EUROPEAN CENTRAL BANK
EUROSYSTEM

WORKING PAPER SERIES
NO 1094 / SEPTEMBER 2009

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In 2009 all ECB publications feature a motif taken from the €200 banknote.

1 The authors would like to thank an anonymous referee for very useful suggestions as well as Marcel Fratzscher, Isabel Vansteenkiste, Frank Westermann, Thierry Bracke and Filippo di Mauro. The views expressed are solely our own and do not necessarily reflect those of the European Central Bank.

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ISSN 1725-2806 (online)

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Abstract

The contribution of this paper is to revisit the Early Warning System (EWS) literature by analysing selected episodes of financial market crisis, i.e. those preceded by a spell of credit and real estate expansions. The aim is to disentangle instances when this constitutes a natural phenomenon associated with a process of financial development and innovation from those where it constitutes a worrisome signal. We identify economic variables that have leading indicator properties, thus helping to distinguish between "benign" episodes from those likely ending with *downward pressures on the exchange rate* or even a fully-fledged *banking crisis*. We find that a large current account deficit, a fall in price competitiveness, strong real growth and high public debt-to-GDP ratio increase the probability that a lending or housing boom would be accompanied by financial market tensions shortly after the peak.

Keywords: Early warning system, financial crises, house prices, credit booms

JEL Classification: E32, F31, F37

Non technical summary

Even just narrowing the attention to Europe the rapid growth of credit and housing prices have been a widespread phenomenon over recent years. This has featured in several central, eastern and south-eastern countries and was particularly evident in the Baltics. Although the stock of credit relative to GDP started from a very low base, this ratio rose sizeably over the period 2000 to 2007 from 19 to 90 percent in Latvia, 30 to 100 percent in Estonia or 7 to 35 percent in Romania. At the same time, residential prices increased, in real terms, by 16 percent in Latvia, 19 percent in Slovenia, 30 percent in Slovakia and Turkey and almost tripled in Romania, from 2002 to 2007. Spain, Ireland, the UK have also seen rapid growth in credit aggregates and/or real estate prices before the ongoing financial turmoil took grips of the world economy.

A key question for the policy maker is whether instances of credit and housing booms constitute natural phenomena associated with a process of financial development and innovation or should be worrisome. In this paper we try to provide some answers by reviewing the evidence on the basis of past experiences over the period 1980 to 2008.

The analysis can be embedded in the literature on Early Warning System (EWS) models that has flourished in the wake of the Asian crisis of 1997-98, which aimed at assessing countries' vulnerability to a financial crisis. We propose a different approach to EWS models by focusing only on special instances of financial market pressures, i.e. those preceded by a domestic credit or real estate sector boom. We aim at capturing and quantifying leading indicators that may have a more muted signalling power when a sample of heterogeneous crisis episodes is considered. The specificity of this approach lies in the fact that information about the deterioration in the fundamentals or asset price variation is extracted only from boom periods.

Technically, we start by choosing two main indicators of financial excesses for lending and housing prices. We identify booms and bust episodes for both indicators using a simplified Bry-Boschan algorithm, taken from the business-cycle literature. We then date large pressures in currency markets as well as banking crises. Putting together this information we disentangle boom episodes that were followed by episodes of financial tensions (either in the foreign exchange market or affecting the banking sector) and those that were resolved without any major consequences.

The final step consists in estimating a fixed effect logistic model which links the probability that a peak in lending or housing prices triggers a crisis within a given time period, to the evolution of a set of fundamentals. External imbalances (current account balance-to-GDP ratio), real effective exchange rate variation and public debt-to-GDP ratio best predict lending booms that result in financial market pressures. Sizeable credit and house prices growth as well as large currency appreciations increase the probability that a housing boom is likely to be followed by financial market tensions. Overall, this approach seems to help predict events of financial distress events rather well: by using a standard 10 percent signal threshold, when the boom is defined in terms of credit or housing prices, the model picks 90 and 81 percent of episodes of financial pressures respectively, although false alarms are also high at 83 and 68 percent respectively. This tool is complementary to expert analysis for quantifying country risks during lending or housing booms.

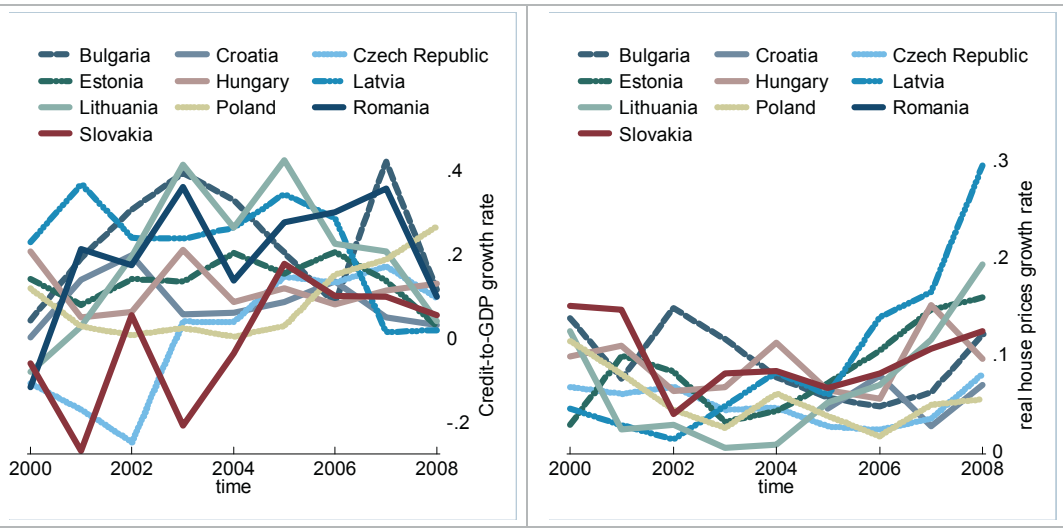
1. Introduction

Financial crises never seem to repeat themselves twice in the same way, as the world keeps finding new ways to generate them (Krugman, 1999: 471). At the same time financial crises are so disruptive that continuous efforts are made to identify commonalities among different episodes of financial turmoil. The ultimate aim is to draw lessons and design the appropriate policy responses to prevent new crises from erupting. One could argue, for example, that a common feature among the crises in Latin America in the 1980s, in the Scandinavian countries in 1992, Mexico in 1994, and South-East Asia in 1997-98 was the weaknesses of the regulatory financial systems in managing large inflows of foreign savings. All the above cases, besides resulting in periods of sustained exchange rate weakness or a fully fledged banking crisis, were preceded by a prolonged spell of excessive credit creation granted to the private sector, which in some cases was also linked to the presence of institutional distortions created by public explicit and implicit safety nets.

The over lending pattern in presence of large capital inflows and concerns over sudden stop phenomena are key issues policy makers are confronted with, as the accumulation of credit creation encourages the financing of unproductive activities or spurs excessive household consumption and may be ultimately accompanied by a large housing boom. These developments may be rationalised in terms of greater market access to world capital markets, although a point could be reached whereby a bubble develops which, ex-post at least, appears self-evident.

This paper was originally motivated by the observation of rapid credit growth and fast rising real estate prices in some European countries, particularly in central eastern and south-eastern Europe. Albeit the stock of credit relative to GDP started from a very low base in all these countries, the ratio rose sizeably over the period 2000 to 2007 in several countries, on average, by around 15% in Estonia, 21% in Lithuania, 25% in Bulgaria and Latvia (see Figures 1a-b).

Figures 1a-b: Evolution of credit-to-GDP and house prices growth rates in CEECs and the Baltics



Similar phenomena were taking place also in some Asian, Latin American countries, South Africa etc. The question facing policy makers in circumstances such as these is to what extent financial deepening, favourable external financing conditions, and improved medium-term prospects could justify the underlying developments; or policy makers should rather come to the opposite conclusion that the economy is overheated, bringing the discussion

to the next (equally difficult) level of whether corrective measures are required. In this paper our perspective is clearly at the country level, although the recent financial turmoil experience has shown the important spillover risks associated to housing and lending booms for the world economy.

Even if frequently de-emphasised in "good years" the underlying economic debate is not new:

(i) on the one hand, the economic literature has shown that promoting credit markets through an improved allocation of capital enhances economic development (King and Levine, 1993, 1994). By reducing the costs for external finance, financial deepening spurs economic growth especially in countries that have already reached a minimum threshold of financial development (Rajan and Zingales, 1998, Levine, Loayza and Beck, 2000). Empirical results point to positive effects on growth only if the countries in process of liberalising their financial sector are already at a sufficiently advanced stage of economic development and have no major macroeconomic misalignments (Arteta, Eichengreen and Wyplosz, 2001, Edwards, 2001). Moreover, the quality of the institutional framework and regulatory system in which the financial liberalisation process takes place limits the emergence of negative externalities in the form of sudden stops and international financial crises (Demirguc-Kunt and Detragiache, 1998, Kaminsky and Reinhart, 1999).

(ii) on the other hand, the economic literature has shown that periods of excessive asset prices growth, either lending or housing prices "booms", could lead to episodes of fully fledged financial crises, financial distress or protracted periods of economic slowdown.[1] Theoretically, the link between credit booms and crises has found an explanation in the financial accelerator of Kiyotaki and Moore (1997) or in the moral hazard explanations of the over-lending cycle fuelled by large capital inflows and excessive liquidity of the financial system (McKinnon and Pill (1996)). There it is argued that in an environment whereby the possibility of bank bailout encourages moral hazard on both the supply and demand sides of credit, consumption booms and current account deficits are likely to take place. Boom-bust cycles in asset prices have been documented empirically in the literature on third-generation crises as the common cause of both banking and currency crises (McKinnon and Pill, 1996, Kaminsky and Reinhart, 1999).

The crises affecting the emerging markets in the 1990s have stimulated several researchers looking for ways to explain and predict crises. The academic literature on financial crises has flourished and several models to predict the occurrence of financial crises were developed. One major approach to building an Early Warning System is the signalling approach proposed by Kaminsky, Lizondo and Reinhart (1998). Country-specific crises thresholds are derived for a large set of indicators, relating the external position, the financial sector, the real sector, the institutional structure and fiscal policy. Whenever the value of the indicator is higher than the threshold, a crisis signal is issued. If a crisis follows within 24 months, the signal is shown as having good predictive power, otherwise the signal is viewed as "noise". The optimal set of thresholds is set so as to minimise the noise-to-signal ratio.

The alternative approach consists in the use of discrete choice techniques to assess the probability of a crisis based on a set of indicators. As showed by Berg and Pattillo (1999b), a simple probit model outperforms the signalling approach in terms of out-of-sample predictions. However, as it turns out, the results are highly dependent

[1] In the literature on the costs of financial crises (e.g. Hoelscher and Quintyn, 2003), the higher the speed of credit growth in the run-up to the crises, the more disruptive its effects on the real economy.

on the way crisis episodes are defined.[2] A major element to be considered is that the nature of financial crises is not taken into account in the canonical EWS literature. This a major drawback considering that, as the currency crisis literature emphasises, not all crises have common origins or are driven by macroeconomic disequilibria given the role of psychological self-fulfilling factors and/or contagion. Aggregating and pooling countries and crises together might lead to a loss of information that could affect the estimated parameters.

In this paper our main contribution is to explore a modified approach to EWS models by focusing exclusively on the financial distress episodes preceded by a boom in domestic credit and asset prices, in particular in the real estate sector. We believe there could be merit in narrowing the search and leave aside other episodes, especially those where self-fulfilling expectations, contagion and spillover effects reduce the researcher's ability to forecast crises, as argued by Berg and Patillo (1999a).

The way we proceed is as follows. We first identify booms and bust episodes for each country and construct a large panel of data, compiling only the boom periods. We then date large swings in the currency markets and banking crises. Putting together this information we split boom episodes that were followed by financial tensions from those that were resolved without any major consequences. The final step consists in estimating a fixed effect logistic model that estimates the probability that a peak in lending or housing prices triggers a crisis as a function of a set of fundamentals.[3] This framework can be extended out-of sample for countries that never experienced instances of instability due to financial excesses. As such it can be used to gauge the probability that booming countries might experience pressures in the currency markets or a fully-fledged banking crisis shortly after the peak.

The remainder of the paper is organised as follows. In Section 2 we describe the data. In Section 3 we identify boom and bust episodes in credit and real estate markets in our sample. In Section 4 we date financial pressures in terms of large currency swings and banking crises. In Section 5 we combine the information from the previous two sections and identify the boom episodes that are followed by financial pressures. In Section 6 we use a variety of macroeconomic and financial indicators that the literature has identified as having leading indicators properties of financial crises and perform a fixed effects logistic estimation for both credit-to-GDP growth and house prices series. In Section 7 we present the in-sample results of the signal extraction methodology and derive an out-of sample example for selected central and eastern European countries. Section 8 pulls together our main conclusions.

2. Data availability

Our analysis is based on annual data. To identify lending booms we construct credit to GDP ratios using bank lending data and nominal GDP in domestic currency from the International Financial Statistics (IFS, Line 32d) and World Economic Outlook (WEO) databases respectively. These series are jointly available for 174 countries. To compute growth rates in house prices we rely on different sources. For advanced economies we employ data from

[2] More generally, Bussière and Fratzscher (2006) highlight the presence of a post-crisis bias that lowers the predictive power of any given EWS. To tackle this problem, they propose to consider a post-crisis regime, such that the crisis variable equals "zero" in normal times, "one" before and during the crisis and "two" in post-crisis periods.

[3] A fixed effects logistic model on pooled data seems therefore more appropriate than the signalling approach to capture events that are in the tail of a distribution, as noticed by Kumar, Moorthy and Perraudin (2003). Also see van den Berg, Candelon and Urbain (2008) on the use of panel models to predict financial crises.

OECD Main Economic Indicators (Housing prices index from CPI components) and Eurostat (residential property prices of existing dwellings). For emerging markets we rely on Haver Analytics, which in turns provides series directly from national sources.[4] Overall the data coverage allows us to include housing data for a set of 66 countries (using the criterion that at least 5 years of data must be available for each country). To detect currency pressures, we construct an indicator based on the nominal effective exchange rate variation and total reserves minus gold, both series being available from the IFS (Line neu and ll.d, respectively). This indicator is available for 109 countries, spanning the period from 1980 to 2008. To identify banking crises, we employ the results of existent studies of banking crises as compiled in the Annex of Reinhart and Rogoff (2008).[5]

To compile the required set of macroeconomic fundamentals we rely on a number of variables from the WEO database, i.e. current account positions, public deficit, public debt, real growth and CPI data while the real effective series is taken from the IFS (Line reu). Among the considered indicators the ones constraining the most the sample are public deficit and public debt, reducing the number of countries to 76.[6]

3. Identification of boom episodes in credit and real estate markets

The starting point for the analysis is to identify peaks and troughs for two series of economic exuberance for the period 1980 to 2008, stacking all available countries in a panel. Our analysis focuses on two economic indicators (i) credit to the private sector-to-GDP expressed in growth rates and (ii) house prices' growth rates.

Credit typically grows more rapidly than GDP as the economy develops- a process known as financial deepening. Already 40 years ago Goldsmith (1969) remarked that the level of financial intermediation moved in tandem with the level of development of an economy. Beyond financial deepening, credit can temporarily expand more rapidly than GDP because firms' investment and the requirements for working capital —i.e., funds needed to pay in advance for production inputs — are procyclical. In some emerging market countries, working capital can constitute a large part of total credit, as showed by Tornell and Westermann (2003). The risks to the financial system have been found to be associated empirically more to the rate of increase than the level of credit-to-GDP (Eichengreen and Arteta, 2000, Gourinchas, Valdes, and Landerretche, 2001). Growth in housing prices is also said to be a crucial measure for identifying periods of economic exuberance, as the economic literature has increasingly recognised (see Agnello and Schuknecht, 2009, Detken and Alessi, 2009 for recent studies).

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[4] We selected the most comprehensive indicator, mainly CPI category Housing, or if not available as such, Housing and household operations/ Housing, water, electricity, gas and other fuels.

[5] Among these studies they consider in particular, Caprio and Klingebiel (1996), Bordo and Eichengreen (1999), Kaminsky and Reinhart (1999), Jácome (2008), Jonung and Hagberg (2002), Reinhart (2002), Bordo et al. (2001). For more recent instances of turmoil, we have adopted the criterion of defining a banking crisis the situation where the IMF assistance or government bailout was required.

[6] The countries are: Antigua and Barbuda, Armenia, Australia, Austria, The Bahamas, Belgium, Belize, Bolivia, Bulgaria, Burundi, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Equatorial Guinea, Fiji, Finland, France, Georgia, Germany, Greece, Guyana, Haiti, Honduras, Hungary, Iceland, Iran, Ireland, Israel, Italy, Japan, Lesotho, Libya, Lithuania, Luxembourg, Malawi, Malaysia, Malta, Moldova, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Paraguay, Philippines, Poland, Portugal, Romania, Saudi Arabia, Singapore, Slovak Republic, South Africa, Spain, St. Lucia, St. Vincent & Grens, Sweden, Switzerland, Trinidad and Tobago, Tunisia, Uganda, Ukraine, United Kingdom, United States, Uruguay.

To identify boom-busts periods in both credit-to-GDP growth and house prices growth, we use a Bry-Boschan algorithm used by the NBER since the 1970s to date recessions. This is standard in the business-cycle literature from the early paper by Burns and Mitchell onwards (1946).[7] The turning points identified in the series of credit-to-GDP and house prices (expressed as growth rates) marks the shifts from phases of boom and bust. This methodology imposes a strict succession alternating peaks and troughs by taking out irrelevant local extreme points. Given the aims of our paper we keep in the sample only the boom years, as long as the ascending period lasts for at least three years, removing from our sample all other observations.

4. Dating currency and banking crises

The next step requires dating large currency swings and banking crises. For the former, we follow an approach that is common in the EWS literature. Following Sachs et al. (1996), we define a market pressure index as the weighted average of nominal effective exchange rates and reserves' three-month changes.

$$I_{i,m} = -\ln\left(\frac{e_m}{e_{m-3}}\right) - w \cdot \ln\left(\frac{R_m}{R_{m-3}}\right), w = \frac{\sigma_e^{\,2}}{\sigma_R^{\,2}} \qquad (1)$$

The choice of these two terms in the index is standard reflecting the notion that monetary authorities may respond to a speculative attack in the foreign exchange market by selling reserves; hence the pressure may not be apparent from movements in the exchange rate. In the above expression σ_e denotes the standard deviation of the nominal effective exchange rate 3-month variation and σ_R the standard deviation of the 3-month rate of change of total reserves over the period 1980 to 2008 to account for the different volatility in the two series.

We identify pressures in the currency markets for those months when the exchange market pressure index is two standard deviations or more above its country average market pressure index.

$$CurrencyCrisis_{i,t} = \begin{cases} 1, \text{if } I_{i,m,t} > \bar{I}_i + 2\sigma(I_i) \\ 0, \text{if otherwise} \end{cases} \qquad (2)$$

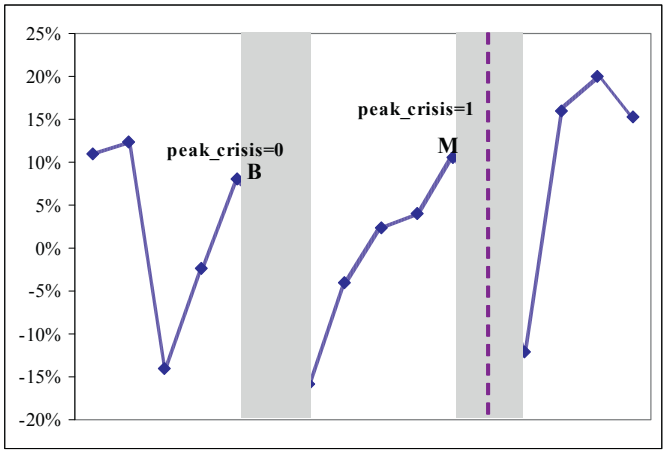
5. Combining the information: booms followed or not by a crisis

As discussed earlier, the specificity of our approach is to develop a tool assessing the likelihood that booms may eventually lead to episodes of financial crisis. Figure 2 illustrates how the final dataset is constructed combining the information on booms and crises. The grey area denotes the bust years, i.e. the data excluded from our sample. We follow the convention that vertical lines denote the year of turbulence in the exchange market (dotted lines) or the beginning of a banking crisis (dashed lines).

[7] The initial idea of Burns and Mitchell (1946) was later implemented through the multi-step Bry-Boschan (1971) algorithm, mainly used for the analysis of economic cycles (NBER) but also more recently transposed to equity (Harding and Pagan, 2002) or commodity prices (Cashin, McDermott and Scott, 1999). In our case the methodology is simplified as annual data avoids the adjustment requirements due to seasonality factors. For alternative methods see Borio and Lowe (2002, 2004).

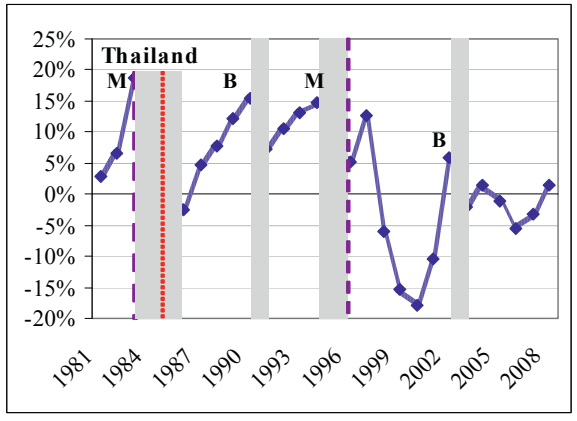
We have two peaks in this example, the first that turns out to be benign (denoted as point B), the second one malign (point M) as is followed for example by a banking crisis within two years. We proceed by assigning to our indicators of exuberance a value equal to 1 for points such as M and zero to all other points in the sample.[8]

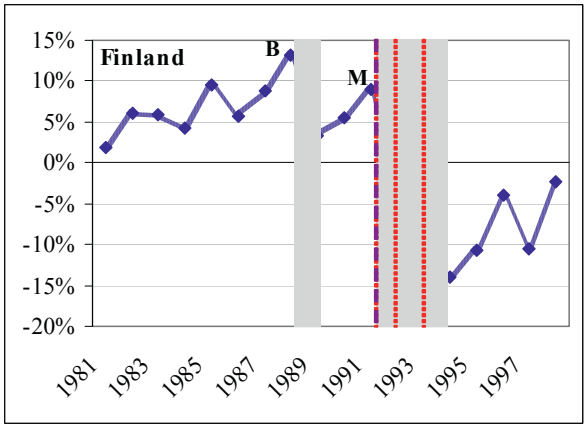
Figure 2: Dataset construction



As an illustration, let us review a number of past episodes of credit booms (see Figures 3a-b below) for the cases of Thailand and Finland. Thailand became increasingly outward-oriented and integrated into global trade and finance starting from the 1980s. In our sample a peak in lending took place in 1983, which led to a banking crisis in the same year followed by devaluation in 1985.[9] A new boom in credit started building up immediately thereafter leading to two further peaks, one in 1990 and one in 1994. Only the latter was followed by financial turmoil, i.e. a fully-fledged banking crisis in 1996 (see Bordo et al., 2001, Reinhart, 2002 and Caprio and Klingebiel, 1996) on the eve of the Asian currency crisis.

Figures 3a-b: Past episodes of credit booms and crises: Thailand and Finland





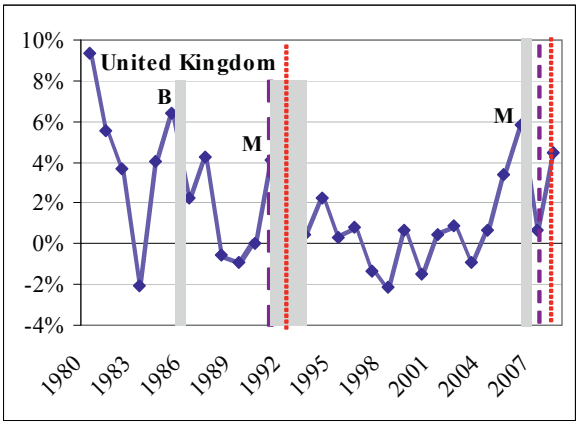
[8] To improve the predictive power of this modelling strategy, we only considered episodes of booms followed by financial crisis with an additional constraint: that the indicator of exuberance is positive at least for two years prior to the peak.

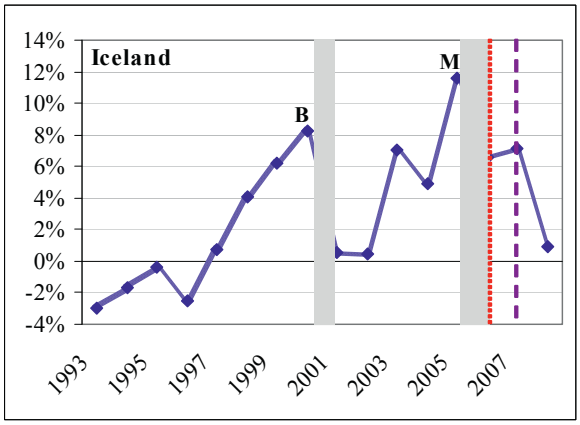
[9] Other devaluation episodes took place in that period but were not preceded by booms in credit so they are not included here.

Figure 3b also illustrates an example of a European country, the case of Finland, for which we identify two peaks in 1988 and 1991. While the first had no consequences, the second was followed by financial tensions manifesting as a banking crisis starting in 1991 and pressures on the exchange rate for three years, in the form of devaluations prior to the abandonment of ERM or depreciations.

Finally, we illustrate two past episodes of house prices booms, which took place one in UK and the other in Iceland (see Figures 4a-b). We identified for the case of the UK three booms, the first that was not followed by financial pressures (in 1985), the second and the third leading instead to tensions in the banking sector and downward pressures on the pound in 1991 and 2006 (twin crisis). The case of Iceland also foresees two housing peaks in 2000 and 2005, only the latter leading to a twin crisis within our two-year window.

Figures 4a-b: Past episodes of house prices booms and crises: Iceland, UK





These episodes are just a few examples of periods of exuberance in credit and housing markets that were followed by pressures on the currency or banking sector. The full dataset of peaks in credit-to-GDP and house price growth for our sample of countries is available in Appendix 1, reporting all the episodes of currency or banking crisis as long as they occurred within two years from the peak. In the next section we look for economic indicators that may help us to investigate more formally the likelihood of financial crisis episodes in the aftermath of a boom.

6. Indicators of vulnerability to a financial crisis

The existent literature has identified several possible indicators of vulnerability for currency/banking crises that are already apparent in the boom phase. We refer in particular to the studies by Kamisky, Lizondo and Reinhart (1998), Goldstein, Kaminsky, Reinhart (2000) and Bussière and Fratzscher (2006). Our choice of macroeconomic fundamentals resembles closely that literature. The first variable that we include is the rate of change of the real effective exchange rate to proxy - albeit imperfectly – a large deterioration in price competitiveness, which may have a destabilising role on the financial system. We also include the current account as a share of GDP, as beyond its competitiveness relevance, it may also signal to what extent a country is reliant on external financing. In the domain of the domestic real and public sector, our chosen indicators are standard, i.e. real GDP growth, fiscal balance and public debt to GDP ratios. In the domestic financial sector domain, we follow the literature and include domestic credit to the private sector-to-GDP and house prices both expressed in growth rates. We also attempted to

include other indicators of external exposure, such as short-term debt over total reserves and net foreign assets as a ratio of GDP but they turned out to be either statistically insignificant or constraining our sample excessively.

6. 1 Signals extracted for booms identified with credit data

Table 1 reports the standard output for the conditional fixed-effects logistic regression for the case of booms defined in terms of credit data.

Table 1: Results of the Conditional fixed-effects logistic regression on credit-to-GDP data. Initial sample 1981-2008.

Variables	Coef.	*Std. Err.*
Credit-to-GDP growth (-1)	27.15***	*8.53*
Credit-to-GDP growth (-2)	14.80***	*5.22*
Current Account balance (-2)	-23.14*	*13.08*
REER variation (-1)	14.28**	*5.63*
Real growth rate (-2)	11.49	*12.92*
Public Debt-to-GDP ratio (-2)	5.14**	*2.41*

Number of obs = 174; Group variable: country;Number of groups = 18; Obs per group: min = 5; avg = 9.7; max = 20
LR chi2 (6) = 45.87; Log likelihood = -20.61; Prob > chi2 = 0.00; Log-Lik Intercept Only: -43.55 Log-Lik Full Model: -20.61
D (12): 41.22; LR (6): 45.87; Prob > LR: 0.000; McFadden's R2: 0.53; McFadden's Adj R2: 0.39; ML (Cox-Snell) R2: 0.92; Cragg-Uhler(Nagelkerke) R2: 0.93; Count R2: 0.50
*** indicates significance at 1%, ** indicates significance at 5% and * indicates significance at 10%.

Our choice of specification comes from a general to specific approach, i.e. reducing the number of variables and lags based both on statistical as well as economic considerations. We find that credit to GDP growth, the current account balance-to-GDP ratio, the change in the real effective exchange rate and the public debt to GDP ratios are all statistically significant and enter with the expected sign in the logistic regression. In particular, the probability that the reversal in the credit boom would lead to tensions in the foreign exchange market or in the banking sector is higher the larger the current account deficit and public debt to GDP indebtedness. High real output growth during the boom also enhances the likelihood of a crisis. The coefficient is not significant, possibly because robust growth is not always evidence of economic overheating.

For each year and country in the sample, the model provides a "fitted probability" i.e. the probability that a boom in credit would result in financial tensions (in the form of pressures on the exchange rate or a banking crisis) within a time span of two years after the turning point. The fitted probability can then be used to assess the effectiveness of our EWS framework in correctly predicting crises stemming from financial excesses.[10] The typical convention is that a signal is issued when the model-based fitted probability goes beyond the 10 or 20 percent thresholds. A false alarm or "noise" denotes a situation instead whereby a signal is issued and is not accompanied by an episode of financial pressures within two years after the turning point. Table 2 summarises the predictive performance of the model specified on credit over GDP growth rate, for the 10 and 20 percent thresholds.

[10] See Bussière (2007) on the limits of static specifications in timing the crisis signal sent by the leading indicators.

Table 2: Predictive performance of the model –crises occurring within two years from the moment a signal is issued. Credit-to-GDP data.

Threshold	Signals	Good signals	False alarms	Total boom-crises analysed*	Well signalled boom_crises
10%	162	28	134	20	18
% Well signalled boom crises	90%				
False signals % total signals	83%				
Threshold	**Signal**	**Good signal**	**False alarms**	**Total boom-crises analysed***	
20%	112	21	91	20	16
% Well signalled boom crises	80%				
False signals % total signals	81%				

Taking into account (i) our definitions of booms (ii) data availability for economic fundamentals and (iii) the identified financial crises in our sample we find 20 instances of booms followed by financial tensions within a time span of two years after the peak. Imposing for example a 10 percent probability threshold criterion, 162 signals are issued, 28 are well signalled at the cost of 134 false alarms.[11] This is a reminder of the several instances in which booms are not synonymous of pending financial crises.

Of the 20 instances where tensions are identified, the model anticipates 18. Imposing a 20 percent probability threshold to reduce the overall signals to 112 has a cost, since only 16 of the 20 episodes are anticipated. From a policy-making perspective, as in the standard EWS literature, a large number of false alarms is the price to incur to predict the large majority of financial crisis in the precise time span of two years.[12] The analysis is nevertheless useful, pointing to those economic fundamentals that help preserve a boom from turning "malign". As it turns out, current account surpluses, low public debt, sustainable output and credit growth as well as avoiding appreciating real exchange rates help prevent instances of turmoil.

6.2 Signals extracted for booms identified with house prices

Analogous results can also be presented for booms identified with house growth rates. The results of the fixed effects logistic analysis on house prices data are presented in Table 3.

The results show that, beyond house prices growth, strong credit expansion during the boom phase increases the probability that the turning point in house prices will be followed by financial tensions.[13] Sizeable appreciations in real effective exchange rates are similarly having an adverse impact. Both the current account-to-GDP ratio and real growth enter with the expected sign, albeit the coefficient is not significant.

[11] There are in some case multiple signals for the same episode of a peak followed by market pressures.

[12] To increase the number of observations we have bundled together banking crises and instances of exchange rate pressures. If we apply the analysis separately, we find that (i) a deterioration of credit growth or (ii) larger current account deficits (iii) sizeable exchange rate appreciations are more important factors in explaining the likelihood of credit boom episodes being followed by banking crisis rather than by pressures in foreign exchange markets.

[13] On the importance of credit as indicator for detecting asset price misalignments, see Gerdesmeier, Reimers and Roffia (2009).

Table 3: Results of the Conditional fixed-effects logistic regression on house prices data. Initial sample 1981-2008.

Variables	Coef.	*Std. Err.*
House prices growth (-1)	25.62***	*7.67*
Credit-to-GDP growth (-2)	4.95*	*2.71*
Current Account balance (-1)	-0.39	*10.13*
Current Account balance (-2)	-3.03	*8.48*
REER variation (-2)	10.69**	*5.28*
Real growth rate (-2)	3.57	*11.28*

Number of obs = 211; Group variable: country; Number of groups = 21; Obs per group: min = 4; avg = 10.0; max = 17; LR chi2 (5) = 32.60; Log likelihood = -38.19; Prob > chi2 = 0.00; Log-Lik Intercept Only:-54.50; Log-Lik Full Model: -38.19; D (15): 76.389; LR (6): 32.60; Prob > LR: 0.00; McFadden's R2: 0.30; McFadden's Adj R2: 0.19;ML (Cox-Snell) R2: 0.79; Cragg-Uhler(Nagelkerke) R2: 0.79; Count R2: 0.52;

*** indicates significance at 1%, ** indicates significance at 5% and * indicates significance at 10%.

For completeness, entirely analogously to before, Table 4 reports the predictive performance of the optimal set of vulnerability indicators identified on housing data for both the 10 and 20 percent crisis thresholds.

Table 4: Predictive performance of the model –crises occurring within two years from the moment a signal is issued. House prices data.

Threshold	**Signals**	**Good signals**	**False alarms**	**Total boom-crises analysed***	**Well signalled boom-crises**
10%	117	37	80	26	22
% Well signalled boom crises	81%				
False signals % total signals	68%				
Threshold	**Signal**	**Good signal**	**False alarms**	**Total boom-crises analysed***	
20%	67	22	45	26	16
% Well signalled boom crises	62%				
False signals % total signals	67%				

The bottom line is unchanged. To capture the majority of peaks followed by a crisis, one has to incur in a high number of false alarms. The point remains that the vulnerability indicators have information content, i.e. the likelihood that the end of a boom would lead to financial tensions depend on these indicators of imbalances.

7 Applications of the EWS

7.1. In-sample predictions

There is another neat way of presenting the predicting performance of the EWS model. We rank the 20 episodes of credit and the 26 episodes of housing booms that turned "malign" in terms of the estimated probability provided by the logit models. Let us start again with the case of credit booms. The first three columns of Table 5 report the years when (i) the peak in lending took place (ii) financial market tensions manifested themselves (iii) the signal was issued. The fourth and final column reports the corresponding estimated probability.

Table 5: Episodes of booms in credit-to-GDP growth followed by downward exchange rate pressures and/or banking crises –in sample predictions

Country	Credit peaks	Year of sizeable currency swing (a) or banking crisis (b)	Year where the signal was issued	Model-based probability for the year where the signal was issued
Banking crises/major currency swings predicted at the 20 % threshold				
Burundi	2000	2002(a)	2000	0.92
Canada	2006	2008(a)	2006	0.26
Cyprus	1999	2000(a)	1997, 1998, 1999	0.23, 0.30, 0.28
Croatia	2006	2008(a)	2004, 2006	0.67, 0.13
Denmark	1987	1987(b), 1989(a)	1987	0.98
Ecuador	1993	1994-95(b)	1991, 1992, 1993	0.44, 0.26, 0.28
Finland	1991	1991-92-93(a), 1991(b)	1990, 1991	0.35, 0.19
Italy	1992	1992-93(a)	1991, 1992	0.43, 0.33
Japan	1987	1989(a)	1987	0.82
New Zealand	1988	1988(a)	1987, 1988	0.30, 0.69
Norway	1986	1986(a), 1988(b)	1986	0.88
Saudi Arabia	1993	1993-94(a)	1993	0.94
Trinidad&Tobago	1997	1997-99(a)	1997	0.87
Uganda	1993	1994(b)	1993	0.73
Banking crises/major currency swings predicted at the 10 % threshold				
Austria	1989	1991(a)	1989	0.11
Grenada	2000	2002(a)	1999, 2000	0.19, 0.37
South Africa	1984	1984-86(a)	1984	0.14
South Africa	1998	1998(a)	1998	0.12
Banking crises/major currency swings not predicted by the model				
Dominican Rep.	1996	1996(b)		
Norway	1998	1998(a)		

In some cases the signal was issued for a number of consecutive years, with the predicted probability of a crisis changing over those years. The findings are intuitive: the downward pressures on the Japanese yen in 1989, the devaluation of the Finnish markka in 1991, the exit of a number of European currencies from ERM in 1992, the financial market tensions taking grip of the Northern European countries in the 1980s (Norway, 1986 and Denmark, 1987) are all included with high probability. Other cases are captured when the threshold is reduced to 10 percent and therefore predicted only if the policy maker is prepared to accept a larger number of false signals.

A similar story emerges when investigating the case of malign booms in house prices growth rates (see Table 6). A number of well-know episodes are predicted, for example the Philippine peso devaluation in 1984, the Swedish banking and currency crisis in 1991-92, the pressures on the UK banking sector and on the pound sterling in 1991-92, the sharp fall in the Icelandic króna in 2006. As a reminder of the limitations of any methodology based on backward looking phenomena, the signal for the 2006 housing peak in the UK stands at 8 percent, lower than our 10 percent threshold, therefore it is not, in our definition, a boom-crisis example. This could be ascribed to (i) choice of fundamentals that may not capture for example the excessive risks taken by the banking sector (ii) data limitations (iii) the role of global financial interlinkages that appear to have dominated the recent turmoil. However, most examples of booms/ crisis in our sample are identified.

Table 6: Episodes of booms in house prices growth followed by downward exchange rate pressures and/or banking crises –in sample predictions

Country	House price peak	Year of sizeable currency swing (a) or banking crisis (b)	Year where the signal was issued	Model-based probability for the year where the signal was issued
Banking crises/major currency swings predicted at the 20 % threshold				
Austria	1983	1984(a)	1983	0.31
Canada	1990	1992(a)	1990	0.28
Finland	1989	1991(a), 1991(b)	1989	0.64
Germany	1992	1993(a)	1992	0.60
Greece	1991	1991(b)	1991	0.76
Israel	1984	1984(a)	1984	1
Japan	1991	1992(b)	1989, 1990	0.29, 0.30
New Zealand	1987	1988(a), 1987(b)	1986, 1987	0.30, 0.61
Paraguay	2001	2001(a), 2001(b)	2001	0.47
Spain	1993	1993(a)	1991, 1992	0.16, 0.12
Sweden	1991	1992-93(a), 1991(b)	1990, 1991	0.19, 0.54
Banking crises/major currency swings predicted at the 10 % threshold				
Australia	1988	1989(b)	1986	0.18
Belgium	1992	1993(a)	1990, 1991, 1992	0.18, 0.24, 0.28
Denmark	1988	1989(a)	1987, 1988	0.11, 0.53
Iceland	2005	2006(a), 2007(b)	2005	0.21
Norway	1988	1988(b)	1986, 1987, 1988	0.10, 0.16, 0.41
Philippines	1984	1984(a)	1984	0.15
Singapore	1985	1986(a)	1984, 1985	0.25, 0.25
Singapore	1997	1998-99(a)	1997	0.10
United Kingdom	1991	1992(a), 1991(b)	1990, 1991	0.18, 0.16
United States	1985	1987(a)	1984, 1985	0.11, 0.14
Banking crises/major currency swings not predicted by the model				
Italy	1990	1992(a), 1990(b)		
Italy	1994	1995(a)		
Norway	2002	2003(a)		
United Kingdom	2006	2008(a), 2007(b)		
New Zealand	2004	2004(a)		

7.2. Out-of-sample predictions

The framework that we have developed has a particularly interesting application out-of sample. Whenever an upward movement is identified in our indicators (either credit or housing prices), we are in a boom situation that will eventually reverse. Using our estimated equations allows us to calculate the probability that a crisis will erupt once the boom is reversed.[14] Given the initial motivation of this paper, we calculate such probabilities for the case of Central and Eastern Europe economies (see Table 7), which did not experience in their recent history a credit or housing boom related crisis and therefore were not included in-sample.

[14] This is based on the assumption that fundamentals will have remained unchanged at the peak. As the boom progresses they typically deteriorate unless policy actions are taken.

Table 7: Out-of-sample predictions for the CEECs

Country	Year	Credit data		Housing data	
		Point estimate	*95% CI*	Point estimate	*95% CI*
Bulgaria	2005	0.13	*(0.05, 0.29)*	0.21	*(0.07, 0.49)*
	2006	0.07	*(0.03, 0.15)*	0.18	*(0.05, 0.47)*
	2007	0.04	*(0.02, 0.07)*	0.14	*(0.03, 0.41)*
	2008	0.12	*(0.04, 0.34)*	0.11	*(0.02, 0.45)*
Croatia	2005	0.03	*(0.02, 0.06)*	0.09	*(0.05, 0.15)*
	2006	0.04	*(0.02, 0.06)*	0.09	*(0.05, 0.15)*
	2007	0.04	*(0.03, 0.08)*	0.11	*(0.07, 0.19)*
	2008	0.03	*(0.02, 0.06)*	0.12	*(0.06, 0.21)*
Czech Rep.	2005	0.03	*(0.01, 0.05)*	0.08	*(0.05, 0.15)*
	2006	0.05	*(0.03, 0.09)*	0.09	*(0.04, 0.18)*
	2007	0.05	*(0.03, 0.09)*	0.11	*(0.05, 0.20)*
	2008	0.05	*(0.03, 0.10)*	0.11	*(0.05, 0.2113)*
Estonia	2005	0.08	*(0.04, 0.15)*	0.10	*(0.05, 0.18)*
	2006	0.07	*(0.03, 0.13)*	0.13	*(0.06, 0.23)*
	2007	0.08	*(0.04, 0.15)*	0.06	*(0.02, 0.17)*
	2008	0.07	*(0.03, 0.15)*	0.12	*(0.04, 0.28)*
Hungary	2005	0.05	*(0.03, 0.07)*	0.18	*(0.09, 0.34)*
	2006	0.05	*(0.04, 0.08)*	0.15	*(0.07, 0.29)*
	2007	0.04	*(0.02, 0.06)*	0.13	*(0.07, 0.22)*
	2008	0.06	*(0.04, 0.09)*	0.11	*(0.06, 0.21)*
Latvia	2005	0.09	*(0.05, 0.17)*	0.08	*(0.03, 0.18)*
	2006	0.13	*(0.06, 0.27)*	0.12	*(0.05, 0.26)*
	2007	0.11	*(0.05, 0.24)*	0.08	*(0.02, 0.29)*
	2008	0.05	*(0.02, 0.13)*	0.16	*(0.05, 0.43)*
Lithuania	2005	0.10	*(0.04, 0.20)*	0.11	*(0.04, 0.27)*
	2006	0.15	*(0.06, 0.30)*	0.11	*(0.06, 0.20)*
	2007	0.09	*(0.04, 0.18)*	0.11	*(0.04, 0.27)*
	2008	0.08	*(0.04, 0.14)*	0.09	*(0.04, 0.20)*
Poland	2005	0.02	*(0.01, 0.04)*	0.04	*(0.01, 0.12)*
	2006	0.04	*(0.03, 0.07)*	0.07	*(0.03, 0.14)*
	2007	0.06	*(0.03, 0.11*	0.11	*(0.05, 0.22)*
	2008	0.04	*(0.02, 0.07)*	0.10	*(0.05, 0.20)*
Romania	2005	0.05	*(0.02, 0.12)*	0.17	*(0.06, 0.41)*
	2006	0.07	*(0.03, 0.15)*	0.12	*(0.05, 0.28)*
	2007	0.08	*(0.04, 0.20)*	0.19	*(0.08, 0.38)*
	2008	0.11	*(0.04, 0.28)*	0.21	*(0.07, 0.50)*
Slovakia	2005	0.02	*(0.01, 0.05)*	0.09	*(0.02 0.29)*
	2006	0.05	*(0.03, 0.09*	0.12	*(0.05, 0.27)*
	2007	0.06	*(0.03, 0.11)*	0.16	*(0.07, 0.33)*
	2008	0.05	*(0.03, 0.11)*	0.15	*(0.05, 0.34)*

Several signals are issued if we content ourselves with a 10 percent threshold, almost none if this threshold is raised to 20 percent. Signals of similar magnitude are also found for several other non-European countries, underscoring how global this phenomenon has been. Despite the large number of false signals, the methodology developed here is helpful to quantify the risks associated to a boom phase. From a policy maker perspective an early warning,

irrespective of whether the crisis materialises or not, is a call for corrective measures, signalling that the boom episode is characterised by macro imbalances.[15]

8 Concluding remarks

In this paper we have taken a different approach from what is standard in the literature by focusing exclusively on the vulnerabilities of a country at the time of a boom in housing prices or bank lending. Like in the EWS literature, from a forecasting perspective a large number of false signals must be incurred to anticipate these episodes. This does not change however that *there is* information content in the identified fundamentals. Their deterioration might increase the chance that the end of a boom phase leads to pressures on the domestic currency or a fully-fledged banking crisis.

A methodology quantifying the risks stemming from macro disequilibria is helpful, although expert analysis remains vital for it incorporates additional aspects, such as the degree of foreign exchange exposure, the health of the banking system, etc. Several extensions to the present analysis may be conceivable, as for instance developing a more elaborate method for detecting booms (for example in terms of deviation from trend, peaks and trough on rolling averages, etc). Future research may also explore if the information content from lending and housing booms could not only help assess the probability of financial crises but also anticipate prolonged periods of economic slowdown.

[15] A point emphasised in Bussière (2009).

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Appendix 1

Table A1.1: Benign and malign peaks in Credit-to-GDP

Countries	Credit Peaks T_C	FX market pressure $T_C \rightarrow T_C+2$	Banking Crises $T_C \rightarrow T_C+2$	Countries	Credit Peaks T_C	FX market pressure $T_C \rightarrow T_C+2$	Banking Crises $T_C \rightarrow T_C+2$
Albania	1997 2001 2005	- - -	- - -	Jordan	1983 1993 2001 2005	n.a.	- - - -
Algeria	1982 2002 2005	- - -	- - -	Kazakhstan	2000 2005	- -	- -
Argentina	1998 2005			Kuwait	1986 1994 1997 2001	n.a.	
Australia	1985* 1989** 1995 1999 2003	1985, 1986 - - - -	- 1989 (CK, B) - - -	Kyrgyz Rep.	1998 2004	n.a.	- -
Austria	1985 1989*	- 1991		Latvia	1997 2001* 2005*	- 2001 2005	- - -
Azerbaijan	1997 2004			Lebanon	1994 1998	- -	- -
Bahamas	1987* 1990 1997* 2000 2006	1987 - - - 2007		Lithuania	1999 2005	- -	- -
Bangladesh	1984 1989 1995 2001	n.a.		Malaysia	1985 1989 1992 2001 2005	- - - - -	- - - - -
Barbados	1991 1994 1998 2005	n.a.		Malta	1983 1990* 1996	- 1992, 1993 -	
Belarus	1998 2003 2006	n.a.		Mauritius	1985 1992 1997 2003	n.a.	- - - -
Belgium	1989			Moldova	2003	-	-
Belize	1988 1991 1997 2001	- - - -		Mozambique	1991 1997 2005	n.a.	- - -
				Netherlands	1988	-	-
Bhutan	1989 1997 2002	n.a.		New Zealand	1988* 1992 1997 2005	1988 - - -	- - - -
Bolivia	1992** 2002	- -	1994 (CK)	Norway	1986*** 1998*	1986 1998	1988 (KR, CK, B, JH) -
Bosnia & Herzegovina	2002 2005	n.a.		Oman	1983 1994 1997 2001	- - - -	- - - -
Brazil	1983** 2000	- -	1985 (KR)	Pakistan	1985* 2000 2004	1985 - -	- - -
Bulgaria	2003			Panama	1993* 1998 2005	1995 - -	- - -
Burkina Faso	1985 1989 1997 2000	n.a.		Papua New Guinea	1984*	1984	-
Burundi	2000* 2006	2002 -		Peru	1996 2002	- -	- -
Canada	1989 1996 2001 2006*	- - - 2008	- - - -	Philippines	1983* 1996*** 2000	1983, 1984 1997 -	- 1997 (R, CK) -

Cape Verde	1990 1993 1999 2002	n.a.	- - - -	Romania	1985* 2003	1985	
Central African Rep.	1989 1996 2004	- - -		Rwanda	1985 1994 1997		
Chile	1989 1993 1996 2000	- - - -	- - - -	Samoa	1987 1994 1999 2006		
China,P.R.: Hong Kong	1994 1997*** 2003	- 1998 -	- 1998(CK) -	Saudi Arabia	1993* 1998 2001 2004	1993, 1994 - - -	- - - -
Comoros	1988 1997 2003	n.a.		Senegal	1992 1996 2000 2005	n.a.	- - - -
Costa Rica	1983 1998			Serbia & Montenegro	2000 2005	n.a.	- -
Croatia	2002 2006*	- 2008		Seychelles	1989 1994 2003	n.a.	- - -
Cyprus	1988 1999*	- 2000		Sierra Leone	1993 1997 2003	- - -	- - -
Denmark	1987*** 2000	1989 -	1987 (KR, CK, B)	Slovenia	1995* 1998 2005	1996 - -	- - -
Dominica	1989 1995 2000 2006	- - - -					
Dominican Republic	1992 1996** 1999	- - -	- 1996 (J) -	South Africa	1984* 1998* 2006	1984, 1985, 1986 1998 -	
Ecuador	1986 1993** 2000 2004	- - - - -	- 1994 (J), 1995 (CK, B) - -	Spain	1988	-	-
Egypt	1986 1994 1998	- - -	- - -	Sri Lanka	1995 1999 2005	n.a.	- - -
El Salvador	1984 1994 2003	- - -		St. Lucia	1989 1993 2001	- - -	- - -
Estonia	1997** 2006	- -	1998 (CK) -	St. Vincent & Grens.	1989 1995 1999	- - -	- - -
Ethiopia	1987 1999 2002 2005	n.a.	- - - -	Sudan	1986 1990 2002 2005	n.a.	- - - -
Fiji	1989 2000 2005	- - -	- - -	Suriname	1985 1990 1996 2002	n.a.	- - - -
Finland	1988 1991***	- 1991 1992 1993	- 1991 (KR, CK, B, JH)	Swaziland	1991 1994 1997 2003	n.a.	- - - -
Gabon	1987* 2001	1987 -	- -	Sweden	1988 2001	- -	- -
Gambia	1988 1993 1997 2002*	- - - 2003	- - - -	Switzerland	1987 1995 2006	- - -	- - -
Georgia	2005			Tanzania	1989 1993 1998 2003 2006	n.a.	- - - - -
Germany	1985 1996	- -	- -	Thailand	1983*** 1990 1994** 2002	1985 -	1983 (KR, CK, B) - 1996 (R, CK, B) -
Grenada	1993 1997 2000* 2006	- - 2002 -	- - - -	Togo	1986 1993*** 1998 2003	- 1994 - -	

Guatemala	1983 1987 1995 1998 2003	n.a.	- - - - -	Trinidad and Tobago	1983* 1997*	1983, 1985 1997, 1998 1999	
Guinea-Bissau	1993** 1998	n.a.	1995 (CK)	Tunisia	1993 1997 2000 2005	- - - -	- - - -
Guyana	1996 2001			Turkey	1986 1992*** 1996 2005	- - - -	- 1992 (CK, B), 1994 (CK, B), - -
Haiti	1988 1992 1997 2002 2005	n.a.	- - - - -	Uganda	1993** 1996 2001	- - -	1994 (CK) - -
Honduras	1987 1992	n.a.		Ukraine	2003 2006**	- -	- 2008 (IMF)
Hungary	1987* 2000 2003	1987	- - -	United Arab Emirates	1983 1986 1991 1994 1998 2001	- - - - - -	- - - - - -
Iceland	1989 1997 2000	- - -	- - -	United Kingdom	1986 2000		
Indonesia	1990** 1997*** 2004	- 1997, 1998	1992 (KR), 1997 (CK) -	United States	1995 2000		
Israel	1984* 1987 1993 1998 2001 2005	1984, 1985 - - - - -	- - - - - -	Uruguay	1985 1988 1992 1998 2006	- - - - -	- - - - -
Italy	1984 1992*	- 1992, 1993	- -				
Japan	1987* 2005	1989 -	- -	Vietnam	1999 2004	n.a.	- -

with the following notations for the banking crises sources: CK=Caprio and Klingebiel (1996), KR=Kaminsky and Reinhart (1999), J=Jácome (2008), JH=Jonung and Hagberg (2002), R=Reinhart (2002), B=Bordo et al. (2001), compiled by Reinhart and Rogoff (2008)), IMF = IMF programme during the global crisis. * denotes a currency crisis ** a banking crisis and *** a twin crisis that follows the peak in credit/house prices within two years.

Table A1.2: Benign and malign peaks in house prices growth

Countries	House Peaks T_H	FX market pressure $T_H \rightarrow T_H+2$	Banking Crises $T_H \rightarrow T_H+2$	Countries	House Peaks T_H	FX market pressure $T_H \rightarrow T_H+2$	Banking Crises $T_H \rightarrow T_H+2$
Argentina	1990* 2005	1990,1991		Kuwait	2000	n.a.	n.a.
Australia	1988** 2001	- -	1989 (CK, B)	Malaysia	2003	-	
Austria	1983* 1995 2001	1984 - -	- - -	Mexico	1983* 1988* 1996	1985 1988 -	
Belgium	1992* 2001 2006	1993 n.a. n.a		Morocco	1996 1999	- -	n.a.
Bolivia	1991 1996 2000 2003	- - - -		Netherlands Antilles	1982* 1992 2003	1983 - -	- - -
Bulgaria	2002			New Zealand	1982* 1987*** 1994 2004*	1984 1988 - 2004	- 1987 (CK, B) - -
Canada	1982*** 1990* 1995 2000	1982, 1984 1992 - -	1983 (CK, B)	Norway	1982 1988** 2002*	- - 2003	- 1988 (KR, CK, B, JH)
China,P.R.:Hong Kong	1991 2006			Pakistan	2004	-	-
Colombia	1991 2003			Paraguay	2001***	2001	2001 (CK, J)
Czech Republic	1998	-	-	Peru	1999** 2003	- -	1999 (J)
Denmark	1988* 2001 2004	1989		Philippines	1984* 1991 2005	1984 - -	- - -
Estonia	2001	-	-	Singapore	1985* 1990 1997* 2000	1986 - 1998, 1999 2001	- - - -
Finland	1989*** 2000	1991 -	1991 (KR, CK, B, JH) -	Slovak Rep.	2000 2004	- -	-
France	1988 2005	- -	- -	Slovenia	2000 2005	- -	- -
Germany	1983 1992* 2002	- 1993 -	- - -	Spain	1986 1993* 1996 2002	- 1993 - -	- - - -
Greece	1986 1991** 2005*	- - 2005	- 1991 (CK, R, B) -	Sweden	1985 1991*** 2002	- 1992, 1993 -	- 1991 (KR, CK, B, JH)
Hungary	2004			Switzerland	1982 1986 1991 1996 2001	- - - - -	- - - - -
Iceland	2000 2005***	- 2006	2007	Taiwan Prov.of China	1991 1994**	n.a.	- 1995 (CK, B)
Indonesia	2002 2006	- -	- -	Thailand	1998* 2001 2006	1998 - -	- - -
Israel	1984* 1990 1994 2002	1984 - - -	- - - -	Turkey	1988 1994*** 1998**	1991 1994 -	- 1994 (CK, B) 2000 (CK)
Italy	1984 1990*** 1994* 2004	- 1992 1995	- 1990 (CK, B) - -	United Kingdom	1985 1991*** 2006***	- 1992 2008	- 1991 (CK) 2007
Japan	1991** 2001	- -	1992 (CK, B) -	United States	1985* 1998 2002	1987 - -	- - -
Jordan	2002	n.a.	-	Uruguay	1990 2003	- -	- -
Korea	1991 1998* 2001	- 1998 -	- - -	Venezuela	2003		

with the same conventions as in Table A1.1

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