

Drivers of housing bubbles: the role of monetary policy¹

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1 Introduction

The recent house price bubbles in advanced economies have renewed the debate about the drivers of asset price bubbles. Taylor (2008) is the most prominent in blaming “too loose” monetary policy, by focusing on deviations from the Taylor rule as the relevant indicator for its stance, but is not alone in accusing monetary policy (e.g. Hume/Sentence 2009). A more refined argumentation accuses monetary policy of concentrating too much on output and inflation while ignoring asset price inflation (Borio/Lowe, 2002, 2004, White 2006). Others see the main explanation in the “savings glut”, i.e. high capital flows from emerging markets that depressed long term interest rates (e.g. Bernanke 2010, Caballero et al. 2008, Warnock/Warnock 2009). A third group identifies financial innovation and deregulation as the main driver for bubbles (e.g. Basco 2014, Dokko et al. 2011, Marqués et al. 2010).

According to theoretical models, bubbles occur once an asset price exceeds “the asset’s fundamental value” (Brunnermeier 2008), yet there is no consensus on how to model the fundamental value. One option is to determine the fundamental housing price as a function of expected future net rents, expected long term interest rates and inflation expectations. In this case, a decrease in long term interest rates would increase the equilibrium price for housing, but not necessarily cause a bubble. The results of empirical cross-country studies for the explanation of housing prices are in line with such an approach: Monetary policy affects house prices in a statistically significant way (Assenmacher-Wesche/Gerlach 2010, Calza et al. 2013, Carstensen et al. 2009, and Goodhart/Hofmann 2008).

Interestingly, the theoretical literature does not answer “when and why bubbles start” (Brunnermeier 2008). Price bubbles are attributed either to information asymmetries, to heterogeneous beliefs among agents, or to the interactions of two different groups of traders, of which only one acts rational, however based on distorted price signals due to the actions of the other group (Black 1986, Brunnermeier 2008, Shleifer/Vishny 1997). Yet, “... most of these models do not address the question of whether monetary policy easing can start a bubble.” (Dokko et al. 2011: 264)

Regarding empirical cross-country studies for housing bubbles, only few try to explain the role of economic policy in bubble formation. The few that control for the stance of monetary policy provide diverging results: While Bordo/Landon-Lane (2013a,b) conclude that deviations from Taylor-rule recommendations contribute to bubble formation in housing prices, albeit not in all cases, Dokko et al. 2011 rather stress the role of financial innovation and deregulation. While both studies use OECD house price data starting in the 1970s, econometric approaches and explanatory variables used differ. The latter authors e.g. do not use deviations from the Taylor rule as an explanatory variable, but control for monetary policy by using a broad set of relevant indicators.

As the results are not directly comparable and as both studies can be blamed for assuming an unchanged inflation target of monetary policy since the 1970s, this paper tries to complement the existing studies with a different empirical cross-country approach for advanced economies, focusing on the more recent decades. Our aim is to analyze the role of monetary policy in bubble formation. Even though we agree with the arguments against the use of a Taylor rule in Dokko et al. (2011), we explicitly control for Taylor rule deviations in order to see if the stance of monetary policy measured this way contributes to bubble formation. Yet,

we also control for financial sector developments, in order to see if inadequate regulation of the financial sector should be blamed.

The focus is on housing bubbles only, and not on asset price bubbles in general, as the empirical literature points to differences in duration and varying explanatory variables for housing versus stock price bubbles that call for separate estimation approaches (see e.g. IMF WEO 2009, ch. 3; Bordo/Landon-Lane 2013a,b).

Econometric cross-country approaches aiming at the explanation of house price bubbles face several general problems:

- i. The lack of agreement on how to detect bubbles in reality.
- ii. A general lack of internationally comparable high quality data on housing market features, including data on housing prices, mortgage credits, and regulation that affects the housing market.
- iii. The fact that bubbles are a rather rare event makes it difficult to detect regularities in bubble formation with econometric techniques.

These problems also affect our approach. We follow the empirical literature in using a “pragmatic” approach, identifying bubbles ex post by a strong price increase (a “boom”) in real housing prices that is followed by an equally severe decrease (a “bust”, see details below). We use the BIS data on nominal housing prices that is more detailed and better documented than the OECD data. Yet, it has the disadvantage that the time series provided vary over countries and are generally much shorter than the OECD series.

As we need the time series dimension for our research focus⁵ and a balanced sample, i.e. data for all countries over a common period of time, we concentrate on the period 1990-2012. This aggravates the third problem by excluding bubbles that happened before. This is in contrast to the mentioned studies that rely on OECD data and can therefore use time series starting in 1970 (Bordo/Landon-Lane 2013a,b, Dokko et al. 2011).

Yet, besides data availability, there are good reasons to concentrate on the later period:

- First, the global macroeconomic environment changed over time to such an extent that the analysis of housing bubbles based on long time series starting in the 1970s may be misleading. The IMF therefore separates the analysis on housing price busts (its focus) into pre-1985 and post-1985. This breaking point is supposed to separate the period of oil price shocks from the start of the “great moderation” and higher financial liberalization in advanced economies (IMF WEO 2008, 2009, p. 96f).
- Second, part of the change in the macroeconomic environment is the declining level of inflation in advanced economies and with it the (explicit or implicit) inflation target of

⁵ We cannot follow the IMF 2009 approach that analyzes the behavior of relevant explanatory variables before the bust of a bubble, and apply it to the formation of a bubble. This would imply running a cross-country regression at an artificially constructed point in time (e.g. the start or bubble formation) and only be able to explain differences in bubble formation, as the sample would only include bubble episodes. We would not be able to answer the question if too “loose” monetary policy necessarily increases the probability of a bubble. The results would only point to the contribution of monetary policy, given that a bubble is forming. Another problem with this approach is the differences in length of bubble formation between the countries in the sample (see appendix 1).

central banks. As we follow the literature in using a Taylor rule in order to judge the stance of monetary policy, we need an assumption about the inflation target. While the assumption that advanced economies target a 2 % inflation rate is convincing for the post-1985 period, it is rather questionable for the previous period. The results in Bordo/Landon-Lane (2013a,b) that are based on time series starting in 1970 and assuming an inflation target of 2 % since the 1970s may be affected by that assumption.

- Third, the decline in inflation rates in advanced economies has the nice side effect that peaks and busts in real housing data, the focus of our analysis, more closely match those in nominal data. As most non-economists focus on nominal price developments (instead of calculating the real price level as economic theory would suggest), every day experience relates peaks and busts to nominal developments only. It is therefore helpful for policy advice that the post-1985 differences in nominal and real developments are negligible.

Nevertheless, there is one disadvantage of this period, if one is interested in the effect of financial regulation on housing prices: All advanced countries in the sample started liberalizing their financial markets in the 1980s or even before, and therefore before the start of our analysis. As our sample is rather homogenous in this regard, an indicator for deregulation therefore can at best capture additional (de-) regulation in mortgage markets, for which comparable high quality data is not available (see below).

The structure of the remainder of this paper is as follows: Section 2 describes the data and section 3 explains the estimation approach. Section 4 presents our estimation results and interpretation. Section 5 summarizes the findings.

2 Data

In order to differentiate between the varying bubble explanations, we use an indicator for the formation of a housing bubble and run a cross-country-time-series regression based on annual data during the period 1990 to 2012. In contrast to standard panel approaches, we do not directly restrict the coefficients to be the same across countries. The sample consists of economically advanced countries for which BIS data on nominal house prices are available (extended with OECD data for Germany) and that fulfill the criteria: "OECD member countries before 1990" and "high income country since 1997" according to the World Bank. This leads to slightly more than 20 countries. As some explanatory variables are not available for the selected countries, especially indicators on financial regulation, the country sample shrinks to a maximum of 16 countries: Austria (AT), Australia (AU), Belgium (BE), Canada (CA), Switzerland (CH), Germany (DE), Spain (ES), France (FR), United Kingdom (GB), Italy (IT), Netherlands (NL), Norway (NO), New Zealand (NZ), Portugal (PT), Sweden (SE), United States (US). Depending on the explanatory variables used in the regression, the sample is partly smaller.

Endogenous variable:

Housing bubbles are identified by a "boom" in real house prices that is later followed by a "bust".

- “Boom” periods are defined as periods when the four-quarter moving average of the annual growth rate of the house price, in real terms, exceeds the threshold of five percent.
- “Bust” periods are (symmetrically) defined as periods, when the same four-quarter moving average of the annual growth rate of the house price, in real terms, falls below minus five percent, for at least two quarters in a row. The bust definition follows IMF (2009).

As we are interested in the contributing factors for the formation of a bubble, we concentrate on a binary “boom” indicator: The indicator takes the value “one” for a boom, yet only, if the boom is later followed by a bust, and “zero” otherwise.⁶

The indicator is based on quarterly BIS data for the nominal house price that is deflated by OECD CPI. As the regression is based on yearly data, we construct the endogenous variable in a way that allows for extended boom phases: the endogenous takes the value one if in that year the indicator exhibited at least one boom signal (but no bust signal) and if the last boom signal is followed by a bust signal less than 12 quarters later. Boom periods can be interspersed by no signal periods (for a maximum of 12 quarters) or even a single bust signal in only one quarter, but only, if this one bust signal is surrounded by boom signals.⁷

Table 1 gives an overview of the boom and bust signals used in the regressions. As can be seen, three countries in our sample (Austria, Belgium, and Germany) did not experience a bubble during our regression period. According to our indicator, 13 countries suffered from at least one bubble during 1990 and 2012, yet, the boom phase occurred before 1990 in five of them, and is therefore not covered by the regression. Australia, United Kingdom and the United States had two bubbles during the observed time period, but for all three countries the boom phase of the first bubble happened before 1990 and is therefore not reflected in our regressions. Table A1 in appendix 1 contains more details on the selected BIS housing data, and the resulting boom and bust signals.

Comparing the lengths of bubbles in our analysis with those in IMF 2009, we also find that average bubble duration after 1985 exceeds the mean duration before that time (IMF 2009). For the period 1985-2012, booms last on average four and a half years and thereby more than double the time of busts (two years), while the mean period between the last boom and first bust signals is only one year according to our data (see table A1 in appendix 1). All in all, the average bubble lasts about seven and a half years. Periods of boom signals are not always interspersed by no-signal quarters, and if they are, then by less than eight quarters at most.⁸

To concentrate on the boom phase of a bubble differs from the approach in Bordo/Landon-Lane (2013a,b), where the trough of a housing bubble is taken as the starting point. Yet, we deliberately chose not to follow their definition of a bubble. The reason is that a trough marks the end of a former price decrease. As housing busts may go hand in hand with a general

⁶ As a robustness check, we also use an indicator that does not only control for booms, but also for busts with the following three outcomes: “one” in a boom, “minus one” in a bust, and “zero” otherwise. This does not change our main results.

⁷ The reason is to allow for temporary and short lived price corrections, see information on Netherland’s bubble around 2007 and the Australian bubble in 2010 in Appendix 1.

⁸ The only exception are the Netherlands, where the last boom signal follows after 19 quarters of no signals, before the first bust signals start.

economic recession, one would expect expansionary policy to stimulate demand. The resulting house price increase may just correct a former too strong price decrease – without necessarily signalling the start of a bubble. The approach in Bordo/Landon-Lane (2013a,b) may therefore overstate the evidence for expansionary monetary policy as a cause of bubble formation by assuming that bubble formation starts at the trough. Yet, even though our method differs from the one in Bordo/Landon-Lane (2013a,b), we seem to get roughly similar boom and bust periods for the time periods where our data overlaps, apart from the fact that our boom phase starts slightly later.

Table 1: Boom and bust signals used for the analysis

BIS housing data for		available since	Boom signals for analysis	Bust signals for analysis
AT	Austria	2000 (1986) ¹	none	none
AU	Australia	1986	none ³	1990-91
	...		1998-2004, 2007-08, 2010	2011-12
BE	Belgium	1973	none	none
CA	Canada	1981	none ³	1990-92
CH	Switzerland	1970	none ³	1990-97
DE	Germany	2000 (1990) ²	none	none
ES	Spain	1995	1999-2007	2009-12
FR	France	1996	1999-2007	2009-10
GB	United Kingdom	1968	none ³	1990-93
	...		1997-2005, 2007-08	2009; 2011
IT	Italy	1990	1991-93	1994-95
NL	Netherlands	1976	1993-2001, 2006	2009-10; 2012
NO	Norway	1992	1994-2002, 2004-08	2009-10
NZ	New Zealand	1979	2002-2007	2008-09
PT	Portugal	1988	1991-92	1993-94
SE	Sweden	1986	1990	1992-94
US	United States	1975	none ³	1991
	...		1998-2006	2007-12

1) Data before 2000 refers to Vienna only; 2) Data before 2000 stems from the OECD housing price database;

3) Boom phases before 1990 cannot be covered by the regression as it starts in 1990.

For more details on the construction of the indicator and the resulting boom and bust periods, please see appendix 1.

Explanatory variables

A sample of 16 countries over 23 years limits the amount of explanatory variables that we can use in regressions. Our aim is to find robust statistical evidence for the following explanatory variables for which we use at least two different proxies for each one of them:

- (1) **Indicator for economic activity**
- (2) **Indicator for foreign capital**
- (3) **Indicator for the stance of monetary policy**
- (4) **Indicator for the level of development and regulation of the financial sector**

Most of the explanatory variables enter in our regressions as deviations from their “normal” behaviour as they are non-stationary in levels. For economic activity and monetary policy, we use deviations from past trends, in order to control for “exceptional” developments, closely following other studies: For the calculation of trends we mainly follow IMF WEO (2009 p. 95f.) by using an eight-year-trailing moving average. For the calculation of the Taylor rule, we follow the literature and use a HP filter (see below). To calculate deviations from trends does not only ease the problem of non-stationarity, but also makes sense, as we do not want to explain house price levels but “booms” in housing prices, i.e. exceptionally strong price increases (plus “busts in the case of the ternary boombust indicator, i.e. exceptionally strong price decreases).

All right-hand side variables enter with their previous year values, with the exception of variables that control for the level of development of the financial system or the level of regulation. The reason is to ease endogeneity concerns, since the direction of causality is highly questionable for several of our explanatory variables. This can be exemplified for foreign capital inflows that can be seen as precursors of housing bubbles. For instance, Aizenman/Jinjarak (2009) find a statistically significant negative correlation between real house prices and the current account. Yet, capital inflows can also follow asset price rises according to Fratzscher/Straub (2010). This motivated us to use past year’s values only.

For changes in housing market regulation we construct an indicator based on a database provided by Shim et al. (2013), explained below. As this indicator seems to be too narrow in focus, we also control for the level of development and regulation of the financial system in a broader sense. Indicators like domestic credit to GDP are frequently used in comparative studies on the development of the financial sector in different countries.⁹ Yet, during our period of interest, this indicator increased enormously for all countries in the sample, leading to non-stationary series. We therefore tried to rely on national averages over the estimation period or deviations from OECD developments. Indirect indicators for changes in financial regulation like the gap between mortgage rates and a risk-free rate were unfortunately impossible to include as comparable data on mortgage credit for all countries are not available. It is important to stress that we do not use credit supply (for housing) as an explanatory variable, as supply would follow demand according to theoretical concepts of endogenous money.

The following provides a brief overview on the variables used. For a detailed overview on variable names, construction, source and interpretation please see appendix 2.

(1) Indicator for economic activity

- Real GDP growth, deviations from an eight year trailing moving average.
- Real personal consumption expenditure growth, deviations from an eight year trailing moving average.

⁹ M2 to GDP constitutes an even more accepted control for the development of the financial system, yet was not available for all countries for the entire time period under study.

(2) Indicator for foreign capital

- Current account balance of a country as percent of GDP.
 - Version 1: simple form.
 - Version 2: deviations from an eight year trailing moving average.

(3) Indicator for the stance of monetary policy

- Deviations of the nominal policy rate¹⁰ from a standard Taylor rule.¹¹
- Deviation of the real policy rate¹² from an eight year trailing moving average.

(4) Indicator for the level of development and regulation of the financial sector

- Domestic credit to the private sector, as percent of GDP.
 - Version 1: national average over the entire estimation period.
 - Version 2: national deviation from an eight-year trailing moving average.
 - Version 3: deviations from the same variable's OECD average, in percent, as a control for national deviations from OECD developments.
 - Version 4: the standard deviation of version 3 since the mid-1970s up to the actual year, in order to measure the stability of credit developments in comparison to OECD developments.
- Indicator of securitization: The “quantitative de jure mortgage backed securitization indicator” used by Sa et al. 2014, which builds on the one developed by Hoffmann and Nitschka 2009.¹³ This indicator almost acts like a country specific constant, as it hardly fluctuates over time. The higher the indicator, the more securitization is allowed in the respective country.
- Indicator for changes in housing regulation based on the Shim et al. (2013)¹⁴ database for policy actions on housing markets that we transformed to numerical values. The indicator has the following three outcomes: +1 indicates tightening regulation; -1 indicates lowering regulation standards, and 0 reflects no change in regulation.

Table 2 summarizes the expected signs for the coefficient estimates of the exogenous variables. While positive deviations from economic activity in the past should further housing price bubbles, higher current account positions reflect lower capital inflows and should therefore have a dampening effect on bubble formation. Similarly, positive deviations from past monetary policy signal a more restrictive policy stance and should decrease the

¹⁰ We use the three months interbank rate for the policy rate to also account for changes in money provision by tender operations.

¹¹ The Taylor rule assumes equal weights for the inflation goal (2 %) and the output goal. Output trend is measured by a HP filter, following the literature (see e.g. Bordo/Landon-Lane 2013a,b), yet taking GDP data up to the respective year into account.

¹² Nominal three months interbank rate deflated by OECD CPI.

¹³ Even though the data ends 2008Q1, the dataset has been expanded until the end of 2012 by replicating the value of the last available data point. Unfortunately, the indicator is not available for all 16 countries in the sample.

¹⁴ This database collects information published by central banks of 60 countries between 1990 and 2012 and codes it as measures tightening or loosening the housing market.

probability of bubbles. For indicators on the level of development of the financial sector, the direction is not always clear. A more developed financial system, being reflected in a higher level of domestic credit to GDP and/or higher levels of securitization could dampen or further bubble formation. Yet, stricter financial regulation should dampen the probability of bubbles, while higher credit growth should further it.

3 Estimation approach

Our sample has the disadvantage that 16 countries are a small number of cross-sections for a standard panel approach. As we do not have data on all OECD countries, we cannot claim that this was a non-random sample – a justification that is often used in cross-country studies with a limited amount of countries and time series features (see e.g. Beck 2001). At the same time, 23 observations over time are rather short for a time series analysis, especially regarding the non-stationarity issues of several of our explanatory variables that cannot be fully solved by our transformations.

With a larger country sample, our binary endogenous variable would call for a standard panel probit or logit model (or even a multinomial model for the ternary boombust indicator). This would help in interpreting the estimated coefficients as probabilities, as the (in-sample) forecast of the endogenous would be restricted to outcomes between zero and one. Fixed or random effects should not play a relevant role, as countries should not be “prone” to bubbles in a country-specific way. We would need a dynamic panel probit or logit model, as our results indicate that bubbles depend on past developments in housing prices. Yet, this approach assumes common coefficients for the exogenous variables. As will be demonstrated later, this restriction is not adequate for several of our exogenous variables. Especially the coefficients for monetary policy and financial regulation cannot be restricted to be the same for all countries in the sample. We therefore do not use a dynamic panel probit or logit model.

Our main approach is a system of seemingly unrelated time series regressions that allows for cross-country shocks (cross-country SUR).¹⁵ The country-specific time series equations are estimated by generalized least squares (GLS) and connected via their error terms. To allow for cross-country shocks improves the fit of the regressions and implies that a shock in one country (as well as a global shock) affects other countries.

While the cross-country SUR approach is very robust due to the GLS estimation, it has the negative side effect that the forecast for our endogenous variable is not restricted to outcomes between zero and one. This inhibits a direct interpretation of the estimated coefficients regarding the size of the influence, however not their sign. We therefore mainly concentrate our presentation of results on the question if variables influence the probability of a boom in a statistically significant negative or positive way and analyze the robustness of these results regarding changes in the country sample, the time period under study, the inclusion of other exogenous variables as well as a modified version of the endogenous variable.

¹⁵ SUR stands for seemingly unrelated regression. Due to the limited amount of data, we cannot allow for cross-time shocks.

Table 2: Interpretation and expected signs of the explanatory variables' coefficients

Control for...	Interpretation	Coefficient's expected sign
Indicator for economic activity		
Deviations from real GDP growth	Positive (negative): GDP is above (below) trend	Positive
Deviations from real household consumption growth	Positive (negative): household consumption expenditure is above (below) trend	Positive
Indicator for foreign capital		
Current account balance, % of GDP	The more negative, the higher are capital inflows	Negative
Current account balance, deviations from past values	The more negative, the higher are capital inflows compared to the past	Negative
Indicator for the stance of monetary policy		
Deviation from the Taylor rule	Positive (negative): interbank rate is above (below) trend, monetary policy is rather restrictive (loose)	Negative (according to Taylor 2008)
Deviation from past real policy rate	Positive (negative): 3m interbank rate is above (below) the trend; i.e. monetary policy is rather restrictive (loose)	Negative
Indicator for the level of development and regulation of the financial sector		
Domestic credit, version 1	The higher (lower) the value, the more (less) important are bank credits for economic activity over the period average.	Ambiguous
Domestic credit, version 2	Positive (negative): credit expansion is above (below) trend	Positive
Domestic credit, version 3	Positive (negative): bank credits to GDP are higher (lower) than for the OECD average	Positive
Domestic credit, version 4	The more stable the domestic credit development is with regards to average OECD developments, the lower the value.	Negative Less volatile credit developments should dampen the probability of bubbles
Indicator on securitization	The higher (lower) the indicator, the more (less) securitization is allowed.	Ambiguous
Indicator for changes in housing market regulation	Positive (negative) values indicate the number of policy actions that tighten (lower) the regulation of the housing market.	Negative The tighter regulation, the lower the probability for bubbles

If we had enough data points, we would follow the common estimation procedures. For estimating the cross-country SUR, this would imply:

- We would start by using all explanatory variables and then eliminate those that are not significant.
- We would start with country-specific coefficients for all explanatory variables, then test if we can restrict them to be the same across countries, and only do this if we cannot reject the hypothesis of common coefficients.

Due to data limitations, we start instead with small models, and check which estimation set-up proves to be robust to changes in the country-sample, time-period, as well as to adding additional explanatory variables. We mostly start with common coefficients and test the adequateness afterwards, for one explanatory variable at a time. We may therefore run into problems of path dependence for our results.

4 Estimation results

The estimation set-up that proved to be the most robust regarding changes in the country composition, the time period considered, and the inclusion of additional variables is the following: It is a cross-country SUR approach with a constant, a lagged endogenous and a lagged indicator for economic activity. We call this estimation set-up the “**baseline equation**”. The restriction to common coefficients of the lagged endogenous and, separately conducted, the lagged indicator for economic activity could not be rejected. The results are in line with theoretical models that stress herding behavior on the side of investors (Scharfstein/Stein 1990):

- 1 The **lagged endogenous** is highly significant with a positive sign, indicating, that past bubble developments increase the probability of actual bubbles.
- 2 Cross-country and/or global shocks seem to play a relevant role: to allow for **cross-country SUR** improves the fit of the regression enormously.
- 3 An above-the-trend increase in **economic activity** in the past year increases the probability of a bubble, be it measured by deviations from past real GDP growth or by deviations from real private household consumption growth.

As can be seen in the tables in appendix 3, the coefficient estimates for the lagged endogenous are rather stable around 0.69 to 0.73 for the period 1991-2012, whatever additional variables are included. This estimation range is independent of the country sample and the time period used in the estimation and reflects that most of bubble formation is explained by past bubble developments. This result is less satisfying for explaining bubble formation, but in line with other empirical studies (e.g. Bordo/Landon-Lane 2013b). Similarly, deviations from the trend in economic activity seem to be highly significant for the boom explanation, even though their effect is smaller than past bubbles.

Almost all other explanatory variables seem to be significant if they are added individually to the “baseline equation”. In addition, they mostly bear the expected sign. Interestingly, some of them cease to be significant if other exogenous variables are controlled for. This is partly the

case for the current account and some variables controlling for the level of development and regulation of the financial sector.

More interestingly for the focus of our study, the past stance of monetary policy seems to be highly significant in explaining bubble formation if we (wrongly!) restrict the coefficient to be the same over all countries in the sample. In addition, the negative sign of the estimated coefficient seems to indicate that too “loose” monetary policy increases the likelihood of house price booms.

Yet, allowing the coefficient for the stance of monetary policy, measured by the Taylor rule, to vary for each country indicates that there is no stable pattern for all countries: While the coefficient is indeed negative in a statistically significant way for some countries (Spain, France, and Portugal), this is not the case for all countries. Three countries even show a statistically significant positive coefficient, in contrast to theoretical considerations: Switzerland, United Kingdom, and the Netherlands (see Table 3).

Table 3: Statistically significant signs of the country-specific coefficients for the stance of monetary policy for two different time periods

	1991-2012		1994-2012	
	Significant coefficients	Expected sign?	Significant coefficients	Expected sign?
AT	-	-	Positive***	NO
AU	-	-	-	-
BE	-	-	Positive***	NO
CA	-	-	-	-
CH	Positive***	NO	Positive***	NO
DE	-	-	Positive***	NO
ES	Negative**	YES	Negative***	YES
FR	Negative*	YES	Negative**	YES
GB	Positive*	NO	Positive*	NO
IT	-	-	Negative***	YES
NL	Positive*	NO	-	-
NO	-	-	-	-
NZ	-	-	Negative***	YES
PT	Negative**	YES	Positive***	NO
SE	-	-	-	-
US	-	-	-	-

Significant at a 10 % level, ** 5 % level, * 1 % level.*

Binary boom indicator, 16 countries, estimated by cross-section SUR with common coefficients for the constant, the lagged endogenous and economic activity, but country-specific coefficients for the stance of monetary policy, measured by Taylor-rule deviations. For details see Appendix 4.

Restricting the time period to 1994 to 2012, the amount of results that are not in line with positions blaming loose monetary policy for housing booms even increases: While Spain, and France keep a statistically significant negative coefficient, and Italy as well as New Zealand join this club, the number of countries with a statistically positive sign increases as well: Next to Switzerland and the United Kingdom, also Austria, Belgium, Germany plus Portugal form that group. Portugal is especially interesting, as it has the opposite sign for an estimation

period that has been shortened by only three years (Table 3 and Appendix 4). Interestingly, results for the alternative indicator for monetary policy, deviations from past policy rates, yield similarly conflicting results.

Deviations from the Taylor continue to have country-specific statistically different signs, even if one controls for the level of development and regulation of the financial sector, independently of the included indicator. Interestingly, the control variables for the financial system do not improve the fit of the regression, if their coefficients are restricted to be the same across countries: The indicator for housing market regulation is not statistically significant, neither is the first version of domestic credit to GDP (national average over the estimation period). All other versions are statistically significant, yet with unexpected signs: Versions 2 and 3 enter with a negative sign, version 4 with a positive sign. The indicator on securitization shows that securitization increases the probability of bubbles in a statistically significant way. While this last result is in line with other econometric studies (see Sa et al. 2014), the surprising results of the other controls for the development of the financial sector may again be due to the incorrect restriction to common coefficients: similar to monetary policy, coefficient signs vary between countries from significantly negative to significantly positive, if estimated without restriction.

It seems as if none of our indicators for the development and the regulation of the financial sector captures the entire regulatory framework in a way that would allow for the common coefficient restriction: Single indicators added to the “baseline equation” (not controlling for the stance of monetary policy) seem to be highly significant and often yield the expected sign, even though they partly cease to be significant once other explanatory variables are included. But the hypothesis that the coefficient can be restricted to be the same for all countries has to be rejected, similarly to monetary policy. Akin to monetary policy, the sign depends on the country, once country-specific coefficients are allowed for.

5 Conclusion

We focus on the boom period of housing prices in order to explain the driving factors for the formation of housing bubbles. In a sample of 16 advanced economies during the period 1990 to 2012 we show in a cross-country-time-series approach that booms in housing prices are explained by the following variables in an econometrically robust way:

- Past booms increase the probability of actual booms.
- Economic activity above the former trend increases the probability of actual booms.
- Housing price shocks in other advanced economies contribute to house price booms.

These findings are in line with theoretical approaches that stress the importance of herding behavior among investors and bounded rationality (Black 1986, Scharfstein/Stein 1990).

We cannot find a clear influence of monetary policy on the formation of housing bubbles. To account for the role of monetary policy, we measure its stance by deviations from the Taylor rule. An alternative indicator is based on deviations from real policy rates from past trends. Irrespective of the indicator used, our results are similar: “Too loose” monetary policy may at best contribute to bubble formation in a few selected countries, where we find a statistically

significant sign that would be in line with the argumentation of Taylor (2008). Yet, for the country group as a whole, we cannot confirm this result. For some countries, expansionary monetary policy even decreases the probability of bubbles. In addition, only the result that the influence of monetary policy is country-specific seems to be robust – with the exception of Portugal, where a small change of the time period leads to contrary effects of monetary policy.

Regarding our regression setup, it is surprising that we do not find more support for the hypothesis that too “loose” monetary policy drives housing bubbles. Central banks had several reasons to deviate from the Taylor rule around the 2000s, e.g. to stabilize stock market developments. Yet, we do not control for these variables in our regression. Therefore, the role of monetary policy for housing bubbles might even be overstated in our approach. That we nevertheless do not find a statistically significant and robust influence of deviations from the Taylor rule stresses the point that it is not an important driver for bubbles.

Interestingly, we neither find a robust influence of financial sector developments and financial regulation on housing bubble formation that would be common to all countries under study, even though we use a wide variety of controls for them. These results could indicate that the general regulatory framework is relevant for the probability of bubbles. Case studies on selected countries indicate that it is not the financial regulation of the housing market alone, but rather regulatory settings in a broader sense, including a regulation of the rental market favoring low-rents as well as state subsidies for construction that seem to stabilize housing prices in the case of Austria, together with a taxation that decreases the attractiveness of buying a house as an investment object (Kunnert/Baumgartner 2012, Schneider 2013). In addition, the changing treatment of credit default swaps seems to play a role for the U.S. housing bubble (see Roe 2011, Stout 2008). Unfortunately, high quality data for country comparison of the general regulatory framework are not available.

Appendix 1: Details on the construction of the bubble indicator

We use an indicator for bubble formation. Housing bubbles are identified by a “boom” in real house prices that is followed by a “bust” in less than three years.

“Boom” periods are defined as periods when the four-quarter moving average of the annual growth rate of the house price, in real terms, exceeds the threshold of five percent. “Bust” periods are (symmetrically) defined as periods, when the same four-quarter moving average of the annual growth rate of the house price, in real terms, falls below minus five percent, for at least two quarters in a row. The bust definition follows IMF 2009.

The binary “boom” indicator takes the value “one” for a boom, yet only, if the boom is later followed by a bust, and “zero” otherwise. An alternative “boombust” indicator differentiates between three outcomes, “one” in a boom, “minus one” in a bust, and “zero” otherwise.

Sample: Housing data has been selected for countries that fulfill the following criteria: OECD country since before 1990 and, high income country according to the World Bank since 1997.

Data source: The indicator is based on quarterly BIS data for the nominal house price that is deflated by OECD CPI. If available, the following quarterly BIS series have been used (or have been constructed out of monthly series for Iceland, and Portugal):

- Covered Area: whole country, with the exceptions Australia (8 cities) and Iceland (Capital)
- Property type: all, exceptions: Australia, Switzerland, Poland (single flats), Canada (houses, new structures); France (existing dwellings),
- Vintage: all, exceptions: Canada (New), Netherlands, US (existing)
- Priced unit: pure price or price per dwelling, exceptions: Canada, Spain, Poland, Portugal (price per square meters)
- Adjustments: no seasonal adjustments, besides the seasonally adjusted US data.

As the regression is based on yearly data, we construct the endogenous variable in a way that allows for extended boom phases: the endogenous takes the value one if in that year the indicator exhibited at least one boom signal but no bust signal and if the last boom signal is followed by a bust signal less than 12 quarters later. Boom periods can be interspersed by no signal periods (for a maximum of 12 quarters) or even a single bust signal in only one quarter in order to allow for temporary and short lived price corrections like in the case of the Netherland’s bubble around 2007.

Results:

For the period after 1985, booms last on average more than four years and thereby at least double the time of busts (two years), while the period between the last boom and first bust signals is only one year (see table A1 below). Periods of boom signals are not always interspersed by no-signal quarters, and if they are, then by less than eight quarters at most. The only exception are the Netherlands, where the last boom signal follows after 19 quarters of no signals. Another case to mention is the Australian bubble around 2010, where boom signals are interspersed by one bust signal (see table A1).

Appendix 2, Table A2: Explanatory variables – data sources and construction

Control for...	Abbreviation	Data source	Construction	Interpretation
Indicator for Economic Activity				
Deviation from real GDP growth	DevGDP00	AMECO GDP at 2005 market prices	National deviation from the national 8 year moving average of year-on-year real growth rates	Positive (negative): GDP is above (below) trend
Deviation from real household consumption growth	DevC00	AMECO final consumption expenditure of households and NPISH, extended** by IMF IFS* data, OECD CPI deflated	National deviation from the national 8 year moving average of year-on-year real growth rates	Positive (negative): household consumption expenditure is above (below) trend
Indicator for foreign capital				
Current account balance, % GDP	CAGDP	IMF WEO current account balance, percent of GDP	-	The more negative, the higher are capital inflows
Current account balance, deviation from trend	CAGDP	IMF WEO current account balance, percent of GDP	National deviation from the national average of the past eight years (including the current year)	The more negative, the higher capital inflows have been for the last four years
Indicator for the stance of monetary policy				
Deviation from the Taylor rule	DevTaylor	OECD* 3 month interbank rates,	Deviation of the national 3m interbank rate from Taylor rule (r) following Taylor (1993), calculated as: $r=p+0.5y+0.5(p-2)+2$ with p=actual inflation rate in %, y=output gap (GDP deviation in % from a trend calculated by HP filter), inflation target assumed as 2 % and long-term real interest rate as 2 %.	Positive (negative): 3m interbank rate is above (below) Taylor recommendations rule; i.e. monetary policy is rather strict (lax)

Deviation from past real policy rate	Devinter00	OECD* 3 month interbank rates, OECD* CPI deflated	Deviation from the eight year moving average of y-o-y real growth rates (in percentage points)	Positive (negative): interbank rate is above (below) trend, monetary policy rather strict (lax)
Indicator for the level of development and regulation of the financial sector				
Domestic credit, version 1	CredGDPav	World Bank*: domestic credit to GDP in %	National average over the period 1990-2012	The higher (lower) the value, the more (less) important are bank credits for economic activity on average over the period.
Domestic credit, version 2	Dev8ycredGDP	World Bank*: domestic credit to GDP in %	National deviation from the national 8 year moving average	Positive (negative): credit expansion is above (below) trend
Domestic credit, version 3	DevOECDcredGDP	World Bank*: domestic credit to GDP in %	National deviation from the same year OECD average in % of OECD av.	Positive (negative): bank credits to GDP are higher (lower) than OECD average
Domestic credit, version 4		World Bank*: domestic credit to GDP in %	Standard deviation of version 3 since the mid 1970s up to the respective year	The more stable the domestic credit development is with regards to the OECD average developments, the lower the value.
Indicator on securitization	FI_Sa2014	Qualitative de jure mortgage-backed securitization indicator extracted from Sa et al. 2014, values by construction between 0 and 1.	-	The higher, the more securitization is used in the country
Indicator on housing market regulation	FI	Shim et al. (2013) database for policy actions on housing markets, based central banks information. Data coded as measures tightening or loosening the housing market.	Transformation to numerical values: +1 = tightening, -1 = lowering regulation standards; 0 = no regulatory change. Indicator sums up actions taken in one year.	Positive (negative) values indicate the number of policy actions that tighten (lower) the regulation of the housing market.

*via Macrobond; ** Extension with IMF IFS data for AU, CA, IS, KR, NZ, partly: AT, BE, CH, DE, ES, GB, PT

Appendix 3: Detailed regression results for cross-section SUR

Table A3: Regression results for baseline regression plus one additional variable, activity variables: deviations from GDP trend

Endogenous	Binary Boom-Indicator	Coefficient estimates and significance level									
Exogenous variables plus constant											
Past Booms	binary boom-indicator (lag)	0.73***	0.73**	0.73***	0.73***	0.74***	0.72***	0.72***	0.73***	0.73***	0.72***
Activity	deviation from GDP growth (lag)	0.02***	0.02***	0.02***	0.02***	0.01***	0.02***	0.02***	0.01***	0.02***	0.02***
Mon. Policy	dev. past policy rate (lag)		-0.01***								
	dev. from Taylor rule (lag)			-0.00***							
Financial system	Change in housing market regulation (lag)				-0.00						
	dev. of credit to GDP from OECD average					-0.00***					
	credit to GDP average over period						-0.00				
	standarddev. of dev. from OECD av.							0.00***			
	Securitization indicator (lag)								0.03***		
Foreign Capital	Current account to GDP (lag)									-0.00***	
	dev. From current account to GDP (lag)										0.00***
weighted adjusted R-square		0.87	0.90	0.89	0.84	0.84	0.86	0.87	0.80	0.87	0.86

Regression: Cross-section SUR approach for a sample of 16 countries with constant.

*Significant at the 10 % level, **... at the 5 % level, ***... at the 1 % level.

Regressions for the alternative activity variable, private consumption expenditures of households, lead to similar results.

Appendix 4: Detailed regression results for monetary policy

Table A4: Sample period 1990-2012

Table A5: Sample period 1994-2012

System of equations for 16 countries, cross-section SUR, with common coefficients for all variables but monetary policy, 1991-2012			System of equations for 16 countries, cross-section SUR, with common coefficients for all variables but monetary policy, 1994-2012		
Endogenous variable: Binary Boom-Indicator			Endogenous Variable: Binary Boom-Indicator		
Exogenous variables (in lags)	Coefficient	Significance	Exogenous variables (in lags)	Coefficient	Significance
Constant	0.04	***	Constant	0.04	***
Past Booms: binary boom-indicator (lag)	0.70	***	Past Booms: binary boom-indicator (lag)	0.70	***
Activity: deviation from GDP trend (lag)	0.02	***	Activity: deviation from GDP trend (lag)	0.02	***
Mon. Policy: dev. from Taylor rule (lag) - country specific coefficients			Mon. Policy: dev. from Taylor rule (lag) - country specific coefficients		
AT	0.00		AT	0.02	***
AU	-0.01		AU	0.01	
BE	0.00		BE	0.01	***
CA	0.00		CA	0.00	
CH	0.01	***	CH	0.01	***
DE	0.00		DE	0.01	***
ES	-0.01	**	ES	-0.02	***
FR	-0.01	*	FR	-0.01	**
GB	0.05	*	GB	0.05	*
IT	0.00		IT	-0.05	***
NL	0.05	*	NL	-0.02	
NO	0.00		NO	-0.05	
NZ	-0.02		NZ	-0.04	***
PT	-0.03	**	PT	0.01	***
SE	0.00		SE	0.00	
US	-0.01		US	-0.03	
Weighted R-Squared	0.84		Weighted R-Squared	0.76	
Unweighted R-Squared	0.59		Unweighted R-Squared	0.61	

*Significant at 10 % level, **...at 5 % level,***...at 1 % level.

Bibliography

- Abiad, A., Detragiache, E., Tressel, T. (2010): A New Database of Financial Reforms. *IMF Staff Papers*, 57(2), 281–302. doi:10.1057/imfsp.2009.23
- Aizenman, J., Jinjark, Y. (2009): Current Account Patterns and National Real Estate Markets, *Journal of Urban Economics*, 66, 75-89.
- Assenmacher-Wesche, K., Gerlach, S. (2010): Financial Structure and the Impact of Monetary Policy on Property Prices, Working Paper, University of Frankfurt.
- Basco, S. (2014): Globalization and financial development: A model of the Dot-Com and the Housing Bubbles. *Journal of International Economics*, 92(1), 78–94. doi:10.1016/j.jinteco.2013.10.008
- Bernanke, B. (2005): The global saving glut and the US current account deficit. *Remarks at the Sandridge Lecture, Virginia Association of Economists, April.*
- Bernanke, B. (2007): Global Imbalances : Recent Developments and Prospects. *Speech at the Bundesbank Lecture, September.*
- Bernanke, B. (2010): Monetary policy and the housing bubble. *Speech at the Annual Meeting of the American Economic Association, January.*
- Black, F. (1986): Noise, *The Journal of Finance*, 41, 529-543.
- Bordo, M. D., Landon-Lane, J. (2013a): Does Expansionary Monetary Policy Cause Asset Price Booms? Some Historical and Empirical Evidence, NBER Working Paper Series, 19585.
- Bordo, M. D., Landon-Lane, J. (2013b): What Explains House Price Booms? History and Empirical Evidence, NBER Working Paper Series, 19584.
- Borio, C., Lowe, P. (2002): Assessing the risk of banking crises. *BIS Quarterly Review*, (December), 43–54.
- Borio, C., Lowe, P. (2004): Securing sustainable price stability: should credit come back from the wilderness? *BIS Working Papers*, 157.
- Caballero, R. J., Farhi, E., Gourinchas, P.-O., (2008): An Equilibrium Model of 'Global Imbalances' and Low Interest Rates, *American Economic Review*, 98, 358-393.
- Calza, A., Monacelli, T., Stracca, L. (2013): Housing Finance and Monetary Policy, *Journal of the European Economic Association*, 11 (S1), 101-122.
- Carstensen, K., Hülsewig, O., Wollmershäuser, T. (2009): Monetary Policy Transmission and House Prices: European Cross-Country Evidence, CESifo Working Paper No. 2750.
- Dokko, J., Doyle, B. M., Kiley, M. T., Kim, J., Sherland, S., Sim, J., Van Den Heuvel, S. (2011): Monetary policy and house prices. *Economic Policy*, (April), 237–287.

- Fratzscher, M., Straub, R. (2010): Asset Prices, News Shocks and the Current Account, CEPR Discussion Paper No. 8080.
- Gambacorta, L. (2009): Monetary policy and the risk-taking channel. *BIS Quarterly Review*, (December), 43–53. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1519795
- Goodhart, C., Hofmann, B. (2008): House Prices, Money, Credit, and the Macroeconomy, *Oxford Review of Economic Policy*, 24, 180-205.
- Hume, M., Sentence, A. (2009): The Global Credit Boom: Challenges for Macroeconomics and Policy, *Journal of International Money and Finance*, 28, 1426-1461.
- International Monetary Fund. (IMF 2009): Lessons for monetary policy from asset price fluctuations. In *World Economic Outlook* (pp. 93–120). Washington, D.C.: International Monetary Fund. Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.163.8725>
- International Monetary Fund. (IMF 2008): The changing house price cycle and the implications for monetary policy, in: *World Economic Outlook*, Washington, D.C., 93-120.
- Kunnert, A., Baumgartner, J. (2012): Instrumente und Wirkungen der österreichischen Wohnungspolitik, Österreichisches Institut für Wirtschaftsforschung WIFO, Wien, November, retrieved from: http://www.wifo.ac.at/jart/prj3/wifo/resources/person_dokument/person_dokument.jart?publikationsid=45878&mime_type=application/pdf
- Kuttner, K. N., Shim, I. (2013): *Can non-interest rate policies stabilise housing markets? Evidence from a panel of 57 economies* (No. 433) (p. 41).
- Maddaloni, A., Peydro, J.-L. (2011): Bank Risk-taking, Securitization, Supervision, and Low Interest Rates: Evidence from the Euro-area and the U.S. Lending Standards. *Review of Financial Studies*, 24(6), 2121–2165. doi:10.1093/rfs/hhr015
- Marqués, J. M., Maza, L. Á., Rubio, M. (2010): Una Comparación de los ciclos inmobiliarios recientes en España, Estados Unidos y Reino Unido. *Boletín Económico*, (1), 107–120.
- Roe, M. J. (2011): The Derivatives Market's Payment Priorities as Financial Crisis Accelerator, *Stanford Law Review*, 63, 539-90.
- Scharfstein, D. S., Stein, J. C. (1990): Herd behavior and investment. *The American Economic Review*, 465-479.
- Schneider, M. (2013): Are Recent Increases of Residential Property Prices in Vienna and Austria Justified by Fundamentals? *Monetary Policy and the Economy*, Q4/13, Österreichische Nationalbank, 29-46 (deutsch: Ein Fundamentalpreisindikator für Wohnimmobilien für Wien und Gesamtösterreich, Österreichische Nationalbank).

- Shim, I., Bogdanova, B., Shek, J., Subelyte, A. (2013):. Database for policy actions on housing markets. *BIS Quarterly Review*, (September), 83–95. Retrieved from http://www.bis.org/publ/qtrpdf/r_qt1309i.pdf
- Shleifer, A., Vishny, R. W. (1997): The Limits of Arbitrage, *The Journal of Finance*, 52, 35-55.
- Stout, L. A. (2008): Derivatives and the Legal Origin of the 2008 Credit Crisis, *Harvard Business Law Review*, 1, 1-38.
- Taylor, John B. (1993): Discretion versus policy rules in practice, Carnegie-Rochester Conference Series on Public Policy, Elsevier, 39 (1), 195-214.
- Taylor, John B. (2007): Housing and monetary policy, paper presented at the Federal Reserve Bank of Kansas City 31st Economic Policy Symposium: Housing, Housing Finance and Monetary Policy, Jackson Hole, Wyoming, August 31-September 1.
- Taylor, John B., (2008): The Financial Crisis and the Policy Response: An Empirical Analysis of What Went Wrong, keynote lecture at the Bank of Canada, Ottawa, November.
- Warnock, F. E., Warnock, V. (2009): International Capital Flows and U.S. Interest Rates, *Journal of International Money and Finance*, 28, 903-919.
- White, William R. (2006): Procyclicality in the Financial System: Do We Need a New Macrofinancial Stabilisation Framework? BIS Working Paper No. 193 (Basel).