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Booms, busts and normal times in the housing market

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Abstract

We assess the existence of duration dependence in the likelihood of an end in housing booms, busts and normal times. Using data for 20 industrial countries and a continuous-time Weibull duration model, we find evidence of positive duration dependence and suggesting that housing market cycles have become longer over the last decades. Then, we extend the baseline Weibull model and allow for the presence of a change-point in the duration dependence parameter. We show that positive duration dependence is present in booms and busts that last less than 26 quarters, but that does not seem to be the case for longer phases of the housing market cycle. For normal times, no evidence of change-points is found. Finally, the empirical findings uncover positive duration dependence in housing market booms of European and non-European countries and housing busts of European countries. In addition, they reveal that while housing booms have similar length in European and non-European countries, housing busts are typically shorter in European countries.

Keywords: *housing booms and busts, duration analysis, Weibull model, duration dependence, change-points.*

JEL Classification: *C41, E32, E51, E52.*

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1 Introduction

Following the burst of the technological bubble in the early 2000s, housing prices fuelled into an unsustainable growth path in a large number of countries. However, as the subprime mortgage market crisis emerged in the Summer of 2007 and the world economy witnessed the Great Recession, prices collapsed giving rise to a long and persistent slump in the housing market.

Against this background, investigating the behaviour of the housing sector and, especially, on the determinants of the boom-bust phases was brought into the first front of the policymaking agenda (Agnello and Schuknecht, 2011). Similarly, understanding the characteristics of the housing cycles and their likely impact on the macroeconomy and the financial system has gained a renewed interest from academics and researchers (Afonso and Sousa, 2011, 2012).

The recent research on the topic has shown that the likelihood of an ending in a given housing market cycle depends on its age, that is, as time goes by, the probability that a housing boom (upturn) comes to an end increases. As for housing busts (downturns), no evidence of such positive duration dependence has been found (Cunningham and Kolet, 2011). Bracke (2013) uses a discrete-time duration model and also suggests the existence of lagged duration dependence, as housing downturns are less likely to end when the previous upturn was abnormally long.

Our paper is highly indebted and simultaneously inspired by the abovementioned works. In particular, we aim at answering relevant questions such as: How long are housing booms, busts and normal times likely to last? How similar (or different) are these phases between European and non-European countries? Does the end of a housing boom or bust depend on its own age? Is the duration of housing market cycles smooth or bumpy, i.e. is there evidence supporting the presence of a change-point in the duration dependence of booms or busts in the housing prices? How has the duration of housing market cycles evolved over time? Therefore, we try to make one step forward in that we assess the extent to which the likelihood of a boom, bust or normal time ending changes after a certain duration. More specifically, not only do we consider that the likelihood of a housing market phase ending increases over time, but we also allow it to change when it has

already lasted for more than a certain duration. To the best of our knowledge, our paper provides the first assessment of this second dimension of housing price cycles, i.e. the existence of breaks or change-points in the duration dependence.

We start by identifying the various stages of the housing market cycles via the methodology proposed by Burnside et al. (2011), which relies on a preliminary detection of upturns and downturns in real housing prices. Then, we use data for a group of 20 industrialized countries over the period 1970Q1-2012Q2 and formulate a continuous-time Weibull model. This framework allows us to analyze the existence of duration dependence in housing booms, busts and normal times. Moreover, it makes it possible to investigate the existence of breaks in the duration dependence parameter, by extending the baseline duration model to the case of the presence of a change-point.

We find evidence of positive duration dependence, that is, the likelihood of housing price booms and busts (and, to some extent, normal times) ending increases over time. Moreover, both booms and busts (and even normal times) tend to be longer when the previous phase of the cycle (no matter what its kind is) is long. In addition, we find that the duration of the different stages of the housing markets has increased over the last decades.

In what concerns the differences between the housing market cycles in European and non-European countries, the empirical findings suggest that housing booms are broadly similar in terms of length, but housing busts are typically shorter in European countries. Similar results are found when we distinguish between euro area and non-euro area countries and between countries of the "Anglosphere" and non-Anglo-Saxon countries. We also uncover a positive duration dependence in the housing market booms of European and non-European countries, while housing busts in non-European countries do not seem to be duration dependent.

Finally, our results corroborate the existence of a time-varying duration dependence parameter for housing booms and busts. In particular, we find that housing booms and busts that last less than 26 quarters display (positive) duration dependence, but the same does not hold for older events. In fact, when housing booms (busts) have a duration that is shorter than 26 quarters, each

additional quarter of duration, on average, increases the likelihood of the end of such stages of the cycle by 4.00 (7.01) percentage points. In contrast, for housing booms (busts) that are longer than 26 quarters, each additional quarter of duration raises the likelihood of their end by only 1.76 (3.68) percentage points. For normal times, no evidence of change-points is found.

Our findings give support to preventive policy interventions during periods of booms and busts. More specifically, a timely counter-cyclical policy response that takes place before housing booms and housing busts last for 26 quarters on average is crucial for avoiding large and persistent housing price swings and for fastening the return of the housing market cycle to a 'normal' phase. Indeed, policy interventions may be less effective in keeping the fluctuations of housing prices under control when episodes of booms and busts in the housing market have lasted 'too long'.

Our paper tries to improve upon the existing literature in several directions. First, we identify the various stages of the housing market cycles using a novel approach developed by Burnside et al. (2011). This procedure is particularly effective at replicating various stylized facts about the housing market behaviour, such as: *(i)* it explains why booms (busts) are marked by increases (decreases) in the number of agents who buy homes only because of large expected capital gains; *(ii)* it shows that the probability of selling a home is positively correlated with house prices; *(iii)* it uncovers a positive correlation between sales volume and house prices; and, most importantly; and *(iv)* it is consistent with the empirical evidence that shows that while some housing booms are followed by busts, others are not. Second, we rely on a continuous-time Weibull model to assess the presence of duration dependence in housing market cycles. This allows us to analyse not only the characteristics of the booms and busts in housing prices - as Agnello and Schuknecht (2011) do -, but also: *(i)* the determinants of the duration of the various phases of the housing market cycle; and *(ii)* whether the likelihood of an ending in a given housing market cycle depends on its age, that is, whether, as time goes by, the probability that a housing boom (upturn) comes to an end increases or not. Third, we uncover a new dimension of the phases of the housing price cycle: the existence of breaks or change-points in their duration dependence. In fact, while it is generally

assumed that the behaviour of duration dependence is smooth over time (i.e. either constant, or increasing, or decreasing), we conjecture that the likelihood of a housing boom or a housing bust ending may change after a certain duration. In this context, we follow the general Weibull model framework with a change-point that has been developed by Castro (2013) - to assess the drivers of the length of the business cycle - and retaken by Agnello et al. (2013a, 2013b) - for the purposes of evaluating the determinants of the duration of fiscal consolidation programmes -, and apply it to the case of the housing market cycle. Apart from granting more flexibility in terms of modelling, it also makes it possible for us to evaluate the extent to which the hazard function exhibits some nonlinearity over time. Finally, we rely on a database for a group of 20 industrialized countries over the period 1970Q1-2012Q2. Therefore, we are able to compare the duration of the various phases of housing market cycles between European and Non-European countries, as well as to understand their major determinants. Moreover, we capture the most recent slowdown in housing markets, i.e. one of the most striking and visible features of the Great Recession.

The rest of the paper is organized as follows. Section 2 briefly looks at the related literature. Section 3 presents the econometric methodology. Section 4 describes the data and discusses the empirical results. Finally, Section 5 concludes.

2 Literature Review

The link between the housing market developments and the macroeconomy has been extensively explored for major industrialized countries (Gilchrist and Leahy, 2002; Leung, 2004). Regional or country level and cross-country studies have typically found that housing prices are strongly influenced by business cycle fluctuations, being driven by fundamentals such as income growth, industrial production and employment rate (Ceron and Suarez, 2006; Hwang and Quigley, 2006). Others have highlighted the importance of financial variables, such as the interest rate and the monetary aggregates or the availability of credit (Gyourko and Keim, 1992; Englund and Ioannides, 1997).

There is also a related literature on the interaction between the housing market and the real economic activity, especially, the capital market. Among others, Chen and Leung (2008) show that if some agents are subject to the collateral constraint, the reduced-form joint dynamics of the house price and the output displays a structure that is similar to the regime-switching model under some conditions. Chang et al (2011) estimate a regime-switching model which seems to suggest that the monetary policy, the term spread and the housing market return as a system experiences regime-switch since the mid-1970s. Chang et al. (2012, 2013) further show that a similar regime-switching structure applies not only to the U.S., but also to some Asian countries. Jin et al (2012) argue that when entrepreneurs are subject to collateral constraints, the external finance premium, the house price, the output and the business investment form a non-trivial dynamic system. However, none of these works considers the case of endogenous regime-switching, i.e. the probability of regime-switch itself being a function of other economic variables such as the house price or the interest rates. In this respect, our paper is close in spirit to the above mentioned literature in that: (i) it focuses on the regime-change of the house price; and (ii) puts aside the potential relationship between the house price and other macroeconomic and financial variables.

Some relevant pieces of research have considered the driving forces for the occurrence of episodes of booms and busts in asset markets. Using a similar approach to Kaminsky and Reinhart (1999) and identifying such events as periods during which the three-year moving average of the growth rate of asset prices lies outside a confidence interval defined by reference to the historical first and second moments of the series, Bordo and Jeanne (2002) show that busts are generally associated with a slowdown in economic activity and a rise in financial stress. Machado and Sousa (2006) use a nonparametric quantile regression to detect booms in stock prices and emphasize the role played by the real economic activity and real interest rates. Most importantly, they show that stock market booms, which are identified as realizations at the tails of the distribution, seem to occur at times of robust credit growth or when loan growth is close to its peak. More recently, Sousa (2010a) relates the behaviour of housing wealth with the dynamics of future risk premium and Sousa (2012)

argues that investors using housing assets as a hedge against unfavourable wealth shocks. Agnello and Schucknecht (2011) look at the characteristics and determinants of housing booms and busts for a sample of eighteen industrialized countries over the period 1980-2007. They uncover a very significant influence of domestic credit and interest rates on the probability of occurrence of such episodes. Interestingly, the authors find that international liquidity is prone at leading to housing booms, while banking crises are likely to generate housing busts.

In what concerns the question about the duration dependence in asset markets, it gained a renewed momentum, especially, in the aftermath of the global financial crisis. In particular, some studies have started to assess whether the likelihood of an ending in asset booms or busts is dependent on its age, i.e. the so called "duration dependence". In this context, Lunde and Timmermann (2004) find negative duration dependence in bull stock markets and positive duration dependence in bear stock markets. Other works have focused on the duration dependence in housing markets. Cunningham and Kolet (2011) test for duration dependence in housing price cycles, by estimating a discrete-time survival model with a probit specification for expansions and contractions. Using data for Canada and US, they find that housing market expansions have positive duration dependence, but the same does not hold for contractions. More recently, Bracke (2013) uses a discrete-time duration model and finds that housing expansions and contractions exhibit duration dependence. The author also shows that downturns are less likely to end when the previous upturn was abnormally long. Therefore, housing booms can be described as periods of deviations from fundamentals that are increasingly unsustainable, while housing busts can be characterized as episodes of readjustment. Additionally, the empirical results suggest that some macroeconomic variables help shaping housing cycles. For example, an increase in interest rates has a negative effect on housing prices. By contrast, a rise in the output and an increase in the working-age population growth have a positive impact.

To the best of our knowledge, our paper is the first to explore a second dimension of housing price cycles: the existence of breaks or change-points in the duration dependence. In fact, while

the abovementioned research assumes that the behaviour of duration dependence is smooth over time (i.e. either constant, or increasing, or decreasing), we conjecture that the likelihood of a housing boom or a housing bust ending may change after a certain duration. From a policy perspective, testing such hypothesis can provide valuable information for predicting the timing and the length of housing boom-bust cycles, thereby, facilitating the formulation and the implementation of stabilizing policies (Rafiq and Mallick, 2008; Granville and Mallick, 2009; Mallick and Mohsin, 2010; Sousa, 2010b; Castro, 2011; Agnello et al., 2012). To do it, we follow the general model framework developed by Castro (2013) and build a Weibull model for housing prices booms, busts and normal phases with a change-point. For instance, a recent application of the Weibull model with a change-point to the duration of fiscal consolidation programmes is presented in Agnello et al. (2013b). Other frameworks looking at the fiscal (un)sustainability and the success of fiscal consolidations are provided by Agnello et al. (2012, 2013a).

3 Econometric Methodology

3.1 Duration Analysis

We start by assuming that the duration variable is defined as the number of periods (quarters) over which a housing market boom, bust or normal cycle takes place. If T measures the time span between the beginning of the respective event and its end, then, $t_1, t_2, \dots, t_n$ will represent its observed duration. The probability distribution of the duration variable, T , can be characterized by the cumulative distribution function, $F(t) = Pr(T < t)$, so the density function is $f(t) = dF(t)/dt$. Alternatively, the distribution of T can be assessed via the survivor function, $S(t) = Pr(T \geq t) = 1 - F(t)$, which measures the probability that the duration of a housing market phase is larger or equal to t .

A particularly useful function for duration analysis is the hazard function

$$h(t) = f(t)/S(t), \tag{1}$$

which measures the rate at which housing price spells will end at time t , given that they lasted until that moment. In other words, it measures the probability of exiting a state in moment t conditional on the duration of that state. This function helps characterizing the path of duration dependence. For instance: (i) if $dh(t)/dt > 0$ for $t = t^*$, there is positive duration dependence in t^* ; (ii) if $dh(t)/dt < 0$ for $t = t^*$, there is negative duration dependence in t^* ; and (iii) if $dh(t)/dt = 0$ for $t = t^*$, there is no duration dependence. Therefore, when the derivative of the hazard function with respect to time is positive, the probability of a boom, bust or normal time ending in moment t , given that it has reached t^* , increases with its age. Consequently, the longer the respective phase in housing prices is, the higher the conditional probability of its end will be.

From the hazard function, we can derive the integrated hazard function

$$H(t) = \int_0^t h(u)du, \quad (2)$$

and compute the survivor function as follows:

$$S(t) = \exp[-H(t)]. \quad (3)$$

While different parametric continuous-time duration models can measure the magnitude of duration dependence and the impact of other time-invariant variables on the likelihood of the end of an event, the most commonly used functional form of the hazard function is the proportional hazard model

$$h(t, \mathbf{x}) = h_0(t) \exp(\boldsymbol{\beta}' \mathbf{x}), \quad (4)$$

where $h_0(t)$ is the baseline hazard function that captures the data dependence of duration and represents an unknown parameter to be estimated, $\boldsymbol{\beta}$ is a $(K \times 1)$ vector of parameters that need to be estimated and x is a vector of covariates. The proportional hazard model can be estimated without imposing any specific functional form i.e. the so called "Cox model". However, this model

does not allow for the estimation of a duration dependence parameter, which is crucial for our analysis, especially, when the presence of a change-point is considered. Hess and Persson (2010) also highlight that the use of Cox proportional hazards models may be inadequate when applied to large data sets, because: (i) it may lead to biased coefficient estimates and standard errors, especially, when there are many tied duration times; (ii) it can improperly control for unobserved heterogeneity; and (iii) it imposes the restrictive assumption of proportional hazards. Therefore, we opt by using a more popular alternative which imposes a specific parametric form for the baseline hazard function ($h_0(t)$) i.e. the "Weibull model". This also explains the use of a continuous-time version of the model, which makes it possible to investigate the existence of change-points in the duration of the various phases of the housing market cycle. Indeed, this type of analysis cannot be performed with a discrete-time duration model, even though this family of models may be more adequate when the minimum duration for the phases is relatively short (Ohn et al, 2004; Castro, 2010). In other contexts, Licandro and Puch (2006) propose a simple time-to-build technology in a one-sector growth model in continuous time. The authors show that, under some sufficient conditions, a discrete-time version is a true representation of the continuous-time problem. Bretó and Veiga (2011) show that, with the exception of the stochastic volatility family, volatility forecasts based on continuous-time models may outperform those of GARCH-type discrete-time models.

3.2 The Basic Weibull Model

The Weibull model is characterized by the following hazard function

$$h_0(t) = \gamma p t^{p-1}, \quad (5)$$

where p parameterizes the duration dependence, t denotes time, γ is a constant, $p > 0$ and $\gamma > 0$. If $p > 1$, the conditional probability of a turning point occurring increases as the phase gets older and, as a result, there is positive duration dependence; if $p < 1$, there is negative duration dependence; finally, there is no duration dependence if $p = 1$, in which case the Weibull model is equal to an

Exponential model. By estimating p , we can test for duration dependence in housing prices phases.

If we plug the Weibull specification for the baseline hazard function as expressed by equation (6) in the proportional hazard function denoted by (5), we get:

$$h(t, \mathbf{x}) = \gamma p t^{p-1} \exp(\beta' \mathbf{x}). \quad (6)$$

Hence, the corresponding survivor function can be written as:

$$S(t, \mathbf{x}) = \exp [-H(t, \mathbf{x})] = \exp [-\gamma t^p \exp(\beta' \mathbf{x})]. \quad (7)$$

This model can be estimated by Maximum Likelihood, and the log-likelihood function for a sample of $i = 1, \dots, n$ episodes of booms, busts or normal times is given by

$$\begin{aligned} \ln L(\cdot) &= \ln \prod_{i=1}^n f(t_i, \mathbf{x}_i) = \ln \prod_{i=1}^n h(t_i, \mathbf{x}_i)^{c_i} S(t_i, \mathbf{x}_i) = \sum_{i=1}^n [c_i \ln h(t_i, \mathbf{x}_i) + \ln S(t_i, \mathbf{x}_i)] = \\ &= \sum_{i=1}^n [c_i (\ln \gamma + \ln p + (p-1) \ln t_i + \beta' \mathbf{x}_i) - \gamma t_i^p \exp(\beta' \mathbf{x}_i)], \end{aligned} \quad (8)$$

where c_i indicates when observations are censored. If the sample period under analysis ends before the turning point has been observed, the observations are censored (i.e. $c_i = 0$); when the turning points are observed in the sample period, the observations are not censored and $c_i = 1$.

3.3 A Weibull Model with Change-Points

While the basic structure of the log-likelihood function for the Weibull model allows us to analyze the presence of duration dependence in the various phases of the housing market, we investigate the extent to which the likelihood of a boom, bust or normal time ending (as it gets older) changes after a certain duration. Thus, we allow for a structural break in the Weibull model and consider the possibility of a change in the parameters of the baseline hazard function (p and γ) at a certain point in time. Consequently, we do not only expect that the likelihood of a phase

ending increases over time, but also that, if it has lasted more than a certain time, the likelihood of ending would have significantly changed after that point.

We propose a Weibull model for housing prices phases with change-points that follows the framework proposed by Castro (2013) for cases where the Weibull distribution or the respective parameters characterizing the baseline hazard function vary over time for different intervals, but remain constant within each interval. For simplicity, let us re-write equation (6) as

$$h_0(t) = \gamma p t^{p-1} = \lambda p (\lambda t)^{p-1}, \quad (9)$$

where $\gamma = \lambda^p$. Hence, the survival function becomes

$$S(t, \mathbf{x}) = \exp[-H(t, \mathbf{x})] = \exp[(\lambda t)^p \exp(\boldsymbol{\beta}' \mathbf{x})], \quad (10)$$

Denoting $g(t) = \ln H(t)$ and considering a change point, τ_c , and two intervals, $t_0 < t \leq \tau_c$ and $\tau_c < t \leq t_T$, $g(t)$ can be expressed as

$$g(t) = \ln(\lambda_j t)^{p_j}, \quad (11)$$

with $j = 1, 2$. Due to the fact that the continuity of $g(t)$ in the change-point, τ_c has to be verified, we must impose that:

$$\ln(\lambda_1 \tau_c)^{p_1} = \ln(\lambda_2 \tau_c)^{p_2}. \quad (12)$$

Solving this equation with respect to p_2 , we get:

$$p_2 = p_1 \frac{\ln(\lambda_1 \tau_c)}{\ln(\lambda_2 \tau_c)}. \quad (13)$$

Consequently, in the case of the survival time ending in the first interval, we have

$$g(t) = p_1 \ln(\lambda_1 t), \quad (14)$$

and, similarly, for the survival time ending in the second interval:

$$g(t) = p_2 \ln(\lambda_2 t) = p_1 \ln(\lambda_2 t) \frac{\ln(\lambda_1 \tau_c)}{\ln(\lambda_2 \tau_c)}. \quad (15)$$

Considering the i -th spell, we get

$$g(t_i) = d_i p_1 \ln(\lambda_1 t_i) + (1 - d_i) p_1 \ln(\lambda_2 t_i) \frac{\ln(\lambda_1 \tau_c)}{\ln(\lambda_2 \tau_c)}, \quad (16)$$

where $d_i = 1$ if $t_0 < t \leq \tau_c$, $d_i = 0$ if $\tau_c < t \leq t_T$, and $i = 1, 2, \dots, n$ (i.e. the number of spells).

For $H(t_i, \mathbf{x}_i) = \exp[g(t_i) + \beta' \mathbf{x}_i]$, the hazard function is given by

$$h(t_i, \mathbf{x}_i) = dH(t_i, \mathbf{x}_i)/dt_i = g'(t_i)H(t_i, \mathbf{x}_i) = \left[d_i \frac{p_1}{t_i} + (1 - d_i) \frac{p_1}{t_i} \frac{\ln(\lambda_1 \tau_c)}{\ln(\lambda_2 \tau_c)} \right] H(t_i, \mathbf{x}_i), \quad (17)$$

and the corresponding survivor function can be expressed as:

$$S(t_i, \mathbf{x}_i) = \exp[-H(t_i, \mathbf{x}_i)]. \quad (18)$$

Therefore, the log-likelihood function can be written as:

$$\ln L(\cdot) = \sum_{i=1}^n \left\{ c_i [\ln g'(t_i) + g(t_i) + \beta' \mathbf{x}_i] - \exp [g(t_i) + \beta' \mathbf{x}_i] \right\}, \quad (19)$$

where $g'(t_i) = d_i \frac{p_1}{t_i} + (1 - d_i) \frac{p_1}{t_i} \frac{\ln(\lambda_1 \tau_c)}{\ln(\lambda_2 \tau_c)}$. This model is estimated by Maximum Likelihood, given a particular change-point τ_c . The relevance of the change-point is evaluated by testing whether there is a statistically significant difference between p_1 and p_2 , i.e. whether the duration dependence

parameter changes significantly between the two sub-periods.

4 Data and Empirical Results

4.1 Data

Quarterly data on housing prices is provided by the Organisation for Economic Co-Operation and Development (OECD) and covers a sample of 20 industrialized countries over the period 1970Q1-2012Q2. The countries included in our sample are: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

The episodes of booms and busts in housing markets are identified using the methodology proposed by Burnside et al. (2011). This requires the preliminary detection of upturns and downturns in real housing prices. In this context, to avoid identifying high-frequency changes as upturns and downturns, quarterly real housing price series are smoothed.

Let y_t denote the logarithm of real housing prices and x_t the centred moving average of y_t , that is, $x_t = \frac{\sum_{j=-n}^n y_{t+j}}{2n}$. An upturn is defined as an interval of time during which $\Delta x_t > 0$ for all t , while a downturn is an interval of time in which $\Delta x_t < 0$. A peak or trough is the last time period within an upturn and downturn, respectively. It follows that a housing boom is defined as an upturn such that $y_T - y_{T-L} > z$ and, analogously, a housing bust is a downturn for which $y_T - y_{T-L} < -z$, where T indicates the peak of the boom or the trough of the bust and L is the duration of the upturn or the downturn. The identification of booms and busts is based on the assumption that $n = 5$ and $z = 0.15$. In line with Burnside et al. (2011), centred moving averages are computed by using two lagged and two forward observations of the real housing price series in addition to their current value (i.e. five quarterly data points in total). The inclusion in the filter of an equally-spaced number of data points on both sides of a central value (and, therefore, the use of an odd number of data points in the sample window) ensures that the variations in the mean are

aligned with the variations in the data rather than shifting in time (as induced, for instance, by the use of 'past' data only). A potential drawback of considering a larger sample window (for instance, seven, nine or even eleven observations) is that the filtered series might become smoother than expected. Put it differently, the removal of some peaks and/or troughs in the series could lead to an implausible or inconsistent identification of episodes of housing booms and housing busts. Such artefacts do not emerge when we use a sample window with a five-quarter length. Despite this and as a robustness check, we have also considered different values of z for housing booms and housing busts. More specifically, z has been set equal to the average size of housing upturns and housing downturns over the entire sample of analysis. Following this rule, boom and bust episodes occur when $y_T - y_{T-L} > 0.23$ and $y_T - y_{T-L} < -0.11$. The results remain qualitatively and quantitatively unchanged and are available upon request.

By organizing the data in spells where a spell represents the duration of a boom, a bust or a normal period, denoted by Dur - which corresponds to t_i in the model described in the previous Section -, we are able to identify 59 booms, 31 busts and 59 normal time spells. Figure 1 shows the booms (light shaded areas) and the busts (dark shaded regions) as compared with the normal periods (non-shaded areas) over time and across countries. It is worth noting that, with the exceptions of Australia and Germany, all the other countries have experienced booms and busts and, in most of the cases, boom-bust cycles. In particular, a large group of countries including Denmark, France, Italy, Sweden and UK could be labelled as "repeated boom busters". Another group of countries can be labelled as "new busters", as they were hardly hit by the sub-prime mortgage crisis. While this was initially confined to the US, it quickly spilled over the European housing markets, in particular, in countries such as Greece, Ireland, Netherlands and Spain, which recorded the most severe bust episodes in the Summer of 2007 and the beginning of 2008. The recent drawn-out bust seems to be relatively muted only in Belgium, Norway and Switzerland (the "resilient league"). Finally, Australia and Canada can be called as "boomers" given that the periods of boom in their housing markets have never been followed by sharp collapses in housing prices.

Despite this, it is important to highlight that the limited number of housing booms and housing busts makes the estimation of the duration models unfeasible on a country basis. Consequently, we implement the econometric framework on a panel structure.

[INSERT FIGURE 1 HERE.]

While testing for the presence of duration dependence in housing price phases and change-points in their behaviour, we also allow for differences between European and non-European countries. That is, we test whether there is a significant difference in the average duration of housing price phases, as well as in the duration dependence parameter, p , between these two groups of countries. This is done by including the dummy D_EC in the model, which takes the value of 1 for European countries and 0 otherwise. Additionally, we estimate separate regressions for each of these groups.

We also take into account the effects of some regressors that are assumed to be time-invariant. For the analysis of the business cycle, Zellner (1990) and Sichel (1991) suggest that the duration of the previous business cycle phase may affect the length of the current phase. Therefore, we assess whether that might also be the case for housing market cycles and include the variable $DurPrev$ in the estimations. The type of the previous phase is also controlled for with the dummy variable $Prev$: during booms, this dummy variable takes value 1 for busts and 0 for normal times; during busts, it takes value 1 for booms and 0 for normal times; and during normal times, it takes value 1 for booms and 0 for busts.

In addition, we analyze whether the duration of booms, busts and normal times becomes gradually longer or shorter over time. As such, we consider a trend variable, labelled as $Event$, which reports the order or the observation number of each event over time and for every single country: it is equal to 1 for the first event, 2 for the second one, and so on. If the coefficient associated to this variable is significantly smaller (larger) than zero, phase durations get longer (shorter) over time. Additionally, we replace this variable by a set of dummy variables corresponding to the four decades involved in the analysis: $Dec70$, $Dec80$, $Dec90$, $Dec00$.

In Table 1, we report the descriptive statistics regarding the duration of the housing price episodes. It shows the number of spells for each type of episode (*Obs*) and for all countries (*All*), for European countries (*EC*) and for non-European countries (*NEC*). It can be seen that, on average, booms and busts last the same time, but normal times tend to be slightly shorter. Interestingly, housing booms seem to last longer for European countries than for non-European countries, but the opposite happens for busts and normal times. Whether these differences are statistically significant or not is an issue that we will try to answer with the estimation of the continuous-time Weibull model.

[INSERT TABLE 1 HERE.]

4.2 The Baseline Model

The empirical evidence that emerges from the estimation of the Weibull model presented in Section 3.2 is summarized in Table 2. A one-sided test is used to detect the presence of positive duration dependence (i.e. whether $p > 1$) and the sign '+' indicates significance at a 5% level. The results corroborate such hypothesis for housing booms and busts, that is, the likelihood of the end of a boom or a bust phase in the housing market increases as the time goes by. This is valid not only for the basic regressions presented in Column 1, but also for the other regressions. Moreover, in most of the cases, p is equal to 2, that is, the statistical analysis of the second-order derivative of the baseline hazard function indicates the presence of constant positive duration dependence both in booms and busts. This means that the probability of booms and busts ending at time t , given that they lasted until that moment, increases over time at a constant rate. For details on the analysis of the second-order derivative of the baseline hazard function, see Castro (2010, 2013).

While we start by assuming that housing booms and busts may last from one quarter to the maximum number of time periods that are observable in our sample, the data suggests that their minimum duration is five and seven quarters, respectively. Therefore, we investigate if truncating

those phases at their minimum duration affects the results or not. This implies that the hazard rate must be zero for the first quarter and some non-zero value thereafter. Truncation is set at the minimum observable duration for housing booms and busts, that is: $d_0 = \min(d_i) - 1$, where $\min(d_i)$ is the shortest boom/bust observed in the sample. As a result, the survival function becomes:

$$S(t_i, \mathbf{x}_i) = \exp \left[-\gamma(t_i^p - d_0^p) \exp(\beta' \mathbf{x}_i) \right] \quad (20)$$

Column 2 of Table 2 displays the results where we allow for truncation and shows the main findings are not affected i.e. there is still positive duration dependence in housing booms and busts. In general, the results in this type of studies are not sensitive to the choice of the minimum observable duration (Sichel, 1991; Castro, 2010, 2013).

In the regressions presented in Column 1, the population of individual spells is assumed to be homogeneous, as each housing boom or bust is under the same risk of ending. Given that this may not be a good description of reality, Column 3 allows for the presence of unobserved heterogeneity or frailty. In statistical terms, a frailty model is similar to a random-effects model for duration analysis: it represents an unobserved random proportionality factor that modifies the hazard function of an individual spell and accounts for the heterogeneity caused by unmeasured covariates or measurement errors. In order to include frailty in the Weibull model, the hazard function expressed by equation (7) is modified as follows

$$h(t, \mathbf{x}|v) = v h(t, \mathbf{x}), \quad (21)$$

where v is an unobserved individual-spell effect that scales the no-frailty component. The random variable v is assumed to be positive with unity mean, finite variance, θ , and independently distributed from t and $\mathbf{x}$. The survival function is then expressed as:

$$S(t, \mathbf{x}|v) = [S(t, \mathbf{x})]^v. \quad (22)$$

Since the values of v are not observed, we cannot estimate them. In this context, we follow Lancaster (1990) and assume that v follows a Gamma distribution with unity mean and variance θ , implying that the frailty survival function can be written as

$$S(t, \mathbf{x}|\boldsymbol{\beta}, \theta) = [1 - \theta \ln S(t, \mathbf{x})]^{-(1/\theta)}, \quad (23)$$

while the frailty hazard function becomes

$$h(t, \mathbf{x}|\boldsymbol{\beta}, \theta) = h(t, \mathbf{x}) [S(t, \mathbf{x}|\boldsymbol{\beta}, \theta)]^\theta, \quad (24)$$

and the corresponding log-likelihood function can be expressed as:

$$\ln L(\cdot) = \sum_{i=1}^n \left\{ c_i [\ln \gamma + \ln p + (p-1) \ln t_i + \boldsymbol{\beta}' \mathbf{x}_i] - \left(c_i + \frac{1}{\theta} \right) \ln [1 + \gamma t_i^p \exp(\boldsymbol{\beta}' \mathbf{x}_i)] \right\}. \quad (25)$$

The variance parameter, θ , which measures the presence (or absence) of unobserved heterogeneity, needs to be estimated. As θ is always greater than zero, the limiting distribution of its maximum-likelihood estimate is a normal distribution that is halved or chopped-off at the zero-bound. Therefore, the likelihood ratio test, *LR test*, that is used to detect its presence is a ‘boundary’ test that takes into account the fact that the null distribution is not the usual chi-squared with one degree of freedom, but rather a mixture of a chi-squared with zero degrees of freedom and a chi-squared with one degree of freedom (Gutierrez et al., 2001). The results do not show strong evidence of unobserved heterogeneity, as corroborated by the p -value of the *LR test* reported at the bottom of Column 3: at a 5% significance level, we reject the presence of frailty. Despite this, some works emphasize the cross-country heterogeneity, even among the European countries. For instance, Carstensen et al. (2009) show that transmission of monetary policy shocks to macroeconomic variables is amplified in the case of countries with a stronger response of real house prices. Berben et al. (2004) highlight that the financial structures, the fiscal policy frame-

work, the credit channel contribute to account for the heterogeneity in the responses of countries to a monetary policy shock. Additionally, while entry barriers and pervasiveness of the employment protection legislation raise the adjustment costs associated with a monetary policy shock, the industrial structure does not seem to play an important role. Georgiadis (2012) finds that a large share of the cross-country asymmetries in the response of output and prices to a monetary policy shock is explained by cross-country differences in the financial structure, the industry mix and the labor market rigidity.

Even though the presence of frailty is not statistically significant, individual-country effects may still be present, given that the sample consists of 20 countries that can have individual-specific characteristics. Therefore, in Column 4, we add country-dummy variables to the set of regressors. In this case, we test for pooling, i.e. the *LR test* is used to assess whether the model controlling for country-specific effects is preferred to simple pooling. The *p*-value of the *LR test* reported at the bottom of Column 4 does not support the existence of country-specific effects. Hence, we are unable to find heterogeneity in the population of individual boom and bust spells.

In Column 5, we analyze if the mean duration of housing booms and busts is significantly different for European and non-European countries, by adding the dummy variable D_EC to the set of regressors. We find that the coefficient associated to D_EC is not statistically significant for booms, but remains marginally significant (and positive) for busts. This suggests that, on average, housing booms tend to last the same in European and non-European countries, while busts are shorter for European countries. Indeed, a positive coefficient implies a higher probability of the event ending over time, i.e. a shorter duration.

One question remains: is the duration dependence parameter the same for European and non-European countries in the respective housing phase? To answer it, we start by replacing the parameter p by $p + \Delta p$ in Columns 7 and 8; in Column 8, we also include the dummy variable D_EC . The empirical findings confirm that the average duration of booms in European and non-European countries is broadly the same and constant positive duration dependence characterizes

housing booms in both groups of countries. However, with regard to housing busts, the results show that there are significant differences in the magnitude of the duration dependence parameter and in the average duration of busts in European and non-European countries. In particular, housing busts are not duration dependent in non-European countries, but still display constant positive duration dependence in European countries.

Finally, in Columns 8 and 9, we estimate separate regressions for non-European and European countries, respectively. The results confirm that the duration dependence parameter is very similar for housing booms and there is constant positive duration dependence for both groups. They also reveal that housing busts are not duration dependent for non-European countries, while positive duration dependence characterizes housing busts in European countries.

[INSERT TABLE 2 HERE.]

As we are using a continuous-time duration model, there is no scope to add regressors that are time-variant, but it is possible to consider some that remain constant over each spell, such as the dummy variable D_{EC} . Other regressors include the trend variable $Event$, the previous phase, $Prev$, and the duration of the previous phase, $DurPrev$. In Column 1 of Table 3, we consider these additional regressors. The empirical findings confirm the presence of constant positive duration dependence in housing booms and housing busts. Moreover, they show that booms have become longer over time, as the coefficient on $Event$ is negative, which means that the likelihood of a boom ending fell over time. In addition, the longer the previous phase is, (no matter what, as the coefficient on $Prev$ is not statistically significant), the smaller the likelihood of a housing boom ending tends to be, i.e. housing booms typically last longer. In the case of housing busts, we find that the longer the previous phase is, the longer the housing bust will be.

In Column 2, we investigate whether the inclusion of these time-invariant regressors affects the conclusions regarding the differences in the duration dependence parameter between European and non-European countries. As before, we show that it is not statistically different for the two

groups of countries and uncover the presence of constant positive duration dependence. Moreover, the variable *Event* and *DurPrev* are statistically significant. In what concerns housing busts, the duration dependence parameter is significantly larger for European countries and we only find evidence of positive duration dependence for this group. We reach the same conclusions when we estimate separate regressions for non-European and European countries (Columns 3 and 4). Due to the small number of busts for the non-European countries, we only include the regressor that presented a significant coefficient (*DurPrev*). Moreover, it also remains significant for the group of European countries. Regarding the housing booms in the non-European countries, we should stress that the likelihood of they end decreases with the duration of the previous phase, especially if it was a bust (*Prev* has a significantly negative coefficient).

In Column 5, we only include the regressors with significant coefficients and find the same empirical evidence. These regressors are then excluded in the regressions presented in Column 6 and replaced by dummies for the decades. While these are measures of the passage of time like *Event*, they are based on a real time perspective and not on a sequence or order of events over time. The results are quite interesting because: 1) they confirm the trend towards a fall in the likelihood of housing booms ending over time; and 2) they unveil a similar feature for housing busts, which was not captured by the variable *Event*. This means that, over the last decades, the boom-bust cycles have become longer. These results may be linked with the works that argue that the pre-Volcker period is characterized by indeterminacy (Lubik and Schorfheide, 2004; Beyer and Farmer, 2007; Bullard and Singh, 2008). Other authors also suggest that there may be a change in the monetary policy regime before and after the 1980s (Schmitt-Grohe et al., 2001; Benhabib et al., 2002; Sargent et al., 2006). In addition, Stock and Watson (2005), among others, identify a “structural change” in the business cycle dynamics even among the major industrialized countries. Consequently, our empirical findings seem to indicate that such regime changes in the monetary policy and in the real economic activity that took place in the 1980s have contributed to longer housing cycles since then, as indicated by the negative and significant coefficients for the respective

decades.

Additionally, in the case of housing busts, we continue to observe significant differences regarding the duration dependence parameter and the respective mean durations between European and non-European countries.

Finally, Columns 7 and 8 present the same specifications as Columns 5 and 6, respectively, but with the truncation set at the minimum duration, that is, six quarters in the case of housing booms and eight quarters for housing busts. The main conclusions are not significantly affected with this change.

[INSERT TABLE 3 HERE.]

In Table 4, we apply the same kind of analysis to the "normal times". The results indicate that positive duration dependence is only found when additional regressors are included in the model and, in particular, for European countries. We also find that: *(i)* setting truncation at the minimum duration of normal times (i.e. two quarters) does not affect the magnitude of the duration dependence parameter, p (Column 2); *(ii)* "frailty" effects and fixed effects are not present (Columns 3 and 4, respectively); *(iii)* normal times are typically shorter in European countries (Columns 5, 10, 11, 14 and 15); *(iv)* the duration dependence parameter is higher for European countries (Columns 6-13); *(v)* the likelihood of "normal times" ending is negatively affected by the duration of the previous phase, no matter what its type is (Columns 10, 11 and 14); and *(vi)* the duration of normal times has increased over time (Column 15), which, together with the findings for housing booms and housing busts, shows an increase in the persistence of the housing price phases and, consequently, a substantial increase in the length of the housing market cycles over time.

[INSERT TABLE 4 HERE.]

4.3 The Model with Change-points in Duration Dependence

The results presented so far rely on the assumption that the magnitude of duration dependence parameter is time-invariant. To have a first idea of the plausibility of such hypothesis, in Figure 2, we plot the survivor functions for housing booms, busts and normal times for all countries, European and non-European countries. It shows that the proportion of booms, busts or normal times surviving after duration t_i substantially decreases as they become older. This sharp decline is consistent with the existence of positive duration dependence.

Moreover, for booms and busts, the survivor functions quick fall until $t_i = 26$ (for the full sample and and the European), or $t_i = 18$ (in the case of housing booms in non-European countries). Then, they evolve at a slower pace. This, in turn, suggests the possibility of a break in the duration dependence and the need of a more flexible framework allowing for a change-point in the Weibull distribution at $\tau_c = 26$ (or $\tau_c = 18$). Indeed, the Figure points to a duration dependence parameter that might be lower when housing booms and busts are longer than 26 quarters (18 quarters for non-European countries) and to the possibility that the likelihood of their ending significantly changes above that period.

Another signal of the existence of a break-point in duration dependence for booms and busts is provided by the slope of the survivor functions. In the case of the full sample, the average slope is equal to -0.0400 (-0.0701) for housing booms (busts) that are shorter than 26 quarters and -0.0176 (-0.0368) for those that last longer than 26 quarters. Putting it differently, when housing booms (busts) have a duration shorter than 26 quarters, each additional quarter of duration, on average, increases the likelihood of their end by 4.00 (7.01) percentage points, respectively. In contrast, in the case of longer booms (boosts), each additional quarter of duration raises the likelihood of their end by just 1.76 (3.68) percentage points, respectively. Similar results can be found for the sample of European and non-European countries: (i) in the case of European countries, the average slope of the survivor function changes from -0.0447 to -0.0238 for booms and from -0.0928 to -0.0622 for busts; and (ii) for non-European countries, the average slope of the survivor function changes

from -0.1067 (in the case of booms that are shorter than 18 quarters) to -0.0667 (for booms that are longer than 18 quarters).

Regarding the survivor functions for normal times and following the graphical analysis indicating at most a slight change in their slope, we consider the following durations for potential change-points: 31, for all countries; 21, in the case of European countries; and 29 for non-European countries. The differences in the slopes before and after the change-points are not substantial. Indeed, our computations show that they change: from -0.0335 to -0.0243 for the full sample; from -0.0423 to -0.0430 for the European countries; and from -0.0698 to -0.0750 for the non-European countries.

[INSERT FIGURE 2 HERE.]

In order to test for the presence of change-points in the duration dependence parameter, we consider a Weibull model with a change-point. We estimate two duration dependence parameters, one for the first period (p_1) and another one for the second period (p_2), and evaluate the statistical significance of the difference between the two ($p_2 - p_1$). The estimates for the two constant terms are $\gamma_1 = \lambda_1^{p_1}$ and $\gamma_2 = \lambda_2^{p_2}$, respectively. We use the delta method to compute the corresponding standard-errors.

The results for housing booms and busts are reported in Table 5. Column 1 displays the estimates from a simple equation without covariates. In Column 2, we control for differences in the average duration of booms and busts between European and non-European countries and account for the possibility that their duration changes over time and depends on the type and the duration of the previous spell. Columns 3 and 4 present the results of separate regressions for non-European and European countries, respectively. In Column 5, we include only the significant regressors and, in Column 6, we replace the regressors by the dummy variables for the various decades.

The results strongly suggest that the duration dependence parameter is time-varying. In fact, the magnitude of the duration dependence parameter is always significantly lower when housing

booms or busts are longer than 26 quarters (in the case of the full sample and the European countries) and when housing booms are longer than 18 quarters (for the non-European countries). The difference between the parameters after and before the respective change-point ($p_2 - p_1$) is negative and statistically significant. An increasing positive duration dependence is observed in housing booms and busts that last less than 26 quarters but, when their length is longer, duration dependence generally is no longer present. Indeed, while the parameter p_1 is statistically significant in all specifications, p_2 does not seem to exhibit statistical significance. Additionally, these findings are not affected by the truncation of booms and busts at their minimum values, as confirmed in Columns 7 and 8. Housing booms and busts also appear to have become longer over time (Column 6) and, as before, the likelihood of a housing boom or bust ending tends to be smaller when the previous phase is longer.

[INSERT TABLE 5 HERE.]

In Table 6, we present the analysis of the Weibull model with a change-point for the "normal" periods of the housing markets. As we had previously conjectured, it does not support the existence of a change-point in duration dependences given that the difference between the parameters after and before the change-point ($p_2 - p_1$) is not statistically significant in any of the regressions. Despite this, the results clearly point to a positive duration dependence parameter both before and after the change-point. Regarding the effect of the additional regressors, the estimations suggest that normal times are, on average, shorter in European countries (Column 2). In addition, the likelihood of an ending in such periods is negatively affected by the duration of the previous phase irrespective of its kind and whether truncation is used or not (Columns 2, 5 and 7). We also confirm that the duration of "normal times" has increased over the last decades (Column 6).

[INSERT TABLE 6 HERE.]

4.4 Sensitivity Analysis

In the previous Sections, we used a dummy variable to distinguish between European and non-European countries. This has led to the conclusion that European housing busts are significantly different from housing busts in other regions when we split the sample and measure cycle duration and test for duration dependence.

Despite this, some countries like Denmark, Norway, Sweden, Switzerland and the UK do not use the euro as a currency (and, thus, are not members of the euro area), but are included in the set of European countries. Given that it is quite possible that monetary policy affects the duration of house price phases, we redefine the dummy variable more precisely (*Euro*), restricting it to be 1 only for euro area countries or countries that are actually pegged to the euro (and, hence, have a common European Central Bank (ECB) monetary policy), and zero otherwise. This means that the UK and other countries are not in the "euro area" dummy variable.

Columns 1-3 of Tables 7-9 provide a summary of the main findings (for housing booms, housing busts and normal times, respectively). As before, they reveal some significant differences in the duration of housing bust cycles, but not in the case of housing booms and normal times. Moreover, when the change point in the duration of the housing market phase is taken into account, no relevant distinction emerges between euro area countries and non-euro area countries. Consequently, the empirical findings are in line with those reported for the dummy variable of European countries (*D_EC*) and suggest that a common monetary policy is not affecting the duration of housing prices in a different manner. More specifically, countries in the region with independent, non-ECB monetary policy do not appear to exhibit housing market phases that differ significantly from those in the euro area. In fact, the dummy variable *Euro* is not statistically significant.

Additionally, we also test for the potential synchronization and similarities among housing markets in Australia, Canada, New Zealand, the UK, and the US, i.e. the "Anglosphere". Thus, we create a dummy variable that takes the value of 1 for this set of countries and 0 otherwise (*Anglox*) and replace the dummy variable *D_EC* with it in the group of regressors.

The results are reported in Columns 4-6 of Tables 7-9 and do not point to important differences vis-a-vis the baseline model. In particular, housing booms and housing busts seem to be shorter in the "Anglosphere" countries. However, this evidence disappears when we control for the presence of a change-point, which is present in both phases. As for normal times of the housing market, our findings do not suggest the existence of significant differences.

Overall, we can conclude that our characterization of the duration of the housing market cycles based on the distinction between euro area and non-euro area countries and between countries of the "Anglosphere" and non-Anglo-Saxon countries is similar to the one based on the distinction between European and non-European countries. Moreover, positive duration dependence remains present in all the three phases considered, as well as the presence of a change-point for housing booms and housing busts.

[INSERT TABLE 7 HERE.]

[INSERT TABLE 8 HERE.]

[INSERT TABLE 9 HERE.]

5 Conclusion

In this paper, we analyze the characteristics of housing cycles. Using data for 20 industrialized countries over the period 1970Q1-2012Q2, we assess whether the likelihood of an end in housing price booms, busts and normal times indeed depends on its own age, i.e. whether there is duration dependence. Relying on a continuous-time Weibull duration model, we find evidence suggesting that, as time goes by, the probability that such phases of the housing market cycle will end increases, i.e. corroborating the existence of positive duration dependence. Moreover, we show that these events tend to be longer, when the previous phase (no matter what its kind is) is longer. In addition,

our empirical findings provide support to an increase in the duration of housing market cycles over the last decades.

In the same vein, our results show that both the housing market booms of European and non-European countries are positive duration dependent, but housing busts in non-European countries do not display duration dependence. In addition, they point to the same length of housing booms in European and non-European countries, but reveal that housing busts are shorter in European countries. Similar evidence emerges when we distinguish between euro area and non-euro area countries and between countries of the "Anglosphere" and non-Anglo-Saxon countries.

Finally, we investigate a dimension that has been typically neglected by the housing literature: the existence of breaks in duration dependence. While the existing works tend to consider that the behaviour of the survivor function is smooth, we investigate the extent to which the likelihood of a boom, bust or normal time ending changes after a certain duration. Therefore, we extend the baseline Weibull model to the case of a change-point in the duration dependence parameter. We show that while positive duration dependence still characterizes housing booms and busts lasting less than 26 quarters, for longer phases of the cycle, that feature does not seem to hold. As for normal times, we do not find evidence of change-points.

From a policy perspective, our study provides information that can be useful for predicting the timing and the length of housing boom-bust cycles. This, in turn, helps designing and implementing stabilizing policies, in particular, given the likely impact of the housing market dynamics on real economic activity and the stability of the financial system. Moreover, by characterizing the properties of the various stages of the housing cycles and presenting their similarities and differences across groups of countries, it contributes for a better understanding of the degree of synchronization of housing prices around the world. Therefore, it raises the debate about the role of global factors (in particular, international financial integration) in shaping the behaviour of housing markets.

While we cannot draw predictions and policy implications for specific countries - due to the reduced number of episodes of booms and busts, which invalidates the estimation of the duration

models at a country level -, the use of a panel framework allows such conclusions to be stated. The key finding of our study is that, while relatively short-lived housing booms tend to deflate, more prolonged booms are likely to spiral out of control. Similarly, compared to short housing busts, longer housing busts are more likely to turn into chronic slumps and, ultimately, lead to severe recessions.

Consequently, we conclude that the assessment of the time-varying nature of the housing cycles provides a rationale for (preventive) policy interventions during periods of booms and busts. In particular, given that the duration of housing boom and housing bust episodes is conditional on their own age, a timely policy response to such events is crucial to keep them under control. Therefore, a counter-cyclical policy intervention that takes place before housing booms and housing busts last for 26 quarters on average is key for smoothing out large and persistent housing price swings and speeding up the return to a normal time phase. Indeed, when housing booms and housing busts get too long, the likelihood of their end increases by only half when compared to shorter events, making it more difficult for economic policy to circumvent such episodes without avoiding financial distress and crisis management. For this reason, a 'wait and see' strategy is not recommended for housing booms and housing busts lasting less than 26 quarters.

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Appendix

A List of Tables

Table 1: Descriptive statistics.

<i>Dur</i>	Booms					Busts					Normal Times				
	Obs.	Mean	S.D.	Min.	Max.	Obs.	Mean	S.D.	Min.	Max.	Obs.	Mean	S.D.	Min.	Max.
<i>All</i>	59	23.5	14.2	6	68	31	23.1	14.6	8	85	59	18.6	17.1	2	107
<i>EC</i>	44	23.9	15.0	6	68	25	21.2	9.3	10	55	44	15.3	11.2	2	54
<i>NEC</i>	15	22.6	11.7	9	53	6	31.2	27.6	8	85	15	28.3	26.2	2	107
<i>D_EC</i>	59	0.75	0.44	0	1	31	0.81	0.40	0	1	59	0.75	0.44	0	1
<i>Event</i>	59	2.19	1.06	1	5	31	1.42	0.56	1	3	59	2.20	1.06	1	5
<i>Prev</i>	53	0.25	0.43	0	1	31	0.84	0.37	0	1	44	0.73	0.45	0	1
<i>DurPrev</i>	53	18.4	17.1	2	107	31	25.2	16.5	4	68	44	22.5	12.3	7	55

Notes: Booms and busts episodes are identified using the methodology proposed by Burnside et al. (2011). The Table reports the number of episodes (*Obs.*), the mean duration (*Mean*), the standard deviation (*S.D.*), the minimum (*Min.*) and the maximum (*Max.*) duration for each spell. The data are quarterly and comprises 20 industrialized countries over the period 1970Q1-2012Q2.

Table 2: Duration dependence in housing booms and busts: basic Weibull model estimations.

Booms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
γ	0.0025** [0.0010]	0.0065* [0.0037]	0.0001 [0.0001]	0.0003 [0.0004]	0.0028** [0.0012]	0.0024** [0.0010]	0.0009 [0.0009]	0.0009 [0.0010]	0.0031** [0.0014]
p	1.821 ^{+,c} [0.127]	1.569 ^{+,d} [0.162]	3.806 ^{+,c} [1.229]	2.216 ^{+,c} [0.238]	1.833 ^{+,c} [0.132]	1.891 ^{+,c} [0.159]	2.145 ^{+,c} [0.326]	2.145 ^{+,c} [0.347]	1.747 ^{+,c} [0.132]
Δp						-0.073 [0.083]	-0.398 [0.351]		
$p + \Delta p$						1.819 ^{+,c} [0.127]	1.747 ^{+,c} [0.131]		
θ			1.621* [0.948]						
D_EC					-0.2059 [0.2638]		1.1772 [1.0615]		
<i>LogL</i>	-53.92	-224.62	-49.85	-46.18	-53.70	-227.79	-227.50	-11.09	-42.19
<i>LR test</i>			0.087	0.629					
<i>SBIC</i>	116.00	457.40	111.93	173.91	119.63	467.81	471.30	27.60	91.95
<i>Spells</i>	59	59	59	59	59	59	59	15	44
Busts	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
γ	0.0030 [0.0027]	0.0044 [0.0049]	0.0000 [0.0000]	0.0007 [0.0010]	0.0004 [0.0005]	0.0010 [0.0008]	0.0143 [0.0146]	0.0143 [0.0159]	0.0005 [0.0004]
p	1.723 ^{+,c} [0.319]	1.622 ^{+,c} [0.364]	6.160 ^{+,i} [2.080]	2.021 ^{+,c} [0.318]	2.027 ^{+,c} [0.284]	1.744 ^{+,c} [0.264]	1.108 [0.312]	1.108 [0.339]	2.369 ^{+,c} [0.326]
Δp						0.399** [0.182]	1.261*** [0.448]		
$p + \Delta p$						2.143 ^{+,c} [0.264]	2.369 ^{+,c} [0.323]		
θ			2.653* [1.479]						
D_EC					1.3546* [0.7238]		-3.4494** [1.3692]		
<i>LogL</i>	-28.95	-102.55	-19.60	-24.15	-25.74	-99.00	-97.85	-7.89	-15.66
<i>LR test</i>			0.073	0.791					
<i>SBIC</i>	64.77	211.97	49.50	103.25	61.78	208.30	209.44	19.37	37.76
<i>Spells</i>	31	31	31	31	31	31	31	6	25

Notes: Heteroscedasticity and serial autocorrelation robust standard errors clustered by country are reported in square brackets; ⁺ indicates that p is significantly higher than 1 using a one-sided test with a 5% significance level; d , c , and i indicate decreasing, constant and increasing positive duration dependence, respectively; Δp is the estimated difference in the duration dependence parameter between European and Non-European countries; hence, $p + \Delta p$ is the value of the duration dependence parameter for the European countries; ***, **, * - statistically significant at 1%, 5% and 10% level, respectively. Truncation at the minimum values of Dur is used in the regressions presented in Column 2. In Column 3, the p -value of the *LR test* for unobserved heterogeneity/frailty gives assesses if the estimated variance (θ) is different from zero. In Column 4, the p -value of the *LR test* analyses the statistical significance of country-specific dummy variables (pooling test), that is, $LR = -2(\log L_r - \log L_u)$, where r and u correspond to the restricted and unrestricted models, respectively. Columns 8 and 9 present separate regression results for the non-European and European countries, respectively. The Schwartz Bayesian Information Criterion (SBIC) is computed as follows: $SBIC = 2(-\log L + (k/2)\log N)$, where k is the number of regressors and N is the number of observations (spells).

Table 3: Duration dependence in housing booms and busts: basic Weibull model with additional regressors.

Booms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
γ	0.0066** [0.0032]	0.0043 [0.0043]	0.0001 [0.0002]	0.0057 [0.0043]	0.0073** [0.0037]	0.0005 [0.0004]	0.0147 [0.0097]	0.0009 [0.0007]
p	2.143 ^{+,c} [0.157]	2.272 ^{+,c} [0.375]	3.736 ^{+,c} [1.109]	2.288 ^{+,c} [0.242]	2.123 ^{+,c} [0.184]	2.803 ^{+,i} [0.227]	1.911 ^{+,c} [0.220]	2.643 ^{+,i} [0.262]
Δp		-0.167 [0.467]						
$p + \Delta p$		2.105 ^{+,c} [0.198]						
D_EC	0.1573 [0.4318]	0.7176 [1.3157]						
$Event$	-0.8115*** [0.1656]	-0.8021*** [0.1760]	-0.5603*** [0.1742]	-0.9777*** [0.2138]	-0.7825*** [0.1784]		-0.7450*** [0.1663]	
$Prev$	-0.1700 [0.3603]	-0.2052 [0.3764]	-2.9799** [1.5232]	0.1682 [0.3999]				
$DurPrev$	-0.0190* [0.0066]	-0.0119* [0.0072]	-0.0305** [0.0127]	-0.0034 [0.7565]	-0.0124** [0.0062]		-0.0123** [0.0060]	
$Dec80$						-0.6531** [0.3112]		-0.6391** [0.3079]
$Dec90$						-1.8486*** [0.6051]		-1.7631*** [0.5723]
$Dec00$						-2.8824*** [0.4378]		-2.7648*** [0.4351]
$LogL$	-39.36	-196.71	-4.45	-28.66	-39.65	-30.37	-194.59	-203.22
$SBIC$	102.55	421.21	21.32	75.89	95.18	81.14	405.06	426.83
$Spells$	53	53	12	41	53	59	53	59

Busts	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
γ	0.0003 [0.0006]	0.0107 [0.0228]	0.0084 [0.0232]	0.0001 [0.0002]	0.0110 [0.0209]	0.0011 [0.0027]	0.1139 [0.4442]	0.0056 [0.0233]
p	2.897 ^{+,c} [0.565]	1.790 [0.552]	2.162 [1.012]	3.214 ^{+,i} [0.639]	1.798 [0.554]	2.418 ^{+,c} [0.755]	1.132 [1.046]	1.945 [1.239]
Δp		1.513** [0.622]			1.298** [0.620]	2.588*** [0.875]	1.677* [1.002]	2.911** [1.166]
$p + \Delta p$		3.303 ^{+,i} [0.633]			3.096 ^{+,i} [0.557]	5.005 ^{+,i} [1.067]	2.810 ^{+,c} [0.635]	4.8553 ^{+,i} [1.141]
D_EC	0.8314 [0.5774]	-4.3129* [2.2745]			-3.9288* [2.2722]	-7.5127** [2.9986]	-5.4491 [3.9241]	-8.7066** [4.1233]
$Event$	-0.4100 [0.6969]	-0.5765 [0.7768]		-0.5521 [0.7440]				
$Prev$	0.1412 [0.5154]	0.3487 [0.4907]		0.7243 [0.4501]				
$DurPrev$	-0.0657** [0.0298]	-0.0576** [0.0266]	-0.1206* [0.0646]	-0.0420* [0.0255]	-0.0742*** [0.0277]		-0.0654** [0.287]	
$Dec80$						-0.7621 [0.5228]		-0.7163 [0.5385]
$Dec90$						-1.0767* [0.5834]		-1.0196* [0.5953]
$Dec00$						-5.0433*** [1.4856]		-4.8452*** [1.5696]
$LogL$	-17.76	-90.41	-4.20	-10.92	-90.95	-78.84	-89.59	-78.36
$SBIC$	56.12	204.85	13.77	37.94	199.08	181.72	196.35	180.75
$Spells$	31	31	6	25	31	31	31	31

Notes: See Table 2. Columns 3 and 4 present separate regression results for the non-European and European countries, respectively. Truncation at the minimum values of Dur is used in the regressions presented in Columns 7 and 8.

Table 4: Duration dependence in normal times: basic Weibull model estimations.

Normal	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
γ	0.0241** [0.0101]	0.0356* [0.0189]	0.0143** [0.0073]	0.0019 [0.0019]	0.0093 [0.0061]	0.0174** [0.0082]	0.0182 [0.0145]	0.0182 [0.0158]	0.0171* [0.0099]	0.0120 [0.0108]	0.0043 [0.0061]	0.0007 [0.0008]	0.0368 [0.0350]	0.0071 [0.0045]	0.0429** [0.0183]
p	1.181 [0.130]	1.176 [0.155]	1.447+, ^d [0.255]	1.613+, ^d [0.196]	1.297+, ^d [0.137]	1.130 [0.132]	1.119 [0.190]	1.119 [0.185]	1.375+, ^d [0.182]	1.581+, ^d [0.195]	1.141 [0.295]	1.454 [0.886]	1.506+, ^d [0.199]	1.590+, ^d [0.163]	1.229+, ^d [0.117]
Δp						0.240** [0.101]	0.256 [0.262]				-0.365 [0.312]				
$p + \Delta p$						1.370+, ^d [0.152]	1.375+, ^d [0.180]				1.506+, ^d [0.203]				
θ			0.412 [0.461]												
D_EC					0.8526** [0.4206]		-0.0639 [0.9825]			0.9863*** [0.3555]	2.2244* [1.2003]			1.0990*** [0.3461]	
$Event$										-0.0610 [0.2066]	-0.5589 [0.2122]	0.2945 [0.4938]	-0.0897 [0.2139]		
$Prev$										-0.3691 [0.4589]	-0.3879 [0.4454]	-5.6961*** [1.9747]	-0.0663 [0.4082]		
$DurPrev$										-0.0353* [0.0189]	-0.0351* [0.0189]	-0.0108 [0.0435]	-0.0368* [0.0198]	-0.0353** [0.0163]	
$Dec80$															-0.6432** [0.2875]
$Dec90$															-0.8940** [0.4546]
$Dec00$															-1.2570*** [0.2943]
$LogL$	-77.08	-195.45	-76.30	-64.96	-73.80	-193.53	-193.53	-20.45	-53.01	-45.22	-127.39	-5.53	-33.60	-45.68	-72.68
$LR\ test$			0.372	0.113											
$SBIC$	162.32	399.06	164.84	207.40	159.82	399.30	403.37	46.31	113.59	113.15	281.28	18.52	84.52	106.50	165.74
$Spells$	59	59	59	59	59	59	59	15	44	44	44	12	32	44	59

Notes: See Table 2 and Table 3. Truncation at the minimum values of Dur is used in the regression presented in Column 2. In Column 3, the p -value of the $LR\ test$ for unobserved heterogeneity/frailty assesses whether the estimated variance (θ) is different from zero or not. In Column 4, the p -value of the $LR\ test$ analyses the statistical significance of country-specific dummy variables (pooling test), that is, $LR = -2(\log L_r - \log L_u)$, where r and u correspond to the restricted and unrestricted models, respectively. Columns 8, 12 and 9, 13 present separate regression results for the non-European and European countries, respectively.

Table 5: Duration dependence in housing booms and busts: Weibull model estimations with change-points.

Booms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
γ_1	0.0427*** [0.0017]	0.0778*** [0.0100]	0.1967 [0.6499]	0.1066*** [0.0292]	0.0841 [0.0652]	0.0769*** [0.0249]	0.1858*** [0.0495]	0.1349 [0.0220]
γ_2	0.0489*** [0.0060]	0.1727** [0.0732]	0.4221 [2.7037]	0.2710 [0.3012]	0.2012 [0.2446]	0.1294 [0.1108]	0.9436 [0.6917]	0.3270** [0.1606]
p_1	2.611 ^{+,i} [0.310]	3.021 ^{+,i} [0.375]	4.942 ^{+,i} [2.340]	2.969 ^{+,i} [0.344]	2.984 ^{+,i} [0.394]	3.495 ^{+,i} [0.434]	2.795 ^{+,i} [0.473]	3.333 ^{+,i} [0.495]
p_2	1.140 [0.155]	1.416 [0.264]	3.081 ^{+,c} [1.144]	1.551 [0.415]	1.410 [0.261]	1.998 ^{+,c} [0.362]	1.376 [0.294]	1.954 ^{+,c} [0.393]
$p_2 - p_1$	-1.472*** [0.395]	-1.605*** [0.542]	-1.860 [2.447]	-1.419** [0.595]	-1.574*** [0.533]	-1.498** [0.641]	-1.419** [0.642]	-1.378** [0.703]
D_EC		0.1188 [0.3710]						
$Event$		-0.7976*** [0.1470]	-0.5118*** [0.1779]	-0.9028*** [0.2017]	-0.7751*** [0.1548]		-0.7549*** [0.1534]	
$Prev$		-0.2495 [0.3447]	-2.4662 [1.650]	0.0142 [0.4428]				
$DurPrev$		-0.0141** [0.0063]	-0.0264** [0.0127]	-0.0076 [0.0227]	-0.0148** [0.0058]		-0.0145** [0.0059]	
$Dec80$						-0.8091** [0.3614]		-0.7806** [0.3591]
$Dec90$						-1.7751*** [0.5461]		-1.7221*** [0.5316]
$Dec00$						-2.7052*** [0.4175]		-2.6331*** [0.4176]
$LogL$	-222.57	-192.22	-40.79	-146.81	-192.62	-201.60	-191.76	-200.92
$SBIC$	451.15	412.24	98.98	319.61	409.07	431.75	403.37	426.31
$Spells$	59	53	12	41	53	59	53	59

Busts	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
γ_1	0.0436*** [0.0021]	0.0653* [0.0377]		0.0342*** [0.0028]	0.0602*** [0.0125]	0.0703*** [0.0053]	0.1177 [0.0734]	0.0317 [0.0312]
γ_2	0.0962 [0.0690]	0.3456 [1.1208]		0.0222* [0.0116]	0.2460*** [0.0896]	0.1826 [0.1339]	0.4202** [0.1798]	0.8421 [0.6743]
p_1	3.930 ^{+,i} [0.617]	4.342 ^{+,i} [0.825]		4.844 ^{+,i} [0.906]	4.258 ^{+,i} [0.800]	4.588 ^{+,i} [0.829]	4.103 ^{+,i} [0.887]	4.552 ^{+,i} [0.861]
p_2	0.541 [0.287]	1.047 [0.517]		1.042 [0.485]	1.028 [0.415]	1.779 [0.851]	0.977 [0.530]	1.780 [0.854]
$p_2 - p_1$	-3.389*** [0.706]	-3.295*** [0.809]		-3.802*** [0.785]	-3.229*** [0.851]	-2.810*** [1.019]	-3.125*** [0.975]	-2.772*** [1.0406]
D_EC		0.5341 [0.5818]						
$Event$		-0.1135 [0.6487]		-0.1428 [0.7088]				
$Prev$		-0.2022 [0.4833]		0.1367 [0.3109]				
$DurPrev$		-0.0474** [0.0231]		-0.0386* [0.0226]	-0.0526** [0.0240]		-0.0510** [0.0252]	
$Dec80$						-0.8066* [0.4908]		-0.8002 [0.4919]
$Dec90$						-1.2413** [0.5834]		-1.2336** [0.5849]
$Dec00$						-3.5881*** [1.1541]		-3.5801*** [1.1586]
$LogL$	-91.70	-86.67		-68.98	-87.28	-82.15	-87.02	-81.11
$SBIC$	193.71	200.81		160.49	191.73	184.90	187.78	184.82
$Spells$	31	31		25	31	31	31	31

Notes: See Table 2 and Table 3. $p_2 - p_1$ is the estimated difference in the duration dependence parameters. Columns 3 and 4 present separate regression results for the non-European and European countries, respectively. The change-point is located at duration equal to 26 quarters for booms (18 for non-European countries - Column 3) as well as for busts (due to the small number of observations, the analysis is not feasible for non-European countries). Truncation at the minimum values of Dur is used in the regressions presented in Columns 7 and 8.

Table 6: Duration dependence in normal times: Weibull model estimations with change-points.

Normal	(1)	(2)	(3)	(4)	(5)	(6)	(7)
γ_1	0.0455*** [0.0063]	0.0690*** [0.0126]	0.0314*** [0.0096]	0.0522*** [0.0083]	0.0419* [0.0239]	0.0600 [0.0433]	0.1160** [0.0501]
γ_2	0.0550*** [0.0197]	0.0597*** [0.0194]	0.0302** [0.0121]	0.0524*** [0.0096]	0.0393** [0.0192]	0.0847 [0.1233]	0.0794** [0.0334]
p_1	1.319 ^{+,d} [0.151]	1.549 ^{+,d} [0.217]	1.283 [0.202]	1.393 ^{+,d} [0.221]	1.546 ^{+,d} [0.185]	1.356 ^{+,d} [0.150]	1.404 ^{+,d} [0.228]
p_2	0.848 [0.269]	1.912 ^{+,c} [0.457]	0.922 [0.318]	1.337 [0.300]	2.041 ^{+,c} [0.441]	0.871 [0.271]	1.995 ^{+,c} [0.294]
$p_2 - p_1$	-0.470 [0.336]	0.363 [0.560]	-0.361 [0.272]	-0.056 [0.364]	0.495 [0.549]	-0.485 [0.334]	0.592 [0.547]
D_EC		1.0406*** [0.4052]			1.1691*** [0.3965]		1.0690*** [0.4079]
$Event$		-0.0506 [0.2075]					
$Prev$		-0.3500 [0.4746]					
$DurPrev$		-0.0354* [0.0190]			-0.0351** [0.0163]		-0.0145** [0.0059]
$Dec80$						-0.5892** [0.3027]	
$Dec90$						-0.7527* [0.4382]	
$Dec00$						-1.2621*** [0.3036]	
$LogL$	-196.21	-127.54	-54.46	-138.86	-127.93	-191.86	-191.76
$SBIC$	404.65	285.36	117.04	289.08	278.57	412.25	403.37
$Spells$	59	44	15	44	44	59	31

Notes: See Tables 2, 3, 4 and 5. Columns 3 and 4 present separate regression results for the non-European and European countries, respectively. The change-point is located at duration equal to 31 quarters (29 for non-European countries and 21 for European countries). Truncation at the minimum value of Dur is used in the regression presented in column 7 (convergence is not achieved when the dummies for decades are included).

Table 7: Sensitivity analysis: Housing booms.

Booms	euro area			Anglosphere		
	(1)	(2)	(3)	(4)	(5)	(6)
γ_1	0.0067** [0.0033]	0.0040* [0.0021]	0.0772*** [0.0097]	0.0060 [0.0042]	0.0123* [0.0072]	0.0790 [0.6946]
γ_2			0.1724*** [0.0657]			0.1701 [0.1600]
p_1	2.141 ^{+,c} [0.161]	2.289 ^{+,c} [0.187]	3.036 ^{+,i} [0.367]	2.202 ^{+,c} [0.212]	2.067 ^{+,c} [0.194]	3.052 ^{+,i} [0.407]
p_2			1.411 [0.266]			1.477 [0.303]
Δp		-0.266 [0.273]			1.137** [0.558]	
$p + \Delta p$		2.023 ^{+,c} [0.210]			3.204 ^{+,i} [0.545]	
$p_2 - p_1$			-1.625*** [0.542]			-1.576*** [0.550]
<i>Euro</i>	0.2132 [0.3181]	1.1351 [0.9047]	0.2375 [0.2999]			
<i>Anglox</i>				0.5479** [0.2664]	1.1019* [1.7430]	0.4276 [0.2950]
<i>Event</i>	-0.8074*** [0.1516]	-0.7968*** [0.1506]	-0.7986*** [0.1370]	-0.8261*** [0.1805]	-0.9035*** [0.1989]	-0.8206*** [0.1645]
<i>Prev</i>	-0.1626 [0.3713]	-0.1907 [0.3846]	-0.2439 [0.3403]	-0.0832 [0.4319]	-0.0054 [0.4482]	-0.1613 [0.4134]
<i>DurPrev</i>	-0.0118* [0.0063]	-0.0120 [0.0064]	-0.0142** [0.0060]	-0.0169*** [0.0064]	-0.0232*** [0.0072]	-0.0184*** [0.0061]
<i>LogL</i>	-39.18	-196.34	-191.92	-38.42	-193.92	-191.63
<i>SBIC</i>	102.18	420.47	411.64	100.65	415.63	415.03
<i>Spells</i>	53	53	53	53	53	53

Notes: Robust standard errors are reported in square brackets. See Tables 2-6 for further details. Columns 1-3 present results with a dummy variable for the euro area countries; Columns 4-6 report similar regressions with a dummy variable for the Anglo-Saxon countries. The results in Columns 1-2 and 4-5 are from a basic Weibull specification, while in Columns 3 and 6 they are based on a Weibull model with a change-point.

Table 8: Sensitivity analysis: Housing busts.

Busts	euro area			Anglosphere		
	(1)	(2)	(3)	(4)	(5)	(6)
γ_1	0.0007 [0.0014]	0.0020 [0.0033]	0.0629*** [0.0123]	0.0004 [0.0008]	0.0005 [0.0009]	0.0657*** [0.0128]
γ_2			0.3456 [0.4044]			0.3740 [0.4006]
p_1	2.765 ^{+,c} [0.548]	2.322 ^{+,c} [0.399]	4.249 ^{+,i} [0.805]	2.885 ^{+,c} [0.547]	2.829 ^{+,c} [0.567]	4.360 ^{+,i} [0.788]
p_2			0.951 [0.470]			1.026 [0.466]
Δp		1.726* [1.018]			0.453 [1.601]	
$p + \Delta p$		4.048 ^{+,i} [1.261]			3.282 ^{+,c} [1.555]	
$p_2 - p_1$			-3.298*** [0.815]			-3.334*** [0.819]
<i>Euro</i>	0.0318 [0.3583]	-5.5735* [3.1201]	-0.0728 [0.3795]			
<i>Anglox</i>				0.9818** [0.4849]	-0.3798 [4.9361]	0.8566 [0.6004]
<i>Event</i>	-0.0205 [0.6479]	-0.1306 [0.6128]	0.1231 [0.5859]	0.1902 [0.6591]	0.2071 [0.6724]	0.3059 [0.5859]
<i>Prev</i>	-0.0651 [0.4596]	0.6725 [0.7125]	-0.3399 [0.4254]	-0.1542 [0.4586]	-0.1666 [0.4559]	-0.4322 [0.4328]
<i>DurPrev</i>	-0.0810*** [0.0315]	-0.0825** [0.0368]	-0.0542** [0.0246]	-0.0888*** [0.0339]	-0.0877*** [0.0333]	-0.0614** [0.0265]
<i>LogL</i>	-18.58	-91.01	-87.04	-17.43	-91.68	-86.17
<i>SBIC</i>	57.75	206.05	198.11	55.47	207.39	196.37
<i>Spells</i>	31	31	31	31	31	31

Notes: Robust standard errors are reported in square brackets. See Tables 2-6 for further details. Columns 1-3 present results with a dummy variable for the euro area countries; Columns 4-6 report similar regressions with a dummy variable for the Anglo-Saxon countries. The results in Columns 1-2 and 4-5 are from a basic Weibull specification, while in Columns 3 and 6 they are based on a Weibull model with a change-point.

Table 9: Sensitivity analysis: Normal times.

Normal	euro area			Anglosphere		
	(1)	(2)	(3)	(4)	(5)	(6)
γ_1	0.0292 [0.0245]	0.0318 [0.0297]	0.1278** [0.0539]	0.0388 [0.0346]	0.0519 [0.0464]	0.0945** [0.0417]
γ_2			0.1313 [0.0883]			0.0874* [0.0510]
p_1	1.477 ^{+,d} [0.187]	1.445 ^{+,d} [0.260]	1.481 ^{+,d} [0.217]	1.500 ^{+,d} [0.186]	1.398 ^{+,d} [0.196]	1.488 ^{+,d} [0.213]
p_2			1.452 ^{+,d} [0.340]			1.603 ^{+,c} [0.450]
Δp		0.072 [0.335]			0.416 [0.278]	
$p + \Delta p$		1.518 ^{+,d} [0.239]			1.814 ^{+,c} [0.243]	
$p_2 - p_1$			-0.029 [0.434]			0.116 [0.545]
<i>Euro</i>	0.3685 [0.3414]	0.1448 [1.1473]	0.3667 [0.3373]			
<i>Anglo</i>				-0.5563 [0.4132]	-1.9323 [1.1319]	-0.5716 [0.4542]
<i>Event</i>	-0.0359 [0.2183]	-0.0363 [0.2171]	-0.0372 [0.2195]	-0.0780 [0.2196]	-0.0539 [0.2215]	-0.0749 [0.2197]
<i>Prev</i>	-0.6538 [0.4478]	-0.6371 [0.4672]	-0.6541 [0.4508]	-0.5512 [0.4834]	-0.5868 [0.4762]	-0.5463 [0.4961]
<i>DurPrev</i>	-0.0321* [0.0189]	-0.0318* [0.0194]	-0.0321* [0.0189]	-0.0309 [0.0193]	-0.0320* [0.0191]	-0.0309 [0.0192]
<i>LogL</i>	-47.43	-129.81	-129.83	-47.00	-129.02	-129.39
<i>SBIC</i>	117.56	286.12	286.15	116.71	284.54	285.27
<i>Spells</i>	44	44	44	44	44	44

Notes: Robust standard errors are reported in square brackets. See Tables 2-6 for further details. Columns 1-3 present results with a dummy variable for the euro area countries; Columns 4-6 report similar regressions with a dummy variable for the Anglo-Saxon countries. The results in Columns 1-2 and 4-5 are from a basic Weibull specification, while in Columns 3 and 6 they are based on a Weibull model with a change-point.

B List of Figures

Figure 1: Real housing prices, booms, busts and normal times.
Australia Belgium

Notes: Booms and busts episodes are identified using the methodology proposed by Burnside et al. (2011). Dark shaded areas denote bust phases while light shaded regions indicate boom phases. The vertical axis denotes the index. The horizontal axis corresponds to time.

Figure 1: Real housing prices, booms, busts and normal times (cont.).
Finland

Germany

Greece

Notes: Booms and busts episodes are identified using the methodology proposed by Burnside et al. (2011). Dark shaded areas denote bust phases while light shaded regions indicate boom phases. The vertical axis denotes the index. The horizontal axis corresponds to time.

Figure 1: Real housing prices, booms, busts and normal times (cont.).
Ireland

Japan

Korea

Notes: Booms and busts episodes are identified using the methodology proposed by Burnside et al. (2011). Dark shaded areas denote bust phases while light shaded regions indicate boom phases. The vertical axis denotes the index. The horizontal axis corresponds to time.

Figure 1: Real housing prices, booms, busts and normal times (cont.).
 Netherlands
 New Zealand

Norway

Spain

Notes: Booms and busts episodes are identified using the methodology proposed by Burnside et al. (2011). Dark shaded areas denote bust phases while light shaded regions indicate boom phases. The vertical axis denotes the index. The horizontal axis corresponds to time.

Figure 1: Real housing prices, booms, busts and normal times (cont.).
Sweden

UK

US

Notes: Booms and busts episodes are identified using the methodology proposed by Burnside et al. (2011). Dark shaded areas denote bust phases while light shaded regions indicate boom phases. The vertical axis denotes the index. The horizontal axis corresponds to time.

Figure 2: Survivor functions: booms,busts and normal times in the housing market.

Booms

Busts

Normal times