An Early Warning System to Predict House Price Bubbles

Christian Dreger and Konstantin Kholodilin
DIW Berlin[1]

Abstract

Financial shocks can exert huge negative impacts on real economic activity. Hence, there is a high payoff on timely and correct warnings on speculative components in house prices. A preemptive policy reaction can help to limit the buildup of financial imbalances and the risks of a bust in the future. In this article, an early warning system for the timely detection of house price bubbles is developed. Different empirical methods are applied to ensure the robustness of results.

JEL: C25, C33, E32, E37
Keywords: House prices; early warning system; speculative price bubbles

1 Introduction

The striking role played by housing markets in the recent financial crisis has demonstrated that shocks arising in the housing sector can exert huge effects on real economic activity, especially through the consumption and residential investment channels. Falling house prices might depress private consumption, especially in countries where mortgage markets are highly deregulated. Since they affect the profitability of investments, they could also cause a decline in construction activities. In Anglo-Saxon countries, Spain, and some of the new EU Member States, house prices increased at spectacular rates in the period before the financial crisis. This development was primarily driven by speculation and herding behavior. Since the macroeconomic fundamentals were more stable, they did not play a decisive role.

[1] Dreger: German Institute for Economic Research (DIW Berlin), Mohrenstr. 58, D-10117 Berlin, cdreger @diw.de, Kholodilin: German Institute for Economic Research (DIW Berlin), kkholodilin@diw.de. This paper is a policy oriented version of Dreger and Kholodilin (2013): An early warning system to predict speculative house price bubbles, Economics: The Open-Access, Open-Assessment E-Journal 7, 2013-8, http://dx.doi.org/10.5018/economics-ejournal.ja.2013-8.

The bursting of speculative price bubbles triggered massive production losses and raised serious doubts about the sustainability of growth in these states. In other countries like Germany, house prices did not accelerate at all, despite the same monetary environment. To the extent that the evolution of house prices is unequal across countries, they may constitute a source of business cycle divergence and can limit the prospects of the common monetary policy in the euro area.

In this paper, an early warning toolkit for the timely detection of house price bubbles is constructed. The analysis is based on past episodes of speculative house price bubbles. The early warning system is based on a two-step procedure. First, a bubble chronology is derived on a country-by-country basis, as the timing of bubbles is heterogenous across economies. The chronology is then used to calibrate forecasting methods for the timely detection of bubbles. Different approaches are applied to assess the robustness of the results.

The rest of the paper is organized as follows: In the next section the main transmission channels of house prices to the real economy are reviewed. Section 3 presents the strategy to develop the bubble chronology. Section 4 holds the forecasting methods to detect speculative bubbles in the housing market. Measures of forecasting accuracy are discussed in Section 5. Finally, section 6 concludes.

2 House Prices and the Real Economy

Real house prices can affect private consumption through a housing wealth and a collateral effect, see Case et al. (2005) and Dreger and Reimers (2012). An increase in housing wealth will raise consumption due to its impact on expected lifetime income. Consumption expenditures can be shifted upwards without violating budget constraints. However, the effects of housing wealth are not obvious. A permanent increase in house prices has positive effects for homeowners, but there are also negative effects on tenants who have to pay higher rents, and on prospective first-time buyers who have to save more for future house purchase, see Poterba (2000) and Goodhart and Hofmann (2008). In addition, an increase in the value of owner-occupied housing does not automatically foster the ability of a household to consume more of other goods and services unless that household is willing to realize the higher value by moving into a less expensive flat. Many households are not expected to do that, including those who intend to leave their homes as bequests. A positive impact of house prices implies that the winners win more than losers lose. This is more likely to happen if potential homeowners interpret a house price acceleration as an evidence of future capital gains that can be earned if they step into the housing market.

Besides the effect on wealth, there is also a collateral effect of house prices, since houses are widely used as a security for loans (Muellbauer, 2008). Collateral effects improve the response of aggregate demand to house price shocks. In general, households tend to borrow or lend in order to smooth consumption over time. If liquidity constraints exist, access to credit will be restricted. In periods of rising house prices, the value of the collateral the household can offer to banks is higher and banks become less reluctant to provide loans. Because of deregulation in mortgage markets, it has become easier and cheaper for consumers to borrow against housing collateral to finance extra consumption. This effect is higher in more deregulated financial markets, since financial innovation has increased the availability of funds for credit-constrained agents.

Furthermore, housing markets have an impact on the transmission of monetary policy. In countries with more flexible mortgage rates and higher loan-to-value ratios, i.e., the ratios between the mortgage amount and the value of the property, the response of private consumption and residential investment to monetary policy shocks can be amplified (Calza et al., 2009). But the relationship is not unidirectional, as housing wealth also affects money demand, see Dreger and Wolters (2009). There is evidence that idiosyncratic house price developments have been a major source of divergence in competitiveness and the formation of external imbalances within the euro area, as accelerating house prices give rise to a boom in private consumption and import demand (Aizenman and Jinjarak, 2009). House price dynamics influence the performance of the financial system through their impact on the profitability and soundness of financial institutions.

The institutional conditions in housing and mortgage markets are substantially different across the euro area member states (ECB 2009). In the development of real house prices and their spillovers to the real economy, these structural features play a crucial role. For example, Almeida et al. (2006) reported evidence that the sensitivity of house prices and mortgage borrowing to income shocks tends to be higher in countries with higher loan-to-value ratios. Carroll et al. (2006) stressed that the long-run responsiveness of consumption to permanent changes in housing wealth is higher for countries with a market-based than for countries with a bank-based financial system. According to Calza et al. (2009), strong impacts of real house prices on consumption can be detected especially in countries that have large and responsive mortgage markets. A high degree of mortgage market completeness, i.e., the extent to which the market is able to offer a variety of products and to serve a broad range of potential borrowers is also important. The most crucial element is the extent to which the markets provide opportunities for housing equity withdrawal, that is the magnitude to which the household sector can extract liquidity from the housing market. The response of real house prices to economic conditions as well as their impact on private consumption and residential investment tends to be larger if favorable tax treatment of mortgage interest encourages the leveraging of housing equity.

3 Obtaining a Bubble Chronology

Bubbles are not directly observable. Therefore, the analysis has to separate house prices driven by fundamental factors and the role of speculative attacks. Unfortunately, a widely accepted chronology does not exist. To proceed, the separation is performed on the basis of the historical house price evolution. Empirical methods should distinguish between the two effects to extract the speculative component. For robustness, the chronology is based on filter and structural models. Speculative bubbles are periods, when house prices exceed their fundamental values, the latter being defined on the basis of the fundamental economic development. Not each positive deviation from the fundamental values can be interpreted as a bubble, since deviations might be too short and minor. Thus, this structural chronology should be confirmed by periods, where prices are above their trend.

Specifically, the real house prices (*hp*) are regressed on fundamental factors, such as real per capita GDP that captures disposable income (*y*); urbanization rates (*urb*), i.e., the share of urban population in the total population; and real interest rates (*rir*), as a proxy for financing costs. While higher income and lower real interest rates lead to an increase in house prices, urbanization will have negative effects, as high urbanization implies that less people would migrate from rural to the urban areas. This leads to a structural regression model

$$h_{it}=\beta_{i0}+\beta_{i1}y_{it}+\beta_{i2}urb_{it}+\beta_{i3}rir_{it}+\varepsilon_{it} \quad (1)$$

where i indicates the country, t is time, and ε is the error term. The regression is estimated for each country individually. This accounts for the fact that bubbles are rare events that occur unequally across countries. House prices expected conditional on the fundamental development are the fitted values of the regression model. The positive deviations of the actual values from the fundamentals are treated as bubble candidates. To reduce volatility, the deviations are smoothed using spline regression techniques. By and large, the country regressions reveal meaningful results, i.e., the variables are correctly signed.

In addition, the deviations of actual prices from their long-run trend are considered, where the latter is obtained by the Hodrick-Prescott filter. Potential bubbles require that these deviations (cycle) exceed a certain threshold, i.e.

$$cycle_{it} = hp_{it}-trend_{it}>\gamma\sigma_{i} \quad (2)$$

The threshold is expressed as a multiple (γ) of the standard deviation of the *cycle* variable. The fundamental and filter approaches are considered jointly to produce the bubble chronology. In particular, a speculative bubble is identified if the deviation from the fundamentals is positive and larger than 0.5 times the standard deviation of the residuals taken from the regression (1). Moreover, these bubbles should at least partially coincide with periods suggested by the filter approach. The parameter γ is chosen to maximize the concordance between the two approaches.

4 Predicting Speculative House Price Bubbles

Forecasting is based on a signal and logit models. Variables for predicting bubbles include, for example, nominal and real short-run interest rates, money rowth, house price-to-income and house price-to-rent ratios, the investment rate, GDP growth, and private lending.

In the signal approach, each variable is smoothed by the Hodrick-Prescott filter on a country-by-country basis. To remove differences in the fluctuations across countries, the smoothed series are standardized using country-specific standard deviations. Then, the series are stacked into a panel. Fourth, a grid of potential thresholds is defined, ranging between 0.2 and 3 with a step width of 0.2. A signal is extracted if a variable exceeds the threshold. For each threshold, the accuracy of detecting bubbles is calculated by adding the ratio of correctly identified bubbles to all bubbles and the ratio of correctly identified non bubbles to all non-bubbles. Both ingredients constitute the accuracy measure

$$z_j^{\tau} = \frac{a}{a+c} + \frac{b}{b+d} \tag{3}$$

The index j denotes the particular variable considered, τ is the threshold value and a, b, c, d are defined according to the table

	Bubble	No bubble
Signal	a	b
No signal	c	d

The accuracy function (3) is maximized over the threshold grid. For the optimal threshold, the signal is equal to 1, when the variable exceeds the threshold, and 0 otherwise. A combined indicator is derived by summing the signals for the different variables. Individual signals are weighted according to their squared accuracy coefficients. Hence, variables with a better forecasting fit receive a higher weight.

As an alternative to the signal approach, conditional panel logit and probit models with country fixed effects are estimated to predict the probability of the occurence of bubbles. Logit and probit models can be formulated as

$$Pr(R_{it}=1 \mid X_{it})=F(X_{it}\beta+\varepsilon_{it}) \tag{4}$$

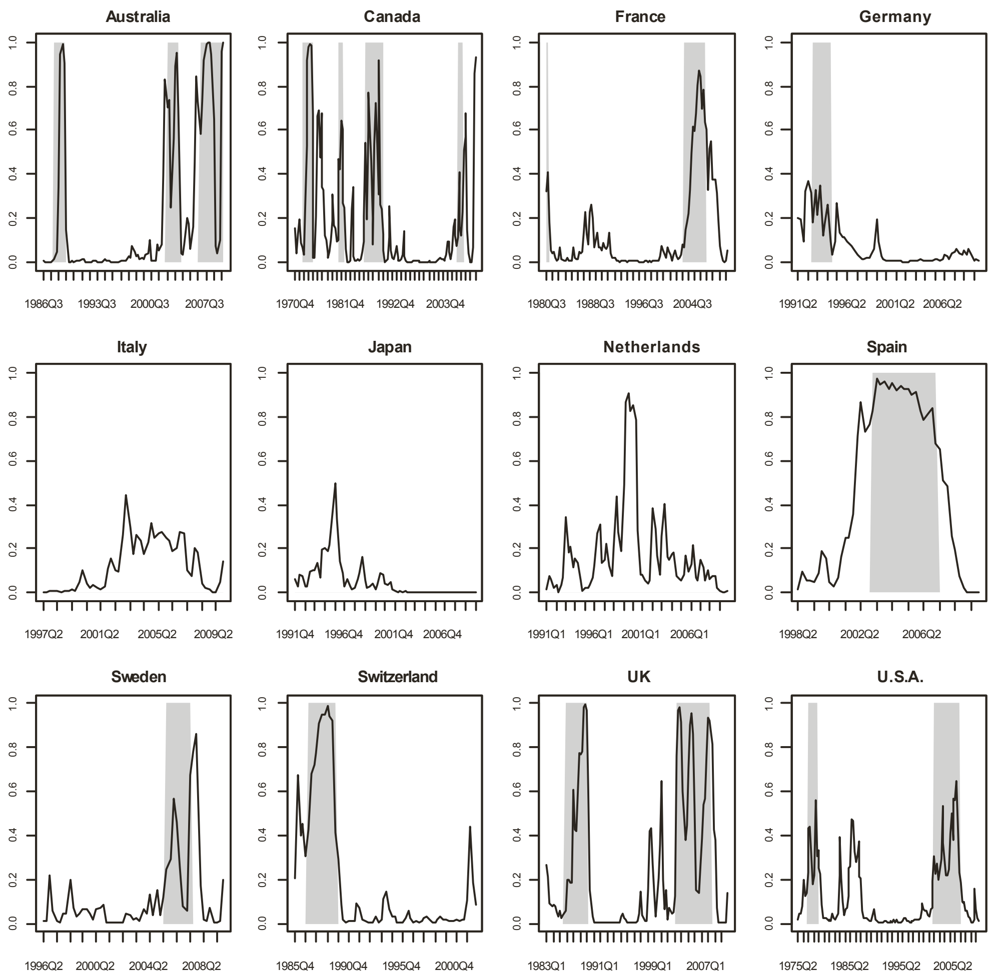
where R is a binary variable equal to 1, if there is a bubble, and to 0 otherwise, otherwise; Pr() is the conditional probability of the bubble, the matrix X is the set of relevant variables and F() is the cumulative probability function, either in the logit or standard normal form. The relevance of variables is evaluated according to their statistical significance (t-values). Table 1 reveals the weighting of different variables in the signal and logit approach in a sample of OECD countries. For example, the house price-to-income ratio receives a high weight in the logit model, but not in the signal approach. Credit growth is similarly weighted. For illustrative purposes, Figure 1 shows the results of the logit approach. The probabilities for excessive price developments are quite high in times of bubbles and low otherwise. Overall, the model is able to capture the historic development, at least to some extent.

Table 1: Weights of Variables in the Prediction of House Price Bubbles

Weights	Signal	Logit
Short term interest rates	15.0	
Real exchange rate	6.9	7.1
Rent	5.0	
House prices / income	7.6	21.7
House prices / rent	8.1	7.2
Investment ratio	7.9	7.2
Credit growth	19.5	20.9
GDP growth	6.5	7.2
Liquidity (based on M3)	19.7	14.4
Public finances	3.8	7.0
Financial regulation		7.3

Note: Unbalanced panel data for 12 OECD countries (Australia, Canada, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, UK, US), 1970–2009. Weights according to quadratic accuracy for signal approach, see equation (3) and log odds ratio in the logit model.

Chart 1: Logit Detection of Speculative Bubbles in Housing Markets



Note: Shaded areas are bubble periods according to the bubble chronology developed in section 3, and the lines show the estimated probabilities taken from the logit model. Evaluating the Predictive Accuracy of Early Warning Systems.

5 Evaluating the Predictive Accuracy of Early Warning Systems

The accuracy of the alternative prediction approaches presented above can be evaluated using goodness of fit measures, such as Quadratic Probability Score (QPS)

$$QPS_j = \frac{1}{T}\sum_{t=1}^{T}(R_{it} - P_{it}^{j}) \tag{5}$$

where R is the binary variable (=0 for no bubble, =1 for bubble) and P is the probability for a bubble according to the j-th forecasting method. In case of a perfect foresight, the *QPS* is equal to 0. Thus, lower values of QPS indicate better forecasting performance. According to the QPS of the different models

QPS	In sample	Out of sample
Signal approach	0.278	0.292
Progit model	0.081	0.139
Logit model	0.081	0.134

the logit and probit models outperform the signal approach. This result holds both within the observation period (in sample) and for annual forecasts obtained in an out-of-sample exercise with perfect foresight of the regressors.

6 Conclusions

The results point to the fact that the emergence of house price bubbles is a rather complex process. Observing credit and liquidity is not sufficient for a reliable detection of speculative bubbles. These variables represent only 35% (logit) and 55% (signal) of the forecast of overall indicator (table 1). Other variables should be monitored as well. Our findings suggest that early warning systems are important tools to be used by policymakers in their attempts to timely detect the house price bubbles and attenuate their devastating effects on the domestic and world economy. Specifically, the detection through the probit and logit approach is recommended. Furthermore, the signalling approach could be useful to assess the robustness of the bubble evidence.

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