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Highlights

-1- Rapid and slow phases of housing price cycles were identified through Ball (1994) method

-2- Associations of housing price cycles with key macroeconomic indicators were estimated

-3- It was revealed that these associations did differ among rapid and slow phases

-4- It is a novel finding that a house price bubble is not a uniform object of analysis

-5- Further insights on GIIPS economies are provided

Does the Speed of Change over the House Price Cycles Matter?

Belgin Akçay and Eray Yucel[*]

Abstract

Housing price boom-bust cycles lied at the heart of the latest global financial crisis. Many countries experienced booms from 2000 to 2006 which turned into bursts at about the same period, leading to a crisis of global scale. As housing booms are defined as periods in which housing price exceeds its fundamental value, the earlier literature devised several approaches to identify and analyze housing price cycles. Those studies have been successful in finding associations between housing price booms-busts and a number of macroeconomic indicators. However, the speed of change of house prices over the cycles remained untouched. So we aim at identifying housing price episodes with special emphasis placed on the pace of price changes and we document associations between housing cycles, macroeconomic factors and financial development for 26 countries. Our finding that these associations depend on the speed of change of prices over the housing price cycles rather than being uniform might be indicative of a missed spot in understanding housing price bubbles and policy design.

Keywords: House prices; Boom-bust cycles; Macroeconomic factors; Financial development; Speed of change.

JEL Classification: E44; C51; C58; G01.

1.Introduction

Up to date an array of economic crises grew with the burst of economic bubbles. The United States (1984), Denmark (1987), Norway (1987), Finland (1991), Sweden (1991), Japan (1992), France (1994), and the United Kingdom (1995) are some examples of countries that faced with boom-bust cycles in their economies (Reinhart and Rogoff, 2008) where most of the crises occurred during 1980s has come about with collapses of asset prices. Despite many of asset price booms did not end in busts historically, following the liberalization of the markets asset price booms became more likely in the recent year, especially due to sizable contagion effects. As a matter of fact, this was verified in the cases of Southeast Asian countries in the 1990s and in the US in the 2000s.

The adverse role of asset price busts in triggering economic recessions was documented by IMF (2003a) regarding the boom-bust cycles of asset prices in the 1970s and 1990s. In the literature, the attention increasingly shifted from stock price fluctuations to real estate prices in 2000s. This is not surprising as the housing price boom lied at the heart of the latest global crisis and a bigger wealth loss was caused by the housing market fluctuations than by stock market fluctuations. In that, Crowe's (2012) comparison of losses during the dot-com bust where the value of American households' equity holdings declined by 44 percent (USD 5.4 trillion) and the real estate bust that started at the end of 2006 where real estate assets declined by 15 percent (USD 3.7 trillion) is quite insightful. IMF (2003a) finds that linkages between stock and housing prices within countries are very strong, as rising stock prices during a boom is likely to raise housing prices. Besides, half of all the housing price crashes matched the stock price busts (Figure 1).

There is a variety of terms referring to the erratic behavior of asset prices such as 'bubble', 'boom', 'panic', 'bust', 'burst', 'crash' and 'irrational exuberance'. While a housing boom (or bubble) can be defined as a period in which housing price exceeds its fundamental value (Kindleberger and Aliber, 2005; Helbling, 2004; Ikromov and Yavas, 2012; Xiong, 2013) it can be defined with specific reference to increases in real (inflation-adjusted) housing prices and mortgage debt, along with persistent rental income losses (Minsky, 1992).

The methods to identify the housing price cycles largely borrows from the business cycles literature, so the empirical identification of cycles is mostly based on picking plausible turning points where a peak is the period immediately preceding a decline and a trough is the period immediately preceding an upturn (Boldin, 1994). Recently, Agnello and Schuknecht (2011), Igan and Loungani (2012) and Corradin and Fontana (2013) have followed the method of Harding and Pagan (2002) and Harding (2003). IMF (2003a) used the method of Helbling (2004) who followed Pagan and Sossounov (2003), a slightly modified version of the NBER procedure. Bordo and Jeanne (2002), Phillips et al. (2007), IMF (2009) and Gerdesmeier et al. (2012), Yiu et al. (2012), and Gomez-Gonzales et al. (2013) can also be visited for further insight.

Owing to its everlasting importance, in this paper we examine the associations between housing price cycles, macroeconomic factors and financial development. In specific, we elaborate the question of whether the pace of price increases or decreases matter, which is the novelty of our analysis. Regarding the determinants of housing price cycles, this is the first paper that relates housing boom-bust cycles to financial development, to the best of our knowledge. We first employ a slightly modified version of the dating procedure due to Ball (1994) and reveal that almost all of 28 countries[1] considered have faced with housing price booms (26 boom countries) while a majority of them have experienced housing price busts (21 boom-bust countries).

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[1] The countries considered are member countries of the EU (28), Iceland, Norway and the US. Croatia, Poland and Romania, who are member countries of the EU, are not included in analysis due to data unavailability.

Consequently, we investigated the linkages between housing price cycles and other variables by means of pooled probit estimates for the period of 2000-2012.The remainder of the paper is structured as follows: Section 2 describes the methodology and data. Section 3 analyses the association between housing cycles and macroeconomic/financial variables and Section 4 concludes the study.

[Insert Figure 1 here]

2.Methodology and Data

2.1.Dating Procedure of House Price Cycles

Like other studies, such as Harding and Pagan (2002), Helbling (2004) and Igan and Loungani (2012), we first identify the housing price cycles and then reveal the boom and bust periods. We use a slightly modified version of the dating procedure due to Ball (1994) to find the trough and peak dates of real house prices and to mark the movements of prices as "rapidly increasing", "slowly increasing" and "falling". The procedure has little complexity in comparison to its benefits as previously documented by Boschen and Weise (2003), Domac and Yucel (2005) and Vansteenkiste (2009) in their earlier works on consumer price inflation.

Implementation is quite simple and transparent: we first construct a trend real housing price inflation series, for each country, as the seven-quarter centered moving average of the quarterly real housing price inflation rates over the period of 1995Q1-2013Q3, wherever the data are available. Thus, a peak (trough) of housing price inflation is defined as a period in which the seven-quarter centered moving average of housing price inflation is the maximum (minimum) within a seven-quarter symmetric window. Our choice of seven-quarters, instead of the nine-quarters as in Ball (1994), has been driven by data limitations and it limits losses in the final number of observations. Once the trend housing price inflation has been computed, the trough and peak dates of house price are identified as dates at which trend housing price inflation is lower (higher) than in the preceding and succeeding three quarters.

[Insert Figure 2 here]

It is important to note that such use of the procedure due to Ball (1994) provides us with the periods of sustained increases of real house prices. We name these periods as episodes of rapidly increasing real house prices (RAPID). By definition, the housing prices keep increasing after the peak dates of housing price inflation until reaching a maximum. The episodes from the peak date of housing price inflation to the peak date of housing price are then marked as episodes of slowly increasing house prices (SLOW). RAPID and SLOW episodes, together, yield the price increase periods suggested by the four-quarter rule which has been widespread in the earlier literature. The major advantage of our simple approach then is the ability to distinguish the

increase in real house prices with respect to pace. Thus, RAPID and SLOW episodes together are defined as a housing price BOOM period. Once the dating of upturns has been completed, the marking of downturns turns out to be an easier task. A period of downturn or BUST is basically one with starting at the peak point of real house prices and ending at a period where house prices tranquil or ending at the end of available data.

2.2. Estimation Strategy

Once the housing price cycles have been obtained for each sample country in line with the previous subsection, we mapped the cycle data onto a binary scale on an annual basis. In that, for each of the RAPID, SLOW and BUST, we defined separate annual series of binary indicators following the simple rule that years with (without) the desired (i.e. examined) property are marked with 1 (0) for years from 2000 to 2012. In case a rapid increase episode (in quarterly data set) is followed by a slow increase episode within a year, that year has been marked with 1 in favor of slow increase. BOOM is defined as the sum of RAPID and SLOW in a straightforward manner. At the end, the data set was structured as a pool of 26 boom countries and 13 years running from 2000 to 2012. Considering that many countries are included in analysis, preference over an annual frequency makes us to avoid complications like seasonality, which might differ across economies. As we focus on those years with ample global liquidity and the recent global financial crisis, our annual dataset for probit analysis has been constructed to cover the period of 2000-2012.

The general form of our estimating equation is $\Pr(Y_{it} = 1 | X) = F(x_{it}\beta + u_{it})$, where Y_{it} is the binary dependent variable which takes the value of 1 in case a desired property is observed and 0 otherwise. x_{it} is a matrix of observable explanatory variables with its coefficient vector β, u_{it} being the error vector for country i in year t. $F(.)$ is the cumulative density function for Normal distribution. The argument $x_{it}\beta + u_{it}$ of function $F(.)$ is called the linear probability index. Once the right hand side expression is evaluated, the resulting value lies between 0 and 1 and it is nothing but the probability that Y_{it} is 1, i.e. occurrence of a desired property. Consequently, a positive (negative) coefficient estimate in β indicates that an increase in the variable of concern increases (decreases) the likelihood of the desired property that is chosen among BOOM, RAPID, SLOW and BUST in this paper. For more information on the technique and the maximum likelihood estimation criterion see Baltagi (2005, Chapter 11).

2.3. Data

Prior to implementing the dating procedure, quarterly real house prices were calculated as the ratio of nominal house prices to consumer prices index, both seasonally adjusted, for each country. In seasonal adjustment we used the Census X12 procedure. The base year for the computed real housing prices (seasonally adjusted) was set as 2005, for visual ease, with the

exception of Luxembourg for which the base year was set as 2007. Sources of data and variable definitions are described in Table 1 and descriptive statistics are presented in Table 2.

[Insert Table 1 here]

[Insert Table 2 here]

3. Empirical Results

3.1. House Price Cycles

Using the methodology of subsection 2.1, we identified the boom-bust cycles displayed in Figure 3. All countries but Germany and Luxembourg experienced a boom and a majority of boom countries faced with bust (Table 3).

Regarding the workings of our approach, data availability imposes some limitations. As our house price data set runs from 1995Q1 to 2013Q3, use of a seven-quarter centered moving average and consecutive choice of peaks and troughs based on another seven-quarter window cause some data loss. So we enjoyed a limited liberty to pick some peak dates at the beginning of data without any accompanying troughs and mark such periods as house price upturns. As described in subsection 2.1, we subsequently translated the identified episodes into binary indicators at an annual frequency so as to obtain the variables RAPID, SLOW, BOOM and BUST, the occurrence frequencies of which against time are provided in Figure 4.

During rapid price increase episodes, it is observed that house prices increase by an average of 1% per quarter. This figure indicates an increase in nominal house prices 1 percentage point in excess of consumer price inflation. This kind of a behavior of prices is a serious one once the sustained nature of house price increases during booms is taken into account. Second, our boom episodes are congruent with those of Agnello and Schuknecht (2011) 59% and those of Igan and Loungani (2012) 89% of the time. When we consider both boom and bust episodes, these figures are revealed as 51% and 54%, respectively. Note that, the congruence between Agnello and Schuknecht (2011) and Igan and Loungani (2012) is 35% for boom periods and 23% for boom and bust periods together. So, despite the differences in data and dating procedures, our approach guarantees a sufficient overlap with the recent literature.

Finally, based on our revealed episodes, the sample countries were classified as boom-countries, boom-bust (BB) countries and boom-non-bust (Non-BB) countries. Here, 26 out of 28 countries experienced housing price booms and 21 of them went into busts, and they are marked with BB. The remaining five countries are marked with Non-BB to indicate that their booms were not followed by a bust. Like many countries in the world, it was accepted that residential real estate markets were overvalued in the EU countries as well as the US before the

global financial crisis had begun. Our results confirm that in respect of housing price boom-bust cycles. Housing markets valuations of these countries show three different patterns since 1995. Most of them had experienced housing price boom-bust cycle (e.g. Denmark, Greece and Ireland), some of boom countries did not have a bust (e.g. Austria, Finland and Sweden), and a few of the EU countries had limited fluctuations only (e.g. Germany and Luxembourg). A complete listing of this separation for our sample can be seen in Table 3.

[Insert Figure 3 here]

[Insert Figure 4 here]

[Insert Table 3 here]

3.2.Baseline Macroeconomic Specification

It is known that there are multiple interactions between housing markets and the major macroeconomic variables. There is a wide agreement on the drivers of prices in the housing markets include income, population, monetary aggregates and credit availability. Following this line, we first try to understand the movements of housing prices in this subsection. Results of this subsection also forms the basis of our subsequent analysis of the relationship between housing price cycles and financial development indicators.

Our specification considers the associations between the binary variable BOOM and the annual growth rate of GDP per capita (GDPPCGR), annual real growth rate of M2 money supply (M2GRREAL), annual growth rate of cross-border credit flows for the world economy (CROSSBORDER), annual growth rate of population (POPGR), age dependency ratio for young population (AGEDEPYOUNG), ratio of gross savings to GDP (GROSSAVGDP) and ratio of domestic credit extended to private sector to GDP (DOMCREPRIVSEC). Then, we change our dependent variable to RAPID, SLOW and BUST one at a time and investigate their associations with the same regressors. In this specification, growth rate of M2 money supply and cross-border credit flows are meant to handle domestic liquidity and international liquidity, respectively. Note that, in an attempt to reveal more, we estimate three versions of each probit regression, namely for the full sample (ALL), for boom-bust countries only (BB) and for boom-non-bust countries only (Non-BB). By definition, BUST could not be used as a dependent variable for the boom-non-bust sub-sample. As to potential multi-collinearity of regressors, it must be noted that the highest correlations exist between POPGR and DOMCREPRIVSEC (0.59) and between GDPPCGR and CROSSBORDER (0.60), both only coinciding with the conventional threshold of 60 percent (Table 4).

[Insert Table 4 here]

Growth rate of GDP per capita, being indicative of an increase in life-time income growth, display a positive association with boom periods in the case of all as well as boom-bust economies. Apart from its negative association with episodes of rapid price increase for boom-non-bust economies, it has no statistical significance in Table 5. On the other hand, the rate of population growth, as a potential determinant of housing demand, has a significant positive association with boom episodes. This relationship is driven chiefly by episodes of rapid price increase. Dependency ratio of young people has a positive linkage with increasing house prices, as well. An increasing dependency ratio for young people has been interpreted as a sign of expanding households which might ultimately translated into demand for additional housing. Gross savings to income ratio displays a positive relationship with increasing house prices and a negative one with falling house prices. Examination of sub-sample estimates suggests that it is mainly associated with episodes of slow price increase. In a nutshell, these findings lend support to the role of real macroeconomic factors in the formation of housing price cycles.

[Insert Table 5 here]

On the financial front, boom periods have a significant positive association with cross-border credit flows with varying degrees of significance. This is quite intuitive as cross-border credits might have fueled the housing prices in our sample period. However, this finding is not preserved when the boom periods are reconsidered based on the pace of price changes. When we consider the periods of rapid price increase, cross-border credits matter only in the case of boom-non-bust countries and when we consider the periods of slow price increase, cross-border credits are significant for all as well as boom-bust economies. For the bust episodes we reveal a negative association with cross-border funds. When we look at the domestic rather than international financial markets, we first reveal that the effect of the growth rate of real M2 turns out to be positive yet insignificant for the episodes of boom and rapid price increase. For the episodes of slow price increase, it has insignificant negative coefficients. Bust episodes, on the other hand, are negatively associated with real M2 growth in a statistically significant manner. Second, domestic credit to private sector has a negative association with boom episodes for all of the boom, boom-bust and boom-non-bust countries. However, this negative association seems to be intact for the whole sample as well as boom countries in the case of rapid episodes and for the boom-non-bust countries in the case of slow episodes. Bust episodes are positively related to changes in domestic credit volume.

An overall assessment of our estimates for liquidity-related indicators suggest that global rather than domestic liquidity has been shaping the house price cycles of the last decade. In that,

likelihood of house price hikes are higher when more funds are available from abroad, as suggested by the positive sign of cross-border credit flows. In a congruent manner, cross-border credits negatively affect the likelihood of bust episodes. Reversal of the ample cross-border liquidity of the earlier half of 2000s in the second half might then be viewed among the main axes of the latest global financial crisis. Weak association of real money growth can consequently be seen as an extension of this finding. It is further interesting that, availability of domestic credit has different effects on housing price cycles as compared to that of cross-border credits. While cross-border credits increase the likelihood of housing price increases regardless of the pace, domestic credits decrease the likelihood of rapid episodes and increase the likelihood of slow episodes, when we focus on the whole sample as well as boom countries. For the bust episodes, availability of cross-border credits seem to be a relief factor as opposed to domestic credits. All in all, usual suspects of housing price booms and busts are still suspects as verified by our probit estimates.

What is unusual here is we reveal that the earlier practice of treating a boom episode as a uniform object of analysis might be misleading. As documented in Table 5, estimated statistical associations among variables differ between rapid and slow sub-periods of an episode of boom, i.e. the very same factors are associated with likelihoods of rapid and slow episodes quite differently.

3.3. Financial Development and Housing Price Cycles

There are many studies suggesting that a strong and well-functioning financial sector helps economic growth and job creation. Financial development, yet, is hard to quantify due to its complexity. The most comprehensive set of indicators has been prepared by Cihak et al. (2012) so as to characterize and benchmark financial systems, where these measures are grouped under the titles of financial depth, financial stability, financial efficiency and financial access and presented as a 4-by-2 matrix of financial system characteristics. These indicators are included in the analysis of this subsection, except for those pertaining to financial access which are not available for all countries of interest.

Keeping our earlier notation, we now use an equation of the form $\Pr(Y_{it}=1|X,Z)=F(x_{it}\beta+z_{it}\gamma+u_{it})$, where Y_{it} is the binary dependent variable (BOOM, RAPID, SLOW or BUST), x_{it} is a matrix of macroeconomic determinants with its coefficient vector β (not reported in Table 6) and z_{it} is the matrix of financial development variables with the corresponding coefficient vector γ. Maintaining the specification of the previous subsection at the core, one financial development measure has been used as an additional regressor at a time. In addition to estimating an array of models for the whole sample, we separately consider Greece,

Ireland, Italy, Portugal and Spain (GIIPS) subsample to gain further insights. Results of this exercise are summarized in Table 6. Our emphasis on GIIPS economies originates from the apparent difficulties they recently faced. Below we elaborate Table 6 based on the grouping of indicators due to Cihak et al. (2012). Whenever possible, we extend our discussion so as to make separate references to financial institutions and financial markets.

Financial Depth

Financial depth indicators show the size of the financial sector (e.g. size of banks, other financial institutions, and financial markets) relative to the economy. Countries with deep financial systems are supposed to have adequate credit and other financial services. Here we measure the financial depth of institutions using the ratio of private credit by deposit money banks to GDP (PCDMBAFIGDP) and the ratio of assets to (for both deposit banks and other financial institutions) GDP. While measuring financial depth for financial markets, we focus on the two main segments of the financial markets and consider the ratio of stock market capitalization to GDP (SMCGDP), stock market total value traded to GDP (SMTVTGDP) and private as well as public bond market capitalization to GDP (PRIVBMCGDP and PUBMCGDP).

Having a look at the association of financial depth indicators related to financial institutions with our episodes, it is seen that the private credit by deposit money banks to GDP ratio has a negative association with boom and rapid episodes and a positive association with bust episodes (row 1). The same is valid when we consider the private credit provided by other financial institutions in relation to GDP (row 2), financial system deposits to GDP ratio (row 3) and deposit money bank assets to GDP ratio (row 4). Findings about the other financial institutions' assets to GDP ratio (note that the likelihood function turned out to be non-convergent in the GIIPS sub-sample for this variable-row 5) and deposit money bank assets to bank assets ratio (row 6) are congruent with these observations, yet they lack statistical significance. Overall, there is a clear-cut association between housing price episodes and depth indicators. The observation that price increases (decreases) in housing markets are negatively (positively) related to depth of financial institutions is indicative of the stabilizing, or correcting, role of more developed financial institutions on housing prices. In other words, the deeper the markets with respect to financial institutions, the smaller the house price movements are; i.e. a large sale of housing will not move the housing prices much.

The same picture, nevertheless, is not valid in the case of the depth of stock markets. As compared to depth of financial institutions, the evidence in the case of stock market depth is mixed. Here, the stock market capitalization in relation to GDP (row 7) has a significant and positive sign in the case of slow episodes in the whole sample; whereas the stock market total value traded to GDP ratio is positively associated with slow and bust episodes and in the whole

sample only (row 8). Such lack of a strong association between these indicators and housing price episodes are not surprising though, since bank- rather than equity-finance, is the dominant mode of finance, as well as housing finance in European countries.

Turning our attention to bond issues by private and public sectors and to international debt issues, interesting findings come out. Having a look at the capitalization of bond market in relation to GDP, it is observed that private bond market capitalization has a positive linkage with the bust episodes for both the whole sample and the GIIPS sub-sample (row 9). Public bond market capitalization, on the other hand, is positively linked to boom and rapid episodes in the case of GIIPS economies only (row 10).

It is viable that declining housing prices (i.e. bust) causes a decline in housing supply, suppresses the collateral values of mortgages hence jeopardizing the receivables of private institutions. A higher capitalization of private bond market in relation to GDP is then likely to follow such financing difficulties (row 9). The case of the public bond market, on the other hand, calls for a different story. We know that expansionary fiscal policy, high public debt and the associated roll-over requirements in GIIPS economies than EU average. These developments resulted in elevation of purchasing power and expansion of consumption demand especially directed toward durables, particularly housing. The positive association between public bond market capitalization and boom/rapid episodes in GIIPS economies, where public bonds have been issued much more than EU average before crisis[2] can be seen as a direct consequence.

[Insert Table 6 here]

Finally, international debt issues to GDP ratio (row 11) has a negative association with the boom and rapid price episodes and a positive association with the bust episodes. This observation is valid for the whole sample as well as the GIIPS economies. As the ability to issue international debt helps economies to extend their average debt maturity, it might have a tranquilizing effect on housing prices, i.e. decreasing the likelihood of a housing price boom and increasing the probability of a bust.

Financial Efficiency

In an ideally efficient banking system, lower bank cost-to-income and bank overhead costs to total assets ratios are expected. These two, indeed, boil down to a narrower net interest margin, i.e. a smaller difference between the lending and borrowing rates. In Table 6, net interest margin (row 12) has a significant positive relationship with the likelihood of a boom (GIIPS sub-sample), a significant negative relationship with the likelihood of slow episodes (whole sample)

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[2]For example, total public bond issue in Greece has increased three times than that of the EU average. See IMF (2003b, p.121) and IMF (2010, p.16).

and a strong negative association with the likelihood of bust episodes for GIIPS sub-sample. This lends support to the view that financers had to operate within wider interest margins in order to overcome various costs they faced. In parallel with this finding, bank overhead costs in relation to their total assets (row 14) have a positive linkage with boom and rapid price episodes where the coefficient estimate for the former is significant in the case of GIIPS economies and for the latter in the case of whole sample. As to bust episodes, a strongly negative relationship between overhead costs and the likelihood of a bust has been estimated.

The stock market turnover ratio (row 15), however, does not suggest any strong pattern of relationships, except that it is positively associated with slow episodes in the whole sample. Dominance of bank rather than equity finance in European countries, except the UK, once again, can be seen as the main driver of this finding.

Financial Stability

A common measure of financial stability is the z-score.[3] In Table 6, bank z-score (row 16) is positively associated with rapid episodes and negatively associated with bust episodes in the whole sample. This indicator does not display any significant relationships in the GIIPS sub-sample. The positive linkage of z-score to rapid episodes is quite intuitive, as more attractive and stable rates of return accompanied, or resulted from, the fast upward trend of housing prices in the earlier phase of booms. In that, the disappearance of the relationship between bank z-scores and housing prices in slow episodes is also meaningful and it might be read as a signal of satiation for returns once the rapid phase of booms has been over. As bank returns fall and volatility of returns increase during busts, the negative association of z-scores and the likelihood of bust episodes is intuitive, as well.

4.Concluding Remarks

Economic dynamics related to housing sector gained an ever high visibility during and in the aftermath of the latest global financial crisis. Owing to high income multiplier in the construction sector and capability of housing sector to mobilize tremendous volume of credits as well as stock market transactions, the recent price boom-bust experience in housing sector resulted in the deepest economic crisis since the Great Depression. Having appeared initially in the second half of 2007, the global crisis was declared in 2008. The following years, then, witnessed a deep global recession and persistently high unemployment rates in many countries. It is then evident that asset price busts affect the economies adversely over many dimensions, as was earlier reported by IMF (2003a). So we focus on the formation and dissolution of housing

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[3] It explicitly compares buffers (capitalization and returns) with risk (volatility of returns) to measure a bank's solvency risk. The z-score is defined as $z \equiv (k+\mu)/\sigma$, where k is equity capital as percent of assets, μ is return as percent of assets, and σ is standard deviation of return on assets as a proxy for return volatility (Cihak, 2012, p.29).

price booms and analyze the factors associated with them using a slightly different perspective than that of the recent literature.

Our numerical approach differs from those in existing literature as we use a simple and transparent methodology (Ball, 1994) to identify the turning points of housing price cycles so as to obtain the rapid and slow sub-phases of booms and we relate housing boom-bust cycles to financial development. In an attempt to understand what has happened in the case of the most problematic economies, we developed our analysis in a way to treat GIIPS economies separately. Using quarterly data from 1995Q1-2013Q3 for 28 countries we identify the housing price cycles and categorize our sample countries as boom countries and boom-bust countries. Our results confirm that the majority of them have faced with housing boom-bust cycle, while most of housing markets of European countries as well the US were overvalued since 1995. Then, we use a panel probit approach to reveal the factors associated with housing price booms and busts from 2000 to 2012 for 26 countries for which a boom period has been identified.

Our findings point at the broad and intuitive observation that both macroeconomic factors and the level of financial development are important in the formation as well as dissolution of housing price booms. At a glance, these are theoretically expected results, e.g. with growing liquidity in domestic markets, housing demand increases because of the decrease in cost of funding for housing buyers in an economy. However, it is not possible for supply of housing to simultaneously increase. Thus, lack of supply speeds up housing prices. These must be positively associated with boom periods. In addition, the findings show that financial institutions are also crucial to provide price stability for housing markets because they shape distribution of resources to housing markets by determining the ratio of down payments to value applies and loan to income ratio etc. In other words, as long as financial institutions influence not only size of the total credit pie in housing markets, but also usage rate, it is possible to prevent both speed price increases and overvalued prices for housing markets, even if money supply is increased in the economy.

In the financial development front, we can highlight (1) financial institutions' depth has a stabilizing or correcting role, whereas the same is not valid in the case of stock market since bank- rather than equity-finance is the dominant mode of finance in a majority of the sample countries, (2) public bond market capitalization has been de-stabilizing in the case of GIIPS economies, where the public debt securities have been issued much more than EU average before crisis and (3) financial efficiency, financial stability and other measures of interest have their expected signs, i.e. the higher the financial efficiency and financial stability are, the less volatile are the housing price movements. Consequently, there is evidence of a significant link between house price cycles and financial variables, especially monetary variables in the countries

considered. It seems that policy makers can affect the speed of increase in housing prices and remove or mitigate the probability of housing price boom (bust) with monetary policy tools. However, the use of these tools did not have efficacy in the housing markets of the EU countries, especially Eurozone, as in most of countries. On the contrary, in the markets of Eurozone where there is a single monetary policy and eighteen fiscal policies and also where the national characteristics in housing markets are still kept, the monetary policy implemented by the ECB might have induced the housing price cycles. Indeed, some countries of Eurozone (e.g. Ireland and Spain) had experienced this situation before the others faced with housing price booms.

At the heart of our findings lies the observation that some of the reported relationships which are valid for boom episodes are not preserved for the sub-episodes with rapid and slow increase in housing prices. A similar observation holds for the GIIPS versus non-GIIPS sub-samples in our analysis of financial development, where some relationships have been revealed for the sample of all countries, some relationships are underlined in the case of GIIPS economies only. Therefore, it is quite possible to obtain some generally acceptable conclusions as to the factors associated with housing price cycles. Yet it is hard to reach a characterization of housing price cycles which is valid for every different period and/or different group of countries. The art of macroeconomic policymaking, then, is supposed to provide various recipes to differing economies. This statement by itself has the potential to pose further questions which are left as part of our future research agenda.

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Figures and Tables – to be placed in the main text at suggested marks of placement

Figure 1. Housing and Equity Prices Declines (number of cases)
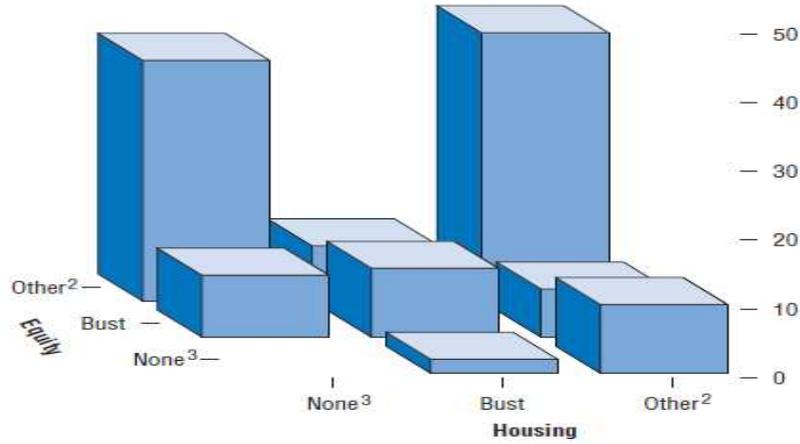
Source: IMF (2003:68).

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Figure 2. A Pictorial Overview of the Dating Procedure Employed
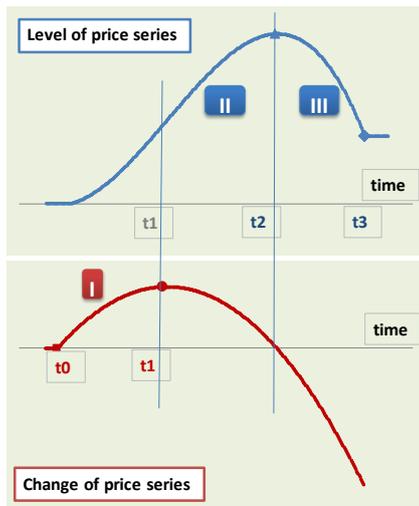
I: using the approach due to Ball (1994) the trough (square) and peak (circle) points of change in prices are found – bottom panel. (t0,t1) is marked as a rapid increase (RAPID) period.

II: the peak point (triangle) of the price series is identified – top panel. (t1,t2) is marked as a slow increase (SLOW) episode.

RAPID and SLOW episodes together, (t0,t2) are viewed as BOOM episodes.

III: the period during which the price falls from its peak point to a tranquil state. (t2,t3) is marked as a BUST episode – top panel.

In our implementation, the top and bottom panels include the level of real housing prices and the seven-quarter centered moving average of the quarterly real housing price inflation rates, respectively.

Table 1. Table 1. Data and Variables

Description	Name	Source
QUARTERLY DATA		
Residential property prices at current prices	See Appendix A for variations.	European Central Bank, EUROSTAT, Federal Reserve Economic Data - FRED, National statistics offices
Consumer prices		
ANNUAL DATA		
Annual growth rate of GDP per capita (%)	**GDPPCGR**	World Bank, World Development Indicators
Annual growth rate of real M2 aggregate of money (%)	**M2GRREAL**	
Annual growth rate of population (%)	**POPGR**	
Age dependency ratio for young population (%)	**AGEDEPYOUNG**	
Ratio of gross savings to GDP (%)	**GROSSAVGDP**	
Ratio of domestic credit extended to private sector to GDP (%)	**DOMCREPRIVSEC**	
Global risk appetite (%, average), Chicago Board Options Exchange Market Volatility Index, implied volatility of S&P 500 index options	**VIX**	Bloomberg
Annual growth rate of cross-border credit flows (world, %, average)	**CROSSBORDER**	IMF, International Financial Statistics, BIS, Bank of International Settlements
Private credit by deposit money banks to GDP (%)	**PCDMBGDP**	World Bank, The Global Financial Development Database. See Cihak et al. (2012) for detailed descriptions of data items.
Private credit by deposit money banks and other financial institutions to GDP (%)	**PCDMBAFIGDP**	
Financial system deposits to GDP (%)	**FSDGDP**	
Deposit money bank assets to GDP (%)	**DMBAGDP**	
Other financial institutions assets to GDP (%)	**OFIAGDP**	
Deposit money bank assets to (deposit money + central) bank assets (%)	**DMBABA**	
Stock market capitalization to GDP (%)	**SMCGDP**	
Stock market total value traded to GDP (%)	**SMTVTGDP**	
Private bond market capitalization to GDP (%)	**PRIVBMCGDP**	
Public bond market capitalization to GDP (%)	**PUBBMCGDP**	
International debt issues to GDP (%)	**IDUGDP**	
Net interest margin (%)	**NIM**	
Bank cost to income ratio (%)	**BCI**	
Bank overhead costs to total assets (%)	**BOCTA**	
Stock market turnover ratio (%)	**SMTR**	
Bank z-score	**BZ**	
Liquid liabilities to GDP (%)	**LLGDP**	
Bank ROA	**BROA**	
Bank ROE	**BROE**	

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Table 2. Descriptive Statistics*

Variable	Obs	Mean	StDev	Min	Max
GDPPCGR	337	1.8634	3.9882	-17.5453	14.9779
M2GRREAL	326	6.5800	11.2939	-19.7290	100.0713
CROSSBORDER	364	5.7778	6.8025	-6.6953	18.1388
POPGR	333	0.4334	0.6865	-1.9110	3.0129
AGEDEPYOUNG	338	25.2437	3.7377	19.2784	35.7324
GROSSAVGDP	327	20.0806	6.3111	0.0107	40.5030
DOMCREPRIVSEC	328	112.0637	60.3950	12.2725	319.4609
(*) Individual post-1999 samples					

Figure 3. Real House Price Episodes
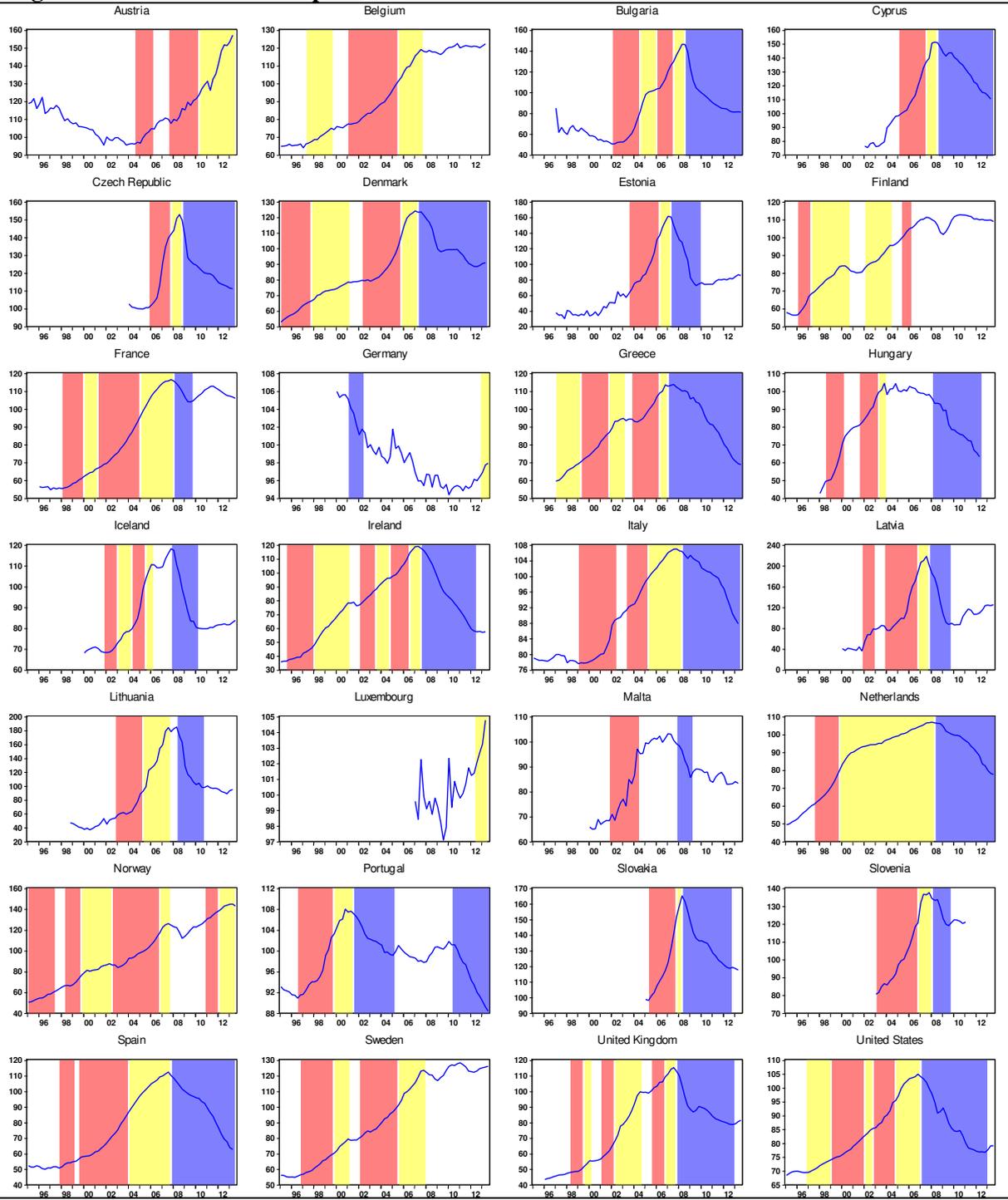
Red: Rapid increase, Yellow: Slow increase, Blue: Fall, Bust

Figure 4. Frequencies of Episodes (2000-2012)
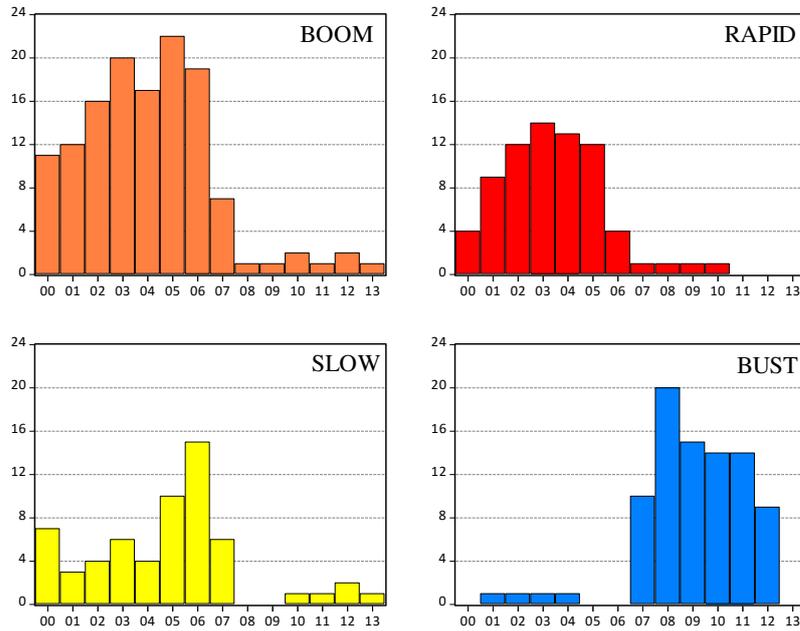
Source: Authors' calculations.

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Table 3. Classification of Countries

Eurozone		Non-Eurozone	Other
Austria*	Italy**	Bulgaria**	United States**
Belgium*	*Luxembourg*	Czech Republic**	Iceland**
Cyprus**	Malta**	Denmark**	Norway*
Estonia**	Netherlands**	Hungary**	
Finland*	Portugal**	Latvia**	
France**	Slovakia**	Lithuania**	
Germany	Slovenia**		
Greece**	Spain**	Sweden*	
Ireland**		United Kingdom**	

All countries but those marked with (*) experienced a BOOM. (**) indicates countries experienced a BUST (i.e.boom-bust countries).

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Table 4. Correlations among Variables

	GDPPCGR	M2GRREAL	POPGR	GROSSAVGDP	DOMCREPRIVSEC
M2GRREAL	0.4285				
POPGR	-0.2508	-0.0157			
GROSSAVGDP	0.1388	0.0680	-0.0237		
DOMCREPRIVSEC	-0.3839	-0.1229	0.5991	-0.2372	
CROSSBORDER	0.6083	0.3859	0.0700	0.2025	-0.1349

Table 5. Associations of Housing Price Cycles with Macroeconomic Factors

Dependent Variable

	BOOM (RAPID+SLOW)			RAPID		
	1	2	3	4	5	6
Sample→	ALL	BB	NON-BB	ALL	BB	NON-BB
GDPPCGR	0.1018**	0.1242*	-0.2165	0.0489	0.0569	-0.2228*
	(0.039)	(0.074)	(0.287)	(0.209)	(0.206)	(0.080)
M2GRREAL	0.0092	0.0130	-0.0332	0.0070	0.0066	-0.0644
	(0.317)	(0.250)	(0.351)	(0.426)	(0.505)	(0.164)
CROSSBORDER	0.0599***	0.0768***	0.1378*	0.0228	0.0235	0.1330**
	(0.001)	(0.001)	(0.076)	(0.219)	(0.299)	(0.027)
POPGR	0.4495*	0.5902**	-4.1528	0.4314**	0.5270***	-3.9322**
	(0.057)	(0.036)	(0.184)	(0.025)	(0.009)	(0.038)
AGEDEPYOUNG	0.0891**	0.1189**	-2.5172***	0.0516	0.0703**	0.2581*
	(0.025)	(0.017)	(0.000)	(0.117)	(0.027)	(0.076)
GROSSAVGDP	0.0637***	0.0827***	-0.2362*	0.0146	0.0254	0.0318
	(0.006)	(0.008)	(0.095)	(0.367)	(0.245)	(0.638)
DOMCREPRIVSEC	-0.0100***	-0.0124***	-0.2008***	-0.0104***	-0.0124***	0.0291*
	(0.002)	(0.002)	(0.000)	(0.001)	(0.000)	(0.065)
CONSTANT	-3.5923***	-4.7256***	93.7903***	-1.7695**	-2.2904**	-9.2655**
	(0.001)	(0.001)	(0.000)	(0.032)	(0.013)	(0.031)
SAMPLE SIZE	291	234	57	293	236	57
GROUPS	26	21	5	26	21	5
LOG LIKELIHOOD	-145.39***	-105.94***	-25.47***	-135.45***	-99.84***	-28.15
	(0.0000)	(0.0000)	(0.0000)	(0.0009)	(0.0000)	(0.4207)

Dependent Variable

	SLOW			BUST	
	7	8	9	10	11
Sample→	ALL	BB	NON-BB	ALL	BB
GDPPCGR	0.0563	0.0386	0.0523	0.0161	0.0278
	(0.196)	(0.493)	(0.693)	(0.676)	(0.445)
M2GRREAL	-0.0034	-0.0012	-0.0086	-0.0673***	-0.0603***
	(0.715)	(0.911)	(0.819)	(0.000)	(0.000)
CROSSBORDER	0.0693***	0.0994***	-0.0050	-0.0350*	-0.0565***
	(0.000)	(0.000)	(0.922)	(0.095)	(0.006)
POPGR	0.0379	0.0157	-1.2761	0.2924	0.1363
	(0.850)	(0.947)	(0.411)	(0.405)	(0.619)
AGEDEPYOUNG	0.0148	0.0343	-0.1284	-0.3496***	-0.2241**
	(0.615)	(0.358)	(0.412)	(0.000)	(0.018)
GROSSAVGDP	0.0520***	0.0622	0.1282**	-0.0841***	-0.0358
	(0.003)	(0.011)**	(0.049)	(0.007)	(0.164)
DOMCREPRIVSEC	0.0020	0.0010	-0.0100	0.0236***	0.0170***
	(0.409)	(0.747)	(0.508)	(0.000)	(0.002)
CONSTANT	-3.2656***	-4.0923***	0.7435	6.9823***	4.1925**
	(0.000)	(0.000)	(0.863)	(0.001)	(0.037)
SAMPLE SIZE	291	234	57	291	234
GROUPS	26	21	5	26	21
LOG LIKELIHOOD	-119.36***	-86.97***	-26.51	-97.28***	-89.79***
	(0.0000)	(0.0001)	(0.4626)	(0.0000)	(0.0000)

p-values are provided in parentheses. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent, respectively. BB stands for countries that experienced a boom followed by a bust (21 countries) and NON-BB indicates those having a boom but not a consequent bust (5 countries). ALL includes both BB and NON-BB countries.

Table 6. Estimates with Financial Development Variables

		BOOM		RAPID		SLOW		BUST	
		All	**GIIPS**	**All**	**GIIPS**	**All**	**GIIPS**	**All**	**GIIPS**
		FINANCIAL DEPTH							
	Financial Institutions								
1	**PCDMBGDP**	-0.0095**	-0.0256***	-0.0074***	-0.0183	0.0004	-0.0073	0.0196***	0.0141***
2	**PCDMBAFIGDP**	-0.0082**	-0.0256***	-0.0062***	-0.0183	0.0003	-0.0073	0.0188***	0.0141***
3	**FSDGDP**	-0.0071*	-0.0524***	-0.0050*	-0.0521***	-0.0004	-0.0087	0.0321**	0.0356***
4	**DMBAGDP**	-0.0088**	-0.0285***	-0.0063***	-0.0252*	0.0002	-0.0078	0.0194***	0.0173***
5	**OFIAGDP**	-0.0056**	NA	-0.0038	NA	-0.0010	NA	0.6890	NA
6	**DMBABA**	-0.0024	-0.3140**	-0.0138	-0.0909	0.0180	-0.0466	0.0271	0.1102
	Financial Markets								
7	**SMCGDP**	0.0012	-0.0045	-0.0035	-0.0004	0.0058***	0.0023	0.0006	0.0029
8	**SMTVTGDP**	-0.0002	0.0050	-0.0021	0.0032	0.0025*	0.0026	0.0037*	-0.0012
9	**PRIVBMCGDP**	-0.0036	-0.0127	-0.0022	-0.0082	0.0005	-0.0057	0.0134***	0.0169**
10	**PUBBMCGDP**	0.0081	0.0268**	0.0063	0.0179**	0.0024	0.0058	-0.0005	-0.0115
11	**IDUGDP**	-0.0085**	-0.0531***	-0.0059**	-0.0326**	-0.0002	-0.0309*	0.0103***	0.0228***
		FINANCIAL EFFICIENCY							
	Financial Institutions								
12	**NIM**	-0.0992	0.7689*	0.0426	0.3869	-0.2355***	0.0252	-0.0891	-0.6144*
13	**BCI**	0.0267***	0.0247	0.0215***	0.0111	0.0109	0.0091	-0.0325***	-0.0220*
14	**BOCTA**	0.0413	0.9886**	0.1276*	0.2947	-0.1437*	0.1205	-0.5893***	-0.8745***
	Financial Markets								
15	**SMTR**	0.0011	0.0046	-0.0018	0.0029	0.0040**	0.0036	0.0035	-0.0023
		FINANCIAL STABILITY							
	Financial Institutions								
16	**BZ**	0.0190	0.0288	0.0188*	0.0217	0.0049	0.0033	-0.0698**	-0.0372

All and GIIPS indicate the whole sample and the GIIPS sub-sample, respectively. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent (also shown in shades), respectively. Model details and p-values are not provided for visual ease and they are available from authors upon request.

Appendix A: Data Codes for Housing and Consumer Prices

Table A1.Data Codes for Housing and Consumer Prices		
	Nominal House Prices	**Consumer Prices**
Austria	ECB: RPP.Q.AT.N.TD.00.3.00	Eurostat: ICP.M.AT.N.000000.4.INX
Belgium	ECB: RPP.Q.BE.N.ED.00.2.00	Eurostat: ICP.M.BE.N.000000.4.INX
Bulgaria	ECB: RPP.Q.BG.N.EF.LC.1.00	Eurostat: ICP.M.BG.N.000000.4.INX
Cyprus	ECB: RPP.Q.CY.N.TD.00.2.00	Eurostat: ICP.M.CY.N.000000.4.INX
Czech Republic	ECB: RPP.Q.CZ.N.EF.00.1.00	Eurostat: ICP.M.CZ.N.000000.4.INX
Denmark	ECB: RPP.Q.DK.N.TH.00.1.00	Eurostat: ICP.M.DK.N.000000.4.INX
Estonia	ECB: RPP.Q.EE.N.TF.00.1.00	Eurostat: ICP.M.EE.N.000000.4.INX
Finland	ECB: RPP.Q.FI.N.ED.00.3.00	Eurostat: ICP.M.FI.N.000000.4.INX
France	ECB: RPP.Q.FR.N.ED.00.1.00	Eurostat: ICP.M.FR.N.000000.4.INX
Germany	ECB: RPP.Q.DE.N.TH.00.5.00	Eurostat: ICP.M.DE.N.000000.4.INX
Greece	ECB: RPP.Q.GR.N.TF.00.3.00	Eurostat: ICP.M.GR.N.000000.4.INX
Hungary	ECB: RPP.Q.HU.N.ED.CC.1.00	Eurostat: ICP.M.HU.N.000000.4.INX
Iceland	National Statistics Office, Residential property market price index from 2000	National Statistics Office, Consumer price index from 1939 [1988=100]
Ireland	ECB: RPP.Q.IE.N.TD.00.3.00	Eurostat: ICP.M.IE.N.000000.4.INX
Italy	ECB: RPP.Q.IT.N.TD.00.2.00	Eurostat: ICP.M.IT.N.000000.4.INX
Latvia	ECB: RPP.Q.LV.N.TF.00.2.00	Eurostat: ICP.M.LV.N.000000.4.INX
Lithuania	ECB: RPP.Q.LT.N.TD.00.2.00	Eurostat: ICP.M.LT.N.000000.4.INX
Luxembourg	ECB: RPP.Q.LU.N.TF.00.1.00	Eurostat: ICP.M.LU.N.000000.4.INX
Malta	ECB: RPP.Q.MT.N.TD.00.2.00	Eurostat: ICP.M.MT.N.000000.4.INX
Netherlands	ECB: RPP.Q.NL.N.ED.00.1.00	Eurostat: ICP.M.NL.N.000000.4.INX
Norway	National Statistics Office, House price index [2005=100]	National Statistics Office, Consumer Price Index [1998=100]
Portugal	ECB: RPP.Q.PT.N.TD.00.5.00	Eurostat: ICP.M.PT.N.000000.4.INX
Slovakia	ECB: RPP.Q.SK.N.ED.00.2.00	Eurostat: ICP.M.SK.N.000000.4.INX
Slovenia	ECB: RPP.Q.SLOW.N.ED.00.1.00	Eurostat: ICP.M.SLOW.N.000000.4.INX
Spain	ECB: RPP.Q.ES.N.TD.00.3.00	Eurostat: ICP.M.ES.N.000000.4.INX
Sweden	ECB: RPP.Q.SE.N.ED.00.1.00	Eurostat: ICP.M.SE.N.000000.4.INX
UK	ECB: RPP.Q.GB.N.TD.00.3.00	Eurostat: ICP.M.GB.N.000000.4.INX
US	FRED: USSTHPI	FRED: CPIAUCSL

Supplement I: List of Real House Price Episodes

Table S1. Real House Price Episodes*

| | | Dates | | Prices (Index value) | | Trend housing price inflation (%) | | Duration (quarters) | Prices (%) | | Trend housing price (percentage points) | |
	Type	Start	End	Start	End	Start	End		Total	Average (Per quarter)	Total	Average
Austria	RAPID	2004Q3*	2006Q1	95.8	104.4	0.33	1.76	7	8.98	1.50	1.44	0.24
	RAPID	2007Q3	2010Q1	109.8	121.2	0.23	1.67	11	10.37	1.04	1.44	0.14
	SLOW	2010Q2	2013Q2	123.3	156.9	1.36	0.00	13	27.25	2.27	-1.36	-0.11
Belgium	SLOW	1997Q2	1999Q3	66.0	74.7	0.71	1.06	10	13.21	1.47	0.35	0.04
	RAPID	2001Q1	2005Q2	77.1	99.0	0.38	2.54	18	28.44	1.67	2.15	0.13
	SLOW	2005Q3	2007Q3	101.2	118.8	2.46	1.13	9	17.49	2.19	-1.33	-0.17
Bulgaria	RAPID	2002Q1*	2004Q2	49.9	73.2	-0.61	8.85	10	46.81	5.20	9.46	1.05
	SLOW	2004Q3	2005Q4	81.2	101.6	8.38	2.60	6	25.24	5.05	-5.78	-1.16
	RAPID	2006Q1	2007Q2	103.1	125.8	2.06	4.48	6	22.07	4.41	2.42	0.48
	SLOW	2007Q3	2008Q2	129.4	146.0	4.43	-0.20	4	12.89	4.30	-4.62	-1.54
	BUST	2008Q3	2013Q3	145.7	80.9	-2.01	0.00	21	-44.48	-2.22	2.01	0.10
Cyprus	RAPID	2005Q1	2007Q2	97.8	132.6	1.89	4.63	10	35.61	3.96	2.73	0.30
	SLOW	2007Q3	2008Q2	137.0	151.0	4.32	1.16	4	10.23	3.41	-3.16	-1.05
	BUST	2008Q3	2013Q2	150.6	109.9	0.47	0.00	20	-27.00	-1.42	-0.47	-0.02
Czech Republic	RAPID	2005Q4*	2007Q3	100.3	139.3	0.84	5.19	8	38.85	5.55	4.34	0.62
	SLOW	2007Q4	2008Q3	141.6	152.5	4.40	-1.07	4	7.71	2.57	-5.47	-1.82
	BUST	2008Q4	2013Q2	149.4	111.0	-1.51	0.00	19	-25.71	-1.43	1.51	0.08
Denmark	RAPID	1995Q1*	1997Q3	52.6	65.5		2.25	11	24.55	2.46	2.25	0.22
	SLOW	1997Q4	2001Q1	66.1	78.3	1.88	0.82	14	18.32	1.41	-1.06	-0.08
	RAPID	2002Q2	2005Q3	79.3	101.6	0.16	4.51	14	28.16	2.17	4.35	0.33
	SLOW	2005Q4	2007Q1	108.3	123.8	4.36	0.82	6	14.31	2.86	-3.54	-0.71
	BUST	2007Q2	2013Q2	123.0	90.6	-0.05	0.00	25	-26.35	-1.10	0.05	0.00
Estonia	RAPID	2003Q3	2006Q1	61.9	130.8	2.95	8.61	11	111.36	11.14	5.66	0.57
	SLOW	2006Q2	2007Q1	136.2	160.9	7.71	1.03	4	18.13	6.04	-6.68	-2.23
	BUST	2007Q2	2009Q4	160.1	74.3	-0.41	-4.55	11	-53.62	-5.36	-4.14	-0.41
Finland	RAPID	1996Q1*	1997Q1	56.3	66.5	1.20	3.35	5	18.26	4.56	2.15	0.54
	SLOW	1997Q2	2000Q3	68.3	82.6	3.27	-0.27	14	20.90	1.61	-3.54	-0.27
	SLOW	2002Q1	2004Q2	82.5	95.3	0.93	1.53	10	15.55	1.73	0.60	0.07
	RAPID	2005Q2	2006Q1	99.0	104.6	1.34	1.58	4	5.64	1.88	0.24	0.08
France	RAPID	1998Q1*	1999Q4	55.2	60.8	0.58	1.74	8	10.26	1.47	1.16	0.17
	SLOW	2000Q1	2001Q1	62.1	66.0	1.51	1.45	5	6.26	1.56	-0.06	-0.01
	RAPID	2001Q2	2004Q4	66.8	92.5	1.37	3.17	15	38.41	2.74	1.80	0.13
	SLOW	2005Q1	2007Q4	95.6	116.2	3.06	-0.09	12	21.57	1.96	-3.16	-0.29
	BUST	2008Q1	2009Q3	115.5	103.8	-0.61	-0.59	7	-10.09	-1.68	0.02	0.00
Germany	BUST	2001Q1	2002Q2	105.1	101.7	-0.52	-0.56	6	-3.23	-0.65	-0.04	-0.01
	SLOW	2012Q4	2013Q3	96.4	97.9	0.42	0.00	4	1.58	0.53	-0.42	-0.14
Greece	SLOW	1997Q1	1999Q1	59.4	69.1		1.61	9	16.32	2.04	1.61	0.20
	RAPID	1999Q2	2001Q3	70.3	85.2	1.60	2.66	10	21.20	2.36	1.06	0.12
	SLOW	2001Q4	2003Q1	86.6	94.5	2.45	0.78	6	9.17	1.83	-1.66	-0.33
	RAPID	2003Q4	2006Q1	94.1	106.6	-0.08	2.30	10	13.26	1.47	2.38	0.26
	SLOW	2006Q2	2006Q4	108.7	113.3	1.85	1.38	3	4.24	2.12	-0.47	-0.23
	BUST	2007Q1	2013Q3	112.5	68.6	0.72	0.00	27	-39.01	-1.50	-0.72	-0.03
Hungary	RAPID	1998Q3*	2000Q1	49.3	70.6		6.55	7	43.06	7.18	6.55	1.09
	RAPID	2001Q3	2003Q1	80.7	96.1	1.77	3.07	7	19.13	3.19	1.30	0.22
	SLOW	2003Q2	2003Q4	99.2	104.2	1.85	1.59	3	5.03	2.52	-0.27	-0.13
	BUST	2008Q1	2012Q2	96.0	63.0	-0.91	0.00	18	-34.32	-2.02	0.91	0.05
Iceland	RAPID	2001Q4*	2002Q4	68.2	70.8	-0.26	1.77	5	3.80	0.95	2.02	0.51
	SLOW	2003Q1	2004Q1	72.9	78.3	1.98	2.13	5	7.47	1.87	0.15	0.04

Table S1. Real House Price Episodes*

		Dates		Prices (Index value)		Trend housing price inflation (%)		Duration (quarters)	Changes in			
									Prices (%)		Trend housing price (percentage points)	
	Type	Start	End	Start	End	Start	End		Total	Average (Per quarter)	Total	Average
	RAPID	2004Q2*	2005Q2	79.5	98.7	2.82	4.83	5	24.14	6.04	2.00	0.50
	SLOW	2005Q3	2006Q1	103.7	110.4	4.42	2.77	3	6.45	3.23	-1.64	-0.82
	BUST	2007Q4	2010Q1	118.0	80.2	-0.39	-2.20	10	-32.05	-3.56	-1.81	-0.20
Ireland	RAPID	1995Q3*	1997Q4	35.9	45.5		5.03	10	26.60	2.96	5.03	0.56
	SLOW	1998Q1	2001Q1	47.7	78.0	4.75	1.59	13	63.36	5.28	-3.16	-0.26
	RAPID	2002Q1	2003Q2	76.5	86.2	0.76	2.43	6	12.81	2.56	1.68	0.34
	SLOW	2003Q3	2004Q3	87.7	95.8	2.33	1.66	5	9.26	2.31	-0.68	-0.17
	RAPID	2004Q4	2006Q2	95.8	109.5	1.53	2.70	7	14.32	2.39	1.17	0.19
	SLOW	2006Q3	2007Q2	114.0	118.8	2.43	0.48	4	4.20	1.40	-1.95	-0.65
	BUST	2007Q3	2012Q2	117.5	57.6	-0.54	-2.80	20	-50.95	-2.68	-2.26	-0.12
Italy	RAPID	1999Q1*	2002Q2	77.5	88.6	0.00	1.77	14	14.38	1.11	1.77	0.14
	RAPID	2003Q2	2005Q1	91.0	98.5	0.66	1.27	8	8.24	1.18	0.61	0.09
	SLOW	2005Q2	2008Q1	99.6	106.4	1.18	-0.21	12	6.91	0.63	-1.38	-0.13
	BUST	2008Q2	2013Q2	106.2	87.7	-0.15	0.00	21	-17.39	-0.87	0.15	0.01
Latvia	RAPID	2001Q4*	2002Q4	35.4	78.0	9.78	14.50	5	120.16	30.04	4.72	1.18
	RAPID	2003Q4	2006Q3	83.7	169.5	0.82	11.69	12	102.54	9.32	10.87	0.99
	SLOW	2006Q4	2007Q3	187.1	217.4	10.35	0.75	4	16.22	5.41	-9.59	-3.20
	BUST	2007Q4	2009Q3	199.9	86.6	-2.21	-7.90	8	-56.66	-8.09	-5.69	-0.81
Lithuania	RAPID	2002Q4	2005Q1	53.1	87.8	2.59	10.70	10	65.55	7.28	8.11	0.90
	SLOW	2005Q2	2007Q3	91.8	183.7	10.55	4.62	10	100.03	11.11	-5.93	-0.66
	BUST	2008Q2	2010Q3	184.5	97.3	-4.27	-2.02	10	-47.24	-5.25	2.25	0.25
Luxembourg	SLOW	2012Q2	2013Q2	101.3	104.7	0.44	0.00	5	3.36	0.84	-0.44	-0.11
Malta	RAPID	2001Q4*	2004Q2	68.2	96.8	0.79	4.45	11	42.00	4.20	3.66	0.37
	BUST	2007Q4	2009Q1	99.0	85.5	-1.31	-1.40	6	-13.64	-2.73	-0.08	-0.02
Netherlands	RAPID	1997Q3	1999Q3	60.7	76.3	2.17	3.69	9	25.76	3.22	1.53	0.19
	SLOW	1999Q4	2008Q1	79.7	106.7	3.67	0.19	34	33.85	1.03	-3.48	-0.11
	BUST	2008Q2	2013Q3	106.3	77.4	-0.11	0.00	22	-27.15	-1.29	0.11	0.01
Norway	RAPID	1995Q1*	1997Q2	50.2	59.8		2.53	10	19.16	2.13	2.53	0.28
	RAPID	1998Q2	1999Q3	65.9	72.7	1.67	2.88	6	10.23	2.05	1.20	0.24
	SLOW	1999Q4	2002Q2	76.0	87.1	2.84	0.30	11	14.63	1.46	-2.54	-0.25
	RAPID	2002Q3	2006Q3	85.9	113.1	0.04	3.11	17	31.70	1.98	3.07	0.19
	SLOW	2006Q4	2007Q3	116.9	125.6	2.93	1.09	4	7.41	2.47	-1.84	-0.61
	RAPID	2010Q4	2011Q4	127.5	136.2	1.27	1.61	5	6.77	1.69	0.34	0.08
	SLOW	2012Q1	2013Q2	137.7	144.5	1.35	0.00	6	4.98	1.00	-1.35	-0.27
Portugal	RAPID	1996Q3*	1999Q3	90.8	102.4	0.03	1.54	13	12.77	1.06	1.51	0.13
	SLOW	1999Q4	2001Q2	103.2	107.5	1.40	-0.01	7	4.20	0.70	-1.41	-0.24
	BUST	2001Q3	2005Q1	107.0	99.0	-0.19	-0.11	15	-7.47	-0.53	0.09	0.01
	BUST	2010Q2	2013Q3	101.1	88.3	-0.24	0.00	14	-12.62	-0.97	0.24	0.02
Slovakia	RAPID	2005Q2*	2007Q3	97.9	140.3		5.51	10	43.34	4.82	5.51	0.61
	SLOW	2007Q4	2008Q1	151.6	158.5	4.72	3.61	2	4.53	4.53	-1.11	-1.11
	BUST	2008Q2	2012Q3	164.8	118.4	1.94	-0.74	18	-28.14	-1.66	-2.68	-0.16
Slovenia	RAPID	2003Q1*	2006Q3	80.4	118.2		4.54	15	47.06	3.36	4.54	0.32
	SLOW	2006Q4	2007Q4	120.3	137.4	4.00	1.55	5	14.18	3.55	-2.45	-0.61
	BUST	2008Q1	2009Q3	134.1	118.8	-0.29	-1.25	7	-11.41	-1.90	-0.97	-0.16
Spain	RAPID	1997Q4*	1999Q1	50.5	54.6	0.91	1.67	6	8.02	1.60	0.76	0.15
	RAPID	1999Q3	2003Q4	56.2	83.9	1.11	3.39	18	49.34	2.90	2.28	0.13
	SLOW	2004Q1	2007Q3	86.8	112.1	3.38	-0.15	15	29.14	2.08	-3.53	-0.25
	BUST	2007Q4	2013Q2	109.8	62.5	-0.72	0.00	23	-43.13	-1.96	0.72	0.03
Sweden	RAPID	1996Q4*	1999Q3	56.2	69.0	0.88	2.33	12	22.69	2.06	1.46	0.13
	SLOW	1999Q4	2001Q1	70.1	79.1	2.19	1.32	6	12.86	2.57	-0.87	-0.17
	RAPID	2002Q1	2005Q2	79.7	98.7	0.92	2.37	14	23.71	1.82	1.45	0.11
	SLOW	2005Q3	2007Q4	100.9	123.2	2.35	0.86	10	22.19	2.47	-1.49	-0.17
United Kingdom	RAPID	1998Q2	1999Q2	47.7	49.6	0.71	2.12	5	3.96	0.99	1.41	0.35

Table S1. Real House Price Episodes*

		Dates		Prices (Index value)		Trend housing price inflation (%)		Duration (quarters)	Changes in Prices (%)		Changes in Trend housing price (percentage points)	
	Type	Start	End	Start	End	Start	End		Total	Average (Per quarter)	Total	Average
	SLOW	1999Q3	2000Q1	51.5	55.2	1.97	2.01	3	7.10	3.55	0.04	0.02
	RAPID	2001Q1	2002Q1	56.3	64.7	1.60	4.68	5	14.87	3.72	3.09	0.77
	SLOW	2002Q2	2004Q3	67.8	99.4	4.40	2.41	10	46.67	5.19	-1.98	-0.22
	RAPID	2005Q3	2006Q3	100.1	105.7	0.85	1.87	5	5.67	1.42	1.02	0.25
	SLOW	2006Q4	2007Q3	109.1	115.0	1.72	-0.27	4	5.42	1.81	-1.99	-0.66
	BUST	2007Q4	2012Q4	112.7	78.4	-1.73	0.13	21	-30.40	-1.52	1.86	0.09
United States	SLOW	1996Q4	1998Q4	69.3	73.5	0.14	0.76	9	6.03	0.75	0.63	0.08
	RAPID	1999Q1	2001Q4	73.9	81.7	0.64	1.22	12	10.49	0.95	0.59	0.05
	SLOW	2002Q1	2002Q3	82.7	84.6	1.11	1.04	3	2.33	1.17	-0.07	-0.03
	RAPID	2002Q4	2004Q3	85.2	94.5	0.97	1.89	8	10.95	1.56	0.92	0.13
	SLOW	2004Q4	2006Q4	95.3	104.8	1.81	-0.04	9	10.00	1.25	-1.85	-0.23
	BUST	2007Q1	2012Q4	103.9	76.6	-0.49	0.27	24	-26.32	-1.14	0.76	0.03

(*) In each row, start and end dates are given with the corresponding values of real house prices and trend inflation (left panel). Total and episode average changes in prices and trend inflation are also displayed (right panel). RAPID, SLOW and BUST correspond to episodes of rapidly increasing, slowly increasing and falling real house prices. Asterisks on start dates indicate use of judgment and RAPID and SLOW are together called BOOM in our analysis.

Supplement II: Alternative Estimates of Table 1

Table S1. Associations of Housing Price Cycles with Macroeconomic Factors – Baseline Estimates

	Dependent Variable										
	BOOM (RAPID+SLOW)			RAPID			SLOW			BUST	
	1	2	3	4	5	6	7	8	9	10	11
Sample→	ALL	BB	NON-BB	ALL	BB	NON-BB	ALL	BB	NON-BB	ALL	BB
GDPPCGR	0.1912***	0.2508***	-0.0006	0.0742**	0.0817**	-0.0222	0.1326***	0.1672***	0.0450	-0.0223	-0.0289
	(0.000)	(0.000)	(0.996)	(0.028)	(0.042)	(0.801)	(0.002)	(0.004)	(0.683)	(0.470)	(0.348)
M2GRREAL	0.0169*	0.0211*	-0.0131	0.0086	0.0079	-0.0150	0.0032	0.0057	-0.0107	-0.0732**	-0.0715***
	(0.068)	(0.065)	(0.620)	(0.320)	(0.430)	(0.523)	(0.707)	(0.563)	(0.726)	(0.000)	(0.000)
POPGR	0.6552***	0.8849***	-3.3503	0.4953***	0.5908***	-2.4676*	0.2654	0.3938	-1.3358	0.2178	0.1361
	(0.007)	(0.003)	(0.195)	(0.009)	(0.004)	(0.107)	(0.191)	(0.116)	(0.355)	(0.533)	(0.672)
AGEDEPYOUNG	0.0909**	0.1135**	-1.6374	0.0498	0.0655	0.1599	0.0054	0.0058	-0.1239	-0.3677***	-0.3062***
	(0.031)	(0.030)	(0.124)	(0.132)	(0.162)	(0.299)	(0.855)	(0.881)	(0.407)	(0.000)	(0.002)
GROSSAVGDP	0.0760***	0.0936***	-0.0313	0.0171	0.0258	0.0495	0.0574***	0.0602**	0.1271	-0.0935***	-0.0612**
	(0.003)	(0.008)	(0.871)	(0.296)	(0.298)	(0.448)	(0.001)	(0.024)	(0.049)	(0.003)	(0.046)
DOMCREPRIVSEC	-0.0102***	-0.0122***	-0.1329	-0.0102***	-0.0120***	0.0148	0.0022	0.0020	-0.0094	0.0246***	0.0212***
	(0.002)	(0.002)	(0.14)	(0.001)	(0.004)	(0.301)	(0.353)	(0.489)	(0.504)	(0.000)	(0.000)
CONSTANT	-3.7694***	-4.7423***	59.6208	-1.7142**	-2.1272*	-6.0997	-2.9329***	-3.1874***	0.6243	7.3828***	5.9182***
	(0.002)	(0.003)	(0.156)	(0.042)	(0.090)	(0.151)	(0.000)	(0.005)	(0.880)	(0.001)	(0.008)
SAMPLE SIZE	291	234	57	293	236	57	291	234	57	291	234
GROUPS	26	21	5	26	21	5	26	21	5	26	21
LOG LIKELIHOOD	-150.49***	-111.34***	-27.91**	-136.20***	-100.38**	-31.18	-126.27***	-96.01**	-26.51	-98.67***	-93.31***
	(0.0000)	(0.0001)	(0.0491)	(0.0010)	(0.0176)	(0.6911)	(0.0023)	(0.0171)	(0.3613)	(0.0000)	(0.0000)

p-values are provided in parentheses. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent, respectively.

Table S2. Associations of Housing Price Cycles with Macroeconomic Factors – After Controlling for Global Risk Appetite

	Dependent Variable										
	BOOM (RAPID+SLOW)			RAPID			SLOW			BUST	
	1	2	3	4	5	6	7	8	9	10	11
Sample→	ALL	BB	NON-BB	ALL	BB	NON-BB	ALL	BB	NON-BB	ALL	BB
GDPPCGR	0.1421***	0.1995***	-0.3696*	0.0745**	0.0808*	-0.1011	0.0845*	0.1055*	-0.0588	0.0612	0.0538
	(0.003)	(0.003)	(0.077)	(0.041)	(0.058)	(0.352)	(0.056)	(0.069)	(0.640)	(0.116)	(0.170)
M2GRREAL	0.0146	0.0178	-0.0361	0.0087	0.0079	-0.0224	-0.0005	0.0001	-0.0332	-0.0826***	-0.0811***
	(0.128)	(0.137)	(0.229)	(0.321)	(0.436)	(0.389)	(0.953)	(0.989)	(0.441)	(0.000)	(0.000)
VIX	-0.0466***	-0.0529***	-0.1452**	0.0003	-0.0011	-0.0486	-0.0530***	-0.0644***	-0.0647	0.0954***	0.0959***
	(0.003)	(0.005)	(0.018)	(0.981)	(0.950)	(0.178)	(0.001)	(0.001)	(0.123)	(0.000)	(0.000)
POPGR	0.5941**	0.8291***	-7.6508**	0.4959***	0.5899***	-3.5295*	0.1785	0.3072	-2.6869	0.2884	0.2240
	(0.017)	(0.006)	(0.020)	(0.009)**	(0.004)	(0.060)	(0.398)	(0.229)	(0.166)	(0.439)	(0.520)
AGEDEPYOUNG	0.1220***	0.1534***	-0.7224	0.0496	0.0664	0.2236	0.0263	0.0395	-0.0586	-0.4086***	-0.3590***
	(0.008)	(0.008)	(0.451)	(0.144)	(0.177)	(0.193)	(0.404)	(0.348)	(0.713)	(0.000)	(0.000)
GROSSAVGDP	0.0737***	0.0935***	0.2032	0.0172	0.0260	0.0470	0.0509***	0.0569**	0.1346**	-0.0814**	-0.0512*
	(0.006)	(0.010)	(0.256)	(0.297)	(0.299)	(0.492)	(0.004)	(0.033)	(0.050)	(0.015)	(0.102)
DOMCREPRIVSEC	-0.0133***	-0.0158***	-0.0752	-0.0102***	-0.0121***	0.0186	0.0004	-0.0009	-0.0057	0.0301***	0.0272***
	(0.000)	(0.000)	(0.420)	(0.001)	(0.006)	(0.240)	(0.870)	(0.788)	(0.705)	(0.000)	(0.000)
CONSTANT	-2.9754**	-3.9816**	29.0183	-1.7208*	-2.1162*	-6.2910	-1.8158**	-2.0224*	0.6991	5.1543**	3.9999*
	(0.023)	(0.018)	(0.431)	(0.053)	(0.095)	(0.174)	(0.040)	(0.086)	(0.870)	(0.021)	(0.061)
SAMPLE SIZE	291	234	57	293	236	57	291	234	57	291	234
GROUPS	26	21	5	26	21	5	26	21	5	26	21
LOG LIKELIHOOD	-145.87***	-107.20***	-24.38	-136.20***	-100.38**	-30.22	-120.50***	-90.20***	-25.18	-87.29***	-81.45***
	(0.0000)	(0.0000)	(0.2144)	(0.0021)	(0.0321)	(0.6865)	(0.0001)	(0.0006)	(0.3828)	(0.0000)	(0.0000)

p-values are provided in parentheses. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent, respectively.