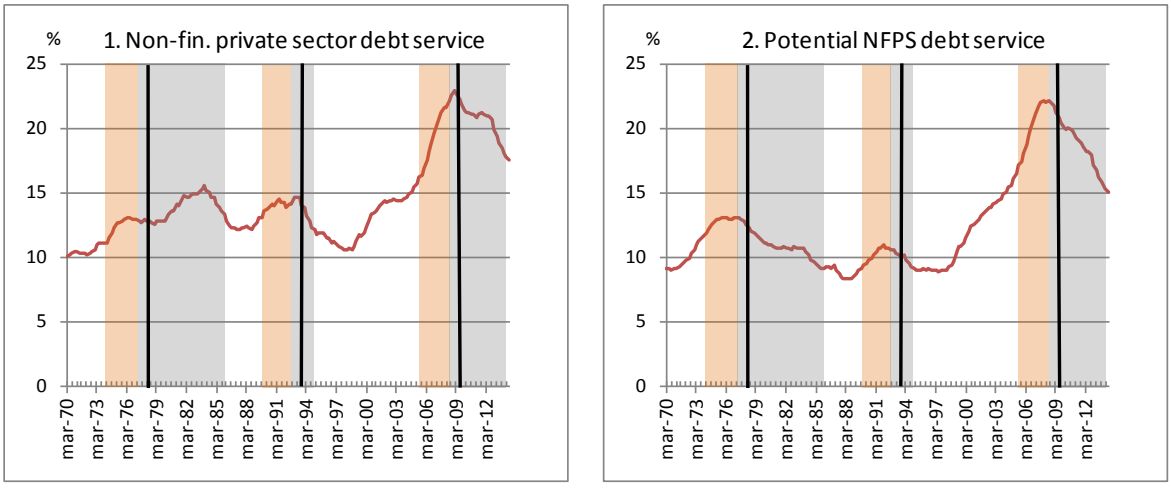


Chart 7: Real estate development indicators

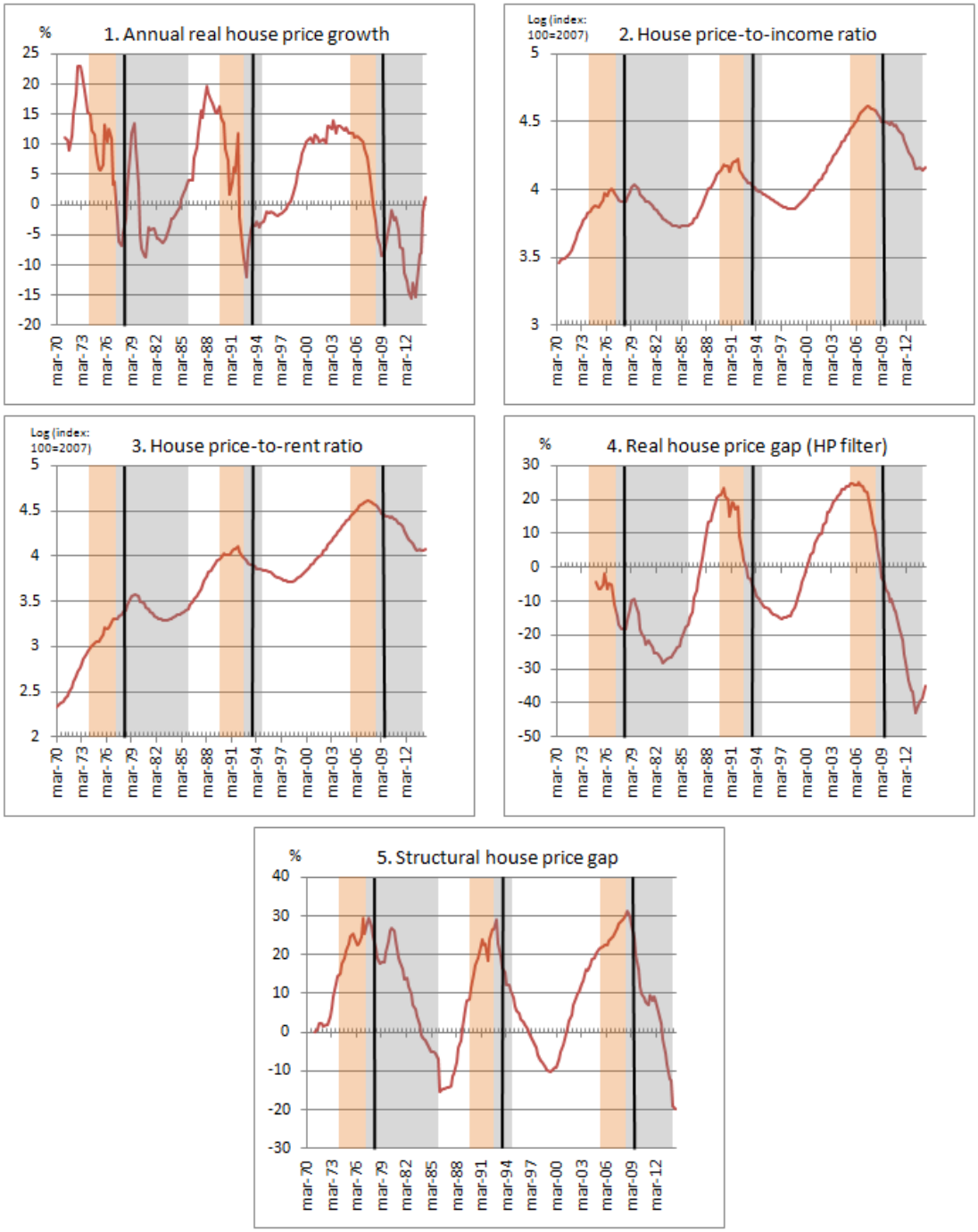
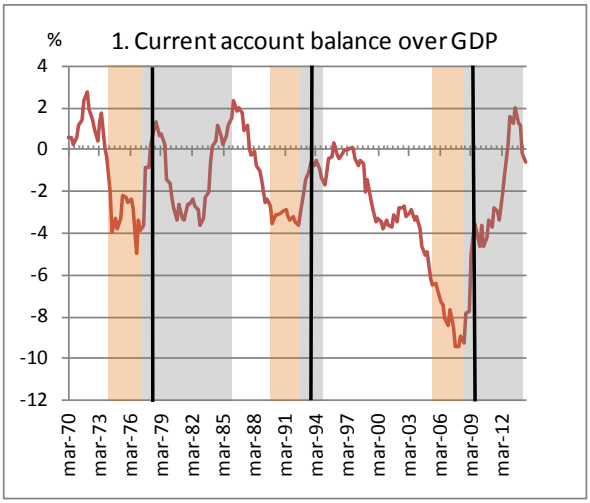
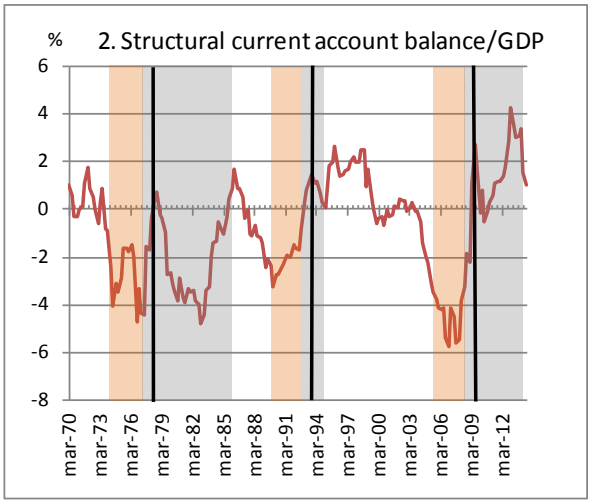


Chart 8: External imbalance indicators





QUANTITATIVE ASSESSMENT OF INDICATORS TO GUIDE THE CCB BUILD-UP IN SPAIN (a) TABLE 1

	AUROC (%)		psAUROC (%)(d)	LOGIT PSEUDO-R2 (%)	
THREE STRESS EVENTS (b)					
Structural house price gap	97.6	***	99.4	69.4	***
Structural current account balance (% of GDP)	96.9	***	100.0	70.8	***
Current account balance (% of GDP)	86.1	***	100.0	37.4	***
Non-fin. private sect. debt service	78.9	***	93.8	21.2	***
House price-to-income ratio	78.2	***	83.6	20.7	***
Potential NFPS debt service	77.1	***	98.8	17.2	***
Structural credit-to-GDP gap	77.0	***	80.4	16.8	***
Real house price gap	75.8	***	100.0	13.0	***
Credit intensity [($\Delta_4$credit)/GDP]	70.8	***	80.5	14.2	***
House price-to-rent ratio	67.2	***	68.5	4.5	**
Credit-to-GDP gap (Basel gap)	60.7	*	60.7	3.2	**
Real annual credit growth	51.1	-	-	0.3	-
Real annual house price growth	44.9	-	-	0.3	(e)
Real annual GDP growth	38.8	-	-	4.8	(e)
TWO SYSTEMIC CRISES (c)					
Structural credit-to-GDP gap	95.6	***	100.0	54.6	***
Structural current account balance (% of GDP)	95.5	***	100.0	63.7	***
Structural house price gap	93.6	***	99.5	50.8	***
Potential NFPS debt service	90.5	***	100.0	42.2	***
Credit intensity [($\Delta_4$credit)/GDP]	88.8	***	100.0	42.0	***
Current account balance (% of GDP)	87.5	***	100.0	42.2	***
Credit-to-GDP gap (Basel gap)	78.2	***	78.2	14.5	***
Non-fin. private sect. debt service	73.5	***	73.8	21.6	***
House price-to-income ratio	69.5	***	69.5	17.0	***
Real house price gap	68.9	***	69.5	4.8	**
Real annual credit growth	65.6	***	-	4.6	**
House price-to-rent ratio	58.3	-	58.3	1.1	-
Real annual house price growth	53.8	-	-	0.9	-
Real annual GDP growth	47.5	-	-	0.4	(e)

SOURCES: Banco de España, Instituto Nacional de Estadística, Ministerio de Fomento, Mineco and own calculations.

a. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.
b. 1978Q1-1985Q3, 1993Q3-1994Q3 and 2009Q2-2013Q4.
c. 1978Q1-1985Q3 and 2009Q2-2013Q4.
d. Partial standardised AUROC, restricted to threshold values consistent with policy-makers at least as concerned about missing crises as about receiving false alarms. Values are not presented when the ROC is not well-behaved, leading to inconsistent results.
e. Coefficient with a sign opposite to the one theoretically expected.

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