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HOUSE PRICE CYCLES IN EUROPE

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Abstract

This paper examines the house price dynamics for thirteen European countries. A Markov-switching error correction model is estimated on house price returns at the country level, with deviations between house prices and fundamentals feeding into the short-run dynamics. The system is assumed to be in either a stable regime, in which deviations from the long-run equilibrium tend to vanish over time, or in an unstable regime, in which no such correction takes place. The analysis yields three sets of results. First, house price returns in Europe are generally characterized by three (high, medium and low) phases; growth rates within regimes differ largely across countries. Second, for some European countries the observed high growth phases are associated with a stable regime. Third, European housing markets have been more in sync with each other since 2000 following a growing trend in the time-span $2002-2006$ and a dramatic downturn after the Lehman collapse in 2008 and during the Euro area sovereign debt crisis.

Keywords: House prices, Markov-switching and Error-correction models.
JEL Classification Numbers: G12, R11 and R31

1 Non-technical summary

Housing markets are historically prone to boom and bust episodes. A striking case in point is the Ireland and Spain housing market, where the current marked downturn was preceded by a prolonged rise in house prices which began in the late 1990s. Some US State housing markets - including those in California and Florida - experienced a similar pattern. The role of house prices as a cause of the financial crisis of $2007 - 2009$ has been a major topic of discussion among policy makers and academia researchers. Housing booms form gradually and may burst suddenly, producing detrimental effects on financial intermediaries, households, and indeed the economy as whole.

In this paper, we focus our attention on Europe which has experienced big swings in house prices in the last decades. This paper contains an econometric model designed to assess housing market cycles in Europe separating the high- and low-growth rates phases. The objective is to identify the different phases with the corresponding growth rates and to assess whether a high growth phase is associated with episodes in which house prices differ markedly from what would be implied by the underlying economic fundamentals. We intend to document both a wide variety of country-level experiences and situations in which housing markets exhibit similar behaviors.

The model is applied to 13 countries in the European Economic Area (including 8 euro area countries) in which the mean rate of house price growth was to switch between three regimes (high-, medium- and low-growth). The model first establishes a long-run equilibrium relationship between house prices and macro-fundamentals at the country level, while the various regimes apply to the short-run dynamics of house price changes around these long-term relationships. The country-specific factors influencing house prices include disposable income, long-term interest rate and unemployment rate. The model produces estimates of the time-varying probabilities of being in a given regime at each point in time and it allows identifying the housing market cycle. Based on this probability for each country, the model allows for a construction of indicators aiming to measure to what extent the high- and low-growth phases of housing markets across Europe are synchronized with each other.

An application of this approach suggests considerable synchronization of both high- and low-growth phases. In particular, housing markets across various European countries seem to have become more synchronized with each other since the 2000s, a trend equally applying to the pre- and post-global financial crisis phase. First, in the run-up to the global financial crisis European housing markets were generally on an upward trend. Approximately 46% of the countries were in a high-growth regime and the remaining countries were in a medium-growth regime. In this period, based on our housing returns *concordance indicator*, Belgium, Denmark, France, Ireland, Spain and Sweden were in the same high-growth regime. Different to the time span $2008-2012$, which is characterized by the "great financial crisis" and the subsequent Euro Area Sovereign crisis, where approximately 40% of the countries were in a low-growth regime and the remaining in a medium-growth regime.

2 Introduction

Housing markets are historically prone to boom and bust episodes. A striking case in point is the Ireland and Spain housing market, where the current marked downturn was preceded by a prolonged rise in house prices which began in the late 1990s. Some US State housing markets - including those in California and Florida - experienced a similar pattern. The role of house prices in the financial crisis of $2007-2009$ is a major topic of discussion among policy makers and academia researchers. Housing booms form gradually over time and may burst suddenly, producing detrimental effects on financial intermediaries, households, and indeed the economy as whole.

Understanding the dynamics of house prices is crucial for at least three reasons. First, the effect of fluctuations in house prices on residential investment might be substantial. The unravelling of the huge construction booms in Ireland and Spain is having a major impact on the growth rates of these economies. Second, a period of large declines in house prices is very often followed by an increase in the rate of mortgage defaults, which has an adverse effect on banks' profits (see Allen, Madura, and Wiant (2009) and Gan (2007)). The reduction in profitability may lead to the failure of banks and other real estate lenders and a subsequent slowdown in economic activity (see Ghent and Owyang (2010)). Third, the behavior of house prices is also important because its impact on household wealth composition. Case, Quigley, and Shiller (2001) present statistical evidence that a 10% rise in housing wealth would lead to a 1.1% increase in consumption. Corradin, Fillat, and Vergara-Alert (2012) exploit the wide variety of high- and low-growth phases across US States and document that some US states, such as California and Florida, switched from a low to a persistent high growth phase. Using household level data from the PSID and SIPP survey, they provide evidence that switching from a low to a persistent high growth phase affects the probability of buying a new house and conditional on moving increases the housing investment. Moreover, a high-growth phase decreases the participation in the stock market investment.

Econometric work can be of crucial importance for understanding what happened to house prices and can contribute to detecting overvaluation and subsequent destabilizing crashes, the ramification of which were seen in the recent financial crisis. In this paper, we focus our attention to the Europe that has experienced big swings in house prices in the last decades. This paper contains an econometric model designed to assess housing markets cycles in Europe separating the high- and low-growth rates phases. The objective is to identify the different phases with corresponding growth rates and to assess whether a high growth phase is associated with episodes in which house prices differ markedly from what would be implied by underlying economic fundamentals. We intend to document a wide variety of country-level experiences and situations in which housing markets exhibit similar behaviors.

The approach chosen is to use a Markov-switching model to characterize changes in the parameters of an error correction model. A two-stage estimation procedure is applied. In the first stage, a long-run equilibrium relationship between house prices and macroeconomic fundamentals is estimated applying a panel dynamic OLS estimation. We link house prices to (i) disposable income, (ii) long term interest rate, and (iii) unemployment rate. Duca, Muellbauer, and Murphy (2010) suggest that credit conditions play a key role in driving real house prices, but such information is only available for a limited number of European countries in recent years. In the second stage, we follow Hall, Psadarakis, and Sola (1997) where deviations between house prices and fundamentals feed into the short-run dynamics of house price returns and expected house price growth rates switch between regimes. The system is assumed to be in either a stable regime, in which deviations from the long-run equilibrium tend to vanish over time via a conventional error-correction mechanism, or in an unstable regime, in which no such corrections take place. The primary purpose is determining the probability of being in the regime associated with the highest and the lowest housing return. In addition, the model allows us to construct indicators aiming to measure to what extent European housing markets' high- and low-growth phases have been synchronized with each other.

The model has been estimated for thirteen European countries on a country-by-country basis, despite the fact that available time series of house price indexes are relatively short and the methodologies of constructing the indexes as well as frequencies of observations are quite heterogeneous. The sample comprises: Belgium, Denmark, Finland, France, Germany, Norway, Ireland, Italy, Spain, Sweden, Switzerland, The Netherlands and United Kingdom (UK). The paper contains extended examination of Ireland, UK and Spain, whose housing market developments have recently drawn the attention of policy makers and media, and summary results for the rest of the sample. The analysis yields three set of results. First, house price returns in Europe are generally characterized as having three (high, medium and low) phases, each with its own growth rate. We document a wide variety of country-level experiences. We cannot refer generally to country level high phases as booms, as is done when describing the country business cycle. For some countries, such as UK and Ireland, the high-growth phases can be associated with booms, while for others the high growth phases are characterized by modest growth in house prices. Second, for some countries the observed high and low growth phases are associated with a stable regime. Third, starting in 2000s European housing markets are more synchronized. In the time span $2002 - 2006$ European housing markets were generally on a growing trend. Approximately 46% of the countries were in a high-growth regime and the remaining countries were in a medium-growth regime. In this period, based to our housing returns *concordance indicator*, Belgium, Denmark, France, Ireland, Spain and Sweden were in the same high-growth regime. Different to the time span $2008 - 2012$, which is characterized by the "great financial crisis" and subsequently by the Euro Area Sovereign crisis, approximately 40% of the countries were in a low-growth regime and the remaining in a medium-growth regime.

2.1 Review of literature

Literature on the determinants of house prices is vast. Before the financial crisis of $2007 - 2009$, it was common to use linear models to examine the relationship between macro-economic variables and the dynamics of house prices. Papers generally applied regression analysis to evaluate how growth in real house prices is driven by economic factors including interest rates, inflation, unemployment rate and economic growth (i.e., see Englund and Ioannides (1997), Tsatsaronis and Zhu (2004) and Glindro et al. (2011)).

Recent empirical literature on housing markets recognizes the importance of cyclical patterns in house prices. Muellbauer and Murphy (1997) explicitly refer to boom and busts in house prices. Hall, Psadarakis, and Sola (1997) provide evidence on UK data that the observed booms in house prices are associated with a regime where deviations from long-run equilibrium have no stabilizing effect on house price dynamics. Ceron and Suarez (2006) examine the experience of fourteen developed countries covering a period of about thirty years ($1970 - 2003$). They model house price dynamic as a combination of a country specific component and a cyclical component common to all countries. They find that a cyclical component, postulated as a 2-regime Markov switching process with parameters common to all the countries, features high and low volatility phases that are quite persistent. While a common factor affecting house prices of various countries sounds plausible, this mechanism hoverer cannot explain the scale of fluctuations we saw in some countries at the beginning of 2000s. Instead, our paper studies the dynamics of house prices with a specific focus on country developments.

Owyang et al. (2008) estimate a Markov-switching model to US cities separating a city's growth path into high and low phases. They document that growth in a high phase is related both to human capital and industry mix, while growth in a low phase is related to industry mix, specifically the relative importance of manufacturing. Hernandez-Murillo, Owyang, and Rubio (2013) estimate a clustered Markov switching model on a panel of US cities allowing for idiosyncratic departures from the national cycle. They find that cities do not form housing regions in the traditional-geographic sense. Instead, similarities in factors affecting the demand for housing, such as the unemployment rate, appear to be more important determinants of cyclical co-movements than similarities in factors affecting the supply of housing, such as housing density and geographic constraints in the availability of developable land.

This paper is organized as follows. Section 3 discusses the data. Sections 4 describes the model. Section 5 presents the results of the empirical analysis. Section 6 concludes.

3 Data

We link house prices to the following three observable determinants: (i) disposable income capturing the affordability of house purchases; (ii) long term interest rates affecting mortgage interest rates and then capturing the cost of financing house purchases; and (iii) unemployment rate capturing the general economic climate. We collect quarterly (seasonally unadjusted) data on house prices P, personal disposable income Y, government interest yield R and unemployment rate U for thirteen countries: Belgium, Denmark, Finland, France, Germany, Norway, Ireland, Italy, Spain, Sweden, Switzerland, The Netherlands and UK. These covariates have been selected for the following two reasons. First, because of their significant contribution to the dynamics of house prices documented in literature. Second, because these are the main economic variables available for all of the European countries taken into consideration. We adjust house prices and disposable income for core inflation, which measures inflation in the personal consumption expenditure basket. Table 1 reports the data sources for each variable.

[INSERT TABLE 1 HERE]

An increase in the long-term interest rate is expected to drive borrowing rates up, thus increasing the cost of servicing mortgages. This would, in turn, lead to a decrease in demand for properties and a subsequent fall in house prices. Growth in real disposable income is expected to have a positive impact on housing markets while the effect of unemployment should be negative.

Table 2 reports a set of summary statistics of the real house prices and the covariates and, at the bottom of the table, the number of quarterly observations per country.

Lower-case letters refer to variables that stand for natural logarithms of the corresponding capitalized variables and Δ denotes the first-difference operator. From the table, it is clear that the average real growth in house prices is modest, varying from a -0.3% to 1.1% per quarter. The distribution of housing returns on investing in the housing market is negatively skewed for some countries, such as Belgium, Finland and France, thus implying that it has a longer left tail. Moreover, the distribution of house price growth is leptokurtic (i.e., kurtosis greater than 3), which implies that the data is highly concentrated around the mean. The mean real growth in disposable income varies from -0.1% to 0.9%. The greatest drop in income in our sample is 22.8% for Norway. As for the interest rate, its average change varies from -10.9 to -1.6 basis points. Finally, the average change in unemployment is generally positive. Effective estimation samples are adjusted to accommodate data availability for each specific country.

[INSERT TABLE 2 HERE]

4 Methodology: Error-correction model with Markov-switching

The approach chosen is to use a Markov-switching model to characterize changes in the parameters of an error correction model. A two-stage estimation procedure is applied. In the first stage, a long-run equilibrium relationship between house prices and macroeconomic fundamentals is estimated.[1] In the second stage, deviations between house prices and fundamentals feed into the short-run dynamics of housing returns where expected growth rates switch between regimes.

Specifically, we follow Stock and Watson (1993) to estimate the long run relationship between real house prices and macro fundamentals in the first stage. They provide a

[1]The existence of a cointegration relationship between the levels of variables characterized by a unit-root (i.e., $I(1)$) means that a linear combination of these variables is stationary. Cointegrated variables move together in the long run, but may deviate from each other in the short run, which means they follow an adjustment process towards the equilibrium condition. A model that considers this adjustment process is the Error Correction Model (ECM).

very simple method for obtaining an asymptotically efficient estimator for the normalized cointegrating vector β augmenting the cointegrating regression of house prices on the macro variable with leads and lags of the changes in the macro-variables themselves. The technique aims to obtain efficient estimators for the co-integrating vectors involving deterministic components and accommodates varying orders of integration and the possible simultaneity among variables. To anchor the coefficients of the long run relationship more firmly, we estimate an unbalanced panel regression with country fixed effects. The efficient estimation procedure is:

$$p_{i,t} = \gamma + \omega_i + \beta x_{i,t} + \sum_{j=-k}^{k} \psi_j \Delta x_{i,t-j} + z_{i,t}, \tag{1}$$

where i denotes the country, x is the set of the macro variables (y, R, U) and ω_i is the country fixed effect. We estimate the augmented regression by least squares and we derive the error correction term $\hat{z}_{i,t}$.

In the second stage, we follow Hall, Psadarakis, and Sola (1997) and estimate the dynamics for the real housing returns for each country i, characterized by the following Error Correction Model (ECM):

$$\Delta p_{i,t} = \mu_{i,s_t} + \sum_{j=1}^{3} d_{i,.,j} D_j + \alpha_{i,s_t} \hat{z}_{i,t-1} + \sum_{j=0}^{p} \gamma_{i,j} \Delta x_{i,t-j} + \sigma_i \epsilon_{i,t}, \tag{2}$$

where the mean rate of house price changes μ_{s_t} and the adjustment coefficient α_{s_t} switch between regimes. The dynamic of the underlying regime s_t follows a homogenous first order Markov chain. In the 2-regime case, let us assume that the mean rate of house price changes takes two values: $\mu_{i,h}$ high-growth and $\mu_{i,l}$ low-growth. Thus, the adjustment coefficient, α_l (low-growth regime) and α_h (high-growth regime), identifies how house prices react to deviations from values implied by underlying economic fundamentals. When the adjustment coefficient is negative and significant, house prices react to temporary deviations and tend to revert back to their equilibrium values; opposed to when the adjustment coefficient is positive and significant the error tends to explode and house prices tend to increase or decrease abnormally. Finally, when the adjustment coefficient is not significant, house prices move independently from the deviations from equilibrium, therefore error correction does not take place.

An important issue in estimating regime switching models is specifying the number of regimes. This is often difficult to determine from data and the choice should be based on economic arguments (see Ang and Timmermann (2011)). It is not uncommon to simply fix the number of regimes, typically at two or three. House price indexes in some European countries recently experienced a sharp appreciation immediately followed by a sharp depreciation (see Ireland and Spain) and we aim to infer periods where house prices grew markedly. As a consequence, we estimate a Markov-switching model on house prices returns to establish whether 2 or 3-regime specification is more appropriate for each country and we implement a series of tests to determine the most appropriate specification (see the Appendix). In the 2 regime case, we have a mean rate of house price changes associated to a low- and high-growth regime, while in 3 regime case we have a mean rate of house price changes associated to a low-, medium- and high-growth regime. Overall, the housing returns are captured well by a 3-regime switching model, but we leave the discussion of country-specific experiences to the empirical section. After pinning down the number of regimes, we allow the seasonal parameters, $d_{i,\cdot,j}$, to be regime-dependent in the equation (2). We test these linear restrictions using the Wald tests. Finally, we determine the number of the lags for the macro variables $\Delta x_{i,t-j}$ maximizing the likelihood function.

An alternative approach for the second stage would be to infer common Markov-switching regimes in a unbalanced panel data-set with large cross-section and time-series dimensions. However, this approach raises several challenges regarding how to explicitly model European countries house prices similarities and is outside the scope of this paper.

5 Empirical analysis

Table 3 reports the panel estimates of the dynamic OLS (equation (1)) for the thirteen European countries (first stage).[2] Coefficients of the explanatory variables are statistically significant and with the expected sign: positive for the disposable income, negative for the interest rate and for the unemployment rate.

[INSERT TABLE 3 HERE]

Based on the panel estimates, we derive the error correction term for each country i, $\hat{z}_{i,t}$. Thus, we estimate the short run regression (2).[3] Table 4 reports the results of the maximum likelihood estimation of the Markov-switching ECM presented in Section 4.

[INSERT TABLE 4 HERE]

Table 5 proposes a country-by-country regime classification exercise. We report the average and standard deviation of the real annual housing returns in each regime. Then, we report the sign of the adjustment coefficient α_{i,s_t}, $+$ (positive sign) or $-$ (negative sign), when it is significant at least at the 10% level, to identify whether house prices tend to explode (positive sign) or revert back (negative sign) to their equilibrium values in each regime. Finally, we report the expected duration, in years, and the frequency of each regime.

[2] In Table 3, we report Newey-West HAC standard errors.

[3] Before estimating regression (2), we verify whether real house prices, real personal disposable income, government interest rate and unemployment rate are cointegrated variables. We test for cointegration in the following two ways. First, we apply the standard unit-root stationarity test to the residuals of the long run regression (1) by mean of the Augmented Dickey Fuller Test:

$$\Delta \hat{z}_{i,t} \quad = \quad a_{i,0} + a_{i,1} \times t + \beta_i \hat{z}_{i,t-1} + \sum_{j=1}^{K} \gamma_{i,j} \Delta \hat{z}_{i,t-1} + e_{i,t}. \tag{3}$$

Rejection of $\beta_i = 0$ means that $z_{i,t}$ has no unit root, so that the variables. In this case, the OLS estimator is super consistent and there are no spurious regression problems when we estimate the vector of parameters α in equation (2). Second, we implement the multivariate Johansen cointegration test (see Johansen (1991)) and by mean of the "Trace test" we find that there is only one cointegration vector. This allows us to use the more simple univariate ECM rather than the multivariate version. We do not report these results, but more information about this analysis can be provided upon request.

[INSERT TABLE 5 HERE]

In the next subsection, we will discuss country specific experiences based on the results of the estimates of the ECM with Markov-switching parameters at the country-by-country level. The main focus is on Ireland, Spain and UK because the recent steep rise and the subsequent downward correction in house prices in these countries has received a lot of attention in the media and among policy makers. Results for other countries will be presented in a summary manner.

In subsection 5.2, we propose a house price indicator for capturing common patterns in high- and low-growth regimes across European countries. The objective is to investigate whether house price cycles have become more synchronized across European countries recently.

5.1 Country case analysis

5.1.1 Ireland

Figure 1.a depicts the pronounced cyclicality in the quarterly real house price returns for Ireland for the period $1981 - 2012$. A model specification that allows three regimes (high-, medium- and low-growth) appears to capture the dynamics of house prices well. The same figure shows the error correction term $\hat{z}_{t-1}$ measuring deviations of house prices form the equilibrium relation (dotted line). Figure 1.b depicts the inferred smoothed probability of being in the regime associated with the high and low mean growth rate (the medium one is the complement).

[INSERT FIGURE 1 HERE]

Three pronounced high growth phases in $Q1{-}1982/Q3{-}1990$, $Q2{-}1996/Q1{-}2001$ and $Q4 - 2002/Q2 - 2007$ stand out markedly. Overall, high growth phases occur relatively frequently, characterizing approximately 59.7% of the sample, and tend to have a long duration, on average 6.1 years (see Column 9 of Table 5). The more recent episodes

$Q2-1996/Q1-2001$ and $Q4-2002/Q2-2007$ are characterized in particular by persistent and long lived appreciation. Such prolonged appreciation in house prices was followed by a substantial market downturn in house prices starting in the third quarter of 2007 with an annual mean growth rate of -18.5% (see Column 1 of Table 5). Most of the time, the probability of a certain regime is approximately either 0% or 100%, meaning that the model clearly identifies the regimes.

Table 4 reports the results of the maximum likelihood estimation of the Markov-switching error correction model presented in Section 4. An increase in disposable income has a positive and significant impact on house price changes with a coefficient of 0.087. The interest rate coefficient is negative but not significant, -0.001. The increase of unemployment rate has a negative and significant impact, -0.009.

The estimate of the adjustment coefficient is such that disequilibrium corrections take place only in the medium and high growth phase, -0.219 and -0.141 respectively (see Columns 5 and 6 of Table 5). Figure 1.a shows that the two high depreciation periods in $Q1-2001/Q4-2001$ and in $Q4-2006/Q4-2012$ were preceded by situations in which house prices were growing substantially.

Overall, the housing market in Ireland is characterized by periods of high appreciation and depreciation in house prices that tend to last, as seen in the last two recent episodes: $Q4-2002/Q2-2007$ (high-regime) and $Q1-2008/Q4-2012$ (low-regime).

5.1.2 Spain

Figure 2.a shows the dynamics of quarterly real house price returns over the period 1988/2012 in Spain (continuous line), which is well captured by a model specification that allows two regimes (high- and low-growth). In addition, the same figure shows the error-correction term $\hat{z}_{t-1}$ (dotted line) measuring deviations of house prices from the long-run equilibrium relations. Figure 2.b shows the inferred smoothed probability that the system was in a high-growth phase (continuous line).

[INSERT FIGURE 2 HERE]

House prices increased substantially throughout the period considered with a historical annual real mean growth rate of 11.3% (see Column 3 of Table 5). Two episodes of pronounced house price appreciation, $Q1-1988/Q2-1992$ and $Q4-2001/Q1-2007$, stand out particularly markedly and these episodes tend to be long lasting. The high-growth phase characterizes approximately 39.8% of the sample. Interestingly, high depreciation over the period $Q2-2007/Q4-2012$ was preceded by situations in which house prices were growing substantially. This latter episode is characterized by large positive deviations between house prices and macroeconomic fundamentals.

Table 4 reports the results of the maximum likelihood estimation of the Markov-switching error correction model. A contemporaneous increase of the disposable income has a positive and significant impact on house price changes. The increase of unemployment has a negative and significant impact, -0.012 , while a contemporaneous change in the interest rates has no effect on house prices.

The estimates of the adjusted coefficient are quite informative (see Columns 4 and 6 of Table 5). The adjustment coefficients are negative and significant in both regimes, suggesting the error has a price correcting-effect that links prices to fundamentals. Overall, the results are consistent with those obtained by Pages and Maza (2003). Using the same annual data over the period 1977/2002, they provide evidence that income and nominal interest rates are key determinants of house prices in Spain. Interestingly, they suggest that house prices were substantially above their long-term equilibrium at the end of their sample. According to our estimates (see the probability of being the high-growth regime Figure 2.b), that boom episode lasted up to 2007. Overall, the housing market in Spain tends to swing between high appreciation periods and high depreciation periods.

5.1.3 UK

Figure 3.a shows the pronounced cyclicality in the quarterly real house price returns (continuous line) for the UK that is captured quite well by mean of a model specification that allows three regimes: high, medium and low growth phases. It also shows the time-series dynamics of the error-correction term $\hat{z}_{t-1}$ (dotted line). Figure 3.b shows the inferred smoothed probabilities that the system was in a high (continuous line) or low (dotted line) growth regime (the medium one is the complement). Most of the time, the probability of a certain regime is approximately either 0% or 100%, meaning that the model clearly identifies the three different regimes. The sample period extends from $Q1 - 1963$ to $Q4 - 2012$.

[INSERT FIGURE 3 HERE]

The first identified regime characterizes the periods $Q3 - 1973/Q2 - 1978$, $Q4 - 1989/Q1 - 1996$ and $Q1 - 2008/Q1 - 2009$ and is associated with a low growth phase, where house prices declined on average at a rate of about 9% (see Column 1 of Table 5). The second regime is associated with a medium-growth phase in which prices grow at real annual rate of 4.7%. The third regime characterizes the periods $Q3 - 1971/Q4 - 1973$, $Q2 - 1978/Q4 - 1979$, $Q2 - 1988/Q1 - 1989$ and $Q2 - 2002/Q2 - 2004$ and associated with a high-growth phase in which prices grew at an annual rate of 208%. These high growth phases were previously identified with booms in the UK housing market (see Muellbauer and Murphy (1997) and Hall, Psadarakis, and Sola (1997)). The medium-growth phase characterizes 59.8% of the sample while the high- and low-growth phases about 28.4% and 11.9% respectively (see Columns $7 - 9$ of Table 5). The high-growth phases occur more often but have a shorter average duration, approximately 1 year, while the low one lasts about 2.3 years on average.

Table 4 reports the maximum likelihood estimates. An increase of the disposable income has, in general, a significant and positive impact on house price changes with a coefficient of 0.115. The interest rate coefficient is significant and has a negative impact on house prices, -0.006. The increase of unemployment has a negative impact, the coefficient is -0.024.

The estimates of the adjusted coefficient in the low-growth phase is such that disequilibrium corrections take place, in fact it is very significant and negative -0.056 (see Table 4). In the medium and high one, the adjustment coefficient is not statistically significant (see Columns 5 and 6 of Table 5). Hence, deviations from the long run equilibrium appear not to affect changes in real house prices; this might be due to the fact that prices exhibit minor fluctuations and not significant impact can be econometrically detected. From an economic point of view it means that house prices are not deviating from the equilibrium in a persistent way.

Figure 3.a shows the quarterly real house price returns (continuous line) and the time-series dynamics of the error-term $\hat{z}_{t-1}$ (dotted line). It is interesting looking at the relation between returns and price deviations. For example, house prices were increasing in a sustainable way over the period $Q2-1971/Q4-1973$, as the error term was negative. Unlike, the high depreciation episode, $Q4-1989/Q3-1996$, which followed a period in which the error term was largely positive, this means that prices where persistently higher to that implied by underlying fundamentals. A large error appears to be a clear warning signal. Overall, high-growth phases in UK tend to occur relatively frequently, but tend to be short in duration.

We extend the analysis provided by Hall, Psadarakis, and Sola (1997), which covers the period 1966/1995, and we also include the house price decline of the period 2007/2009. Similarly, our analysis shows that high appreciation is most likely associated with an unstable regime where the correction is such that house prices persistently increase beyond fundamentals. Interestingly, we find price depreciations to be linked to the deterioration of the underlaying fundamentals.

5.1.4 Other European countries

Overall, housing returns for most European countries are well captured by a 3-regime switching model and the mean growth rate in each regime is accurately portrayed. The only exception are Norway and Spain whose housing returns are modeled using a 2-regime specification. The Appendix discusses in more detail how we determine the number of regimes and which tests we implement to guide our decision.

Our analysis provides evidence that European countries markedly differ in the levels and spread between their high-, medium- and low-growth phases (see Columns $1-3$ of Table 5). We cannot generalize high-growth periods across the European countries as regimes where house prices markedly grow. For some countries, like the UK, the high-growth regime displays real growth rates of 20% on an annual basis while for others, such as Germany and Norway, the high-growth regimes are characterized by modest growth in house prices with an annual mean real growth rate of 7.5% and 5.3% respectively. Some European countries, such as Ireland and Norway, experienced low-growth phases characterized by dramatic market downturns with mean growth rates of -18.5% and -23.3% respectively.

For most countries, we classify the regimes according to the sign of the adjustment coefficient of the error correction term $\hat{z}$. We find both positive and negative signs in the high-growth regime. When the adjustment coefficient is positive, house prices tend to increase or decrease abnormally. According to our estimates, the high-growth regime of France, Norway, The Netherlands and Switzerland are characterized by such dynamics. Interestingly, European countries, such as Germany, Ireland, Italy and Spain, are characterized by a negative sign, suggesting that house prices tend to revert back to their equilibrium values. Thus, the coefficient tends to be negative in the low-growth regime. Only Germany and Finland are characterized by a positive sign in the low-growth regime. Finally, we cannot draw any conclusion regarding the low and high-growth regime for Sweden.

The wide variety of country experiences is apparent from the results concerning the expected duration of each regime reported in Columns $7-9$ of Table 5. Overall, the European countries are in a medium-growth regime most of the time. The only interesting exception is Ireland. As discussed earlier, high-growth periods in Ireland tend to be long in duration. In fact, Ireland has experienced a high-growth regime for almost two third (59.6%) of the sample analyzed. Other countries, like Finland and the UK, have less persistent high growth cycles but they experienced a substantial growth in house prices of 20.5% and 20.8% respectively in that regime. Low-regimes, associated with market downturn, are short lived, although Ireland and Spain have been experiencing a prolonged, negative and deep growth rate phase.

Overall, we observe significant differences in both the frequency and timing of country-level high phases, although our smoothed probabilities estimates suggest that several European countries experienced a high-growth phase in mid 2000 and subsequently a low-growth phase as the recent financial crisis hit.[4] We will investigate this aspect in the next subsection.

5.2 A house price indicator for Europe

As we described above, there is a general tendency for the European countries to experience high- and low-growth phases that differ in growth rates, length and timing. In fact, our analysis suggests that European countries might experience house prices downturns that are not associated with any Europe wide downturn, or continue to be in house price appreciation phase throughout periods when most of the other countries experience medium growth in house prices. However, the precise extent to which the house price cycles are synchronized across European countries remains an open question.

In this subsection, we first construct a house price indicator variable that captures the existence of periods of high and low expected growth in house prices at the European level. This variable denoted $HI_{j,t}$ is inferred from the smoothed probabilities of being in a

[4]The figures of the smoothed probabilities for each country are available on request.

regime of high- and low-growth in house prices for each country j. We obtain a categorical variable that is equal to 1 in a high-growth regime and -1 in a low-growth regime from the estimated smoothed probabilities. We assume that the categorical variable for country j (i.e., j = Ireland) at time t is equal to 1 (-1) when the smoothed probability of being in the regime is associated with highest (lowest) expected real housing return in country j is higher than its historical average plus half of its historical standard deviation for four consecutive quarters. This condition captures the likelihood that there has been a regime change in state j based on the probability of a turning point. This condition is consistent with previous approaches to determine the turning points of business cycles (see Chauvet and Hamilton (2005)) and of house price cycles (see Corradin, Fillat, and Vergara-Alert (2012)).

We define the turning point as the moment when the estimated smoothed probability of being in a regime of high-growth in house prices reaches the 90% significance level. The logic underlying the first condition is to detect whether a housing market peak relative to its past historical average in country j has been reached and has lasted for at least four consecutive quarters. Therefore, the indicator allows us to classify countries house prices according to the degree of cyclicality in their real housing returns.

The condition that the smoothed probability of being in the regime associated with the highest expected real housing return reaches the turning point probability is satisfied in some periods by such countries as Ireland and Spain in which housing markets experienced a particularly high appreciation in the same periods. Thus, these periods are generally characterized by high and pronounced appreciation in house prices. Where as, this condition is not satisfied by Norway where housing markets experienced prolonged and continuous high-growth phases that are primarily characterized by modest growth in house prices. As previously discussed, an alternative approach would be to infer common Markov-switching regimes in an unbalanced panel data-set with large cross-section and time-series dimensions. However, this approach raises several challenges regarding how to explicitly model European country house prices similarities and is outside the scope of this paper.

Finally, we measure the degree to which house price cycles are synchronized by the fraction of European countries in the same regime according to our house price indicator. This measure is a concordance indicator CI_t and it is consistent with previous approaches which aim to determine the degree to which two business cycles are in synchronized by the percentage of time two economies are in the same regime (see Harding and Pagan (2002) and Owyang, Piger, and Wall (2005))

$$CI_{t,high} = \frac{1}{N}\sum_{j=1}^{N} \max\left(HI_{j,t}, 0\right),$$
$$CI_{t,low} = -\frac{1}{N}\sum_{j=1}^{N} \min\left(HI_{j,t}, 0\right),$$

where N is the number of countries. Table 6 reports the house price indicator of each country $HI_{j,t}$ and the concordance indicator CI_t of the high- and low-growth regime in the last two columns. We report our results starting in the first quarter of 1992 and ending in the second quarter of 2012 but the house price indicators of each country are based on the smoothed probabilities obtained on the entire data sample of that country.

[INSERT TABLE 6 HERE]

The table can be used to provide a geographic perspective on the high- and low-growth cycles across the European countries. Although, European house price return regimes differ in intensity and duration, there is some degree of synchronicity in the cycles and some clear patterns. In the beginning of 2000s, most of the countries are in the medium-growth regime with only 15% of the countries in the low-growth regime. In the time span $2002-2006$, European housing markets are generally on a growing trend. At the peak, 46% of the countries are in the high-growth regime and the remaining countries are in the medium-growth regime, while no country appears in the low-growth regime according to our concordance indicator. Perhaps not surprisingly, our housing indicator

HI indicates that Belgium, Denmark, France, Ireland, Spain and Sweden were in the same high-growth regime. In the time span $2008 - 2012$, which is characterized by the great financial crisis and subsequently by the Euro area sovereign debt crisis, approximately 40% of the countries are in the low-growth regime and the remaining ones are in the medium-growth one.

6 Conclusions

We have examined the house price dynamics, of thirteen European countries, by mean of a Markov-switching model characterizing changes in the parameters of an error correction model. The analysis yields three sets of results. First, house price returns in Europe are generally characterized as having three (high, medium and low) regimes. We document a wide variety of countries-level experiences. For some European countries, such as UK and Ireland, the high growth phases might be associated with booms in the housing markets, while for others the high growth phases are characterized by modest growth in house prices. Second, the estimation of error-correction models for some European countries reveal that the observed high phases in real house prices are associated with a stable regime. Third, European housing markets have been more synchronized with each other since 2000s following a growing trend in the time-span $2002 - 2006$ and a dramatic downturn after the Lehman collapse in 2008 and during the Euro area sovereign debt crisis.

A possible future extension could be to analyze whether the mechanisms driving growth during a high phase are different from those driving it during a low phase. In fact, there is no reason to expect that factors relevant for growth during the high phase should not be the same as those relevant for growth during the low phase. Recent academic research has focused on how the access to credit interacts with house prices (see Duca, Muellbauer, and Murphy (2010) for an overview). Then, it would be crucial to examine whether evolution of credit availability, differing over time within countries, has been the main factor for growth in house prices. However, due to limited availability of information on credit conditions in Europe, such analysis could be only developed for very few European countries.

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Table 1: **Data sources**

Country	**Code**	**Sample**	**Housing Prices**	**Disposable Income**	**Consumer Price Index**	**Unemployment Rate**	**10y Government Yield**
Belgium	BE	$1981-Q1/2013-Q1$	Oxford Economics	Eurostat	OECD Economic Indicators	OECD Economic Outlook	Eurostat
Switzerland	CH	$1981-Q1/2013-Q1$	Oxford Economics	Eurostat	Federal Statistical Office Switzerland	OECD Economic Outlook	Swiss National Bank
Germany	DE	$1992-Q1/2013-Q1$	Oxford Economics	Eurostat	OECD Economic Indicators	OECD Economic Outlook	Eurostat
Denmark	DN	$1992-Q1/2013-Q1$	Oxford Economics	Eurostat	OECD Economic Indicators	OECD Economic Outlook	Eurostat
Finland	FI	$1989-Q1/2013-Q1$	Statistics Finland	Eurostat	OECD Economic Indicators	OECD Economic Outlook	Eurostat
France	FR	$1986-Q1/2013-Q1$	Oxford Economics	Eurostat	OECD Economic Indicators	OECD Economic Outlook	Eurostat
Ireland	IE	$1981-Q2/2013-Q1$	Central Statistics Office Ireland	Oxford Economics	Central Statistics Office Ireland	OECD Economic Outlook	Eurostat
Italy	IT	$1981-Q1/2013-Q1$	Oxford Economics	Eurostat Economic Indicators	OECD Economic Outlook	OECD	Eurostat
The Netherlands	NL	$1988-Q1/2012-Q2$	Oxford Economics	OECD National Accounts	OECD Economic Indicators	OECD Economic Outlook	Eurostat
Norway	NW	$1986-Q1/2012-Q2$	Oxford Economics	OECD National Accounts	OECD Economic Indicators	OECD Economic Outlook	Statistics Norway
Spain	SP	$1988-Q1/2012-Q2$	Ministry of Housing Spain	Oxford Economics	OECD Economic Indicators	OECD Economic Outlook	Eurostat
Sweden	SW	$1981-Q1/2012-Q2$	Oxford Economics	OECD Economic Outlook	OECD Economic Indicators	OECD Economic Outlook	Swedish National Bank
United Kingdom	UK	$1964-Q1/2013-Q1$	Nationwide Building Society	Office for National Statistics - UK	OECD Economic Indicators	OECD Economic Outlook	Bank of England

Table 2: **Descriptive statistics.** The table reports the mean, max, minimum, standard deviation, skewness, and kurtosis of the Δ log house prices, Δ log disposable income, Δ interest rate, and Δ unemployment for each country.

	BE	**CH**	**DE**	**DN**	**FI**	**FR**	**IE**	**IT**	**NL**	**NW**	**SP**	**SW**	**UK**
						Δ Log House Prices							
Mean	0.006	0.001	-0.003	0.007	0.002	0.014	0.004	0.004	0.008	0.011	0.008	0.004	0.007
Max.	0.053	0.071	0.036	0.065	0.087	0.049	0.124	0.113	0.052	0.072	0.125	0.047	0.104
Min.	-0.065	-0.041	-0.026	-0.064	-0.147	-0.045	-0.146	-0.048	-0.032	-0.082	-0.051	-0.078	-0.067
Std.Dev.	0.022	0.018	0.011	0.024	0.039	0.017	0.049	0.024	0.016	0.028	0.030	0.024	0.028
Skew.	-0.510	0.276	0.537	-0.185	-1.281	-1.021	0.065	1.939	0.109	-0.370	0.856	-0.690	0.192
Kurt.	3.448	4.120	4.141	3.594	5.916	4.603	2.755	9.402	3.289	3.427	4.296	3.817	3.827
						Δ Log Disposable Income							
Mean	0.004	0.009	0.002	0.005	0.003	0.004	0.008	-0.001	0.005	0.008	0.005	0.005	0.007
Max.	0.041	0.198	0.032	0.060	0.134	0.032	0.122	0.066	0.127	0.118	0.114	0.048	0.064
Min.	-0.049	-0.123	-0.047	-0.049	-0.095	-0.018	-0.119	-0.123	-0.124	-0.228	-0.194	-0.062	-0.040
Std.Dev.	0.015	0.032	0.015	0.020	0.035	0.008	0.033	0.023	0.054	0.063	0.085	0.017	0.016
Skew.	-0.717	1.306	-0.439	0.177	-0.096	-0.179	-0.434	-1.187	-0.125	-0.618	-0.556	-0.443	0.263
Kurt.	4.023	14.016	3.419	3.089	4.918	4.056	5.437	9.798	2.358	3.520	2.204	5.174	4.123
						Δ Interest Rate							
Mean	-0.071	-0.032	-0.084	-0.091	-0.099	-0.075	-0.074	-0.082	-0.047	-0.109	-0.077	-0.088	-0.016
Max.	1.090	0.820	0.800	1.200	1.920	1.060	2.650	2.340	1.030	1.510	1.340	2.070	1.983
Min.	-1.390	-0.900	-0.840	-0.980	-1.340	-1.620	-2.240	-2.300	-0.730	-1.550	-1.830	-1.760	-2.150
Std.Dev.	0.364	0.298	0.316	0.387	0.517	0.410	0.733	0.647	0.337	0.492	0.565	0.552	0.625
Skew.	0.153	0.088	0.294	0.792	0.519	-0.129	0.246	0.029	0.545	0.091	-0.206	0.820	-0.154
Kurt.	4.235	3.262	2.979	4.154	5.677	4.574	5.593	6.012	3.437	4.130	4.164	6.077	4.447
						Δ Unemployment							
Mean	0.001	0.029	0.000	-0.005	0.036	0.008	0.037	0.042	-0.025	0.007	0.094	0.037	0.024
Max.	0.867	0.762	0.667	1.095	1.591	0.831	2.666	0.843	0.412	1.128	2.765	1.874	0.959
Min.	-0.733	-0.581	-0.553	-0.848	-1.916	-0.471	-1.641	-0.462	-0.523	-0.469	-1.025	-0.692	-0.626
Std.Dev.	0.286	0.190	0.252	0.342	0.589	0.223	0.530	0.274	0.214	0.252	0.618	0.388	0.276
Skew.	0.090	0.741	0.302	0.516	0.443	0.388	1.136	0.510	0.338	0.870	1.512	1.357	0.496
Kurt.	3.331	4.770	2.285	4.063	4.946	4.056	8.078	2.969	2.109	6.190	6.645	6.805	3.728
N. Obs.	126	126	82	82	94	106	125	126	98	106	98	126	194

Table 3: **Real house prices Dynamic OLS estimates - First stage.** The table reports the parameters estimated for each country based on the specification

$$p_{i,t} = \gamma + \omega_i + \beta x_{i,t} + \sum_{j=-k}^{k} \psi_j \Delta x_{i,t-j} + z_{i,t},$$

where x_i is the set of the macro variables (y_i, R_i, U_i) for each country i, ω_i is the country fixed effect and k is the number of leads and lags of Δx_i. Newey-West HAC standard errors are reported in parenthesis.

Constant	1.008
	(0.597)
Log Disposable Income	0.925
	(0.127)
Interest Rate	-0.020
	(0.008)
Unemployment	-0.030
	(0.008)
2 Led/Lag Variables	yes
Fixed Effect Country Level	yes
Adj. R2	0.162
N. Obs.	82 to 201

Table 4: **Error-correction model with Markov-switching estimates - Second stage.** The table reports the parameters estimated for each country based on the specification

$$\Delta p_{i,t} = \mu_{i,s_t} + \sum_{j=1}^{3} d_{i,.,j} D_j + \alpha_{i,s_t} \hat{z}_{i,t-1} + \sum_{j=0}^{p} \gamma_{i,j} \Delta x_{i,t-j} + \sigma_i \epsilon_{i,t}.$$

The mean rate of house price changes μ_{i,s_t} and the adjustment coefficient α_{i,s_t} switch between regimes. After pinning down the number of regimes, the seasonal parameters, $d_{i,.,j}$ are allowed to be regime-dependent. Linear restrictions on $d_{i,.,j}$ are tested using the Wald tests. Finally, the number of the lags for the macro variables $\Delta x_{i,t-j}$ is determined maximizing the likelihood function. Newey-West HAC standard errors are reported in parenthesis.

	BE	**CH**	**DE**	**DN**	**FI**	**FR**	**IE**	**IT**	**NL**	**NW**	**SP**	**SW**	**UK**
Δ Disp.Inc.	0.228	0.057	0.048	0.136	0.249	0.190	0.087	0.035	0.018	0.038	0.111	0.229	0.115
	(0.080)	(0.026)	(0.048)	(0.073)	(0.074)	(0.120)	(0.065)	(0.040)	(0.026)	(0.042)	(0.062)	(0.081)	(0.069)
Δ Int.Rate	-0.006	-0.001	-0.002	-0.004	-0.021	-0.002	-0.001	-0.001	-0.002	0.007	0.003	-0.009	-0.006
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.002)	(0.003)	(0.001)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)
Δ Unempl.	-0.005	0.003	0.015	-0.020	-0.014	-0.015	-0.009	-0.011	-0.014	-0.019	-0.012	-0.014	-0.024
	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.003)	(0.003)	(0.004)	(0.007)	(0.003)	(0.004)	(0.005)
$\hat{z}_{t-1}$ - Low	-0.106	-0.051	0.032	-0.072	0.197	0.006	0.012	-0.067	0.012	0.216	-0.072	0.032	-0.056
	(0.016)	(0.007)	(0.010)	(0.019)	(0.082)	(0.011)	(0.042)	(0.010)	(0.009)	(0.160)	(0.034)	(0.021)	(0.014)
$\hat{z}_{t-1}$ - Med.	-0.019	-0.002	-0.013	-0.013	-0.018	-0.015	-0.219	-0.078	-0.047			-0.052	-0.002
	(0.010)	(0.006)	(0.006)	(0.016)	(0.034)	(0.006)	(0.078)	(0.016)	(0.006)			(0.015)	(0.007)
$\hat{z}_{t-1}$ - High	0.010	0.042	-0.054	0.036	0.034	0.009	-0.141	-0.236	0.201	-0.078	-0.061	0.012	-0.008
	(0.026)	(0.019)	(0.015)	(0.025)	(0.093)	(0.005)	(0.027)	(0.014)	(0.040)	(0.035)	(0.020)	(0.020)	(0.019)
σ_i - St.Dev.	0.011	0.008	0.005	0.009	0.018	0.007	0.019	0.008	0.006	0.017	0.019	0.011	0.013
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Other var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log-lik.	377	377	269	238	207	342	266	398	323	268	238	360	512

Table 5: **Regime analysis.** Columns $(1)-(3)$ show the mean and standard deviation of the house price returns in each regime. Columns $(4)-(6)$ report the sign of the regime dependent coefficient of the error correction term $\hat{z}$. Columns $(7)-(9)$ report the frequency and the average duration of each regime.

	House Prices Returns Mean (Std.dev)			Adjust Coeff. Sign			Regimes Frequency % (Av. duration - years)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Regimes	Low	Medium	High	Low	Medium	High	Low	Medium	High
BE	-0.017	0.028	0.091	-	-		35.7%	46.0%	18.3%
	(0.053)	(0.034)	(0.024)				(5.6)	(3.6)	(2.9)
CH	-0.053	0.025	0.145	-		+	35.7%	57.1%	7.1%
	(0.028)	(0.023)	(0.033)				(2.2)	(2)	(0.45)
DE	-0.057	-0.003	0.075	+	-	-	29.3%	62.2%	8.5%
	(0.014)	(0.012)	(0.021)				(0.8)	(1.2)	(0.3)
DN	-0.081	0.043	0.116	-			25.6%	48.8%	25.6%
	(0.036)	(0.024)	(0.043)				(1.1)	(2.0)	(1.1)
FI	-0.328	0.009	0.205	+			7.4%	79.8%	12.8%
	(0.095)	(0.051)	(0.032)				(0.4)	(2.1)	(0.6)
FR	-0.063	0.059	0.101		-	+	15.1%	48.1%	36.8%
	(0.029)	(0.020)	(0.018)				(2.0)	(2.1)	(4.9)
IE	-0.185	-0.035	0.116		-	-	16.3%	24.2%	59.7%
	(0.112)	(0.179)	(0.152)				(5.1)	(2.5)	(6.1)
IT	-0.029	0.031	0.120	-	-	-	50.0%	34.1%	15.9%
	(0.027)	(0.025)	(0.082)				(5.3)	(2.7)	(1.7)
NL	-0.026	0.055	0.115	-	-	+	25.6%	67.1%	7.3%
	(0.021)	(0.020)	(0.042)				(1.3)	(2.8)	(0.8)
NW	-0.233		0.053			+	2.8%		97.2%
	(0.042)		(0.051)				(0.4)		(8.6)
SP	-0.022		0.113	-		-	60.2%		39.8%
	(0.044)		(0.058)				(4.9)		(3.3)
SW	-0.075	0.021	0.091		-		24.6%	46.0%	29.4%
	(0.044)	(0.038)	(0.026)				(3.9)	(2.4)	(1.3)
UK	-0.090	0.047	0.208	-			28.4%	59.8%	11.9%
	(0.039)	(0.030)	(0.044)				(2.3)	(2.4)	(1.0)

Table 6: **House price indicator.** Columns $1-13$ report the house price indicator $HI_{j,t}$ for each country j at time t. The house price indicator is equal to 1 in a high-growth regime and -1 in a low-growth regime from these estimated smoothed probabilities. We assume that the categorical variable for country j (i.e., j = Ireland) at time t is equal to 1 (-1) when the smoothed probability of being in the regime associated with highest (lowest) expected real housing return in country j is higher than its historical average plus half of its historical standard deviation for four consecutive quarters. Columns $14-15$ report the concordance indicator CI_t in the low- and high-growth regime. The indicator provides the fraction of European countries in the same regime, according to the house price indicator $HI_{j,t}$, at time t.

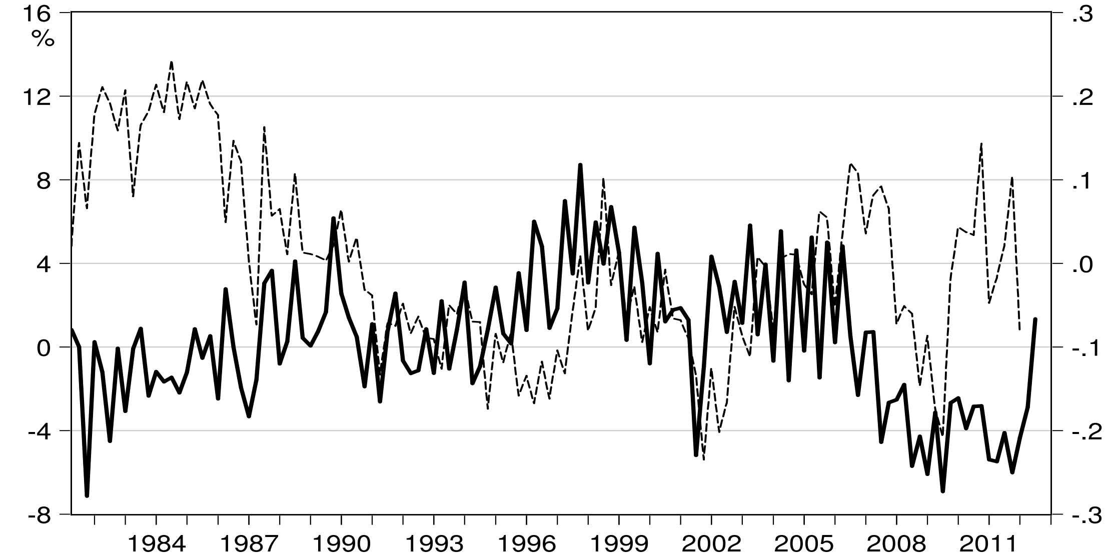
Year	Q	(1) **BE**	(2) **CH**	(3) **DE**	(4) **DN**	(5) **FI**	(6) **FR**	(7) **IE**	(8) **IT**	(9) **NL**	(10) **NW**	(11) **SP**	(12) **SW**	(13) **UK**	(14) *CI* Low	(15) *CI* High
1992	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
1992	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
1992	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
1992	4	-1	-1	0	0	0	0	0	1	0	0	-1	-1	-1	38%	8%
1993	1	-1	-1	0	0	0	0	0	1	0	0	-1	-1	-1	38%	8%
1993	2	-1	-1	0	-1	0	0	0	1	0	0	-1	0	-1	38%	8%
1993	3	-1	-1	0	0	0	0	0	1	0	0	-1	0	-1	31%	8%
1993	4	-1	0	0	0	0	0	0	1	0	0	-1	0	-1	23%	8%
1994	1	-1	0	0	0	0	0	0	1	0	0	-1	0	-1	23%	8%
1994	2	-1	0	0	0	0	0	0	1	0	0	-1	0	-1	23%	8%
1994	3	-1	0	0	0	0	0	0	0	0	0	-1	0	-1	23%	0%
1994	4	-1	0	0	0	0	0	0	0	0	0	0	0	-1	15%	0%
1995	1	-1	0	0	-1	0	0	0	0	0	0	0	0	-1	23%	0%

Year	Q	(1) **BE**	(2) **CH**	(3) **DE**	(4) **DN**	(5) **FI**	(6) **FR**	(7) **IE**	(8) **IT**	(9) **NL**	(10) **NW**	(11) **SP**	(12) **SW**	(13) **UK**	(14) *CI* Low	(15) *CI* High
1995	2	-1	-1	0	0	0	0	0	0	0	0	0	0	-1	23%	0%
1995	3	-1	-1	0	0	0	0	0	0	0	0	0	0	-1	23%	0%
1995	4	-1	-1	-1	0	0	0	0	0	0	0	1	0	-1	31%	8%
1996	1	-1	-1	-1	0	0	0	0	0	0	0	0	0	-1	31%	0%
1996	2	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	23%	0%
1996	3	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	23%	0%
1996	4	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	23%	0%
1997	1	-1	-1	-1	0	1	0	1	-1	0	0	-1	0	0	38%	15%
1997	2	-1	-1	-1	0	0	0	1	-1	0	0	0	0	0	31%	8%
1997	3	-1	-1	-1	0	0	0	1	-1	0	0	0	0	0	31%	8%
1997	4	0	-1	0	0	0	0	1	-1	0	0	0	0	0	15%	8%
1998	1	0	-1	0	0	0	0	1	-1	0	0	0	0	0	15%	8%
1998	2	0	-1	0	0	0	0	1	-1	0	0	0	0	0	15%	8%
1998	3	0	-1	0	0	0	0	1	-1	0	0	0	0	0	15%	8%
1998	4	0	-1	0	0	0	0	1	-1	0	0	0	0	0	15%	8%
1999	1	0	-1	0	0	0	0	1	-1	0	0	0	0	0	15%	8%
1999	2	0	-1	0	0	0	0	1	-1	0	0	-1	0	0	23%	8%
1999	3	0	-1	0	0	0	0	1	-1	1	0	-1	0	0	23%	15%
1999	4	0	-1	0	0	0	0	1	-1	1	0	-1	0	0	23%	15%
2000	1	0	-1	0	0	0	0	1	-1	1	0	-1	0	0	23%	15%
2000	2	0	-1	0	0	0	0	1	0	1	0	-1	0	0	15%	15%
2000	3	0	-1	0	0	0	0	1	0	0	0	-1	0	0	15%	8%
2000	4	0	-1	0	0	0	0	0	0	0	0	-1	0	0	15%	0%
2001	1	0	-1	0	0	0	0	0	0	0	0	-1	0	0	15%	0%

Year	Q	(1) **BE**	(2) **CH**	(3) **DE**	(4) **DN**	(5) **FI**	(6) **FR**	(7) **IE**	(8) **IT**	(9) **NL**	(10) **NW**	(11) **SP**	(12) **SW**	(13) **UK**	(14) *CI* Low	(15) *CI* High
2001	2	0	-1	0	0	0	0	0	0	0	0	-1	0	0	15%	0%
2001	3	0	0	0	0	0	0	0	0	0	0	-1	0	0	8%	0%
2001	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
2002	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
2002	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
2002	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
2002	4	0	0	0	0	0	0	0	0	0	0	1	0	1	0%	15%
2003	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0%	23%
2003	2	0	0	0	0	0	1	0	0	0	0	1	0	0	0%	15%
2003	3	0	0	0	0	0	1	0	0	0	0	1	0	0	0%	15%
2003	4	0	0	0	0	0	1	1	0	0	0	1	0	0	0%	23%
2004	1	0	0	0	1	0	1	1	0	0	0	1	0	0	0%	31%
2004	2	1	0	0	1	0	1	1	0	0	0	1	1	0	0%	46%
2004	3	1	0	0	1	0	1	1	0	0	0	1	1	0	0%	46%
2004	4	1	0	0	1	0	1	1	0	0	0	1	1	0	0%	46%
2005	1	1	0	0	1	0	1	1	0	0	0	1	1	0	0%	46%
2005	2	1	0	0	1	0	1	1	0	0	0	1	1	0	0%	46%
2005	3	1	0	0	1	0	1	1	0	0	0	1	1	0	0%	46%
2005	4	1	0	0	1	0	1	1	0	0	0	1	1	0	0%	46%
2006	1	1	0	0	1	0	1	1	0	0	0	1	1	0	0%	46%
2006	2	1	0	0	1	0	1	1	0	0	0	1	1	0	0%	46%
2006	3	1	0	0	0	0	1	1	0	0	0	1	1	0	0%	38%
2006	4	1	0	0	0	0	0	1	0	0	0	0	0	0	0%	15%
2007	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0%	15%

Year	Q	(1) **BE**	(2) **CH**	(3) **DE**	(4) **DN**	(5) **FI**	(6) **FR**	(7) **IE**	(8) **IT**	(9) **NL**	(10) **NW**	(11) **SP**	(12) **SW**	(13) **UK**	(14) *CI* Low	(15) *CI* High
2007	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0%	8%
2007	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0%	8%
2007	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
2008	1	0	0	0	0	0	0	0	0	0	0	-1	0	0	8%	0%
2008	2	0	0	0	0	0	0	-1	0	0	0	-1	0	0	15%	0%
2008	3	0	0	0	-1	0	-1	-1	0	0	0	-1	0	0	31%	0%
2008	4	0	0	0	-1	0	-1	-1	0	0	0	-1	0	-1	38%	0%
2009	1	0	0	0	-1	0	-1	-1	0	-1	0	-1	0	-1	46%	0%
2009	2	0	0	0	0	0	-1	-1	-1	-1	0	-1	0	0	38%	0%
2009	3	0	0	0	0	0	0	-1	-1	-1	0	-1	0	0	31%	0%
2009	4	0	0	0	0	0	0	-1	-1	-1	0	-1	0	0	31%	0%
2010	1	0	0	0	0	0	0	-1	-1	-1	0	-1	1	0	31%	8%
2010	2	0	0	0	0	0	0	-1	-1	-1	0	-1	0	0	31%	0%
2010	3	0	0	0	0	0	0	-1	-1	-1	0	-1	0	0	31%	0%
2010	4	0	0	0	0	0	0	-1	-1	-1	0	-1	0	0	31%	0%
2011	1	0	0	0	0	0	0	-1	-1	-1	0	-1	0	0	31%	0%
2011	2	0	0	0	0	0	0	-1	-1	-1	0	-1	0	0	31%	0%
2011	3	0	0	0	0	0	0	-1	-1	-1	0	-1	0	0	31%	0%
2011	4	0	0	0	-1	0	0	-1	-1	-1	0	-1	0	0	38%	0%
2012	1	0	0	0	-1	0	0	-1	-1	-1	0	-1	0	0	38%	0%
2012	2	0	0	0	-1	0	0	-1	-1	-1	0	-1	0	0	38%	0%

Figure 1: **Ireland - 3 regimes**. Figure a shows house prices returns in the country on the left hand scale (continuous line) as well as the error-correction term $\hat{z}_{t-1}$ from the long-run regression of house prices on economic fundamentals on the right hand scale (dotted line). Figure b shows the probability that the market is in a high-growth regime (continuous line) and the probability that the market is in a low-growth regime (dotted line). Data span from 1981 to 2012.



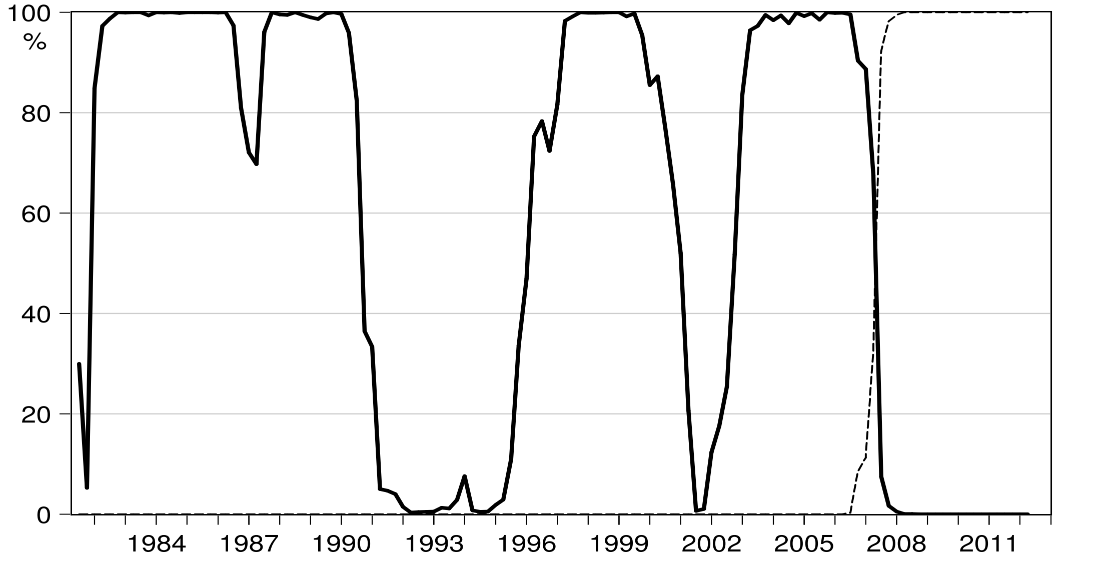
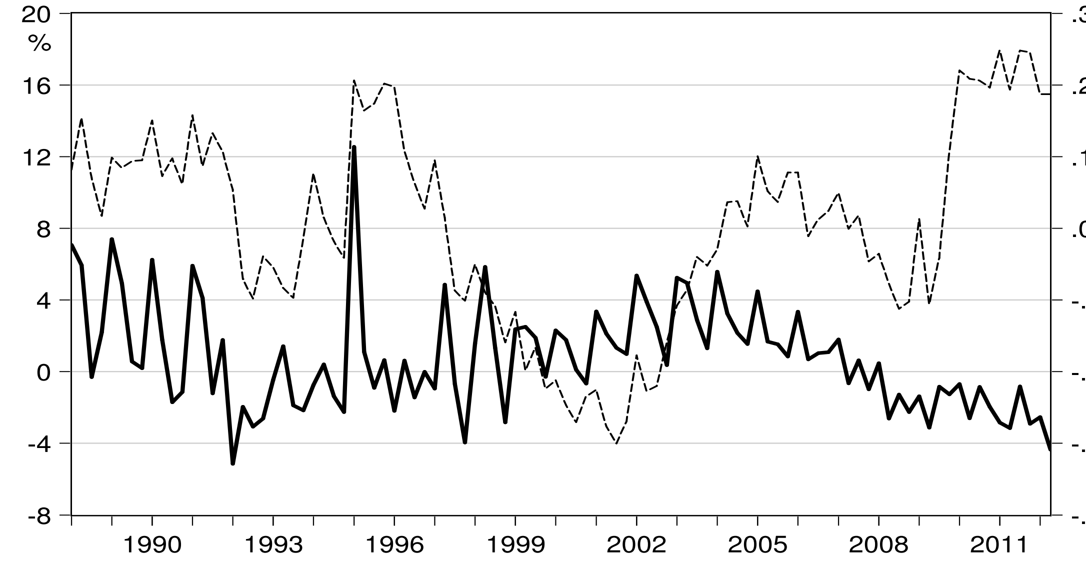


Figure 2: **Spain - 2 regimes**. Figure *a* shows house prices returns in Spain on the left hand scale (continuous line) as well as the error-correction term $\hat{z}_{t-1}$ from the long-run regression of house prices on economic fundamentals on the right hand scale (dotted line). Figure *b* shows the probability that the market is in a high-growth regime (continuous line). Data span from 1988 to 2012.



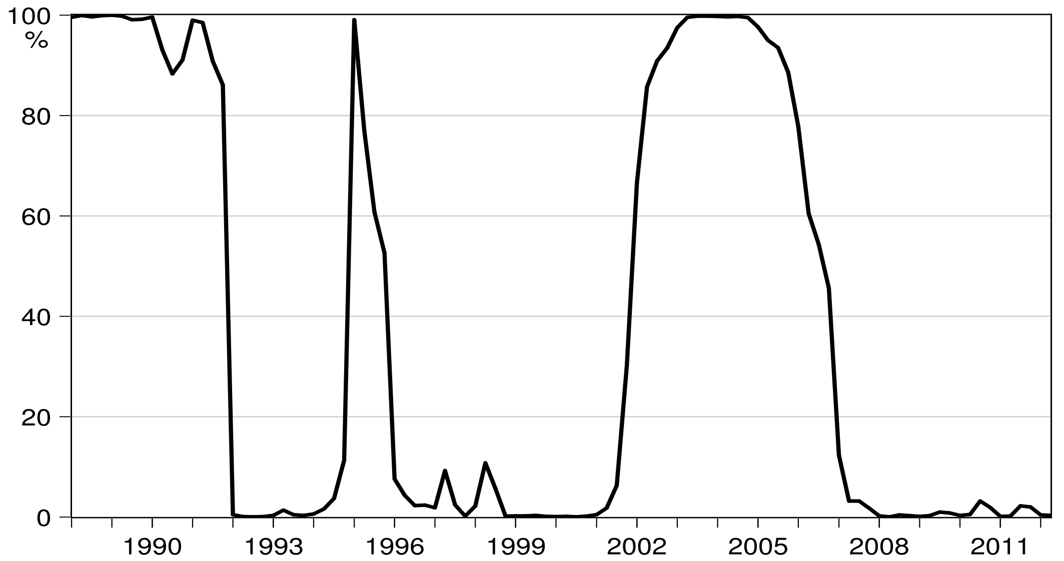
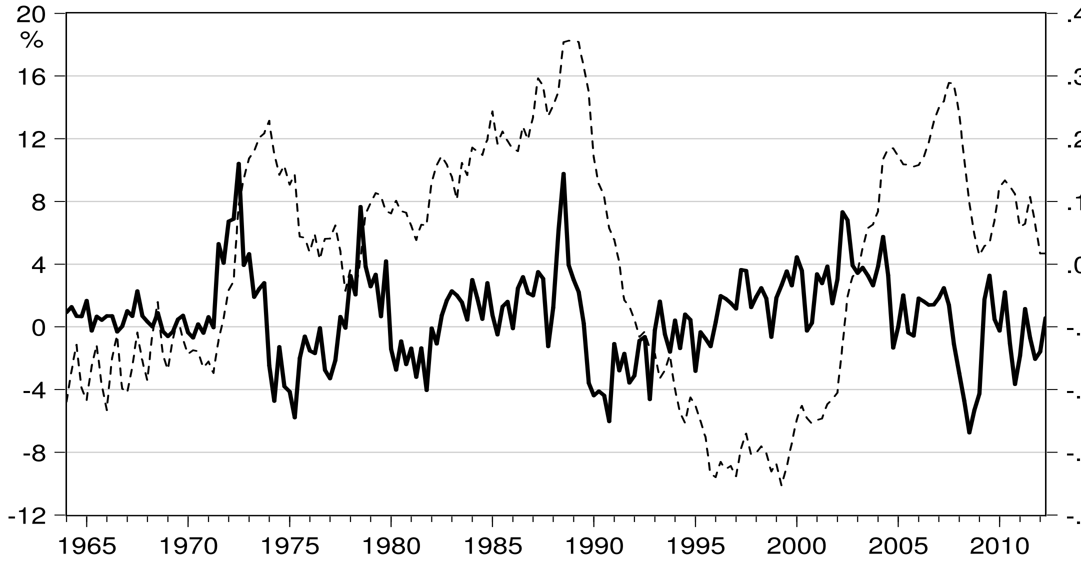
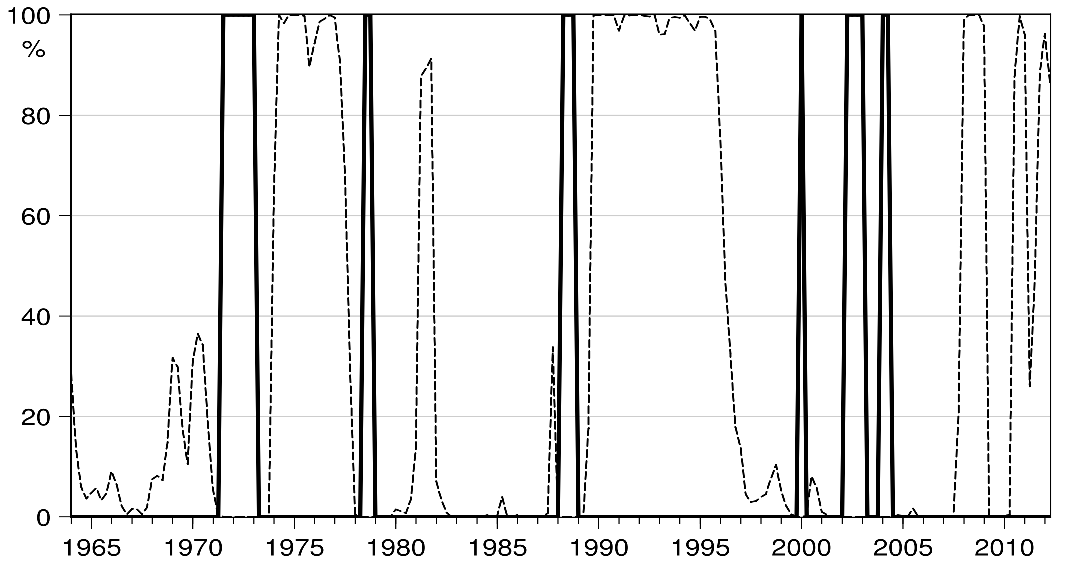


Figure 3: **United Kingdom - 3 regimes**. Figure *a* shows house prices returns in the UK on the left hand scale (continuous line) as well as the error-correction term $\hat{z}_{t-1}$ from the long-run regression of house prices on economic fundamentals on the right hand scale (dotted line). Figure *b* shows the probability that the market is in a high growth regime (continuous line) and the probability that the market is in a low growth regime (dotted line). Data span from 1963 to 2012.





Appendix

6.1 Data

Table 7 reports the results of the Augmented Dickey-Fuller (ADF) test for the presence of a unit root in the series.

[INSERT TABLE 7 HERE]

The null of a unit-root can not be rejected for all the series in their log-levels and levels (see Panel A). Instead, the null of a unit-root can be rejected for all the variables in their log-first and first differences (see Panel B). These results are further confirmed by the panel unit-root Fisher-type test reported on the bottom of the two discussed tables.

6.2 Tests on regimes specification

For each country, we estimate the 2 and 3-regime specification and then we implement a series of tests to determine the most appropriate specification.

[INSERT TABLE 8 HERE]

First, we calculate the Regime Classification Measure (RCM) which captures the quality of a model's regime qualification performance developed by Ang and Bekaert (2002). They argue that a good regime-switching model should be able to classify regimes sharply. This is the case when the smoothed regime probabilities $\hat{\pi}_i$ are close to either one or zero. Inferior models, however, will exhibit $\hat{\pi}_i$ values closer to $1/\theta$, where θ is the number of regimes. A perfect model will be associated with a RCM close to zero, while a model that cannot distinguish between regimes at all will produce a RCM close to 100. Ang and Bekaert (2002) generalization of this formula to the multiple regime case has undesirable features.[5] We therefore adopt the measure adapted by Baele (2005):

$$RCM = 100 \times \left(1 - \frac{\theta}{\theta - 1} \frac{1}{T} \sum_{t=1}^{T} \sum_{i=1}^{\theta} \left(\hat{\pi}_{i,t} - \frac{1}{\theta} \right)^2 \right) \tag{4}$$

lies between 0 and 100, where the latter means that the model cannot distinguish between the regimes. Therefore, lower RCM values denote better regime classification.

Moreover, we report the log likelihood and the AIC test for each specification and country. Overall, the housing returns are well captured by a three-regime Markov switching model.

[5]More specifically, their measure produces small RCM as soon as one regime has a very low probability, even if the model cannot distinguish between the other regimes.

Table 7: **Unit-root test statistics.** Panel A reports the Augmented Dickey-Fuller (ADF) Statistics, P values, for the series in log-levels. Panel B reports the P values for the series in their log-first-differences. Probabilities for the panel unit root Fisher-type test, on the bottom of the two tables, are computed using an asymptotic Chi-square distribution.

Panel A ADF Test	Log House Prices	Log Disp. Income	Int. Rate	Unempl.
BE	0.739	0.757	0.357	0.062
CH	0.246	0.938	0.604	0.345
DE	0.772	0.437	0.735	0.213
DN	0.313	0.377	0.473	0.169
FI	0.749	0.533	0.460	0.122
FR	0.239	0.218	0.747	0.152
IE	0.437	0.644	0.049	0.546
IT	0.282	0.439	0.187	0.306
NL	0.395	0.638	0.812	0.108
NW	0.974	0.976	0.606	0.406
SP	0.626	0.449	0.600	0.712
SW	0.876	0.997	0.884	0.301
UK	0.734	0.770	0.849	0.316
ADF - χ^2	0.889	0.970	0.806	0.067

Panel B ADF Test	Δ Log House Prices	Δ Log Disp. Income	Δ Int. Rate	Δ Unempl.
BE	0.060	0.000	0.000	0.001
CH	0.000	0.000	0.000	0.000
DE	0.037	0.000	0.000	0.012
DN	0.005	0.000	0.000	0.009
FI	0.000	0.000	0.000	0.053
FR	0.050	0.000	0.000	0.000
IE	0.308	0.033	0.000	0.000
IT	0.002	0.000	0.000	0.001
NL	0.768	0.001	0.000	0.022
NW	0.048	0.001	0.000	0.000
SP	0.332	0.324	0.000	0.025
SW	0.012	0.000	0.000	0.000
UK	0.000	0.000	0.000	0.000
ADF - χ^2	0.000	0.000	0.000	0.000

Table 8: **Regimes classification tests.** This table reports the Regime Classification Measure (RCM), the Likelihood test and the Akaike test (AIC) for the 2$-$ and 3$-$regime specification.

	N. Regimes	(1) RCM	(2) Loglikelihood	(3) AIC
BE	2	12.68	370.64	-5.63
	3	19.10	377.20	-5.62
CH	2	32.38	353.45	-5.36
	3	25.06	377.51	-5.61
DE	2	21.13	259.27	-6.01
	3	21.06	269.79	-6.12
DN	2	5.04	228.87	-5.22
	3	3.70	238.28	-5.35
FI	2	9.29	200.78	-4.00
	3	12.24	207.31	-4.05
FR	2	31.35	329.75	-5.98
	3	24.36	342.29	-6.14
IE	2	19.20	258.61	-3.88
	3	26.67	266.43	-3.89
IT	2	5.32	398.79	-6.03
	3	13.30	373.89	-5.73
NL	2	6.77	305.69	-5.91
	3	6.17	323.40	-6.13
NW	2	7.63	268.15	-4.81
	3	16.64	275.53	-4.90
SP	2	16.88	238.25	-4.60
	3	37.18	239.77	-4.55
SW	2	9.90	352.05	-5.24
	3	14.93	360.16	-5.26
UK	2	5.89	492.27	-4.91
	3	16.19	512.23	-5.04