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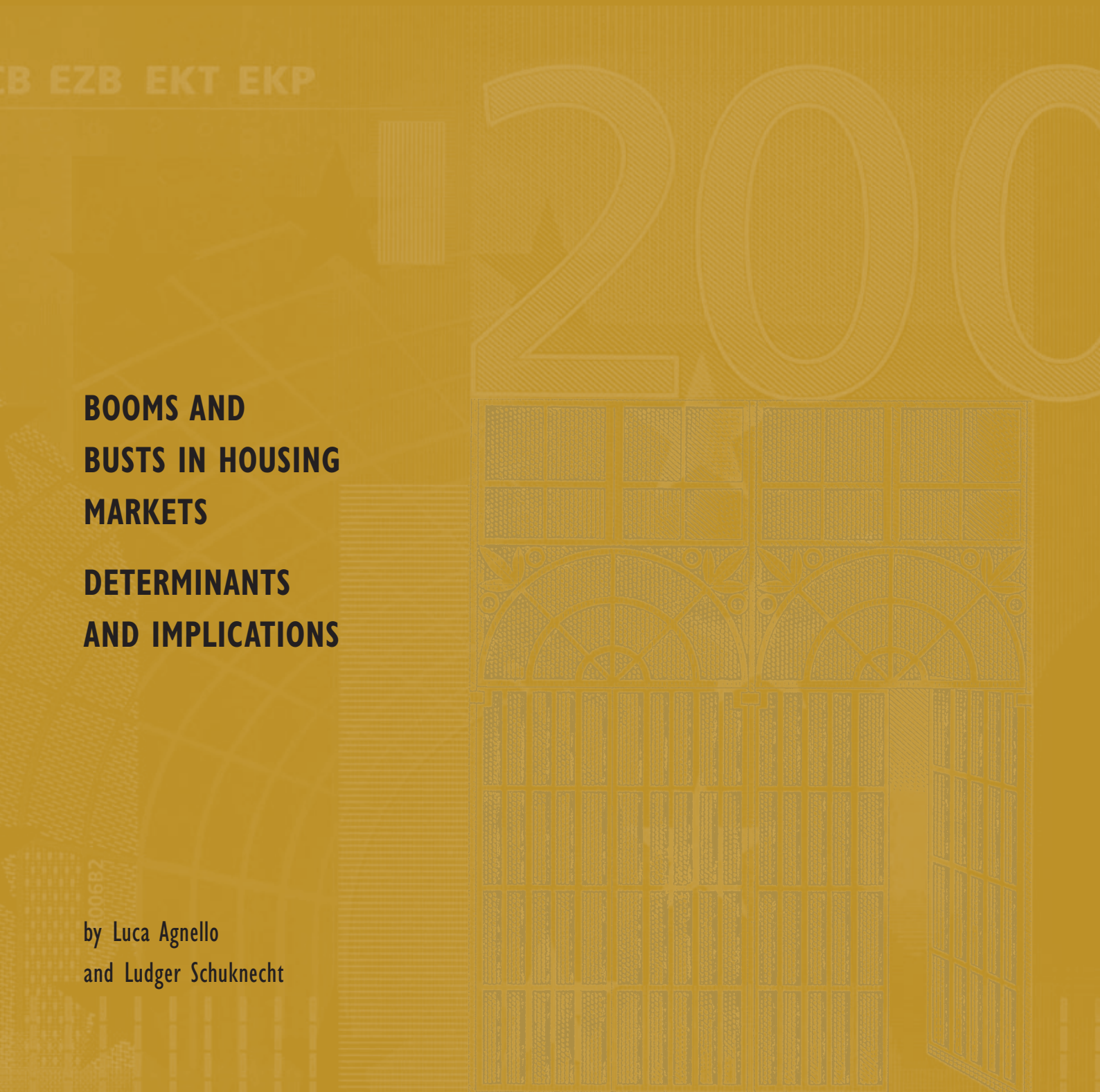

BOOMS AND BUSTS IN HOUSING MARKETS

DETERMINANTS AND IMPLICATIONS

by Luca Agnello
and Ludger Schuknecht

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

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Abstract

This study looks at real estate price booms and busts in industrialised countries. It identifies major and persistent deviations from long term trends for 18 countries and estimates the probabilities of their occurrence using a Random Effects Panel Probit model over the period 1980-2007. It finds that 1) most recent housing booms have been very persistent and of a significant magnitude; 2) there appears to be a strong correlation between the persistence and magnitude of booms and subsequent busts; 3) economic costs (in terms of GDP losses during the post-boom phase) depend significantly on the magnitude and duration of the boom and money and credit developments during that period; 4) a number of policy variables, including short term interest rates, local and global money and credit developments, and the incidence of mortgage market deregulation affect significantly the probability of experiencing booms and busts; and 5) the model is quite successful in identifying booms and busts early on.

Keywords: house prices, housing market, booms and busts.

JEL Classification: E32, R21, R31

Non-technical summary

Looking at real estate price developments in industrialised countries since the 1970s, we aim to address the following questions: 1) How can we identify long term deviations from real estate price trends (booms and busts) that are relevant from a macroeconomic perspective as they "distort" expectations and behaviour? 2) Do the characteristics of booms foreshadow those of busts? And how do more recent housing booms compare from a historical perspective in terms of size and persistence? 3) How far are boom characteristics potentially harmful for output growth? 4) What determines the emergence of booms and busts? 5) What is the estimated marginal impact of these determinants, and notably financial variables on the probabilities of boom and bust episodes? 6) Does this help the early identification and prevention of booms and busts?

In order to address these questions, we proceed as follows. First, we identify, for a sample of 18 industrialized countries, boom and bust periods as major and persistent deviations from trend. We follow the dating approach used by Jaeger and Schuknecht (2007) based on the so-called triangular methodology initially proposed by Harding and Pagan (2002). Second, we use boom episodes in a cross-section analysis and test whether the behaviour of certain variables during booms can help explain output growth during the post-boom period. Third, in order to identify the determinants of booms and busts and measure their impact on the probabilities of these events, we estimate a Random Effects Panel Probit model over the period 1980-2007.

The main findings can be summarized as follow:

- The most recent housing booms have been amongst the most persistent in the past 40 years. The magnitude of deviations in house prices from long term trends has been similar as in past booms;
- In the past, there has been a strong correlation between the persistence and magnitude of booms and of subsequent busts;
- The economic costs (in terms of GDP losses during the post-boom phase) depend significantly on the magnitude and persistence of the boom and money and credit developments during this period;

- Past economic growth, short term interest rates, local and global money and credit developments, and the incidence of mortgage market deregulation affect significantly the probability of experiencing booms and busts;
- The estimated model allows to predict the occurrence of booms and busts already early on during these phases.

As to the contribution of this study, first, our analysis suggests that, a probabilistic identification of booms and busts relatively early on in such phases seems possible on the basis of our model. In particular, for the majority of the countries, the model seems to perform reasonably well as early warning device for the identification of booms.

Second we find that interest rate policies directly or indirectly, via its effect on money and credit, can have a significant influence on the probability of booms and busts occurring. Regulatory policies that slow down money and credit growth are also expected to curtail boom probabilities. Finally, the importance of global liquidity suggests that cross-border externalities of overly lax policies in boom periods may be significant.

Nevertheless, some important caveats have to be made. First of all, the heterogeneity in predicting the most recent turning points experienced by some countries, suggests to interpret cautiously signals issued by our model. Second, we note that the Panel Probit model defines "only" an econometric reduced-form relationship between monetary variables and asset prices booms and busts.

In spite of these limitations, we believe that our estimation results provide useful indications and plausible "rules of thumb" that could be part of the information set of the monetary and regulatory policy makers who take into account (emerging) housing booms in their assessment.

1. Introduction

In the late1990s, a major housing boom coupled with strong money and credit growth emerged in the US and many other industrialised countries. This took place in an environment of strong financial innovation, and as it turned out, insufficient risk management, lack of transparency, poor incentives and increasing leverage. The turn from boom to bust and to crisis started with troubles in the sub-prime mortgage market in the US in early 2007. Initially these troubles were thought to remain well contained. But in the summer of 2007, the sub-prime crisis turned into a wider US housing market downturn and financial crisis that spilled over to Europe as the first wave of confidence loss in the financial sector unfolded. Following the Lehmann default in September 2008, the financial crisis deepened and an international recession emerged as confidence evaporated, banking sectors suffered increasing losses, housing markets turned in more countries and exports slumped in industrialised countries as well as emerging markets.

The global nature of the current downturn in the context of a sharp weakening of the housing sector in many countries adds relevance to the broader questions motivating our study. Looking at real estate price developments in industrialised countries since the 1970s, we aim to address the following questions: 1) How can we identify long term deviations from real estate price trends (booms and busts) that are relevant from a macroeconomic perspective as they "distort" expectations and behaviour? 2) Do the characteristics of booms foreshadow those of busts? And how do more recent housing booms compare from a historical perspective in terms of size and persistence? 3) How far are boom characteristics potentially harmful for output growth? 4) What determines the emergence of booms and busts? 5) What is the estimated marginal impact of these determinants, and notably financial variables on the probabilities of boom and bust episodes? 6) Does this help the early identification and prevention of booms and busts?

In order to address these questions, we proceed as follows. First, we identify, for a sample of 18 industrialized countries, boom and bust periods as major and persistent deviations from trend. We follow the dating approach used by Jaeger and Schuknecht (2007) based on the so-called triangular methodology initially proposed by Harding and Pagan (2002). Second, similar to Adalid and Detken (2007), we use

boom episodes in a cross-section analysis and test whether the behaviour of certain variables during booms can help explain output growth during the post-boom period. Third, in order to identify the determinants of booms and busts and measure their impact on the probabilities of these events, we estimate a Random Effects Panel Probit model over the period 1980-2007. Compared to the existing literature, we provide a more comprehensive approach to assess determinants of booms and busts in housing markets. In fact, by relying on a large set of explanatory variables, we provide a more accurate estimation of the linkage between economic, monetary, demographic variables and the occurrence of booms and busts. In particular, to our best knowledge, no empirical studies have investigated, in a Panel binary framework, the role of global liquidity in determining housing price booms and busts.

Our main findings can be summarized as follow: 1) the most recent housing booms have been amongst the longest in the past 40 years. The magnitude of deviations in house prices from long term trends has been similar as in past booms; 2) In the past, there has been a strong correlation between the persistence and magnitude of booms and of subsequent busts; 3) we find that the economic costs (in terms of GDP losses during the post-boom phase) depend significantly on the magnitude and persistence of the boom and money and credit developments during the boom; 4) The estimated elasticities computed from the Panel Probit model, suggest that past economic growth, short term interest rates, local and global money and credit developments and the incidence of mortgage market deregulation affect significantly the probability of experiencing booms and busts; and 5) our model is successful in identifying booms and busts already early on.

We believe that this paper's analysis and implications are a relevant contribution to the academic and political debate. First, our analysis suggests that, a probabilistic identification of booms and busts relatively early on in such phases seems possible on the basis of our model. In particular, for the majority of the countries, the model seems to perform reasonably well as early warning device for the identification of booms. Second we find that interest rate policies directly or indirectly, via its effect on money and credit, can have a significant influence on the probability of booms and busts occurring. Regulatory policies that slow down money and credit growth are also expected to curtail boom probabilities. Finally, the

importance of global liquidity suggests that cross-border externalities of overly lax policies in boom periods may be significant.

Nevertheless, some important caveats are warranted. First, the heterogeneity in predicting the most recent turning points experienced by some countries, suggests to interpret cautiously signals issued by our model. Second, we note that the Panel Probit model defines "only" an econometric reduced-form relationship between monetary variables and asset prices booms and busts.[1]

In spite of these limitations, we believe that our estimation results provide useful indications and plausible "rules of thumb" that should be regarded as part of the information set of the monetary and regulatory policy makers who take into account emerging housing booms in their assessment.

The remainder of paper is organized as follows. Section 2 provides a brief review of the literature. Section 3 deals with the identification of boom and bust episodes in housing markets and puts recent experiences into a historical perspective. Moreover, it provides some stylised facts on boom and bust characteristics across countries and examines the relation between boom characteristics and post-boom economic performance. Section 4 presents the econometric approach used to estimate the probabilities of boom and bust phases. Section 5 contains the empirical results and focuses on the marginal impact of each driving factors of housing prices on boom and bust probabilities. Section 6 presents a robustness analysis while section 7 concludes and provides some policy considerations.

2. Overview of the literature

The study touches on two strands of literature, i.e. the literature that analyses the determinants of housing prices and, second, the one that links asset prices, macroeconomic developments and economic policies. As to the first question, the empirical literature is vast. Cross- or multi-country studies generally find that real estate prices are driven by income growth and interest rates (see for example Kennedy and Andersen, 1994, Englund and Ioannides, 1997, Kasparova and White, 2001).

[1] A complete structural model would be better suited to throw light on the effective interaction between monetary policy and asset prices and therefore, to judge the appropriateness of monetary and regulatory policies to address financial imbalances.

Other financial variables and, in particular bank credit, have also been considered on the grounds that there may be credit rationing (e.g. Tsatsaronis and Zhu, 2004; IMF, 2004; Lecat and Mésonnier 2005). Some authors examine the impact of the regulatory framework of housing finance on housing prices. For instance, Muellbauer and Murphy (1997) and Iacovello and Minetti (2003) argue that financial liberalization of mortgage markets led to a significant increase of the sensitivity of house prices to short term interest rates.

Regarding the relationship between between asset prices, macroeconomic developments and economic policy a number of empirical studies has emerged in recent years that looks at various aspects mostly under the label of "booms" and "busts" (for a survey of transmission channels and empirical studies, see Gerdesmeier, Reimers and Roffia, 2009).[2] Bordo and Jeanne (2002) and Borio and Lowe (2002) look at the relation between asset prices booms and busts and the conduct of monetary policies. In particular, they consider the potential cases for proactive versus reactive monetary policy based on the situation where asset price reversals can have serious effects on real output. Detken and Smets (2004) and Detken and Alessi (2009) look at monetary policy developments during asset price booms and busts with particular emphasis on identifying high and low cost busts and developing early warning indicators. Jaeger and Schuknecht (2007) assess the fiscal policy stance during boom-bust phases in asset prices. They find a strong reaction of fiscal revenue to asset price cycles which results in a ratcheting up public expenditure in booms and public debt in busts. Jonung, Schuknecht and Tujula (2009) compare the experience of the Nordics in the early 1990s with other episodes where a strong role of financial variables in an environment of financial innovation is found. Martin, Schuknecht and Vansteenkiste (2007) analyse booms and busts in asset prices between the 1970s and early 2000s and find evidence of macroeconomic and, especially, financial variables in explaining the emergence of booms and busts and the choice of exchange regime during the bust

[2] From a more theoretical perspective, the explanation of boom bust cycles is rather complex. One could argue that financial accelerator phenomena (Bernanke et al., 1999) involving the credit and bank lending channel coupled with feedback loops between expectations and outcomes and structural financial sector problems in an environment of strong financial innovation (as surveyed, for instance in Papademos, 2008), as well as wealth effects from the housing boom (Slacalek, 2006; Skudelny, 2008) can help conceptualise the excesses and imbalances that emerge in a boom. These are now unwinding in the bust. Low interest rates can further exacerbate booms via banks taking on more risks (Alessi and Detken, 2009 and Borio and Zhou, 2007).

phase. These studies' findings are broadly consistent with the recent ones by Reinhard and Rogoff (2008a and 2008b) who look at financial crisis episodes more globally.

A number of studies looks at real estate prices jointly with equity prices to examine the question of whether credit growth – and other variables reflecting monetary conditions – result in broader asset price "booms" (see e.g. Detken and Smets, 2004; Borio and McGuire, 2004). Gerdesmeier, Reimers and Roffia (2009) construct a composite (house and stock market-based) asset price indicator and apply a pooled probit-type analysis. Credit aggregates, nominal long term interest rates and investment jointly with asset price dynamics prove to be the best indicators to forecast financial crisis. A few recent studies investigate the connection between asset prices movements and global liquidity trying to quantify the effects of liquidity spillovers (Adalid and Detken, 2007; Greiber and Setzer, 2007; Belke, Orth and Setzer, 2008).

3. Booms and busts in housing markets

3.1. Identification of housing price booms and busts

The objective of this section is to identify booms and busts in real estate prices defined as major, persistent deviations from long term trends. The analysis is based on real housing prices data as provided by the Bank of International Settlement (BIS) for the period 1970-2007 for the following 18 industrialised countries: United Kingdom, United States, Japan, Canada, Australia, New Zealand, Switzerland, Norway, Denmark, Finland, Ireland, Netherlands, Germany, France, Italy, Spain, Belgium and Sweden.

In the empirical literature, however, a commonly accepted method to identify boom and bust episodes does not exist. A good methodology should be simple, reasonably objective and yield plausible results. Different methods for constructing chronologies of booms and busts for various economic series have been used. For example, Bordo and Jeanne (2002) and Borio and Lowe (2002) detect a boom or bust in asset price series when its three-year moving average of the growth rate falls outside a confidence interval defined by reference to the historical first and second moments of the series. Detken and Smets (2004) and Adalid and Detken (2007) define asset price booms as a period in which real asset prices are more than 10 percent

above an estimated trend. This latter is calculated recursively using a one-sided Hodrick-Prescott filter with a very high smoothing parameter.[3]

In our study, we identify boom and bust periods in real housing prices by following a dating approach similar to that initially proposed by Harding and Pagan (2002) and used by Jaeger and Schuknecht (2007) to construct the chronology of boom-bust phases in real asset prices. We consider this method to be informative because it focuses on major long term deviations in real house prices from trend. Such deviations are likely to have the more significant "distortionary" effects on individual behaviour and the macroeconomy. For example, the persistence (and not just the magnitude) of above-trend house price increases may induce house owners (and their creditors) to see such developments as permanent and fundamentals driven (and accordingly adjust their investment, consumption and lending behaviour). An effect on expectations is more likely to occur when deviations last, say, 7 years than when they persist for only 2-3 years. A potential advantage of our method is also that it may lead to reasonable results without requiring particular *'ad hoc'* censoring rules superimposed by the econometrician.[4] This is partly achieved by using annual data in the identification as annual data does not require as much "cleaning" of short term volatility via censoring rules. [5] The drawback is of course, that additional information contained in quarterly indicators is lost, even though from a long term, behavioural perspective the "real" information loss may be rather limited.

The identification approach, used in our analysis, is based on the so-called triangular methodology and it consists of five steps : a) detrending of the existing real estate price series, b) determination of a potential set of turning points, i.e. peaks and troughs in the house price series; c) computation of the persistence of the period from trough to peak (the upswing) and from peak to trough (the downturn) and the magnitude of the price changes over these periods; d) the computation of the

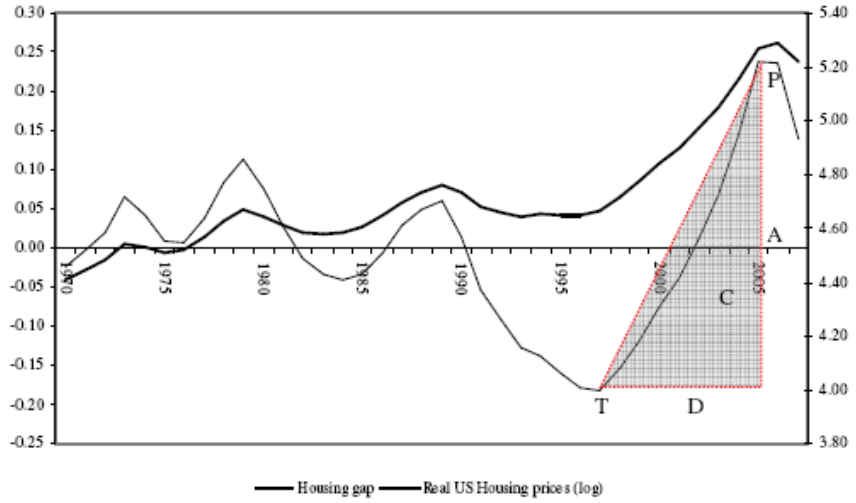
[3] More specifically, Detken and Smets (2004) use annual data and set λ=100, while Adalid and Detken (2007) use quarterly data and set λ=100000.

[4] Such ad hoc rules include, for example, the choice of the length of the window to compute the moving average of the growth rate of the series as in Bordo and Jeanne (2002) or the selection of the threshold levels to disentangle between different cyclical phases.

[5] By using annual data instead of quarterly ones, we circumvent the problem of detecting a large number of interruptions in housing price series and identifying a large number of small-size booms and busts. This, in turn, would be inconsistent with our presumption that major and persistent deviations from long-term trends are of greatest macroecomic relevance. To be consistent with our motivation, we have also decided to employ the HP-filter on ex-post data instead of the recursive HP-filter as in Adalid and Detken (2007). By using this latter method, we would run the risk to identify small and shorter-term fluctuations in housing prices as booms or busts.

cumulative changes in house prices during each phase (upswings and downturns) using the 'triangular approximation' method and finally e) to separate "booms" and "busts" from more normal housing price cycles.

Figure 1. US Housing market



Notes: *Annual US housing price (log) on right axis. Housing price gap x_t on the left axis. Sample: 1970-2007

Following this five-step procedure (see Figure 1), we first compute the housing price gap x_t by de-trending the annual real house price series (in log) using the HP-filtering method and assuming a very high smoothing parameter (λ=10000). By doing so, we try to implicitly account for the long-run driving forces (observable and unobservable) of real housing prices.[6]

We assume that a sequence $\{\Delta x_t > 0, \Delta x_{t+1} < 0\}$ identifies a local peak (P) in the series occurring at time t, while a housing price growth rate sequence $\{\Delta x_t < 0, \Delta x_{t+1} > 0\}$ identifies a local trough (T) occurring at time t. For each phase i (trough-to-peak and peak-to-trough), we compute the persistence or duration (D_i) and the magnitude (A_i). The former is computed as the number of periods (years, in our case) from trough to peak (the upswing) and from peak to trough (the downturn) while the magnitude is measured as the size of change in house prices switching from P to T and from T to P.

6 We employ an HP-filter on ex-post data instead of the recursive HP-filter for the following reasons: 1) the limited number of observations available (we have only data from 1970 to 2007, i.e., 37 years of observations makes it impossible to reasonably set a window (such that t<37) to initialize the recursive approach. 2) The objective is to maintain unchanged along the length of our sample the definition of booms and busts as major, persistent deviations from long term trends. Assuming to employ the recursive HP-filtering method, we run the risk to identify small fluctuations in housing prices as booms or busts. In addition, the definition of the dependent binary variable of the Panel Probit model would change over time thereby undermining the analysis concerning the determinants of booms and busts.

By using the triangle approximation method, we consider each housing price phase as a triangle where the height is the magnitude and the base is the persistence/duration. Therefore, an approximation of the cumulative changes (gains/losses) within each phase (P-T and T-P) could be computed as $C_i = (D_i \times A_i) \times 0.5$.[7]

Finally, after collecting separately the values of C_i computed for both "cyclical" phases, we identify "booms" and "busts" as those episodes which correspond to the first quartile from the empirical distributions of the cumulative changes in housing prices for all countries. By doing so, we are able to separate booms and busts from more normal housing prices movements. This also implies that a boom is not necessarily followed by a bust, and vice versa.

3.2 Booms and busts in real estate prices since the 1970s

By applying the above-discussed methodology to real annual residential property prices series for 18 industrialized countries over the period 1970-2007, we arrive at roughly 100 periods each of real estate price increases and declines. Of these we rank the "top" twenty-five each as housing prices boom and bust episodes.

The identified boom and bust episodes, and their persistence, magnitude and severity indicators (i.e. $C_i = (D_i \times A_i) \times 0.5$) are reported in Table 1. Figure 2 visualises boom and bust phases (shaded light and dark) as compared to "normal" periods (non-shaded) over time and across countries.

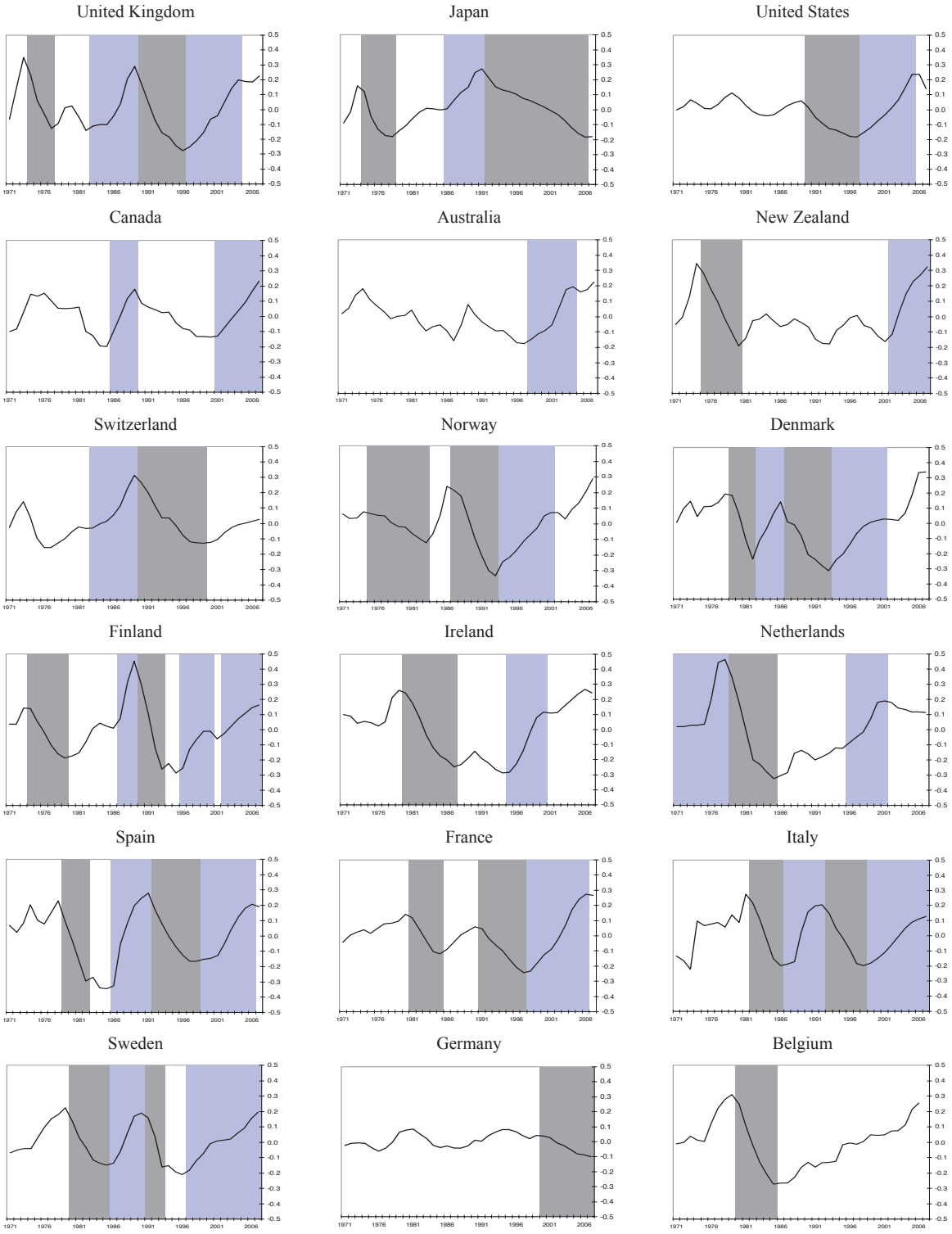
[7] Note that this approach puts much weight on persistence. As explained above, this could be justified by arguing that it is not just the magnitude but also the persistence of booms and bust that affects expectations and behaviour.

Table 1. Industrial countries: Identified Boom and Bust phases in Real housing prices

Boom Phases					Bust Phases				
Country	Years	Persistence	Magnitude	Severity indicator*	Country	Years	Persistence	Magnitude	Severity indicator*
Sweden	1997-2007	11	67.08	368.929	Japan	1992-2006	15	-45.47	-341.055
France	1998-2006	9	51.36	231.112	Netherlands	1979-1985	7	-78.95	-276.339
United kingdom	1997-2004	8	47.58	190.333	Switzerland	1990-1999	10	-44.17	-220.842
Netherlands	1971-1978	8	47.09	188.380	Ireland	1980-1987	8	-50.93	-203.702
Spain	1986-1991	6	62.55	187.664	Norway	1987-1993	7	-57.59	-201.556
United States	1998-2005	8	41.95	167.793	United Kingdom	1990-1996	7	-56.85	-198.991
Norway	1994-2001	8	40.73	162.914	Belgium	1980-1985	6	-58.06	-174.184
United Kingdom	1983-1989	7	43.31	151.592	New Zealand	1975-1980	6	-53.48	-160.434
Spain	1999-2006	8	37.19	148.766	Denmark	1987-1993	7	-45.42	-158.977
Italy	1999-2007	9	32.67	147.010	Spain	1992-1998	7	-44.64	-156.233
New Zealand	2002-2007	6	48.76	146.279	Finland	1990-1993	4	-71.45	-142.892
Denmark	1994-2001	8	34.36	137.422	Sweden	1980-1985	6	-44.48	-133.432
Australia	1998-2004	7	36.97	129.410	Italy	1993-1998	6	-40.36	-121.084
Canada	2001-2007	7	36.93	129.264	Italy	1982-1986	5	-47.12	-117.791
Ireland	1995-2000	6	40.56	121.674	France	1991-1997	7	-30.05	-105.188
Switzerland	1983-1989	7	34.70	121.459	Spain	1979-1982	4	-52.38	-104.754
Italy	1987-1992	6	40.12	120.354	Finland	1974-1979	6	-33.00	-99.002
Netherlands	1996-2001	6	31.10	93.311	United States	1990-1997	8	-24.17	-96.672
Japan	1986-1991	6	27.42	82.267	United kingdom	1974-1977	4	-47.48	-94.955
Canada	1986-1989	4	37.64	75.280	Norway	1975-1983	9	-20.15	-90.684
Denmark	1983-1986	4	37.58	75.167	Denmark	1979-1982	4	-42.76	-85.514
Sweden	1986-1990	5	29.87	74.687	Japan	1974-1978	5	-33.97	-84.922
Finland	1996-2000	5	27.40	68.494	France	1981-1985	5	-26.02	-65.054
Finland	2002-2007	6	22.35	67.048	Germany	2000-2007	8	-14.11	-56.455
Finland	1987-1989	3	44.41	66.611	Sweden	1991-1993	3	-35.61	-53.408
Averages		**7**	**40.07**	**138.129**			**7**	**-43.95**	**-141.765**

Notes: * computed using triangular approximation. Sample: 1970-2007.

Figure 2. Housing prices gaps and Boom and Bust Phases. Period: 1971-2007.



Note: Shaded dark area denote bust phases while the light ones indicate boom phases. Housing price gaps are computed as the deviations of the real housing prices from trend obtained using HP filter (λ=10000)

The past decade has seen many of the most persistent and severe booms since the 1970s: 15 of the "top 25" booms identified occurred during the period since the mid-1990s. In fact, only Japan, Germany and Belgium do not report housing booms in

the past decade. Sweden's boom from 1997 to 2007 lasted 11 years and resulted in an above-trend increase of house prices by 67%. France follows with an above-trend increase by over 50% over nine years. Spain and the UK are represented twice in the "top 10" of the "boom severity league". The magnitude of house price increases beyond trend ranged from 22% to 67% and the duration from 3 to 11 years. Japan's famous boom of 1980s has a surprisingly low boom severity score but this is mainly due to the fact that it was part of a longer boom that had started in the late 1970s and that was briefly interrupted in the early 1980s recession.[8]

Of the 25 busts, about half occurred in the early to mid-1990s. In the case of Japan, the bust lasted until 2006 and house price declining by about 45% as compared to the trend. The remaining busts seem more scattered over the previous 20 years. The Dutch bust around 1980 and the Finnish one from the early 1990s were the deepest with a fall by over 70% from peak to trough.

The pattern of booms and busts as visualised in Figure 2 yields some more interesting results. The largest group of countries (8) could be called "repeated boom busters": the Nordics and the large European countries except Germany (i.e., Denmark, Finland, France, Italy, Norway, Spain, Sweden, UK). Another three countries, Australia, Canada and the US could be called "new boomers". Six countries, including Japan, Switzerland, New Zealand, Ireland, the Netherlands and Belgium could be labelled "long cyclers" where the Dutch boom already came to an end a few years ago and the upswing in Belgium is too slow and interrupted to be statistically labelled as a boom. Germany seems to be the odd country out where house prices have been relatively stable and even the recent drawn-out bust has been relatively shallow.

The period since the mid-1980s seems to feature more countries affected and more synchronicity across countries than the period before: booms in the late 1980s were often followed by busts in the early to mid-1990s. A renewed boom since the late 1990s occurred in most of these and a further number of countries. Recent booms have not only affected the most countries; the group also includes the US and hence

[8] While the use of annual data reduces noise from short term "interruptions" of long term trends, such interruptions may still occur, as was the case in Japan and in few other countries more recently. This constitutes an important shortcoming of our identification method and occasionally leads to an underestimation of the "true" persistence of booms and busts. This has to be weighed against the costs and benefits of using further "ad hoc" rules and techniques.

the country of most global relevance. Furthermore, the most recent booms have been longer (6-11 years instead of 3-8 previously). If it had not been for short interruptions (around 2001 when the dot-com bubble burst and economic growth slowed), we would have seen "mega-booms" in Ireland, Denmark, Finland and Norway lasting about 15 years. The most recent busts have also been longer than earlier ones with Japan's 15 years followed closely by Switzerland's ten and Germany's eight.

3.3. Some stylized facts on the characteristics of boom-bust phases

Turning in some more detail to the results from our identification procedure, we find that, over the period 1970-2007, nine out of twenty-five identified boom episodes were immediately followed by busts. In Table 2, information on the persistence, magnitude and severity of booms and busts is complemented by a measure of their relative size (computed as the difference between boom and bust severity indicators). For Japan, we report boom indicators for both the identified period (JP) and the long term upswing in the real estate market that already started in 1979 and that was briefly interrupted in the mid-1980s (JP2, shaded). The last three columns of the table report the average values of a core set of macroeconomic variables during the selected boom and bust episodes.

When comparing experiences during booms with those during busts over the nine "full" cycles in our sample, a number of interesting patterns emerge. First, the persistence and magnitude (and, thereby, the severity indicators) are highly correlated or, in other words, long and severe booms tend to be followed by long and severe busts. This is illustrated in Figures 2 and 3 and it holds particularly strongly when considering the extended Japanese boom period (JT2). Moreover, bust episodes mostly tend to be equally long or slightly longer and of an equal or higher magnitude than boom episodes. Only in two cases is the overall severity indicator in the late 1980s boom larger than in the subsequent bust (Spain and Sweden).

The last three columns of Table 2 illustrate the marked difference in certain macroeconomic variables across boom and bust episodes. On average, real per capita growth was almost 3% lower during busts than during booms. Given an average bust length of 7.3 years, this translates into a relative output loss of about 20% of GDP (or 10% if one takes the average of boom and bust real growth as a proxy of the long term trend). The most significant difference is in real credit growth which had averaged

about 7% during the boom before falling to -2.2% in the bust. More than half the countries reported negative growth during the busts when excess leverage of the boom was reversed. Short term interest rates were on average almost 2% higher during booms than during busts but the picture is more diverse.

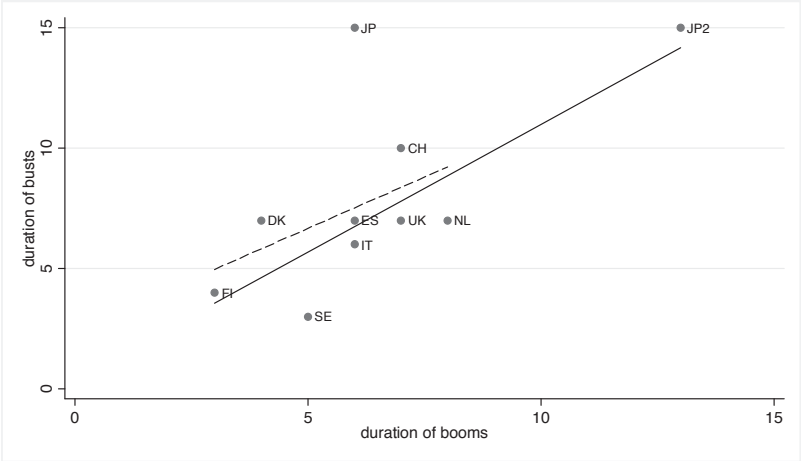
Table 2. Boom-bust phases in industrialized countries over the period 1970-2007

						Averages values over the boom/bust periods		
Country		Years	Persistence	Magnitude	Severity indicator*	Real per capita GDP (growth)	Short-term interest rates	Real credit (growth)
United kingdom (UK)	boom	1983-1989	7	43.31	151.59	3.41	11.02	16.29
	bust	1990-1996	7	-56.85	-198.99	1.41	8.55	0.42
	Difference				**-47.4**	**-2.00**	**-2.47**	**-15.87**
Japan (JP)	Boom	1986-1991	6	27.42	82.27	4.02	5.74	3.87
	Bust	1992-2006	15	-45.47	-341.06	0.99	0.92	-3.78
	Difference				**-258.79**	**-3.03**	**-4.82**	**-7.65**
Japan (JP2)	*Boom*	*1979-1991*	*13*	*45.19*	*293.75*	*3.27*	*6.59*	*2.89*
	Bust	*1992-2006*	*15*	*-45.47*	*-341.06*	*0.99*	*0.92*	*-3.78*
	Difference				***-47.30***	***-2.28***	***-5.67***	***-6.67***
Switzerland (CH)	Boom	1983-1989	7	34.70	121.46	1.97	3.33	3.56
	Bust	1990-1999	10	-44.17	-220.84	0.44	4.04	0.44
	Difference				**-99.38**	**-1.53**	**0.71**	**-3.12**
Denmark (DK)	Boom	1983-1986	4	37.58	75.17	3.86	10.62	10.15
	Bust	1987-1993	7	-45.42	-158.98	0.57	10.2	-6.97
	Difference				**-83.81**	**-3.29**	**-0.42**	**-17.12**
Finland (FI)	Boom	1987-1989	3	44.41	66.61	4.27	10.85	7.55
	Bust	1990-1993	4	-71.45	-142.89	-3.28	10.02	-0.25
	Difference				**-76.28**	**-7.55**	**-0.83**	**-7.80**
Netherlands (NL)	boom	1971-1978	8	47.10	188.38	2.35	6.09	6.93
	bust	1979-1985	7	-78.95	-276.34	0.9	8.31	1.08
	Difference				**-87.96**	**-1.45**	**2.22**	**-5.85**
Italy (IT)	Boom	1987-1992	6	40.12	120.35	2.43	12.2	2.96
	Bust	1993-1998	6	-40.36	-121.08	1.36	8.31	-0.71
	Difference				**-0.73**	**-1.07**	**-3.89**	**-3.67**
Spain (ES)	Boom	1986-1991	6	62.55	187.66	3.86	13.76	2.9
	Bust	1992-1998	7	-44.64	-156.23	1.99	8.5	0.89
	Difference				**31.43**	**-1.87**	**-5.26**	**-2.01**
Sweden (SE)	Boom	1986-1990	5	29.87	74.69	1.98	9.1	7.66
	Bust	1991-1993	3	-35.61	-53.41	-2.05	7.67	-10.9
	Difference				**21.28**	**-4.03**	**-1.43**	**-18.56**
Averages	Boom		5.8	40.79	118.69	3.13	9.19	6.87
	Bust		7.3	-51.44	-185.54	0.26	7.39	-2.20
	Difference		**1.5**	**-10.65**	-66.85	**-2.87**	**-1.80**	**-9.07**
Ad memoriam:	**Latest Booms (Average)**		**7.5**	**39.80**	**153.98**	**2.67**	**4.04**	**6.58**

Note: For Japan, we also compute the cumulative housing price changes by assuming a unique long boom phase during the period 1979-1991. Average values are based on Japan (JP) data. Characteristics of the latest booms episodes are computed as average values of the most recent boom episodes experienced by the following countries: Sweden, France, U.K. , U.S., Norway, Spain, Italy, New Zealand, Denmark, Australia, Canada, Ireland, Netherlands, Finland.

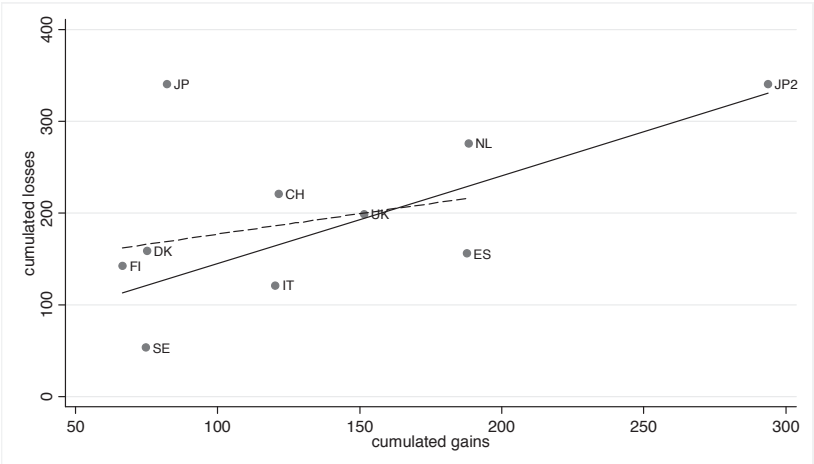
Figures 3a and 3b illustrate what could be expected in the current post-boom phases if the experience of the earlier cycles is of relevance: long and/or severe booms are followed by long and/or severe busts. Recent booms have mostly been on the long side (averaging 7.5 years) and of a similar magnitude as earlier booms so that the overall severity indicator is somewhat higher. When looking at recent boom episodes, it is also noteworthy that average real per capita economic growth and credit growth did not differ much from the boom part of the earlier real estate price cycles.

Figure 3a. Durations of boom (horizontal axis) and bust (vertical axis) periods.



Note: The non-dotted trend line and "JP2" reflects the extended Japanese boom phase. The dotted line and "JP" denotes the trend when the "short" boom for Japan is considered.

Figure 3b. Cumulative gains (horizontal axis) and losses (vertical axis)



Note: See Figure 3a.

If past experiences provide guidance, a similar pattern could be expected for the current post-boom periods as for earlier ones: real per capita GDP growth would be very low and real credit growth distinctly negative over the average of the bust that could last for the best part of a decade. However, it is also conceivable that the global

nature of the current downturn and the rapid deleveraging and balance sheet repair that appears to be taking place at the time of writing of this article leads to a shorter though deeper bust.

3.4 Cross-sectional Post-boom analysis

In this sub-section, we test whether the behaviour of certain variables during booms can help explain output growth during the post-boom period. In particular, we are interested to test whether the cost associated with boom phases (that materialise in busts as output losses) are related to the characteristics of and notably credit developments during these periods. To that end, similar to Adalid and Detken (2007), we estimate the following cross-section equation:

$$y_r\left(post-boom\right)_n = \beta_0 + \beta_1 y_r\left(boom\right)_n + \beta_2 Per + \beta_3 Mag + \beta_4 CR + \varepsilon \qquad (1)$$

where n are the twenty-five real estate boom episodes identified in Table 1, $y_r\left(post-boom\right)$ is the three-years average real GDP growth in the post-boom period while $y_r\left(boom\right)$ indicates the average real GDP growth during the boom periods.

The variable *Per* and *Mag* denote the persistence and the magnitude of the boom episodes, respectively. *CR* is the average real growth rate of credit (to private sector) during the boom periods. We note that, when the boom phases end in 2006 or 2007, the post-boom real GDP cannot be computed. In these cases, we calculate the dependent variable of equation (1), by using the latest European Commission projections of real GDP (AMECO dataset; January 2009 forecast).

Results from equation (1) are reported in Table 3a, columns 1-2. In addition, to cross-check the robustness of our conclusions, we test whether the characteristics of other less severe asset price upswings influence the output growth rate during the following downturn period by re-estimating model (1) with the "next" 25 episodes out of the 100 identified via the dating approach described in section 3.1. Results are reported in columns 3-4. Table 3b provides some descriptive statistics on the top 25 boom episodes and the "next" 25.

Table 3a. Regression explaining the post-boom Real GDP developments.

Dependent variable: Three-years average post-boom real GDP (growth)

	(1)	(2)	(3)	(4)
Avg. Boom Real GDP (growth)	0.8949***	0.8918***	0.1127	0.1248
	[0.1374]	[0.1255]	[0.2537]	[0.2573]
Duration of the boom (*Per*)	0.7034***	0.8124***	0.1549	0.1552
	[0.2172]	[0.2346]	[0.4301]	[0.4399]
Magnitude of the boom (*Mag*)	-0.0507*	-0.0501*	-0.0734*	-0.0627
	[0.0260]	[0.0255]	[0.0420]	[0.0437]
Avg. Credit growth rate during boom	-0.1056***	-	0.0561	-
	[0.0366]	-	[0.0816]	-
Cum. Credit growth rate during boom	-	-0.0154***	-	0.0121
	-	[0.0053]	-	[0.0183]
Constant	-4.0991***	-4.8400***	1.7482	1.502
	[1.2724]	[1.2770]	[3.2619]	[3.5788]
Observations	Top 25	Top 25	Next 25	Next 25
R-square	0.63	0.63	0.16	0.15

Note: OLS estimation. Robust standard error in square brackets. Avg. indicate the value.* significant at 10%; ** significant at 5%; *** significant at 1%..

Estimates reported in columns 1-2 seem to confirm our hypothesis regarding the influence of boom characteristics on post-boom growth rate. We find that a *'level shift'* effect may help explain the positive sign of the estimated coefficient $\hat{\beta}_1$. Countries that experienced higher growth during the boom are also likely to expect higher growth during the bust. Or in other words, growth does not decline by less in countries with low growth during the boom. One explanation could be that this reflects conditional convergence or catching up growth. The positive coefficient for $\hat{\beta}_2$ may point to a "persistence" effect in that countries with a drawn out boom experience also a slower reversal of the growth pattern than countries with a shorter (but potentially steeper) boom. It is consistent with earlier findings in the literature, that drawn out booms were followed by shallower but more persistent downturns while short booms tended to be followed by short and deep busts (see e.g., Jaeger, Schuknecht, 2007).

In addition, we find that the coefficient $\hat{\beta}_3$ reflecting the magnitude of the boom is significant and negatively correlated with post-boom growth. In other words, a more significant overshooting in real estate prices in boom periods is correlated with lower post-boom growth as real estate prices and other imbalances need to adjust more. Finally, the estimated coefficient $\hat{\beta}_4$, associated with the growth rate of private

credit, is also negative and statistically significant. This means that the larger credit growth over the boom phase, the more lacklustre is the real GDP growth in the post-boom phase. This evidence also holds when we consider the cumulated credit growth rate instead of the average growth rate (see column 2). This finding would be consistent with the need for greater deleveraging/balance sheet repair in countries that experienced stronger credit booms in the boom.

Looking at the results reported in column 3-4, we note that all the explanatory variables are not statistically significant. This evidence corroborates our previous empirical findings and the claim that the identified booms are "different" and non-linearities are at work. Given the small number of observations, however, results need to be interpreted cautiously.

Table 3b. Boom and non-boom characteristics

	Top 25	Next 25
Avg. three-years average post-boom real GDP (growth)	1.06	1.46
Avg. Boom Real GDP (growth)	3.50	3.51
Duration of the boom (*Per*)	6.72	4.36
Magnitude of the boom (*Mag*)	40.07	23.08
Avg. Credit growth rate during boom	6.36	5.89
Cum. Credit growth rate during boom	44.03	23.40

Note: average values.

4. Determinants of booms and busts in housing markets

In this section, we examine the determinants of booms and busts in real estate markets and, thereby, indirectly also the question of the identification of factors that can serve as an early warning for booms and busts. To that end, we use an econometric approach that allows a) to assess which factors better predict boom and bust episodes and b) to measure the impact of each identified factor on the response conditional probabilities of these events.

4.1 Empirical model and hypotheses

In order to examine the determinants and the predictability of boom and bust cycles, we estimate a Random Effects Probit model for a panel of 18 industrialized

countries over the period 1980-2007.[9] Specifically, we estimate separately two models that look at boom versus non-boom and at bust versus non-bust phases.

From a theoretical point of view, the use of a binary modelling approach in a Panel framework allows to capture potential "trigger effects" in housing markets due to their common degree of cyclicality and synchronization and, at the same time, to examine the probabilities of simultaneous booms or busts in different real estate markets.

From an econometric point of view, using a panel approach has several advantages. Considering that, for each country, the number of identified boom and bust episodes is small, the estimation of a binary model on a country-by-country basis is not recommended since the robustness of the results would be questionable. The panel nature of the data usually provides an increased number of data points generating additional degrees of freedom, which presumably leads to more efficient estimation. Moreover, incorporating information related to both cross-section and time series variables can substantially diminish the problems that arise when there is an omitted variable problem. On the other hand, the strategy to estimate a pooled regression model imposes uniformity on the conditional probability responses to the explanatory variables across countries, which is a rather restrictive assumption.

Starting from these premises, we estimate the following Panel Probit model:

$$y_{it}^{*} = \mathbf{X}_{it-1}^{'}\beta' + \alpha_i + v_{it-1} \quad t = 1,\ldots,T \quad i = 1,\ldots,N \tag{2}$$

$$y_{it} = \begin{cases} 1 \text{ if } y_{it}^{*} > 0 \\ 0 \text{ if } y_{it}^{*} \leq 0 \end{cases}$$

where y_{it}^{*} is the latent variable (incidence of booms or busts) for which we observe only its realisation, y_{it}. This latter variable receives the value of zero or one depending on whether a boom or bust has occurred or not.[10] $\mathbf{X}_{it}^{'}$ is a vector of regressors, i.e. the set of common driving factors explaining the boom/bust phases. To avoid potential endogeneity problems, lagged explanatory variables are used ($\mathbf{X}_{it-1}^{'}$)

[9] Other approaches can be found in literature. For instance, the signal approach is used, among others, by Kaminsky, Lizondo and Reinharrt (1998) and Alessi and Detken (2009).
[10] In the case of the boom model, all non-boom periods receive a value of zero. In the case of the bust model, all non-bust periods receive the value of zero.

in place of contemporaneous values. β is a vector of parameters to be estimated, α_i are unobserved individual random effects while v_{it} is the white noise error term, such that $v_{it} \sim N(0,1)$.

Within this framework, it is possible to estimate the probabilities of boom or bust episodes conditional on the observable factors $\mathbf{X}'_{it-1}$ as follows:

$$\mathbf{Pr}\left(y_{it} = 1 | \mathbf{X}'_{t-1}, \beta', \right) = F\left(X'_t, \beta'\right) \tag{3}$$

where F denotes the cumulative density function (c.d.f.) of normal standard distribution.

The accuracy of the estimated probability can be evaluated by computing the quadratic probability score (*QPS*, henceforth).[11] Let P_t be the probability of boom/bust during the next year, i.e. $P_t = \Pr\left(y_{t+1} = 1 | I_t\right)$, and R_t a dummy variable taking the value of one if the boom/bust occurs within the next year and zero otherwise. Then, the *QLS* is obtained as:

$$QPS = \frac{1}{T}\sum_{t=1}^{T}\left(P_t - R_t\right)^2 \tag{4}$$

where the value ranges from 0 to 1, with a score of zero corresponding to perfect accuracy.

4.2 Driving factors of housing markets

Following the above-quoted empirical literature, a number of explanatory variables, $\mathbf{X}'_{it}$, was considered in our analysis. As discussed in the robustness section, many variables were not significant while others were not included because of potential reverse-causality problems. Therefore, the final specification of our basic model includes the following set of controls:[12]

- A set of variables ($\boldsymbol{X}_1$) reflecting economic fundamentals:

Growth in per-capita real GDP may be related to house price deviations from trend especially if the persistence of such growth leads to the perception of higher life-time

[11] See e.g. Diebold and Rudebusch (1989), Filardo (1994) and Layton (1998).
[12] See the Annex for the description of data sources.

income growth and, hence, the willingness of agents to take on more debt and spend a larger share of income on housing and related debt service. We may hence see higher growth of personal income being positively associated with a higher probability of a housing boom and lower growth with a higher probability of a bust.

The *level of short-term interest rates* affects household debt financing conditions; an increase should decrease the probability of a boom and increase the one of a bust.[13]

The *growth rate of real credit to the private sector* also mirrors households' debt financing conditions and the degree of credit-rationing. Moreover, it could reflect the interaction between rising house prices and the availability of credit due to higher collateral values. More/less credit growth should hence be correlated with a higher boom/bust probability.

The *growth rate of global-liquidity variable* aims to test for the role of international factors and notably cross-country spillovers via generously (or sparsely) available liquidity in other countries. We consider the growth rate of a "global" money aggregate computed as PPP-GDP weighted average of broad money growth for all sample countries, minus the corresponding national M3 aggregate.

- A Demographic variable (X_2) to account for related demand-side effects on real estate prices:

The growth rate of working-age population may play a role in explaining housing demand and house prices over longer horizons, also given long supply lags in the construction sector. We expect that higher growth increases the likelihood of a boom.

- A set of dummies ($\boldsymbol{X_3}$) controlling for the structural characteristic of local mortgage markets and the banking sector:

A mortgage market deregulation dummy takes the value of one after the deregulation process has taken place in each country and zero otherwise. Deregulation should increase the probability of a subsequent boom. Until the 1980s, mortgage markets were, in general, highly regulated. Interest rate ceilings and quantitative limits on mortgage credit and repayment periods resulted in a chronic or temporary credit

[13] We consider the nominal short-term interest rate instead of the real interest rate for two reasons. First, we expect that nominal interest rates directly reflect the direction of monetary policy. Secondly, as discussed by Sutton (2002) and Tsatsaronis and Zhou (2004, banks typically base their decision to grant a housing loan on the ratio of debt servicing costs to income. This ratio depends on the nominal and not the real interest rate.

rationing in the mortgage market and made it difficult for households to access credit (see e.g. Girouard and Blondal, 2001). The deregulation process which took place in the early to mid-1980s in many advanced economies heightened competition in the banking sector and broadened households' access to mortgage credit (see Diamond and Lea, 1992).[14]

Considering that the fragility of the banking sector is typically associated to drops in house prices, we introduced a *banking crises dummy*. We expect that the sign of the coefficient is positive during booms (when there are no banking crises) and negative during busts (which at times coincide with such crises).We use the information on banking crises that have occurred since 1970s (see e.g. Caprio and Klingebiel 1999; 2003 and Laeven and Valencia, 2008) to compute a binary variable that takes the value of one during the periods of financial crises and zero otherwise.

We remark that, in order to avoid potential problems of endogeneity, all variables enter the Panel Probit model (2) with a lag.

5. Empirical results

The results of our model estimates broadly confirm the relevance of our variables for explaining both boom and bust episodes. Table 4 summarizes the main empirical findings. The overall model fit as reflected in the quadratic probability score is rather good for predicting both booms and busts. Column 1 reports the empirical relationship between economic fundamentals ($\boldsymbol{X}_1$) and the incidence of booms/busts one year later. We then broaden the analysis by including demographic (X_2) and structural indicators ($\boldsymbol{X}_3$) in columns 2 and 3.

Column 1 shows that all coefficients associated with the vector of controls $\boldsymbol{X}_1$ are statistically significant and have the expected signs. Not surprisingly, a high level

[14] As shown in Table 2 of the Annex, in the U.S., the deregulation of housing finance markets coincided with the phasing out of interest rate controls under Regulation Q in 1984 (Green and Wachter, 2007). In the U.K., deregulation occurred mainly through the abolition of credit controls (i.e. the "corset" was abolished in 1980). In Australia and Nordic countries, the deregulation process was relatively rapid and almost completed by the mid-1980s. By contrast, in some continental European countries (i.e. Italy) and Japan, the reform process started later and it was slower. Of particular importance from a policy perspective is the relationship between house prices and the local structural features of mortgage markets, i.e. the degree of access to the mortgage market and the flexibility of conditions under which credit becomes available.

of per capita GDP, a high level of liquidity (both at the local and "global" level) and lower interest rates increase (decrease) the likelihood of boom (bust) episodes.

Table 4. Determinants of boom and bust phases in housing market

	Explanatory variables	Dependent variable: incidence of booms/busts in housing markets					
		Models					
		Booms			Busts		
		(1)	(2)	(3)	(1)	(2)	(3)
Economic Fundamentals	Lagged real per capita GDP (growth)	0.3646***	0.3551***	0.3480***	-0.1991***	-0.1746***	-0.1696***
		[0.0558]	[0.0583]	[0.0612]	[0.0416]	[0.0430]	[0.0439]
	Lagged short-term interest rate	-0.1435***	-0.1776***	-0.1403***	0.0966***	0.1243***	0.1078***
		[0.0217]	[0.0252]	[0.0276]	[0.0200]	[0.0232]	[0.0275]
	Lagged local real credit (growth)	0.0236**	0.0224**	0.0247**	-0.0451***	-0.0440***	-0.0386***
		[0.0098]	[0.0102]	[0.0121]	[0.0135]	[0.0136]	[0.0138]
	Lagged Global liquidity (M3 growth)	0.2667***	0.2460***	0.2554***	-0.1876***	-0.1631***	-0.1736***
		[0.0618]	[0.0637]	[0.0662]	[0.0577]	[0.0591]	[0.0604]
Demographic	Lagged population growth		0.9842***	1.0257***		-0.6599**	-0.5211*
			[0.3238]	[0.3703]		[0.2602]	[0.2680]
Structural indicators	Deregulation (dummy)			0.5716*			-0.0778
				[0.3156]			[0.2397]
	Banking crises (dummy)			-1.2954***			0.6092***
				[0.3512]			[0.2280]
	Pseudo R-square	0.26	0.27	0.31	0.22	0.24	0.25
	Quadratic Probability Score (QPS)			0.38			0.36

Note: Sample 1980-2007. Panel Probit estimation. * significant at 10%; ** significant at 5%; *** significant at 1%.

In the second column, we add the population growth variable (X_2). This does not change the results concerning the importance of fundamentals variables which remain always statistically significant. We find that the level of working-age population matters as it increases housing demand that, in turn, pushes up real estate prices.

Finally, the third column of Table 4 displays the estimation results including structural control variables (X_3). The deregulation variable is statistically significant only in the boom model specification. The signs of the associated coefficients suggest that financial deregulation is significantly correlated with a sustained upswing of house prices. By contrast, it does not seem to play a role in explaining downturns in housing markets. Regarding the importance of the banking crises dummy, we find, as expected, that the higher the fragility of the local financial sector the higher (lower) the likelihood of bust (boom) episodes. Once again, the qualitative and quantitative role of the other variables remains unchanged.

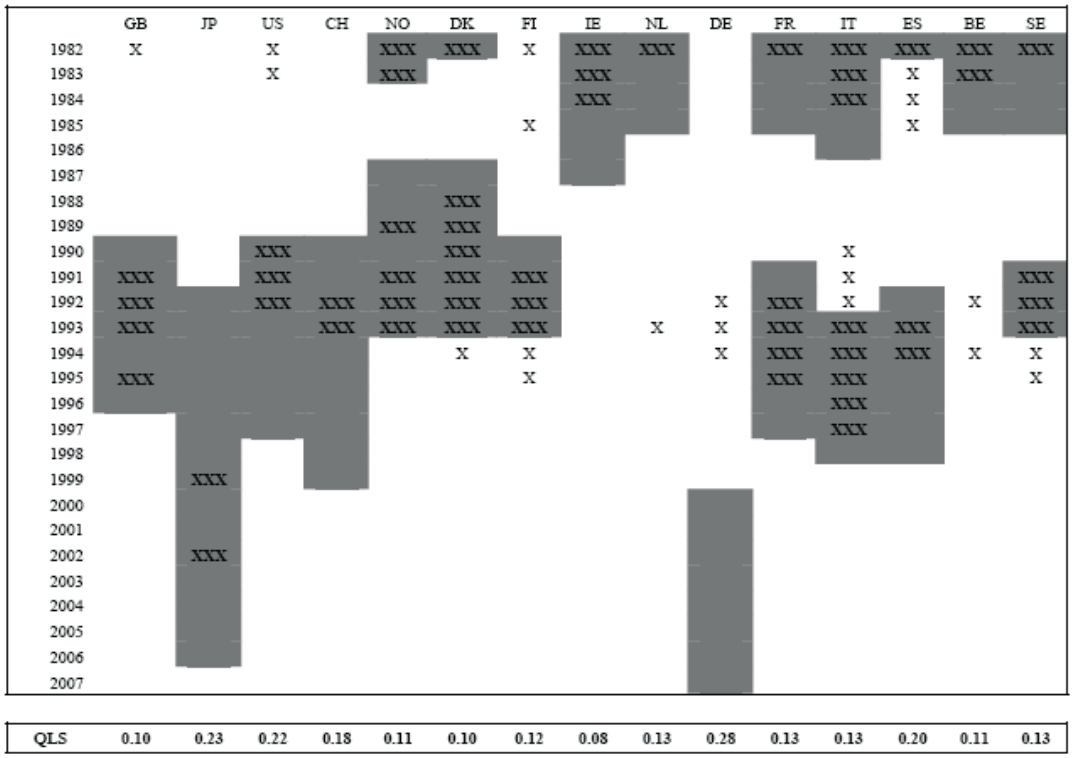
The findings in Table 4 allow us to move a step further and analyse the "success" of the estimated panel probit models in predicting boom and bust events for particular years and countries. The results are reported in Table 5 for booms and Table 6 for busts. In these tables, the shaded area denotes the identified boom and bust periods while the years marked by x serve to count the number of correct and incorrect signals. Following Canova (1994), we discriminate between these signals by using a simple early warning rule: we assume that each boom/bust episode is correctly predicted (cells marked by **xxx**) if, at the time the event occurs, the associated estimated probability is above a conventional threshold value of fifty percent. By contrast, when the predicted probability is above the threshold and a boom/bust has not occurred we argue that the event is incorrectly predicted (cells marked by x) and we interpret the associated probability as a false signal. Given that this approach leads to a rather rough measure of the performance of the model, we also report the values of country-specific QPS indicators at the bottom of the Tables.

Table 5. Boom predictions over the period 1982-2007

	GB	JP	US	CA	AU	NZ	CH	NO	DK	FI	IE	NL	FR	IT	ES	SE
1982							X									
1983							XXX									
1984							XXX					X				
1985							XXX					X				
1986		XXX					XXX	X				X				
1987	XXX	XXX					XXX	X				X				
1988	XXX	XXX					XXX				X	X			XXX	XXX
1989	XXX	XXX					XXX				X	X	X	XXX	XXX	
1990		XXX					X				X	X			XXX	
1991											X					
1992																
1993																
1994						X										
1995											XXX					
1996								XXX			XXX					
1997			X					XXX		XXX	XXX	XXX				
1998			XXX	X	XXX			XXX		XXX	XXX	XXX			X	XXX
1999	XXX		XXX	X	XXX		X	XXX	XXX	XXX	XXX	XXX	XXX		XXX	XXX
2000	XXX		XXX	X	XXX	X	X			XXX	XXX	XXX	XXX	XXX	XXX	XXX
2001	XXX			XXX					XXX	X	X	XXX	XXX		XXX	XXX
2002	XXX		XXX	XXX	XXX	XXX	X	X		XXX	X	X	XXX	XXX	XXX	XXX
2003	XXX		XXX	XXX	XXX	XXX	X	X		XXX	X				XXX	XXX
2004	XXX		XXX	XXX	XXX	XXX	X	X		XXX	X		XXX		XXX	XXX
2005	X		XXX	XXX		XXX	X	X		XXX	X		XXX		XXX	XXX
2006	X		X	XXX			X	X	X	XXX	X	X			XXX	XXX
2007				XXX			X	X	X	XXX	X	X	X		X	XXX
QLS	0.19	0.05	0.10	0.17	0.10	0.11	0.22	0.23	0.26	0.13	0.35	0.23	0.13	0.31	0.15	0.12

Note: Grey areas denote, for each country, identified boom periods. In those periods highlighted with bold X the probabilities exceeding the conventional threshold value of 50% (i.e. booms correctly anticipated) while X denote the false signals. QLS indicate the quadratic Probability Score indicator.

Table 6. Bust predictions over the period 1982-2007



Note: Grey areas denote, for each country, identified bust periods. In those periods highlighted with bold X the probabilities exceeding the conventional threshold value of 50% (i.e. busts correctly anticipated) while X denote the false signals. QLS indicate the quadratic Probability Score indica

The (overall) predictive power of the model is relatively good as can be seen by the low QPS values and the rather large number of shaded cells correctly identified. However, there is also considerable heterogeneity in the performance of the model which may reflect the fact that housing markets are distinguished markedly by idiosyncratic local factors (see IMF, 2004).

For most countries, the model is performing well in predicting booms and the number of false signals is limited. In fact, probabilities exceed the threshold in most cases at the latest by the third boom year and in some cases already in the first year. This suggests a good performance of the model as an early warning device for the identification of booms. Incorrect boom signals occurred in the late 1980s for Ireland and Netherlands. More recently, false boom signals for Ireland and Norway need to be interpreted cautiously in light of the fact that in these countries, a very drawn out house price boom was shortly interrupted during the early 2000s so that the latter years do not qualify as a boom by our method. The model also predicts correctly the majority of busts with the exception of Germany (not at all) and Japan (only late in the bust).

Table 7a. Boom and bust probabilities in 2008

Countries experiencing booms	Predicted boom probabilities for 2008	Predicted bust probabilities for 2008
G-3 countries		
United Kingdom	**0.27**	**0.17**
Japan	**0.35**	**0.16**
United States	**0.12**	**0.28**
Nordic Countries		
Norway	**0.77**	**0.09**
Denmark	**0.55**	**0.10**
Finland	**0.84**	**0.05**
Ireland	**0.89**	**0.03**
Netherlands	**0.81**	**0.04**
Sweden	**0.77**	**0.06**
Euro countries		
France	**0.65**	**0.08**
Italy	**0.45**	**0.13**
Spain	**0.67**	**0.07**
Switzerland	**0.83**	**0.05**
Average overall	**0.61**	**0.10**

Another interesting issue is the identification of turning points from booms to busts. In this regard, Table 7a shows the predicted boom and bust probabilities for 2008 on the basis of 2007 data. This has to be seen against the background of 2008 already appearing during the course of that year as a turning point in house prices in many countries and as the first year of a potential bust in the US and UK. Table 7a, however, still shows often rather high boom probabilities and low figures only for the US and the UK. The predicted probability of 2008 potentially being the first year of a bust is low even for the UK and US. The model hence does not seem to be very powerful in explaining turning points. This assessment is also underpinned by the fact that the first bust year would also not have been predicted with a high probability in the past either (see Table 6).

So far, we have analysed the accuracy of prediction for our model (2) using *in-sample* techniques (see Table 5-7a). In order to investigate its *out-of-sample* performances, we conduct a forecasting experiment based on a recursive scheme. Specifically, after estimating recursively the Panel Probit model, we compute, for each countries, multi-period ahead forecasts of booms and busts. We start to estimate

the model over the sample period 1980-2000[15] and then, we calculate the *out-of-sample* predictions for 2001 through 2007. To save space, we report, in table 7b, results from this forecasting exercise only for the boom model.[16] The shaded cells are denoted years for which out-of-sample predictions are computed. The years marked by XXX serve to count the number of correctly predicted booms while years marked by X count the number of false signals.

By comparing results with those reported in Table 5, we see that the predictive content of our model is stable over time, i.e. in-sample booms predictions match quite well those obtained with different horizon. In addition, we note that, predictive performance across countries are heterogeneous as in Table 5 thereby suggesting, once again, that our model is unable to achieve full prediction accuracy in predicting booms for all countries.

Table 7b. Out-of sample performances

		end of sample (year)						
		2000	2001	2002	2003	2004	2005	2006
United Kingdom	2001	XXX						
	2002	XXX	XXX					
	2003	XXX	XXX	XXX				
	2004	XXX	XXX	XXX	XXX			
	2005	X	X	X	X	X		
	2006	X	X	X	X	X	X	
	2007							
Japan	2001							
	2002							
	2003							
	2004							
	2005							
	2006							
	2007							
United States	2001							
	2002	XXX	XXX					
	2003	XXX	XXX	XXX				
	2004	XXX	XXX	XXX	XXX			
	2005	XXX	XXX	XXX	XXX	XXX		
	2006	X	X	X	X	X	X	
	2007							
Canada	2001	XXX						
	2002	XXX	XXX					
	2003	XXX	XXX	XXX				
	2004	XXX	XXX	XXX	XXX			
	2005	XXX	XXX	XXX	XXX	XXX		
	2006	XXX	XXX	XXX	XXX	XXX	XXX	
	2007	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Australia	2001							
	2002	XXX	XXX					
	2003	XXX	XXX	XXX				
	2004	XXX	XXX	XXX	XXX			
	2005							
	2006							
	2007							
New Zealand	2001							
	2002	XXX	XXX					
	2003	XXX	XXX	XXX				
	2004	XXX	XXX	XXX	XXX			
	2005	XXX	XXX	XXX	XXX	XXX		
	2006		XXX					
	2007							
Switzerland	2001	X						
	2002	X	X					
	2003	X	X	X				
	2004	X	X	X	X			
	2005	X	X	X	X	X		
	2006	X	X	X	X	X	X	
	2007	X	X	X	X	X	X	X
Norway	2001							
	2002	X	X					
	2003	X	X	X				
	2004	X	X	X	X			
	2005	X	X	X	X	X		
	2006	X	X	X	X	X	X	
	2007	X	X	X	X	X	X	X

		end of sample (year)						
		2000	2001	2002	2003	2004	2005	2006
Denmark	2001	XXX						
	2002	X	X					
	2003	X	X					
	2004	X	X					
	2005	X	X	X	X	X		
	2006	X	X	X	X	X	X	
	2007	X	X	X	X	X	X	X
Finland	2001	X						
	2002	XXX	XXX					
	2003	XXX	XXX	XXX				
	2004	XXX	XXX	XXX	XXX			
	2005	XXX	XXX	XXX	XXX	XXX		
	2006	XXX	XXX	XXX	XXX	XXX	XXX	
	2007	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Ireland	2001	X						
	2002	X	X					
	2003	X	X	X				
	2004	X	X	X	X			
	2005	X	X	X	X	X		
	2006	X	X	X	X	X	X	
	2007	X	X	X	X	X	X	X
Netherlands	2001	XXX						
	2002	X	X					
	2003	X	X					
	2004	X	X					
	2005	X	X	X	X	X		
	2006	X	X	X	X	X	X	
	2007	X	X	X	X	X	X	X
Sweden	2001	XXX						
	2002	XXX	XXX					
	2003	XXX	XXX	XXX				
	2004	XXX	XXX	XXX	XXX			
	2005	XXX	XXX	XXX	XXX	XXX		
	2006	XXX	XXX	XXX	XXX	XXX	XXX	
	2007	XXX	XXX	XXX	XXX	XXX	XXX	XXX
France	2001	XXX						
	2002	XXX	XXX					
	2003	XXX	XXX					
	2004	XXX	XXX	XXX	XXX			
	2005	XXX	XXX	XXX	XXX	XXX		
	2006	XXX	XXX	XXX	XXX	XXX	XXX	
	2007	X	X	X	X	X	X	X
Italy	2001							
	2002	XXX	XXX					
	2003							
	2004							
	2005							
	2006							
	2007							
Spain	2001	XXX						
	2002	XXX	XXX					
	2003	XXX	XXX	XXX				
	2004	XXX	XXX	XXX	XXX			
	2005	XXX	XXX	XXX	XXX	XXX		
	2006	XXX	XXX	XXX	XXX	XXX	XXX	
	2007	X	X	X	X	X	X	X

Note: Grey cells denote the years for which out-of-sample predictions are computed. Cells marked by XXX indicate that booms are correctly predicted (probability higher that 50%). Cells marked by X indicate false signals (i.e. the estimated probability is higher than 50% but the boom doesn't occur).

[15] Because of the short length of our sample, we consider 20 years as the minimum number of observations to obtain initial reliable parameter estimates.

[16] We note that results from bust model are available upon request. However, these latter are less interesting for evaluation purposes given that, over the horizon 2001-2007, only Japan and Germany experienced bust episodes.

5.1. Elasticities of explanatory variables

The estimated structural parameters of our model as reported in Table 4, do not allow measuring the sensitivity of the probabilities of booms and busts to marginal changes in each observable explanatory variable. In order to address this question, we compute the marginal effects (elasticities) of specific changes in each regressor $X_i \in \boldsymbol{X}$ of the model on the response conditional probability as follows:

$$e\left(X_{ij}\right) = \frac{\partial}{\partial X_{ij}} F\left(\mathbf{X}_i'\beta\right) = f\left(\mathbf{X}_i'\beta\right)\beta_{,j} \tag{5}$$

where X_{ij} is the jth element of $\mathbf{X}_i'$ while f is the derivative of the c.d.f. F.

The convention is to compute these quantities from the cumulative standard distribution $F(\ )$ at the means of the independent variables $\mathbf{X}_i'$. However, from an economic point of view, it is also interesting to compute the elasticities at specific periods t.

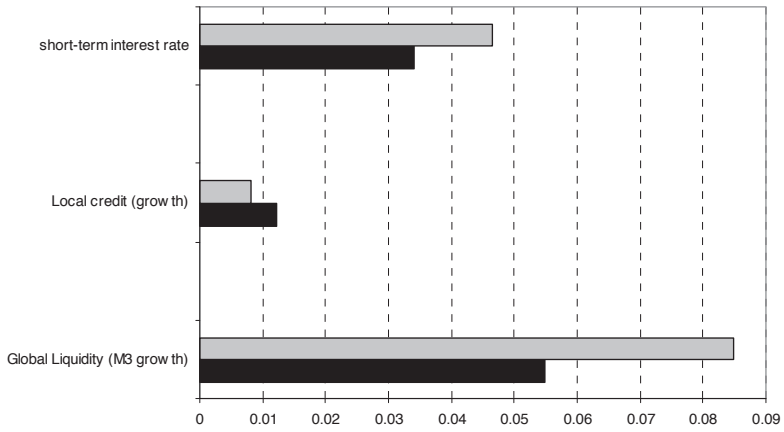
Table 8. Analysis of Marginal Effects (Elasticities)

	At means	
	Booms	Busts
Real per capita GDP (growth)	***0.1156****	***-0.0536****
	[0.0231]	*[0.0145]*
Short-term interest rate	***-0.0466****	***0.0340****
	[0.0105]	*[0.0086]*
Local real credit (growth)	***0.0082****	***-0.0122****
	[0.0042]	*[0.0043]*
Global liquidity (M3 growth)	***0.0848****	***-0.0548****
	[0.0240]	*[0.0195]*

Note: * significant at 10%; ** significant at 5%; *** significant at 1%.

We provide an estimate of the (overall) sensitivity of the probabilities of booms and busts to changes in the core set of economic fundamentals, during the whole period 1982-2007 in Table 8. In the first column, we report the marginal effects evaluated at the averages values of the independent variables for boom periods; the second one reports elasticities during busts. Elasticities range from about 0.01 for local liquidity, via about 0.05 for interest rates to about 0.1 for global liquidity and real per capita growth. For comparative purposes, Figure 4 shows, for a set of variables, the absolute values of elasticities during boom and bust phases. We find that with the exception of the growth rate of local credit, the sensitivities of the conditional probabilities are higher during boom phases.

Figure 4. Comparison between the size of elasticities (at means)

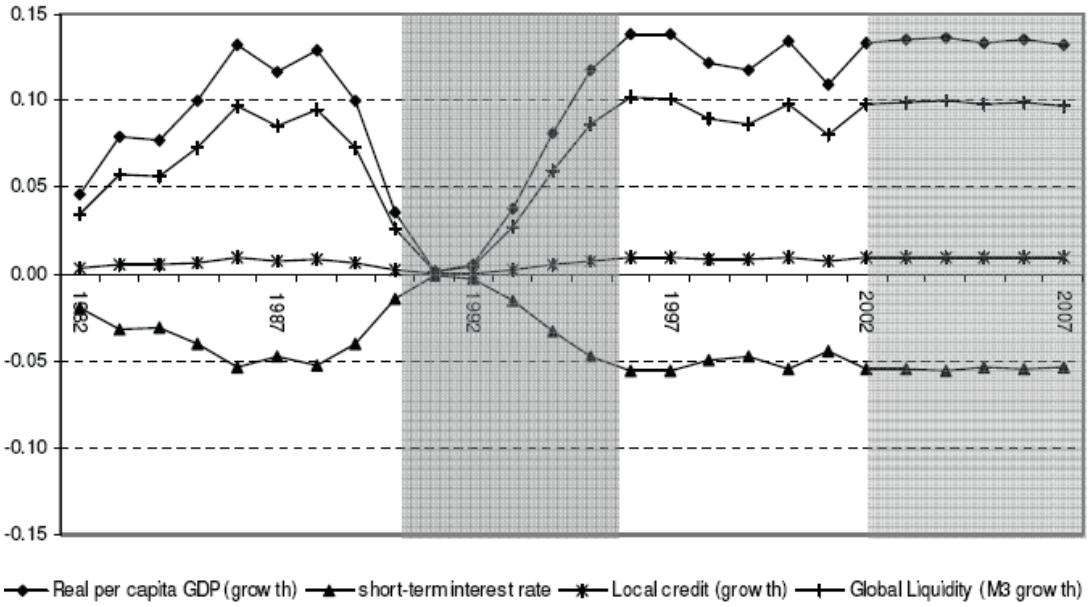


Note: Grey bars denote boom periods while black bars denote bust periods..

As elasticities are not equal in all years, Figure 5 illustrates the pattern of elasticities for booms over the entire sample period graphically. We note that elasticities as regards the probability of a boom were very low in the early 1990s when many countries experienced a synchronous slump. The size of boom-related elasticities experienced a first peak in the late 1980s and then again towards the late 1990s after which they remained relatively stable.

We conclude this section by synthesising the findings on identifying booms and bust episodes and on the elasticities of independent variables on predicted probabilities. On the left of Table 9, we report the predicted boom probabilities for 2000 (based on 1999 data which in principle was available in spring 2000).

Figure 5. Elasticities during the periods 1982-2007 from Boom-Probit model



Note: Dark and light shaded area denote periods characterized by the largest number of contemporaneous busts and booms, respectively.

The Table clearly shows that most countries were seen as experiencing a real estate boom with at least a 50% probability. Already in spring 2000, this probability was seen at 76% in the US, at 68% in the UK or at 84% in Spain. Unsurprisingly, Japan was identified as distinctly not experiencing a boom. The subsequent columns show that an interest rate increase by 1pp in 1999 would have reduced this probability by 0.04. A 1 pp reduction in global and local liquidity growth would have reduced the probability by 7% and 1% respectively.

Estimated boom probabilities remained very high during the following years right until 2008 as we had seen before. In early 2005, on the basis of 2004 data, a boom probability above 50% would have continued to been seen for most countries (right side of Table 9). The elasticities of interest rates and liquidity growth were estimated to be slightly higher than in 2000.

Table 9. Changes in the predicted probabilities of a boom in 2000 and 2005 following a policy change (shock)

	Simulated shocks in 1999				Simulated shocks in 2004				
Countries	Predicted boom probabilities for 2000	Interest rate +1%	Global liquidity -1%	Local liquidity -1%	Countries	Predicted boom probabilities for 2005	Interest rate +1%	Global liquidity -1%	Local liquidity -1%
United Kingdom	**0.68**	-0.05	-0.10	-0.01	United Kingdom	**0.56**	-0.06	-0.10	-0.01
Japan	**0.02**	-0.01	-0.01	0.00	Japan	**0.10**	-0.02	-0.04	0.00
United States	**0.76**	-0.05	-0.09	-0.01	United States	**0.80**	-0.04	-0.08	-0.01
Canada	**0.84**	-0.04	-0.07	-0.01	Canada	**0.64**	-0.05	-0.10	-0.01
Australia	**0.64**	-0.05	-0.10	-0.01	Australia	**0.36**	-0.05	-0.09	-0.01
New Zealand	**0.82**	-0.04	-0.08	-0.01	New Zealand	**0.54**	-0.06	-0.10	-0.01
Switzerland	**0.51**	-0.06	-0.10	-0.01	Switzerland	**0.65**	-0.05	-0.10	-0.01
Norway	**0.31**	-0.05	-0.08	-0.01	Norway	**0.77**	-0.04	-0.08	-0.01
Denmark	**0.46**	-0.06	-0.10	-0.01	Denmark	**0.49**	-0.06	-0.10	-0.01
Finland	**0.83**	-0.04	-0.07	-0.01	Finland	**0.69**	-0.05	-0.10	-0.01
Ireland	**1.00**	0.00	0.00	0.00	Ireland	**0.82**	-0.04	-0.07	-0.01
Netherlands	**0.79**	-0.04	-0.08	-0.01	Netherlands	**0.49**	-0.06	-0.10	-0.01
Sweden	**0.94**	-0.02	-0.04	0.00	Sweden	**0.82**	-0.04	-0.07	-0.01
France	**0.63**	-0.05	-0.10	-0.01	France	**0.51**	-0.06	-0.10	-0.01
Italy	**0.55**	-0.06	-0.10	-0.01	Italy	**0.23**	-0.04	-0.07	-0.01
Spain	**0.84**	-0.04	-0.07	-0.01	Spain	**0.58**	-0.06	-0.10	-0.01
Average overall	**0.66**	**-0.04**	**-0.07**	**-0.01**	**Average overall**	**0.58**	**-0.05**	**-0.09**	**-0.01**

Table 10. Impact of US liquidity on booms and busts in EU countries

	Boom model	Bust model
Lagged real per capita GDP (growth)	0.5029***	-0.2347***
	[0.0903]	[0.0472]
Lagged short-term interest rate	-0.1392***	0.1202***
	[0.0276]	[0.0214]
Lagged local liquidity (M3 growth)	0.0464*	-0.0487**
	[0.0245]	[0.0227]
Lagged US liquidity (M3 growth)	0.1416***	-0.0642*
	[0.0398]	[0.0329]
Lagged EU liquidity (M3 growth)	0.069	-0.0983
	[0.0776]	[0.0683]
Pseudo R-square	0.31	0.25

Note: Sample EU countries, 1980-2007. Panel Probit estimation. * significant at 10%; ** significant at 5%; *** significant at 1%.

Finally, we further divide the global money variable into a US variable and a non-local EU money growth variable. The key results for a panel including only EU countries are presented in Table 10. We note that, although the parameters associated with all monetary variables have the correct signs, only US and local money have a significant effect on both boom and bust probabilities.

6. Robustness checks

In this section, we investigate the robustness of our empirical findings in several directions. First we check whether our estimation results are robust to the inclusion of additional control variables. Specifically, we are interested to test whether the omission of economic variables, which might influence house price dynamics, may impact on the determination of the probabilities of booms and busts. In particular, we control for the following set of (lagged) variables:

- *The growth rate of stock prices index*. This variable aims to capture the impact of fluctuations in households' financial wealth induced by changes in equity prices that, in turn, could spill over into housing demand and, hence, booms/busts (see Borio and McGuire, 2004; Van den End and Kakes, 2002). The sign of the coefficient, however, could also go in the opposite direction as stocks may be a competing asset with housing in households' portfolio.

- *The change in tax on property (as percentage of GDP)*. We expect that a more favourable tax treatment of housing for home ownership is reflected in a low user cost of capital implying a strong incentive to invest in housing (see also Van den Noord, 2005).

- *The Real Effective Exchange rate (REER)*. By including this variable, we explore the role of the competitiveness and trade channel in determining the probabilities of boom/bust episodes. We expect that in a context of depreciation/devaluation, a higher level of competitiveness may stimulate the housing demand.

- *Fiscal balance (percentage of real GDP)*. The role of public finances is little discussed in literature. By controlling for the fiscal channel, we examine whether fiscal policies may exacerbate boom-bust phases. However, we note that the expected effects are not so clear. In fact, we should expect that a higher deficit increases the level of the markets' uncertainty thereby increasing the probabilities of busts episodes. On the other hand, a worsening of public finances might be associated with deficit-spending policies adopted by national governments to stimulate the economy. In this case, we expect an opposite effect: and increase in housing inflation.

Second, we test for the robustness of our results to alternative measure of domestic liquidity. Specifically, we re-estimate the baseline model (2) by replacing, for each country, credit growth to private sector with the growth rate of national broad money.

Finally, in order to validate our model specification, we compare the prediction accuracy of the Panel probit model (2) with those of other alternative models. In particular, we are interested to check whether more parsimonious specifications perform better than our model.

Table 11a. Check for alternative and additional control variables. Boom model

	Dependent variable: incidence of booms in housing markets					
	Models					
	Baseline	(2)	(3)	(4)	(5)	(6)
Lagged real per capita GDP (growth)	0.3480***	0.3551***	0.3476***	0.3415***	0.3826***	0.3983***
	[0.0612]	[0.0639]	[0.0614]	[0.0621]	[0.0651]	[0.0650]
Lagged short-term interest rate	-0.1403***	-0.1422***	-0.1403***	-0.1407***	-0.1435***	-0.1457***
	[0.0276]	[0.0281]	[0.0276]	[0.0276]	[0.0302]	[0.0284]
Lagged local credit (growth)	0.0247**	0.0246**	0.0247**	0.0247**	0.0245*	-
	[0.0121]	[0.0120]	[0.0121]	[0.0121]	[0.0130]	-
Lagged Global liquidity (M3 growth)	0.2554***	0.2506***	0.2557***	0.2530***	0.2679***	0.2642***
	[0.0662]	[0.0672]	[0.0663]	[0.0663]	[0.0692]	[0.0656]
Lagged population growth	1.0257***	1.0255***	1.0240***	1.0422***	0.9357**	1.0162***
	[0.3703]	[0.3711]	[0.3708]	[0.3717]	[0.3948]	[0.3689]
Deregulation (dummy)	0.5716*	0.5462*	0.5708*	0.5969*	0.5477*	0.5848*
	[0.3156]	[0.3220]	[0.3158]	[0.3184]	[0.3277]	[0.3201]
Banking crises (dummy)	-1.2954***	-1.3015***	-1.2953***	-1.2967***	-1.3773***	-1.2949***
	[0.3512]	[0.3521]	[0.3511]	[0.3488]	[0.3648]	[0.3499]
Lagged local M3 (growth)						0.0436**
						[0.0197]
Lagged Real Stock price (growth)		-0.0019				
		[0.0047]				
Lagged change in tax on property			-0.0007			
			[0.0082]			
Lagged REER				-0.0039		
				[0.0068]		
Lagged Fiscal Balance (%GDP)					-0.0216	
					[0.0277]	
Pseudo R-square	0.31	0.31	0.31	0.31	0.31	0.31

Note: Panel Probit estimation. * significant at 10%; ** significant at 5%; *** significant at 1%.

Results from the first two robustness checks are reported in Tables 11a and 11b. As shown in column (1)-(5), none of the additional controls enter in a statistically significant way in our model with exception of the lagged fiscal balance. This variable is significant (with a negative sign) only in the bust model. However, as

discussed above, the interpretation is not clear-cut. Furthermore, from an econometric point of view, the inclusion of this variable is not recommended due to potential endogeneity problems.[17] Column 6 reports the parameter estimate of model (2) when the growth rate of M3 to GDP replaces the credit growth rate variable. We find that the coefficients associated with both the two variables are qualitatively and quantitatively the same and the goodness of fit remains unchanged.

Table 11b. Check for alternative and additional control variables. Bust model

	Dependent variable: incidence of busts in housing markets					
	Models					
	Baseline	(2)	(3)	(4)	(5)	(6)
Lagged real per capita GDP (growth)	-0.1696***	-0.1652***	-0.1696***	-0.1611***	-0.1645***	-0.2192***
	[0.0439]	[0.0450]	[0.0439]	[0.0454]	[0.0451]	[0.0436]
Lagged short-term interest rate	0.1078***	0.1052***	0.1083***	0.1128***	0.1010***	0.1005***
	[0.0275]	[0.0281]	[0.0276]	[0.0289]	[0.0275]	[0.0277]
Lagged local credit (growth)	-0.0386***	-0.0388***	-0.0389***	-0.0400***	-0.0265**	-
	[0.0138]	[0.0138]	[0.0139]	[0.0143]	[0.0132]	-
Lagged Global liquidity (M3 growth)	-0.1736***	-0.1768***	-0.1738***	-0.1700***	-0.1627***	-0.1831***
	[0.0604]	[0.0608]	[0.0605]	[0.0612]	[0.0618]	[0.0584]
Lagged population growth	-0.5211*	-0.5172*	-0.5217*	-0.5774**	-0.4928*	-0.4278
	[0.2680]	[0.2681]	[0.2681]	[0.2807]	[0.2799]	[0.2646]
Deregulation (dummy)	-0.0778	-0.0978	-0.0746	-0.1123	-0.0094	-0.0655
	[0.2397]	[0.2433]	[0.2405]	[0.2499]	[0.2448]	[0.2421]
Banking crises (dummy)	0.6092***	0.6079***	0.6097***	0.6126***	0.5281**	0.7555***
	[0.2280]	[0.2280]	[0.2281]	[0.2330]	[0.2313]	[0.2244]
Lagged local M3 (growth)						-0.0423**
						[0.0188]
Lagged Real Stock price (growth)		-0.0018				
		[0.0043]				
Lagged change in tax on property			0.0015			
			[0.0077]			
Lagged REER				0.0064		
				[0.0075]		
Lagged Fiscal Balance (%GDP)					-0.0594**	
					[0.0252]	
Pseudo R-square	0.25	0.25	0.25	0.25	0.25	0.26

Note: Panel Probit estimation. * significant at 10%; ** significant at 5%; *** significant at 1%.

To compare the performance of our model with those of simpler ones, we report in Table 12a and 12b, the quadratic probability score (QPS) computed from alternative specifications, each of which include on the right-side only at most two lags of an economic variable entering the model (2). By comparing the QPS from the baseline model (first row of table 12a and 12b) with those from the simpler models,

[17] Considering that both boom and bust periods impact on Real GDP, it is difficult to assume that the 'causality' direction works only from deficit to economic developments and not vice versa.

we conclude that, for the majority of countries, the predictive accuracy of our specification is higher than that of simpler models. Overall, our model ensures the higher probability to correctly predict booms and busts as well as the lower probability to send incorrect signals.

Table 12a. QLS indicators from alternative specifications. Boom model

Model specifications	GB	JP	US	CA	AU	NZ	CH	NO	DK	FI	IE	NL	FR	IT	ES	SE
Baseline	**0.19**	**0.05**	**0.10**	**0.17**	**0.10**	**0.11**	0.22	0.23	0.26	**0.13**	0.35	0.23	**0.13**	0.31	**0.15**	**0.12**
Real per capita GDP growth (1)	0.21	0.12	0.24	0.25	0.20	0.20	0.21	0.20	**0.20**	0.21	0.24	0.15	0.23	0.31	0.21	0.25
Real per capita GDP growth (1,2)	0.21	0.10	0.23	0.23	0.19	0.19	0.21	0.20	0.20	0.20	0.27	**0.14**	0.23	0.31	0.19	0.22
Short-term interest rate (1)	0.32	0.37	0.18	0.21	0.14	0.13	0.30	**0.17**	0.30	0.18	0.18	0.21	0.13	0.24	0.27	0.20
Short-term interest rate (1,2)	0.32	0.37	0.18	0.21	0.14	0.13	0.31	0.17	0.31	0.18	0.18	0.21	0.13	**0.24**	0.27	0.19
Local credit growth (1)	0.26	0.18	0.21	0.24	0.22	0.23	**0.19**	0.24	0.25	0.27	0.18	0.19	0.23	0.26	0.25	0.25
Local credit growth (1,2)	0.25	0.17	0.20	0.24	0.23	0.24	0.19	0.24	0.27	0.28	**0.17**	0.19	0.23	0.26	0.25	0.24
Global liquidity growth (1)	0.24	0.20	0.23	0.22	0.19	0.18	0.20	0.26	0.28	0.25	0.23	0.22	0.21	0.26	0.23	0.26
Global liquidity growth (1,2)	0.24	0.21	0.24	0.22	0.19	0.18	0.20	0.27	0.30	0.25	0.24	0.23	0.21	0.25	0.23	0.26

Note: Each row reports results from different specifications. Baseline refers to model specification including all the explanatory variables as reported in table 4. Numbers in parenthesis indicate the number of lagged values used for each variables. Lowest QLS values in bold.

Table 12b. QLS indicators from alternative specifications. Bust model

Model specifications	GB	JP	US	CH	NO	DK	FI	IE	NL	DE	FR	IT	ES	BE	SE
Baseline	**0.10**	**0.23**	0.22	**0.18**	**0.11**	**0.10**	0.12	**0.08**	0.13	0.28	**0.13**	**0.13**	0.20	0.11	**0.13**
Real per capita GDP growth (1)	0.17	0.25	0.21	0.24	0.20	0.18	**0.10**	0.12	0.13	0.25	0.22	0.25	0.18	0.14	0.16
Real per capita GDP growth (1,2)	0.17	0.25	0.21	0.23	0.20	0.18	0.11	0.12	0.12	0.26	0.22	0.25	0.19	0.14	0.15
Short-term interest rate (1)	0.19	0.48	0.25	0.25	0.14	0.17	0.14	0.11	0.12	0.27	0.19	0.17	0.25	0.09	0.14
Short-term interest rate (1,2)	0.19	0.48	0.25	0.26	0.14	0.17	0.14	0.11	**0.11**	0.28	0.18	0.16	0.24	**0.09**	0.14
Local credit growth (1)	0.17	0.26	0.18	0.23	0.23	0.19	0.20	0.15	0.12	0.19	0.23	0.20	0.20	0.15	0.20
Local credit growth (1,2)	0.16	0.25	**0.17**	0.23	0.23	0.20	0.21	0.15	0.11	**0.19**	0.23	0.19	0.19	0.14	0.20
Global liquidity growth (1)	0.17	0.30	0.20	0.21	0.23	0.21	0.14	0.21	0.17	0.24	0.23	0.24	0.17	0.17	0.19
Global liquidity growth (1,2)	0.16	0.31	0.20	0.20	0.23	0.21	0.14	0.20	0.16	0.26	0.21	0.22	**0.14**	0.16	0.19

Note: Each row reports results from different specifications. Baseline refers to model specification including all the explanatory variables as reported in table 4. Numbers in parenthesis indicate the number of lagged values used for each variables. Lowest QLS values in bold.

7. Concluding remarks

This study looks at real estate price booms and busts in industrialized countries. The analysis of these episodes, from an historical and econometric perspective, leads to some interesting conclusions: 1) the most recent housing booms have been amongst the longest in the past 40 years with similarly strong deviations in house prices from long term trends as in past booms; 2) In the past, there has been a strong correlation between the persistence and magnitude of booms and those of subsequent busts; 3) we find that the economic costs (in terms of GDP losses during

the post-boom phase) depend significantly on the magnitude of the boom and money and credit developments during the boom; 4) The estimated elasticities computed from the Panel Probit model, suggest that notably short term interest rates, local and global money/credit and the incidence of mortgage market deregulation affect significantly the probability of experiencing booms and busts; and 5) our model is quite successful in identifying booms and busts already early on.

We find that the abovementioned empirical findings provide useful indications and plausible "rules of thumb" that should be regarded as part of the information set of the monetary and regulatory policy makers who take into account (emerging) housing booms in their assessment. First, our results suggest that a probabilistic identification of booms and busts relatively early on in such phases seems possible on the basis of our model. The contrary has been claimed by some observers and policy makers in the past. Second, interest rate policies directly or indirectly (via its effect on money and credit) can have a significant influence on the probability of booms and busts occurring. Regulatory policies that slow down money and credit growth are also expected to curtail boom probabilities. Finally, the importance of global liquidity suggests that cross-border externalities of overly lax policies in boom periods may be significant.

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Annex:

Annex Table 1. Economic Variables

	Sources
Housing price series	Bank of International Settlement (BIS)
Real GDP per capita	AMECO dataset
Short-term interest rate	Economic Outlook (OECD)
Credit to private sector	International Monetary Fund (IFS)
Broad Money (M3)	ECB dataset and Economic Outlook (OECD)
PPP share weights of the world	World Economic Outlook (IMF)
Working-age population	AMECO dataset
Stock price index	International Monetary Fund (IFS)
Taxes on property	Economic Outlook (OECD Tax Database)
Real Effective Exchange Rate (ULC based)	AMECO dataset
Fiscal balance	AMECO dataset

Annex Table 2. Selected financial deregulation and liberalization measures affecting the housing market

Country	Date	Type of measurement
Australia	1986	Deregulation of interest rates; Removal of ceilings on mortgage interest rate.
Belgium	1992	Deregulation of interest rates, introduction of variable interest rate loans and reduction of the maximum early repayment fee.
Canada	1967	Deregulation of interest rates and relaxation of limits on bank borrowing; Restrictions on banks' participation in mortgage financing abolished
Denmark	1991	Elimination of restrictions on mortgage bond issuance and implementation of the Second Banking Directive (89/646/EEC)
Finland	1986	Deregulation of interest rates; lifting of quantitative credit controls; Funding quotas from the Central Bank to commercial banks eliminated
France	1987	Lifting of credit controls; Bank specialisation requirement reduced
Germany	1967	Deregulation of interest rates
Ireland	1985	Deregulation of interest rates
Italy	1988	Permanent lifting of quantitative credit controls (credit ceilings eliminated*)
Japan	1994	Complete deregulation of interest rates; Bank specialisation requirements reduced
Netherlands	1980	Deregulation of interest rates
New Zealand	1984	Deregulation of interest rates and lifting of components of credit controls (credit allocations guidelines removed)
Norway	1985	Deregulation of interest rates and lifting of components of credit controls (lending controls abolished)
Spain	1987	Deregulation of interest rates
Sweden	1985	Deregulation of interest rates and relaxation of limits of credit controls (lending controls abolished)
Switzerland	1977	Advanced deregulation of the financial sector
United Kingdom	1986	Authorisation granted to building societies to extend their activity to mortgage loans; Lifting of mortgage credit control (guidelines on mortgage lending removed)
United States	1984	Deregulation of interest rates; Removal of Regulation Q and elimination of portfolio restrictions for thrifts.

Note: sources Debelle (2004), ECB (2003), Giroud and Blondal (2001), Mehrez and Kaufmann (1999). The dummy variable that indicates the deregulation of mortgage lending takes the value one after the date this measure was applied in each country. * Officially, credit ceilings were eliminated in 1983 but they were temporary re-imposed during the years 1986-1987.

Annex Table 3: Episodes of banking crises

Country	Date	Most relevant episodes
Australia	1989-1992	Two large banks received capital from government to cover losses. Non-performing loans rose to 6 percent of total assets in 1991-92.
Belgium	-	
Canada	1983-1985	Fifteen members of the Canadian Deposit Insurance Corporation, including two banks, failed.
Denmark	1987-1992	Cumulative loan losses over the period 1990-1992 were 9 percent of loans; 40 of the 60 problem banks were merged.
Finland	1991-1994	Savings banking sector badly affected; Government took control of three banks that together accounted for 31 percent of total system deposits.
France	1994-1995	Credit Lyonnais crises
Germany	Late 1970s	So called Giroinstitutions faced problems.
Ireland	-	-
Italy	1990-1995	During 1990-1994, 58 banks (accounting for 11 percent of total lending) were merged with other institutions.
Japan	1997-2007	Banks suffering from sharp decline in stock market and real estate prices; official estimate of NPLs: 40 trillion Yen (USD 469 billion) in 1995 (10 percent of GDP); unofficial estimates put NPLs at 1 trillion or 25 percent of GDP; for some of bad loans, banks have already made provisions. At end 1998, total banking system NPLs estimated at Yen 87.5 trillion (USD 725 billion), about 17.9 percent of GDP. In March 1999, Hakkaido Takushodu bank closed, Long Term Credit Bank nationalized; Yatsuda Trust merged with Fuji Bank, and Mitsui Trust merged with Chuo Trust.
Netherlands	-	-
New Zealand	1987-1990	One large state-owned bank accounting for one-fourth of banking assets experienced serious solvency problems due to high NPLs.
Norway	1991-1993	Central Bank provided special loans to six banks, suffering from post-oil recession of 1985-86 and from problem real estate loans; state took control of three largest banks (equivalent to 85 percent of banking system assets, whose loan losses had wiped out capital), partly through a Government Bank Investment Fund (Nkr 5 billion) and the state-backed Bank Insurance Fund had to increase capital to Nkr 11 billion.
Spain	1977-1985	During 1978-83, 24 institutions were rescued; four were liquidated, four were merged and 20 small/medium sized banks (Rumasa Group) were nationalized. In total, 52 out of 110 banks were experiencing solvency problems, representing 20 percent of total banking system deposits.
Sweden	1991-1994	Nordbanken and Gota Bank insolvent, accounting for 21.6 percent of total banking system assets. Sparbanken Foresta intervened, accounting for 24 percent of total banking system assets. Overall, five of six largest banks, accounting for over 70 percent of banking system assets experienced difficulties.
Switzerland	-	-
United Kingdom	1974-1976, 1984, 1991, 1995, 2007	Secondary banking crises (1974); notable bank failures included Johnson Matthey (1984); Bank of Credit and Commerce International (1991) and Barings (1995)
United States	1984-1991; 2007	More than 1,400 savings & loans and 1,300 banks failed.

Note: sources Caprio and Klingebiel (2003) and Laeven and Valencia (2008).

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