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House Price Cycles in Europe

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Abstract:

This Project uses data for GDP and real housing prices for twelve European countries plus the United States to study the relationship between the housing market and GDP cycles. The main findings suggest that there is evidence of a strong relationship between the two cycles for most of the countries analysed. Moreover, an analysis of the relationship between the Portuguese economy and other European economies is also performed for the two cycles. This analysis shows that there is a strong correlation between the European economies when the GDP is used as benchmark and that this correlation decreases when the housing market is considered.

Key Words: Housing price cycle, GDP cycle, Synchronization and Convergence, European Union

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1. Introduction

The strong recession that occurred in the US in 2008 as a result of a housing market crash brought up chaos all across the globe in a way that many perceived as the worst global recession since World War II. As stated by Verick and Islam (2010) the effects of this global recession differ largely among countries depending mostly on the state of the economy prior to the burst of the housing market bubble. Among the European Union, the vast majority went through a long-lasting period of economic contraction as a consequence of the big decrease in household's wealth and a rise in unemployment which contributed to the fall of the average GDP all around Europe as referenced by Buti et al. (2009). This was particularly felt by middle-income countries in central and eastern Europe such as Lithuania, Latvia and Estonia.

Given the level of integration inside the European Monetary Union it is of great importance to study how the involved countries are related among each other. A lack of synchronization among these countries could lead to unforeseen effects caused by economic policies. Monetary policy plays an important role in shaping the housing market. This responds negatively to contractionary monetary policy shocks which causes significant effects on the housing market.

The devastating effects of the burst of this house prices bubble intrigued many economists into studying this market more closely. Some of the most common research points in this market consists of how it relates with the GDP cycle and its main components[2]. This project studies both of these problems. In a first approach, the GDP and house price cycle will be used to study the level of correlation between the two cycles. For robustness, this calculation will be computed across various European countries plus the United States. In a second approach, the level of correlation

[2] See Literature Review section for more information

between the Portuguese economy and several other European economies will be analysed. Besides studying the relationship inside the European Union a comparison of the Portuguese cycles and the ones from the United States is also provided.

This project is organized as follows: in section 2 there is a review of the literature already produced on the topics evaluated in this paper; section 3 presents the main procedures applied throughout this project and the data used; section 4 discusses the results and, finally; section 5 provides the main conclusions derived from this analysis.

2. Literature Review

The shocking effects caused by the 2008 housing market crash generated a sudden concern on this market. Since then, many studies have been conducted in order to better understand its behavior. Using a structural VAR, Iacoviello and College (2002) found that "housing price inflation is highly sensitive to forces driving economic fluctuations" which might be an indicator of a high correlation between house prices and GDP.

The high level of correlation between GDP and housing market cycles is found to be true in several European economies. Using data from the French economy, Ferrara and Vigna (2010) found that there are high correlation levels between GDP and several housing market variables like household investment. Moreover, there is also evidence of a high correlation between the household investment and housing prices which, by association, can lead to evidence of correlation between housing prices and GDP. Similar conclusions were drawn by Álvarez and Cabrero (2010) for the Spanish economy and by Bulligan (2009) for the Italian economy. Both found evidence of a high correlation between both the housing investment and GDP and between the housing investment and real house prices. Considering the cross-correlation values between real house price

and GDP these three authors' findings are no longer in accordance. While in Italy housing prices are found to be lagging GDP by 2 years, in France housing prices tend to lead the economic cycle by 2 quarters. In Spain, the results are found to be somewhat inconclusive since the two filters used in the analysis provide two different results. When the Butterworth filter is used, the two cycles are found to be in line with each other while, when using the Epanechnikov filter, the house price cycle is found to be lagging GDP by 4 quarters.

The level of synchronization among the countries integrated in the European Monetary Union (EMU) is one of the most important criteria for an optimal economy. As such it is of great importance to study how these countries are related to each other. Using a dynamic factor model Kose et al. (2008) found evidence of an increase in convergence among industrial economies during the globalization period. These findings are aligned with the ones provided by Ferroni and Klaus (2015) which suggest a high level of interdependence between Germany, France and Italy while Spain seems more dependent on domestic factors. Using a cross correlation analysis similar to the one used in this project, Álvarez et al. (2010) also concluded that, when using GDP as a variable of comparison, there is a high level of correlation between those same economies. Moreover Mink et al. (2008) using synchronicity and co-movement measures found a high correlation between business cycles in France, the Netherlands, Spain and Germany while Ireland and Greece show a lower correlation with the remaining EMU countries.

Through the use of a Markov-Switch model, Corradin and Fontana (2013) showed that house price returns are better characterized as having three phases, a high, low and medium phase which differ largely across countries though this difference has been decreasing since the beginning of the century. However, Álvarez et al. (2010) performing a correlation analysis using the housing market as benchmark found that the level of correlation between them decreases significantly when

this variable is used rather than when GDP is used which suggests that, unlike the GDP cycle, the housing market is more dependent on idiosyncratic characteristics.

3. Methodology

A wide range of different procedures has emerged in order to study the housing market cycles. In this project, the procedure applied is one similar to the one used by Álvarez et al. (2010) which consists in analyzing several metrics like the correlation measure, the concordance index (CI) and the cross-correlation index (CCI) in order to access how the GDP cycle relates to the housing market cycle and also infer on how the Portuguese economy relates to each of the remaining countries based on both GDP and real house prices.

The economic cycle can be interpreted as a combination of three major components as proposed by Clark (1987). These components are: the trend, which represents the direction that the economy is pursuing in the long-run; the cycle, which corresponds to the short-term fluctuations; and the irregular component, which accounts for unpredictable fluctuations around the trend.

$$Y_t = T_t + C_t + \varepsilon_t$$

There are several methods used to represent both the trend and the cyclical components. In this project the trend is assumed to be a combination of two variables, a trend (β_t) and a level (Γ_t) which follow a random walk process as presented by Gilchrist (1976) while the cycle is assumed to follow a second order autoregressive process AR(2) as proposed by Clark (1987). This model can be represented as

$$\begin{cases} y_t = \Gamma_t + C_t + \varepsilon_t \\ \Gamma_t = \Gamma_{t-1} + \beta_{t-1} + \delta_t \\ \beta_t = \beta_{t-1} + \theta_t \\ C_t = \phi_1 C_{t-1} + \phi_2 C_{t-2} + \omega_t \end{cases}$$

There is a vast number of procedures used to separate a data series in its cyclical and trend component being some of the most widely used the Hodrick and Prescott's and the Baxter and King's Filter. The HP Filter is a high-pass filter that splits the trend from its cyclical component by minimizing the deviations from the trend given a predetermined business cycle component. This filter removes the higher frequency fluctuations as part of the cyclical component and retains the smaller ones as being part of the trend (see De Haan et al. (2010)). Meanwhile, the Baxter and King filter proposed by Baxter and King (1999) uses a moving average to isolate the periodic components which lie in a specific band of frequencies.

In this project, the method used to extract the cycle from the series is the Kalman filter. The Kalman filter uses a Bayesian approach in the sense that it is updated recursively using current and past information to infer on the next period forecast. This filter provides minimum mean square estimators using a least-square procedure. Following Pasricha (2006) let us consider a simple model, such as,

$$Z_t = H'_t X_t + v_t \ , \ X_{t+1} = F_t X_t + w_t$$

$$Y_t = T_t X_t + \varepsilon_t \ , \ X_{t+1} = F_t X_t + \eta_t$$

where X_t represents the unobservable variable(s) and Z_t is the observed variable. w_t and v_t are the noise components and are assumed to be white noise and independent. The Kalman filter provides estimations of $\hat{X}_{t|t-1} = E\,[X_t|Z_{t-1}]$ and $\hat{X}_{t|t} = E[X_t|Z_t]$ with covariance matrix $\Sigma_{t|t-1}$and $\Sigma_{t|t}$ respectively and can be expressed as

$$\hat{X}_{t+1|t} = [F_t - K_t H'_t]\hat{X}_{t|t-1} + K_t Z_t$$

where $K_t = F_t \sum_{t|t-1} H_t \,[H'_t \sum_{t|t-1} H_t + R_t]^{-1}$ represents the matrix gain.

A final remark regarding the Kalman filter is related to the initialization process which is assumed to be unknown. Across several existing techniques, the one used in this project is the one presented by Durbin and Koopman (2001) which assumes that some of the state elements might be nonstationary. This method its called diffuse initialisation and provides estimates for the unknown parameters, here defined by θ, through the maximization of the diffuse likelihood

$$log L(\boldsymbol{Y}|\boldsymbol{\theta}) = -\frac{1}{2}\sum_{T=d+1}^{n}\left(log(2\pi|\boldsymbol{F}_t| + \boldsymbol{v}_t'\boldsymbol{F}_t^{-1}\boldsymbol{v}_t)\right)$$

The fact that the Kalman Filter updates itself at each point in time implies that it uses all the information available at each point in time to predict the unobservable values. This feature represents one of the major advantages of this approach.

De Han et al. (2007) provide an analysis of the pros and cons of using different filtering techniques and the main conclusions drawn were that, in most cases, standard filters are found to provide similar results. For robustness purposes, the decompositions using the HP and the Baxter and King filters will also be performed to infer whether they provide similar conclusions to the ones obtained using the Kalman filter.

In order to assess the relationship between two series several metrics will be computed. One of the metrics applied for this purpose is the Pearson correlation. This measure consists of a simple correlation measure which takes values between -1 and 1 where -1 means perfectly negatively correlated, 1 perfectly positively correlated and 0 meaning not correlated.

A second measure used is the Concordance Indicator (CI) proposed by Harding and Pagan (2002) which computes the synchronicity between two series using a binary indicator to assess the percentage of time in which two series are in the same regime. To compute this percentage the

series will undergo a two-step procedure. The first step consists in converting each of the two series in a sequence of -1 and 1 where it acquires a value of 1 when the series is increasing from one moment to the other and -1 when it is decreasing. The second step consists in comparing the two series at each point in time and creating a binary sequence where it presents a value of 0 whenever the two are not in the same phase and 1 when they are in the same phase, same phase meaning either both increasing or both decreasing.

One last measure included in this project is the Cross-correlation Index (CCI) which gives us the number of periods by which one of the cycles is leading or lagging the other. This measure is calculated through an analysis of the various cross-correlation values between two series across a twelve-period horizon, both leads and lags. The period where the correlation value reaches its maximum is the one that provides the number of periods by which one series is leading or lagging the other (see Backus et al. (2016)).

3.1 Data

This project performs two different analysis, the first one is on the correlation between the house price cycle and the GDP cycle and the second one is the correlation between Portugal and the remain economies regarding these two cycles. To do so, logarithmic data for the real house price and GDP is used for thirteen countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, UK and US. The time period used in this analysis differs across countries, due to data availability constrains. The majority of the analyzed countries has data from 1970Q1 until 2015T4 except for Spain which has available data from 1971Q1 to 2015Q4, Austria from 1986Q3 until 2015Q4, Portugal from 1988Q1 until 2015Q4 and Greece which only has data available from 1997Q1 onwards. It is important to remark that the data series used in this analysis for Germany include both pre and post-unification periods which, as shown

by Knetsch (2009) might lead to unreliable conclusions since the housing market suffered several changes during that period of time.

Throughout this analysis the data constraints for each of these regions is taken into consideration when comparing to series with different data lengths. In this cases the length considered is the one from the shortest series which is the case, for example, when comparing the GDP and the housing price cycle between Portugal and the remaining countries, because the period of data available for Portugal is lower than the one from the remaining countries, the data length considered is from 1988Q1 until 2015Q4. Due to a low number of observations, the comparison between the Portuguese cycles and the Greek cycles will not be computed.

4. Results

4.1. GDP and Housing Cycle correlation analysis

This first section provides a discussion of the results obtained from the correlation analysis between the GDP and House price cycles for each individual country. The main results from this analysis are represented in table 1.

The Pearson correlation values obtained from this analysis show evidence of a high level of correlation between the GDP and the house prices in the vast majority of the countries. These values are found to be positive for all countries included in our sample which implies that, even if in a small scale, house prices and GDP move in the same direction. The values for the analyzed countries range between 0,28 and 0,77 where the highest values are found for Portugal with 0,77 Spain 0,7 and Finland with a 0,74 correlation value. The lower values are found for the Netherlands and the UK with 0,28 and 0,36 correlation values, respectively.

Table 1: GDP vs House Price

	AUS		BEL		FIN		FRA		GER		GRE		IRE		ITA		NL		PT		SPA		UK		US	
	GDP	House Price	GDP	House Price	GDP	House Price	GDP	House Price	GDP	House Price	GDP	House Price	GDP	House Price	GDP	House Price	GDP	House Price	GDP	House Price	GDP	House Price	GDP	House	GDP	House
Correlation (Pearson)	0,45		0,43		0,74		0,47		0,53		0,49		0,49		0,52		0,28		0,77		0,7		0,36		0,41	
Lead(+) / Lag(-)	0		1		-1		-2		1		-3		-1		1		2		0		0		-12		0	
Synchrony (%)	59,83%		61,75%		64,48%		54,10%		50,27%		64,00%		52,46%		59,02%		65,03%		64,86%		65,36%		51,91%		59,56%	
Standard Deviation	0,36	0,36	0,38	0,39	0,41	0,36	0,36	0,44	0,37	0,41	0,51	0,54	0,36	0,38	0,3	0,31	0,38	0,32	0,42	0,41	0,36	0,35	0,33	0,36	0,42	0,43
Standard Deviation Ratio		0,99		1,03		0,87		1,25		1,1		1,07		1,05		1,03		0,85		0,98		0,97		1,1		1,04
Autocorrelation x(t)-x(t-1)	0,93	0,88	0,87	0,97	0,94	0,96	0,89	0,96	0,77	0,97	0,96	0,95	0,93	0,96	0,85	0,92	0,9	0,97	0,94	0,95	0,93	0,93	0,92	0,97	0,92	0,96
Autocorrelation x(t)-x(t-2)	0,75	0,66	0,62	0,9	0,8	0,86	0,67	0,86	0,6	0,89	0,86	0,83	0,75	0,85	0,57	0,7	0,68	0,88	0,8	0,83	0,74	0,79	0,72	0,9	0,75	0,84
Autocorrelation x(t)-x(t-3)	0,51	0,45	0,33	0,81	0,62	0,7	0,39	0,71	0,43	0,78	0,73	0,65	0,52	0,71	0,27	0,45	0,44	0,74	0,6	0,67	0,52	0,59	0,5	0,8	0,55	0,66

The second variable analyzed is the Concordance Index (CI) proposed by Harding and Pagan (2002). The conclusions drawn from this measure are similar to the ones provided by the Pearson correlation, which is that there is indeed a high level of synchronicity between the two cycles. All countries show synchronicity values above 50% being the lowest ones Germany with a CI of 50,27% and the UK where there is a synchrony of 51,91% between the cycles. The higher synchronicity values are found in Austria, Spain and the Netherlands with values slightly above 65%.

Lastly the cross-correlation index provides us with information on whether the house price cycle is leading or falling behind the GDP cycle. The conclusions drawn from it, contrary to the previous ones, vary from country to country. There is a slight lead of the housing cycle towards the GDP cycle in countries like the Netherlands, where there is a 2-period lead towards GDP and, Germany, Italy and Belgium where there is a 1-period lead. The results obtained for the Italian economy contrast with the ones obtained by Bulligan (2010) who found evidence of a 2-year delay between the real house prices and GDP. In some other countries like Austria, the US and the Iberian countries, the two cycles are found to be synchronized with each other. Comparing these results with the ones obtained by Álvarez and Cabrero (2010) for the Spanish economy, these ones confirm the results provided by the Butterworth filter which found evidence of a contemporaneous relationship between the two cycles. Greece and France show a 3 and 2 trimester lag towards GDP respectively while Ireland and Finland show a 1 period lag. The results found for France also contradict the ones found by Ferrara and Vigna (2009) who found evidence of a 2-period lead between the housing market and GDP. The biggest outlier in this analysis is the UK which shows a 3-year lag between the two cycles. These findings are consistent with the ones drawn from the two previous measures which provided a low correlation and a low CI for the same country.

4.2. Portugal vs Other Countries Correlation Analysis

So far, it has been shown that there is indeed a correlation between the GDP and the house price cycles, even though not very significant in some of the analyzed countries. Another important issue raised in the course of this project is whether there is a relationship between countries. In this section, such an analysis will be computed for the Portuguese economy by looking at how the two variables in this economy relate to the ones from other economies. The results obtained from the analysis on the GDP cycle are summarized in table 2.

Table 2: Portugal vs Other Countries (GDP approach)

	AUS	BEL	FIN	FRA	GER	GRE	IRE	ITA	NL	PT	SPA	UK	US
Correlation (Pearson)	0,47	0,42	0,22	0,34	0,57	0,43	0,19	0,51	0,59		0,59	0,32	0,18
Lead(+) / Lag(-)	0	0	-10	-1	1	-2	-8	0	0		-1	-1	10
Synchrony (%)	67,10%	62,58%	64,52%	68,39%	70,32%	61,29%	50,97%	63,87%	63,87%		61,29%	54,19%	56,13%
Standard Deviation	0,37	0,37	0,37	0,36	0,35	0,45	0,4	0,41	0,37	0,39	0,38	0,4	0,42
Standard Deviation Ratio	0,95	0,94	0,93	0,91	0,89	1,14	1	1,05	0,95	1	0,96	1,03	1,06
Autocorrelation x(t)-x(t-1)	0,94	0,91	0,95	0,91	0,92	0,94	0,95	0,93	0,88	0,92	0,95	0,94	0,92
Autocorrelation x(t)-x(t-2)	0,79	0,67	0,82	0,7	0,73	0,79	0,84	0,75	0,68	0,72	0,82	0,78	0,73
Autocorrelation x(t)-x(t-3)	0,58	0,36	0,65	0,44	0,5	0,6	0,69	0,53	0,48	0,47	0,66	0,58	0,47

Looking at the Pearson correlation values obtained in this analysis, there is evidence that GDP in some countries is correlated with the Portuguese one. Among these countries are Spain and the Netherlands with a correlation level of 0,59. Other countries like Germany and Italy also show a high correlation level with the Portuguese economy as far as GDP is concerned. Contrary to the

previous, some other countries show very low values of correlation although still positive. Among the European nations, we find that Ireland and Finland are the regions with the lowest correlation with the Portuguese economy with correlation values of 0,19 and 0,22 respectively. For the United States, the correlation seems to be even lower than in the rest of the countries which might suggest a low correlation of economic cycles between the US and the European Countries.

The Concordance Index (CI) shows high levels of synchronicity between the Portuguese and the remaining countries GDP. This is particularly clear in Germany where the two cycles are found to be moving in the same direction more than 70% of the times. France and Austria also show high levels of synchronization with the Portuguese economy, 68,87% and 67,10% respectively. In line with the results obtained from the Pearson correlation, Ireland and the US appear to be the ones less synchronized with the Portuguese economy, even though still showing high values of synchronicity.

Regarding the cross-correlation analysis, some of the conclusions are also in line with the ones obtained in the two-previous analysis. Both Ireland and the US are found to have cycles far apart from the Portuguese one. While Ireland is lagging the Portuguese economy by a 2-year period, the US economy is leading the Portuguese economy by 10 quarters. Finland also shows a big lag towards the Portuguese economy which confirms the findings from the Pearson correlation. Moreover, countries showing high values of correlation are found to be more aligned with each other. This is evident in countries like Netherlands and Italy. Germany, which was found to be the country with the highest synchronicity with the Portuguese economy, is found to have a 1-period lead on the Portuguese economy, being also the only European country leading the Portuguese economy.

After analyzing the GDP cycle correlation between Portugal and the remaining countries, this section provides now a new correlation analysis, this time using the real house price cycle as comparison. The results of this analysis are summarized in table 3.

Table 3: Portugal vs Other Countries (House Prices approach)

	AUS	BEL	FIN	FRA	GER	GRE	IRE	ITA	NL	PT	SPA	UK	US
Correlation (Pearson)	0,45	0,09	-0,05	0,29	-0,09		0,44	0,39	0,33		0,48	0,16	0,23
Lead(+) / Lag(-)	0	-8	-11	2	8		-3	2	3		0	-4	-11
Synchrony (%)	62,16%	57,66%	47,75%	52,25%	57,66%		57,66%	47,75%	64,86%		58,56%	54,05%	54,95%
Standard Deviation	0,34	0,47	0,39	0,45	0,44		0,44	0,37	0,49	0,41	0,45	0,39	0,46
Standard Deviation Ratio	0,84	1,16	0,96	1,1	1,07		1,07	0,92	1,2	1	1,09	0,96	1,14
Autocorrelation x(t)-x(t-1)	0,86	0,94	0,97	0,96	0,95		0,96	0,94	0,95	0,95	0,96	0,97	0,95
Autocorrelation x(t)-x(t-2)	0,68	0,78	0,89	0,86	0,84		0,87	0,8	0,83	0,83	0,87	0,9	0,81
Autocorrelation x(t)-x(t-3)	0,5	0,59	0,77	0,7	0,69		0,75	0,64	0,65	0,67	0,75	0,79	0,63

The conclusions drawn from the Pearson correlation in this new analysis are not as evident as they were for the GDP cycle. Overall, the values are found to be lower than the ones obtained previously plus there are also some cases where values fall below zero. This is true for Germany and Finland which show correlation values of -0,09 and -0,05 respectively. This negative values of correlation mean that, not only there is there a low correlation between the two, but also that the two cycles move in opposite directions, in other words, when the house price cycle is increasing in Portugal, in Germany and Finland it is decreasing. Contrarily to Germany and Finland, Spain,

Austria and Ireland show Pearson correlation values above 0,4 which implies a relatively high level of correlation between the house price cycles in each of these countries and Portugal.

Considering now the Concordance index for each of these countries' house price cycles, the conclusions seem to be somewhat different from the ones drawn from the Pearson correlation. The values obtained for this measure are significantly higher for all the analyzed countries, ranging between 48% and 65% which are similar to the ones obtained for the GDP cycle. Similarly to the Pearson correlation, Spain and Austria are also found to have a high synchronization with Portugal while Finland is found to have the lowest level of synchronization among the analyzed countries. Moreover, the Dutch house price cycle is found to be the one with the highest synchronization with the Portuguese house price cycle.

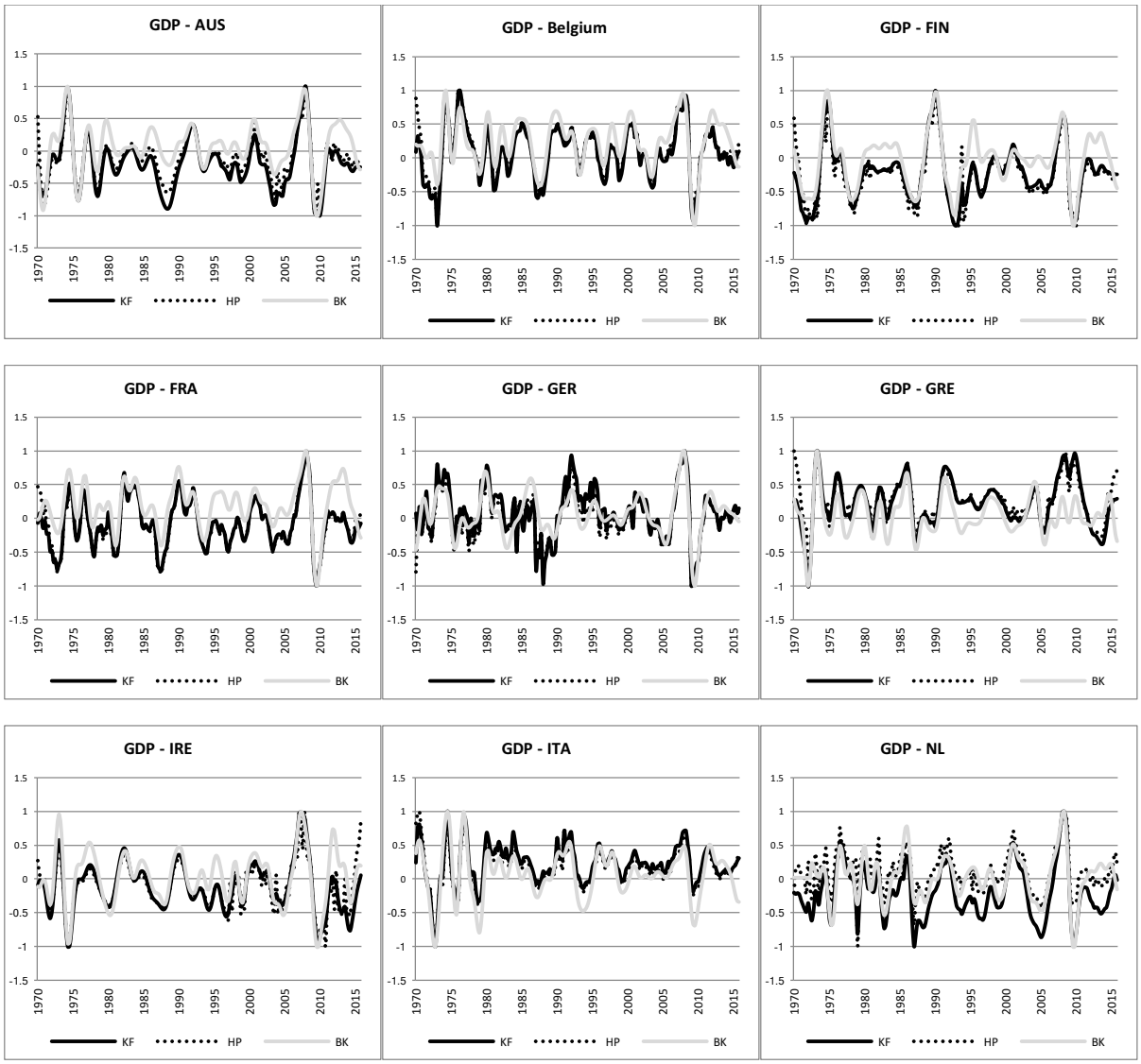
The cross-correlation analysis provides an overall similar conclusion to the one provided by the two previous measures. The house price cycles in Spain and Austria are found to be moving side by side with the Portuguese one while Finland, just like the United States, seems to be lagging the Portuguese cycle by 11-periods which corresponds to a delay of almost 3 years between the two.

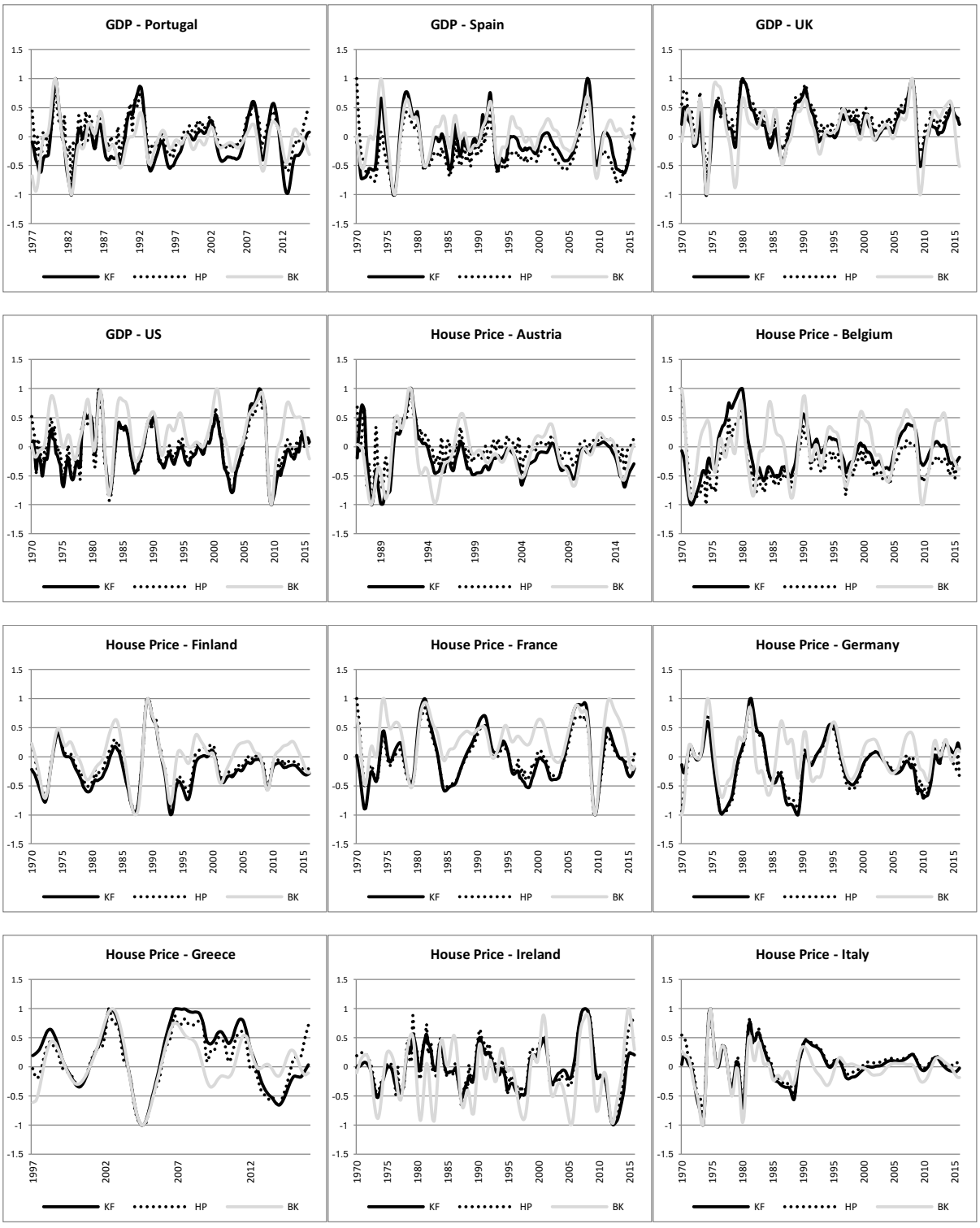
4.3. Robustness

Across a wide range of literature, the answer to which is the best method to be used to separate a series from its components is far from reaching a consensus. The most widely used filters are the HP and the Baxter and King filters but in this project, the Kalman filter is the one chosen to be presented. Several studies have been conducted trying to understand the advantages and drawbacks of each one of this filters and many concluded that, in most of the cases, the filters provide similar conclusions.

In order to tackle this issue, this section will provide an analysis on how the Kalman filter relates to the HP and Baxter-King filters for the all series used in the course of our analysis. The cycles obtained using each one of this filters are represented in Graph 1.

Graph 1: Comparison between Filters




GDP - Portugal
GDP - Spain
GDP - UK
GDP - US
House Price - Austria
House Price - Belgium
House Price - Finland
House Price - France
House Price - Germany
House Price - Greece
House Price - Ireland
House Price - Italy
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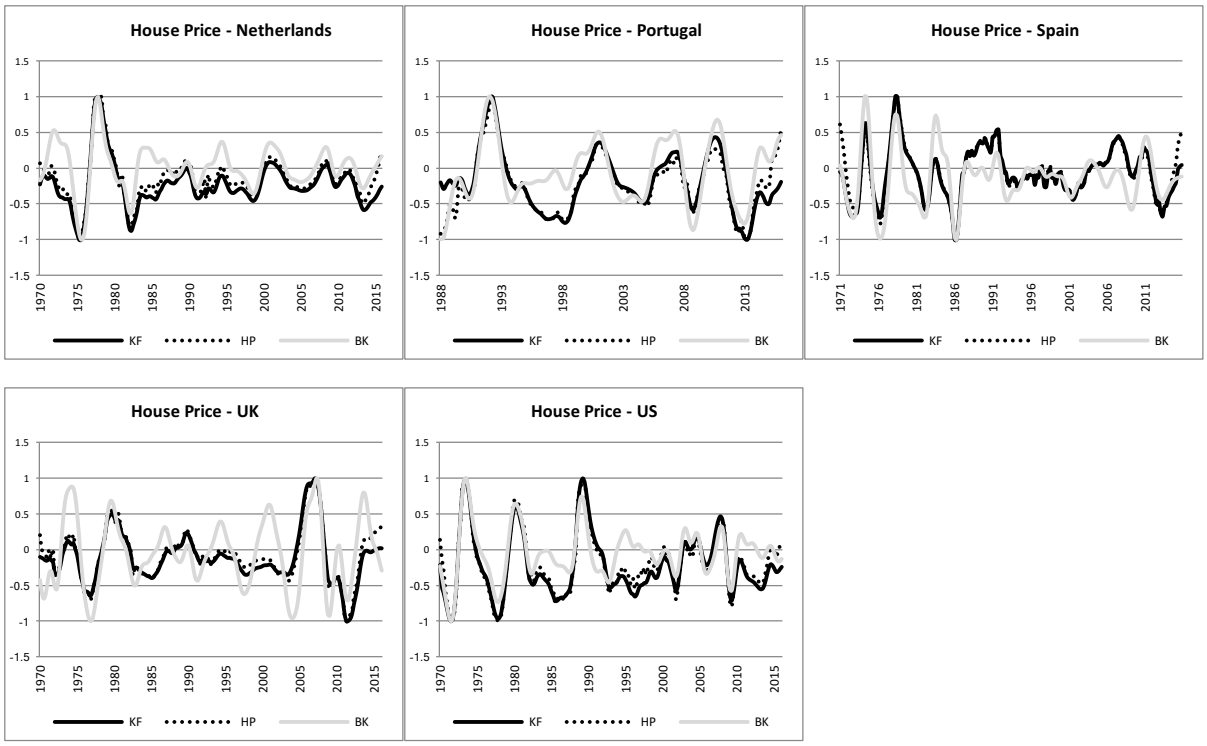
HP
BK



In order to obtain a more exact result, three different tests are performed for all thirteen countries included in our sample for both the GDP and the real house price series. The first metric presented is the R-square, which shows how much one of the cycles can be explained by changes in the other. The second measure presented is the Correlation coefficient which measures the linear dependence between two series and, the last metric presented is Synchronicity which measures how much of the total series length, the cycles given by each of the filters are in the same phase (both decreasing or both increasing). The main results are presented in table 4.

When considering GDP as the series used to study the relationship between the Kalman and the HP filter, the average results provided by each of the metrics are a 0,91 average R-square, a 0,95 correlation and an 87% synchronicity between the two filters. For the same variables, the values are slightly reduced when the variable used for comparison is the housing price series. The

Table 4: Comparison between Filters

	Kalman Filter vs HP Filter			Kalman Filter vs Baxter King Filter			HP Filter vs Baxter King Filter		
GDP	**R-square**	**Correlation**	**Synchrony**	**R-square**	**Correlation**	**Synchrony**	**R-square**	**Correlation**	**Synchrony**
Austria	0.94	0.97	83%	0.88	0.94	79%	0.84	0.92	72%
Belgium	0.96	0.98	93%	0.76	0.87	78%	0.70	0.83	74%
Finland	0.90	0.95	78%	0.81	0.90	86%	0.73	0.74	69%
France	0.97	0.98	95%	0.74	0.86	82%	0.68	0.82	79%
Germany	0.93	0.96	98%	0.56	0.75	62%	0.68	0.82	64%
Greece	0.88	0.94	75%	0.44	0.66	80%	0.54	0.74	68%
Ireland	0.82	0.91	88%	0.76	0.87	89%	0.63	0.79	80%
Italy	0.95	0.97	93%	0.78	0.88	80%	0.73	0.86	75%
Netherlands	0.89	0.94	79%	0.69	0.83	79%	0.58	0.76	66%
Portugal	0.84	0.92	86%	0.50	0.71	81%	0.63	0.79	70%
Spain	0.87	0.93	88%	0.57	0.75	80%	0.38	0.61	73%
UK	0.94	0.97	84%	0.59	0.77	83%	0.52	0.72	72%
US	0.94	0.97	89%	0.66	0.81	79%	0.71	0.84	73%
Average	0.91	0.95	87%	0.67	0.82	80%	0.64	0.79	72%
Max	0.97	0.98	98%	0.88	0.94	89%	0.84	0.92	80%
Min	0.82	0.91	75%	0.44	0.66	62%	0.38	0.61	64%

	Kalman Filter vs HP Filter			Kalman Filter vs Baxter King Filter			HP Filter vs Baxter King Filter		
House Prices	**R-square**	**Correlation**	**Synchrony**	**R-square**	**Correlation**	**Synchrony**	**R-square**	**Correlation**	**Synchrony**
Austria	0.73	0.85	77%	0.53	0.73	73%	0.44	0.66	62%
Belgium	0.73	0.86	81%	0.25	0.50	80%	0.32	0.57	66%
Finland	0.97	0.99	94%	0.77	0.88	83%	0.80	0.90	80%
France	0.86	0.93	91%	0.60	0.77	89%	0.64	0.80	84%
Germany	0.95	0.97	92%	0.31	0.55	80%	0.40	0.63	80%
Greece	0.90	0.95	84%	0.58	0.76	85%	0.61	0.78	75%
Ireland	0.90	0.95	88%	0.46	0.68	85%	0.55	0.74	74%
Italy	0.96	0.98	91%	0.72	0.85	74%	0.73	0.85	73%
Netherlands	0.95	0.98	85%	0.57	0.76	85%	0.62	0.79	78%
Portugal	0.84	0.92	88%	0.57	0.76	80%	0.70	0.83	76%
Spain	0.91	0.96	96%	0.51	0.71	84%	0.48	0.70	82%
UK	0.95	0.97	89%	0.36	0.60	75%	0.42	0.64	69%
US	0.95	0.97	87%	0.67	0.82	83%	0.72	0.85	80%
Average	0.89	0.94	88%	0.53	0.72	81%	0.57	0.75	75%
Max	0.97	0.99	96%	0.77	0.88	89%	0.80	0.90	84%
Min	0.73	0.85	77%	0.25	0.50	73%	0.32	0.57	62%

results obtained in this case are a 0,89 R-square, a 0,94 correlation and a 88% synchronicity which, even though lower than the ones given by GDP, still show evidence of a high relationship between the Kalman and the HP filters.

The results obtained when comparing both the Kalman and the HP filters to the Baxter and King filter are very similar to each other but bellow the values found when comparing each one

with the Kalman Filter. While GDP provides lower values for the relationship between the Kalman and the Baxter King filters, the house price shows lower values for the comparison between the HP and the Baxter King filter. In spite of not being as high as the ones provided by the relationship between the Kalman and the HP filters, the values are still high which means that there is a high relationship between them.

Overall the results obtained from this analysis on the two most used filters and the one used in this project, the Kalman filter, confirm a high relationship between the three. This implies that, even though different, the conclusions drawn when using each one of them are expected to be similar.

5. Conclusions

Two major issues have been tackled in the course of this project. The first one consists on the relationship between the housing market and the economic cycle. This is an issue that gained a massive importance since the horrific effects caused by the burst of the housing market bubble in the United States which spread out across the entire world. In this project an analysis of the relation between the house price and the GDP cycle was performed and the major findings were that there is indeed a high-level relationship between these two cycles across the thirteen analyzed countries especially in Portugal and Spain. The lowest levels of correlation between the two were found in the UK which shows a delay between the two cycles of three years. This high level of correlation between house prices and GDP provides evidence of the effects that the housing sector has on the real economy. These results confirm the ones provided by several authors like Ferrara and Vigna (2009), that house prices provide useful information to better understand the implications of economic policies and, as such, forecasting house price cycles can be very useful to better understand economic fluctuations

The second major issue investigated in this project consist of the level of correlation between European countries. This is an issue of major importance given the level of integration inside the European Monetary Union. This project focuses on the relationships within the Portuguese economy with regards to the GDP and the house price cycle. The major findings from this analysis are that there is a high relationship between Portugal and some other European countries like Germany, the Netherlands and Spain as far as the GDP cycle is concerned but the same reasoning does not apply for countries like Ireland and the US which are found to be the countries with the lowest correlation with Portugal. Moreover, this correlation levels decrease when the house price cycle is used for comparison, although some conclusions remain true. Even with this new benchmark, Spain still shows signs of a high correlation with Portugal which might be related to the high linkage between the Portuguese and Spanish economies. Additionally, Austria is also found to be highly correlated with Portugal while Finland is found to be the country with the lowest correlation to the Portuguese house price cycle, this one is indeed found to be negative for the period length analyzed in this project.

The level of correlation between the economic cycles in Portugal and several other European markets reveal that, to some extent, the European Union is converging but, the same reasoning does not apply for the house price cycle. This one suggests a higher dependence on internal factors more than Euro Area factors. These differences between countries are of extreme importance since two different economies will react in two different ways to the same policy. As such, this differences must be taken into account in the decision-making process which makes it more difficult for the EU since it cannot provide one single measure that applies to all countries. On the contrary, this one must be taken at national level.

For further work, a possible extension could be to consider different variables as representatives of the housing market like housing investment, employment in construction, building permits or nominal house prices. It would also be interesting to analyze the remaining countries correlation with each other and not only with the Portuguese economy to better understand the level of synchronization inside the European Union.

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