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**Article**

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# Speculative Bubble on Housing Markets: Elements of an Early Warning System

by Christian Dreger and Konstantin Kholodilin

Excessive speculation on asset markets can cause significant macroeconomic losses in terms of production and employment. Such developments should be detected as early and as reliably as possible in order to enable corrective action through adequate economic policy measures.

This is the goal of the early warning system, which was developed by DIW Berlin on behalf of the Federal Ministry of Finance for the housing market. The early warning system predicts price surges on real estate market that were caused by speculation. If speculative price developments are detected quickly, economic policy has enough leeway to find an adequate response and possibly prevent further development of the bubble.

Speculative bubbles on asset markets can cause significant macroeconomic losses in terms of production and employment. The abrupt ending of the new economy boom at the time of the millennium contributed to a recession in a number of industrialized countries. The burst of the US real estate bubble in 2007/2008 was the cause of the recent financial and economic crisis. The burst of an asset price bubble can lead to substantial cost for an economy resulting from the recapitalization of the financial systems. Public debt grows fast – partly because of suddenly lacking tax revenues, partly because of comprehensive stimulus programs and other actions taken to combat growth losses.

In a number of cases, the beginnings of an asset price bubble lie in times of economic expansion. The actors' risk awareness diminishes, liquidity restrictions are loosened, and credits can easily be obtained. This further heats the development. Asset prices are more and more driven by price expectations. Assessments no longer fit the values which are justified based on fundamental economic variables like income. Actors no longer act rationally, but orient themselves on the behavior of market leaders. The situation is characterized by herd behavior. The ideal exit time can hardly be foreseen by the individual.<sup>1</sup> For different reasons, the process will finally stop, abruptly revealing the imbalances.

Speculation-caused asset prices can stimulate consumption and investment for a certain time span. This creates additional inflationary pressure, which makes it harder for monetary policy to stabilize the price level. In addition, resources are inefficiently allocated, for example, excessive construction investments, which will not be used due to shortages in demand. Also private households may consume beyond their means and reduce their expenditures when an asset illusion bursts. Another ty-

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<sup>1</sup> See also Shiller, R. (2005): *Irrational exuberance*. Princeton University Press, Princeton, NJ, and De Grauwe, P. (2008): *Animal spirits and monetary policy*. CESifo Working paper 2418.

pical example of an asset price bubble is an exorbitantly rise in the stock market, which may be accompanied by exaggerated investment activities of firms, that can build up excess capacities.

### Prevention of price bubbles through forward looking policy measures

In principle, economic policy should be able to take adequate action to combat the creation and inflation of price bubbles on asset markets.<sup>2</sup> In order to do so, it needs reliable information as a basis for sound decisions. The main challenge is to detect price bubbles as such, which is not an easy task in the phase of their emergence. It is further complicated by the fact that asset prices also go up because of usual cyclical movements or long-term trends: Higher real estate prices can be expected in periods of increasing incomes. Higher stock prices are often a sign for better profit perspectives of listed companies. Rising commodity prices can sometimes be traced back to global growth. In all these cases, price increases are caused by fundamental factors.

Without adequate instruments for diagnosis, the risk is high to wrongly interpret price increases, which are explained by these factors, as a bubble and to take action aiming at curbing a boom. Serious wealth losses will be the result. The challenge is to separate excessive speculation from fundamentally determined price dynamics and construct indicators, which allow for an early and reliable detection of bubbles.

The DIW Berlin has developed an early warning system for the Federal Ministry of Finance.<sup>3</sup> This system can easily be updated, as the necessary data are easily available. In this paper, we are going to present this tool for the real estate market. For many private households, real estate is a major part of their asset investments. In contrast to stock prices, speculative bubbles on real estate markets usually take more time to build up, which

makes their early detection easier.<sup>4</sup> Furthermore, price bubbles occur only rarely. Each bubble has its own characteristics, but we can still identify certain regularities in order to be better equipped for the future. We are going to examine the developments in 12 industrialized countries in order to figure out the determinants of speculative bubbles on the real estate market.<sup>5</sup>

### When Do Price Increases Represent a Bubble?

For the construction of an early warning system, the identification and demarcation of historical bubbles in time is essential. Once the bubbles are defined and detected, we can identify factors that are crucial for their development. This is especially important for housing markets, which are strongly influenced by local conditions. For the sake of a robust calculation we use both filter and so-called structural models.

In the filter model, phases of unusual price developments are identified through deviations from smoothed time series.<sup>6</sup> Significant deviations of housing prices from their long-term trend do not have to be the result of speculation, though. They can also be caused by fundamental factors such as real income, interest rate, and population growth.<sup>7</sup> This is the reason why threshold values are needed for the calculation of an exaggerated price increase. Their purpose is to prevent false classification of price dynamics as bubbles, which in reality are caused by economic fundamentals (i.e., by cyclical developments).

In addition, structural models allow interpreting the price developments. Fundamentally determined prices can be considered as fitted values of a regression, in which asset prices can be traced back to different factors. The literature explains housing prices with income, real inte-

<sup>2</sup> In order to prevent future crises, some researches call for an enlargement of macro-political instruments; see Blanchard, O., Dell'Ariccia, G., Mauro, P. (2010): Rethinking macroeconomic policy. IMF Staff Position Note SPN/10/03. It is also proposed that central banks should behave contrary to market trends; see e.g. Bordo, M.D., Jeanne, O. (2002): Boom-busts in asset prices, economic instability and monetary policy. NBER Working Paper 8966, and Borio, C. (2006): Monetary and financial stability: Here to stay? Journal of Banking and Finance, 30, 3407-3414.

<sup>3</sup> This weekly report is a public policy oriented summary of the research project „Methoden zur Analyse der Entwicklung von Vermögenspreisen mit Blick auf Erkennung von Anzeichen für Blasenbildung“, which was carried out by the authors on behalf of the Federal Ministry of Finance. See Dreger, C., Kholodilin, K. (2011): An early warning system to predict the house price bubbles. DIW Discussion Papers 1142.

<sup>4</sup> For stylized factors for real estate price bubbles see Helbling, T., Terrones, M. (2003): Real and financial effects of bursting asset price bubbles. IMF World Economic Outlook, April, 61-76.

<sup>5</sup> The calculations are based on different data sources. Real estate price indices are taken from the NiGEM database, the relations between housing prices and gross domestic product (GDP) or the relation to rents are courtesy of Mr. A. Christophe of the OECD. The regulation variable, which stands for the time of deregulation of the mortgage market, is taken from Agnello, L. and Schuknecht, L. (2011): Booms and busts in housing markets: Determinants and implications. Journal of Housing Economics, 20 (3), 171-190. Other variables are taken from Datastream and Global Insight or were calculated by the authors themselves.

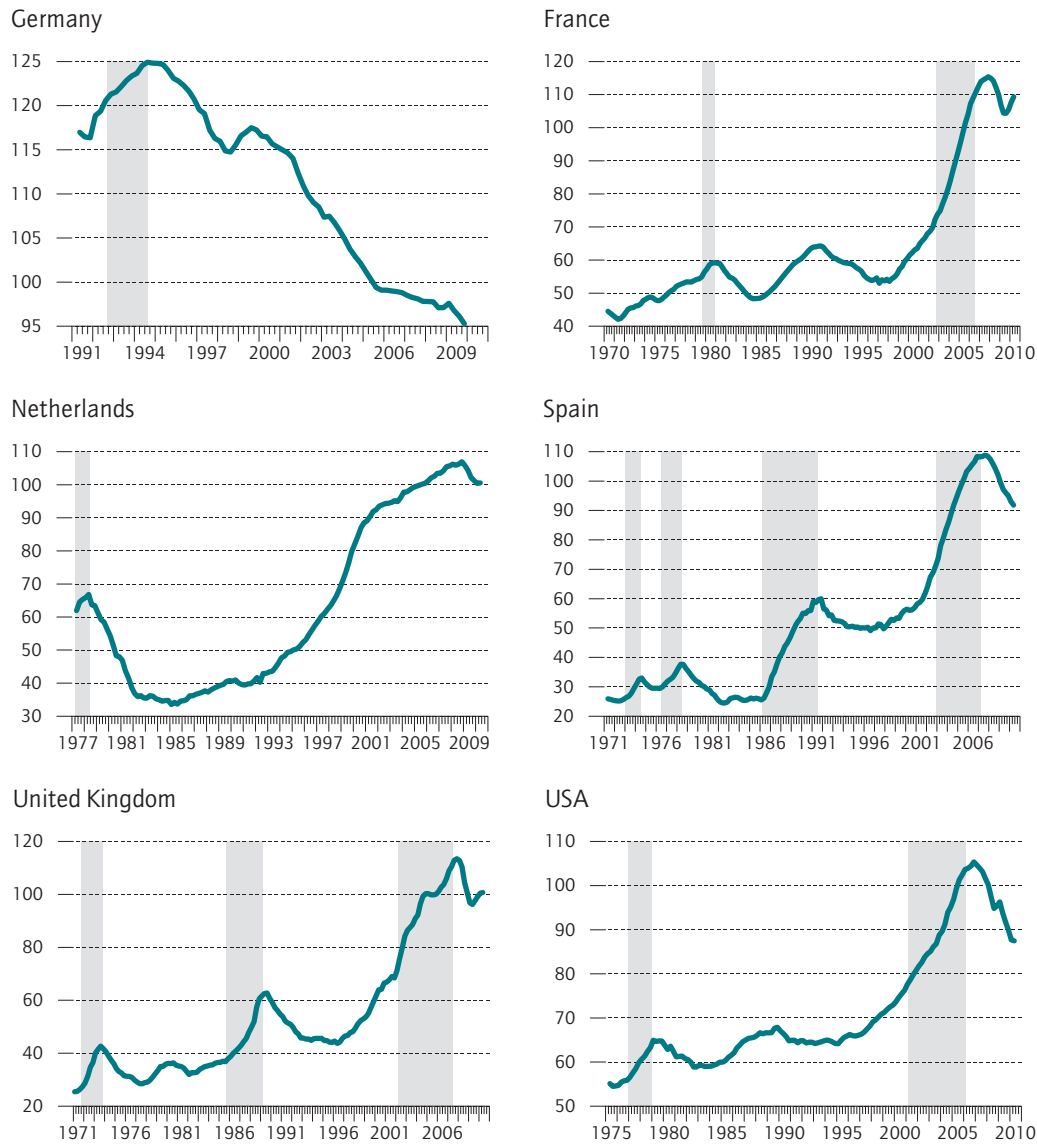
<sup>6</sup> Evaluation is done relative to a trend which is extracted with the usual processes, e.g. the Hodrick-Prescott-Filter.

<sup>7</sup> In order to evaluate asset price dynamics relative to the general price development, we use real asset prices. According to the accessibility of data, either the price index of private consumption or the deflator of the GDP is used.

Figure 1

**Development of Real Housing Price Indices and Periods with Price Bubbles**

Housing Price Index



Note: Periods with price bubbles are marked grey.  
Source: See footnote 5; calculations by DIW Berlin.

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Housing price bubbles are relatively rare and take time to build up.

rest rates, population, and urbanization.<sup>8</sup> Rising incomes and a growing population lead to higher demand for real estate, thus causing higher prices. The real interest rate,

however, has a negative influence, since higher interest rates make other investment forms more attractive, and financing costs for real estate increase. A high degree of urbanization stands for low migration to the cities – meaning that the highest price increase for housing in the agglomerations has already happened.

<sup>8</sup> For a summary of potential determining factors of real housing prices see Girouard, N., Kennedy, M., Van den Noord, P., André, C. (2006): Recent house price developments: The role of fundamentals. OECD Economics Department Working Papers 47.

The bubble is likely to be under way, if prices deviate from the model-based development over a longer period of time. In order to gain robust results regarding earlier bubbles, the above two methods are used jointly. Time periods, which were identified using both methods as possibly characterized by housing price bubbles, need to overlap at least partly. For the identification of time spans, different threshold values are tried out. At the end, the combination with the highest correlation between the two methods is chosen.

### Real Estate Price Bubbles are relatively rare

Real estate price bubbles have occurred in the observed countries in different periods, but remained in general quite rare (Figure 1).<sup>9</sup> Spain and the United Kingdom were the countries with the most bubbles. Their housing prices were even more strongly characterized by speculative surges than in the US. In contrast, France and Germany have witnessed less price bubbles. The only bubble in Germany occurred between the last quarter of 1992 and the third quarter of 1994. A real estate boom had followed German reunification, leading to overinvestment in housing and commercial buildings. After the bubble burst, construction investments fall over a decade. In the Netherlands, no bubble could be identified for the last two decades, although real estate prices have mostly risen. But in this case, the increase can be explained with fundamental variables. No overheating was detected.

### What Are the Causes of Real Estate Price Bubbles?

The basis for an economically and policy relevant early warning system is the identification of the driving forces of price bubbles. Two methods are discussed: A signal approach and logit models. Both methods are based on a panel analysis with data from all 12 industrialized countries of our study. A country-specific analysis would be problematic, given a small number of bubbles per country.

### Crossing the Threshold Values Triggers Crisis Signal

In the signal approach, earlier bubble-like developments are examined and variables identified, which might be relevant for a forecast of the bubble. Then critical values for potentially determining factors are calculated. Threshold values are defined in such a way as to detect as many bubbles as possible, but to send as few as possible false alarms. As quality criterion we use a measure of accuracy based on two elements: the percentage of correctly identified bubbles over the actual number of bubbles that occurred, and the percentage of correctly predicted non-bubbles over all non-bubbles. Non-bubble stands for the periods, in which no bubbles occurred. The optimum threshold is achieved when the sum of both elements is as large as possible. Thus, the two characteristics “correctly predicted bubbles” and “little false alarms” are equally weighted.

Crossing the threshold value of a variable is interpreted as a signal of a looming or already existing bubble. We then construct a combined indicator from several signals based on different variables. The higher the number of variables that predict a looming bubble, the higher the value of the indicator. We recommend stronger weighting of variables, which enable a relatively accurate prediction of bubbles.

The results of the signal approach (Table 1) show, for example, that money supply triggers a signal for a bubble when it rises more than 20 percent above its trend development. Other important influencing variables include the house price-to-rent ratio and the house price-to-income ratio. The higher the housing prices are in relation to rents or incomes, the higher the probability of speculative elements in real estate prices. Credit growth also plays a role in forecasting of speculative bubbles. However, the explanatory contribution of this variable (weight about seven percent) is less important than that of the liquidity indicators on the whole. Nevertheless, credit growth exerts more influence than the credit-to-GDP ratio. The public debt ratio is of less importance (about four percent).<sup>10</sup>

<sup>9</sup> On the whole, this chronology follows the results of other authors, see e.g. Bordo, M.D., Jeanne, O. (2002): I.c., Helbling, T., Terrones, M. (2003): I.c., Adalid, R., Detken, C. (2007): Liquidity shocks and asset price boom/bust cycles. ECB Working Paper 732, Laeven, L., Valencia, F. (2008): Systemic banking crises: A new database. IMF Working Paper 08/224.

<sup>10</sup> Most authors give liquidity and/or credit variables high weighting; see also Borio, C., Lowe, P. (2004): Securing sustainable price stability: Should credit come back from the wilderness? Bank for International Settlements Working Paper 157 and Agnello, L., Schuknecht, L., I.c.

Table 1

### Variables influencing the Occurrence of Price Bubbles on the Housing Market: Threshold Values and Weighting According to the Signal Approach

Variable	Threshold value	Weighting
Short-term interest rate	0.4	5.7
Short-term real interest rate	0.4	5.6
Interest structure	3	3.7
Real effective exchange rate	1	6.9
Rent	0.4	5
Relation housing prices-income	1	7.6
Relation housing prices-rents	1	8
Investment rate	1	7.9
Credit growth, nominal	0.6	7
Credit growth, real	1	7
Credit-to-GDP ratio	1	5.5
Per-capita GDP growth	0.2	6.5
Money supply	0.2	4.6
Growth of nominal liquidity	0.8	8
Growth of real liquidity	1.2	7.1
Government budget balance	1.4	3.8

Note: Calculation of the optimum threshold value by maximization of the quality criterion described in the paper. Weighting in percent, according to individual forecasting quality.

Source: See footnote 5; calculations by DIW Berlin.

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When investment rate or housing price variables exceed their threshold values, this gives an important indication of a price bubble.

### Expansive Monetary Policy and lax lending practices increase probability of speculative developments

The alternative to the signal approach is a logit regression. In this method, the probability of a price bubble is explained by economic determinants. According to the logit model, the probability of a price bubble (defined as 1 for periods with a bubble and 0 for periods without bubbles) is mainly influenced by factors mirroring the financial conditions of the economy (Table 2). Significant nominal money growth increases the probability of a speculation-driven development of housing prices. This applies also to credit growth and the credit-to-GDP ratio. The probability of the occurrence of a bubble increases in times of cyclical upturns, too. This can be observed on the basis of the growth of per-capita income and investment rate. For the diagnosis of real estate price bubbles, the development of housing prices in relation to income or rents is essential. These variables attained a cumulated weight of nearly 30 percent in the overall indicator (22.5 and 7.4). Credit variables make up over

Table 2

### Estimation Values of a Logit Model for the Probability of the Occurrence of Housing Price Bubble

Explanatory variable	Direction of effect	Weighting
Constant	-	
Real exchange rate (-2)	+	7.1
Investment rate	+	7.2
$\Delta$ (House price-to-income ratio)	+	22.5
$\Delta$ (House price-to-income ratio) (-1)	+	
$\Delta$ (House price-to-income ratio) (-2)	+	
House price-to-rent ratio	+	7.4
$\Delta$ Money supply	+	14.1
$\Delta$ Money supply (-1)	+	
$\Delta$ GDP per capita	+	6.9
Credit-to-GDP ratio (-1)	+	13.6
Credit-to-GDP ratio, squared	-	
Credit growth, nominal	+	7
Government budget balance*Tax rate	-	6.7
Deregulation <sup>1</sup> of the mortgage market	-	7.5
Number of observations		1061
Countries		10

Note: Dependent variable: Probability of a price bubble. Weighting (in percent, right column) according to log odds ratio and concordance coefficient.

<sup>1</sup> Deregulation of the mortgage market is defined as dummy variable which is 1 when the mortgage market becomes deregulated and 0 before that point. See Agnello and Schuknecht, l.c.

Source: See footnote 5; calculations by DIW Berlin.

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Credit and monetary conditions influence the building up of housing price bubbles the most.

20 percent, while liquidity conditions account for about 14 percent. The probabilities of a price bubble are shown in Figure 2. Since the forecast accuracy of the logit model proved higher than that of the signal approach, we only present the results of the logit analysis.

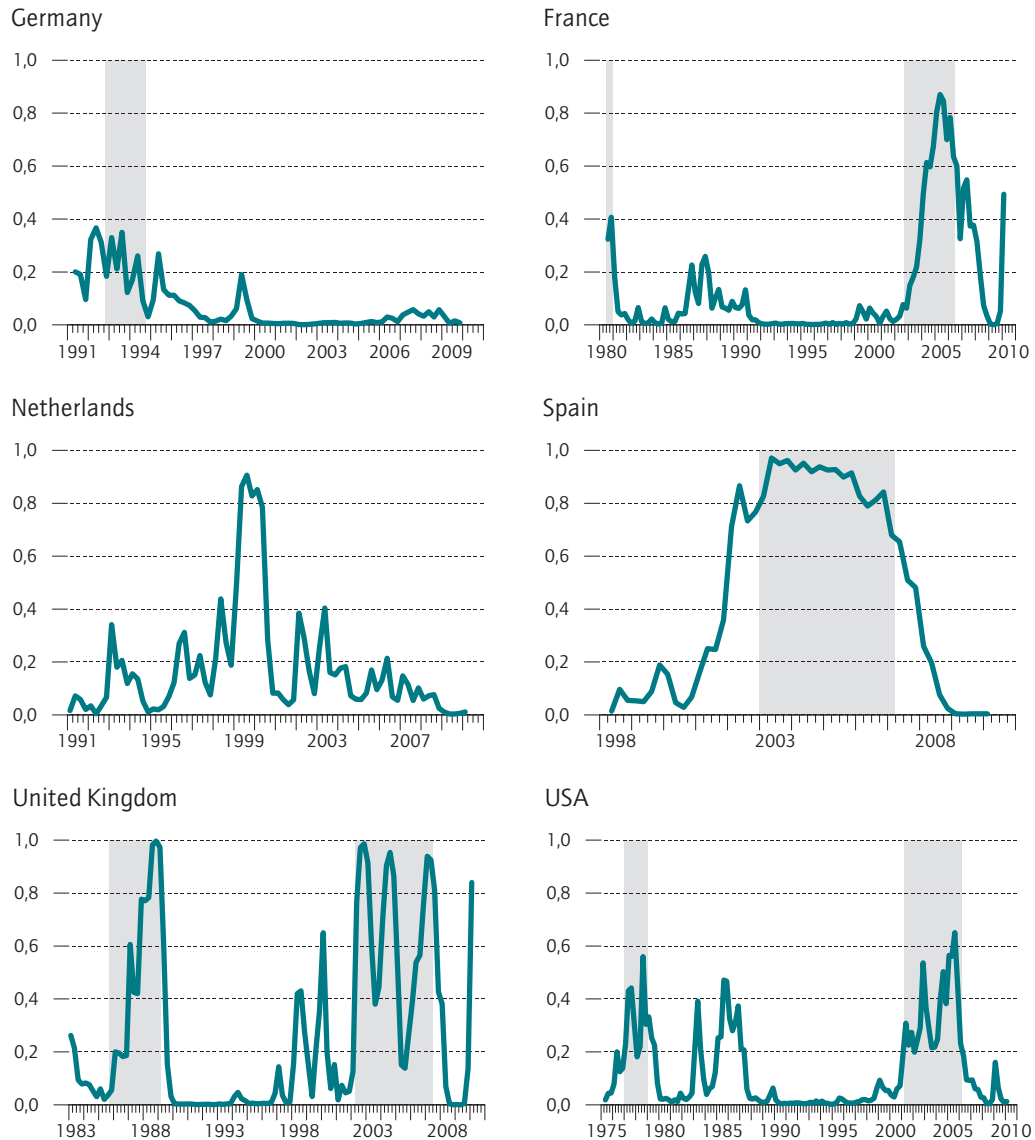
All in all, the results of the logit model show that monetary and financial conditions are crucial for the occurrence and inflation of speculative price bubbles on real estate markets. It makes sense to analyze the development of money and credit aggregates together in order to detect signs of future critical developments. In addition, other indicators can be included, like the cyclical situation or real exchange rates. Especially for smaller countries, a cumulative revaluation of the domestic currency can be an important variable, since it captures the pressure from international capital flows.

Overall, the probability of speculative house price bubbles increases when monetary policy is expansive and the granting of loans is handled laxly. However, a concentration on liquidity and credit variables is insufficient.

Figure 2

**Periods with Speculative Bubbles on the Housing Markets According to Logit Model**

Probability



Note: Periods with price bubbles are marked grey.  
Source: See footnote 5; calculations by DIW Berlin.

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Housing price bubbles are relatively rare and take time to build up.

The emergence of price bubbles is a complex process, which cannot be explained on the basis of just a few variables. Other variables, like per-capita income, investment rates or the government budget balance, need to be taken into account as well in order to obtain sound assessments.

**Conclusions**

Speculation-driven price bubbles on the real estate markets can seriously affect the economy over longer periods of time. For this reason, forward looking policies should combat looming price bubbles. According to the experience, such bubbles tend to burst quite suddenly.

This is why policymakers need instruments for reliable and timely prediction of speculation-caused price increases. DIW Berlin has developed such an early warning system on behalf of the German Federal Ministry of Finance.

In the early warning system presented here, different kinds of information are optimally weighted in order to ensure a reliable diagnosis of real estate price developments and a forecast of speculative price surges. The results make it clear that the formation of price bubbles is a complex process, which is driven by several factors. Most important are credit and money supply of a national economy. Other relevant criteria include the cyclical situation, income development of private households, and the government budget.

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