LISBON SCHOOL OF ECONOMICS & MANAGEMENT
UNIVERSIDADE DE LISBOA

UNDERGRADUATE SEMINAR IN ECONOMICS

MONETARY AND FINANCIAL ECONOMICS

2015/2016

FINAL REPORT

WHAT ARE THE MAIN FEATURES OF THE PORTUGUESE BUSINESS CYCLE?

AUTHORS:

SOFIA CASTILHO, 44004

JOÃO A. DIAS, 43545

RODRIGO M. FERREIRA, 41905

DOMINGOS SEWARD, 43409

TUTOR:

PROFESSOR LUÍS F. COSTA

COORDINATOR:

PROFESSOR CÂNDIDA FERREIRA

ISEG of ULisboa, 17th June 2016

CONTENTS

LIST OF FIGURES

List of Tables

WHAT ARE THE MAIN FEATURES OF THE PORTUGUESE BUSINESS CYCLE?

By S. Castilho, J. Dias, R. Ferreira, D. Seward[1]

THIS ESSAY provides an introductory approach to explaining the main features of the Portuguese business cycle. The business cycle is de-constructed into its cyclical and trend components employing statistical filters as a bridge to their macroeconomic explanation.

1 INTRODUCTION

In this essay we explore, from a macroeconomic perspective, which are the main features of the Portuguese business cycle. We also aim at comparing it with the business cycles of other economies of interest, namely Germany, Spain and the United States of America.

Economies are subject to fluctuations in economic activity. In a particular point in time, an economy may be experiencing a surge in economic activity, usually characterised by a growing Gross Domestic Product (GDP) along with a decreasing unemployment rate. On the other hand, an economy may be undergoing a worsening of economic conditions, frequently associated with a declining GDP along with a rise of the rate of unemployment. While the former scenario is typically referred to in economic literature as an expansion or *boom*, the latter is identified as a contraction or recession. The sequence of these two macroeconomic phenomena over time is called a business cycle. These shifts in economic activity are a common feature of modern economies. In fact, countless business cycles can easily be identified throughout the course of history.

Business cycles have long been the subject of a lively debate amongst economists. The importance of business-cycle theory in understanding economies' behaviour over time is widely acknowledged. Surely it also plays a crucial role in policy-making, as it may help explain the reasons behind their occurrence and eventually provide us with tools to fight stagnant dispositions and to sustain growth and stability. However, whilst most economists do agree on the existence of business cycles, we are yet to reach consensus about its causes, frequency and measurement.

Our analysis will cover several macroeconomic aspects of modern economies. We will thus focus on

[1]Contacts: sofia.castilho@hotmail.com; joaoantoniodias@hotmail.com; rodrigomariabf@me.com; dgosseward@gmail.com

several components of GDP (notably consumption and investment), GDP itself, and, finally, the labour market. In order to determine the essential features of business cycles and examine the relationships between key variables we conduct advanced descriptive statistical analysis. To do so we apply four different statistical filters: the linear filter, the Hodrick-Prescott filter, the Baxter-King filter, and the Christiano-Fitzgerald filter. We hope to compare the results between each of the aforementioned statistical filters, relating our findings with macroeconomic theory. Moreover, several concepts such as series volatility, cyclicality - both absolute and relative - and correlation are put to use as a way to better understand the cyclical components of key variables.

This essay will obey the following structure. In section 2, a brief overview of the basic concepts of business cycle theory is presented: we further explore what a business cycle is, its stages, its most popular measures and their characterisation. In section 3, we discuss measurement issues and the methodology applied throughout the essay. In section 4, the Portuguese business cycle is characterised. In section 5, we intend to outline and interpret the main results regarding the international comparison conducted. In section 6, the main results of the empirical applications carried out are explored and examined in greater detail: we address the cyclical behaviour of consumption, investment and the labour market. Finally, in section 7, the main findings are analysed and conclusions are outlined.

2 BUSINESS-CYCLE THEORY

A business cycle is the fluctuation of the economy around its long-term growth trend between periods of expansion, i.e. *booms*, and periods of contraction, i.e. recessions. Macroeconomic variables such as GDP, interest rates, employment, and consumer spending reflect the stage of a business cycle.

Burns and Mitchell (1946) provide a very precise empirical definition of a business cycle:

> *Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own.*
>
> In Burns & Mitchell (1946), p. 3.

Identifying the features of business cycles and regularities is of great importance in business cycle theory. In this regard, Lucas (1977) presents us with the main qualitative features of business cycles. He states regularities are not observed "in either time or period", as opposed to those visible in the "natural sciences", e.g. the motion of waves. Those are identified, however, as co-movements of several time-series variables:

> *(i) Output movements across broadly defined sectors move together [...].(ii) Production of producer and consumer durables exhibits much greater amplitude than does the production of non-durables. (iii) Production and prices of agricultural goods and natural resources have lower than average conformity. (iv) Business profits show high conformity and much greater amplitude than other series. (v) Prices generally are pro-cyclical. (vi) Short-term interest rates are pro-cyclical; long-term rates slightly so. (vii) Monetary aggregates and velocity measures are pro-cyclical.*
>
> In Lucas (1977), p. 3.

In Lucas's point of view, evidence suggests that these regularities span along different economies over time, which may be an indication that a general and commonly accepted theory can be constructed in order to explain business cycles.

The trend can be thought as a long-run pattern and can be described as upward or downward, e.g. if real GDP increases over time, in spite of decreasing at some points, it will exhibit an upward trend on that period of time (see figure 1 below). The trend line can be drawn by applying statistical techniques. On the other hand, the cyclical component of a time series is an indication of fluctuations about trend. It reveals a succession of phases of expansion and contraction.

As shown by figure 1, turning points are identified as peaks and troughs. A peak is reached at a maximum, for which real GDP stops rising, and starts to decline. A trough, as opposed to a peak, is reached at a minimum, for which real GDP stops declining, and starts to rise. The amplitude of a business cycle is the difference between a peak or a through and trend[1], and the frequency is defined as the number of peaks or troughs in real GDP during a specific period of time.

In a business cycle, we identify a period of contraction, defined as a recession, connecting a peak to a trough, followed by a period of expansion, defined as *boom*, connecting a through to a peak.

A *boom* is a period during which real GDP is rising at a faster rate than the trend rate of growth. A *boom* can be associated with several macroeconomic phenomena, such as high levels of employment

[1] Some authors define the amplitude of a business cycle as the vertical distance between peak and trough.

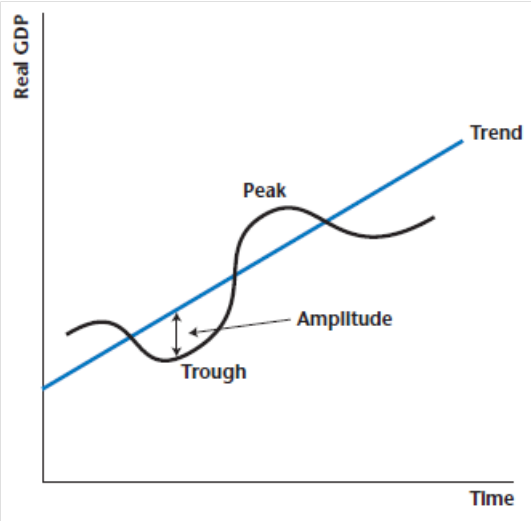

FIGURE 1: Trend and the different stages of a business cycle.

Source: Williamson (2014), p. 88.

and rising wages, a fast growth of consumption supported by rising incomes and strong consumer confidence, a pick-up in demand for capital goods providing higher profits and resulting in higher investment, more demand for imports generating a larger trade deficit (due to a demand for goods and services that surpasses the economy's capacity to supply all the goods and services consumers would like to acquire). Usually in a *boom* overheating takes place, resulting in high levels of inflation.

On the other hand, a recession is associated with a significant decrease in economic activity. A period of recession usually is reflected in several variables and may be associated with various symptoms. Typically, it is accompanied by a rising unemployment and a growing number of business failures leading to lower profits and investment. Recessions can also be identified observing consumption's behaviour over time: usually consumer and business confidence decline and consumer spending tightens. Other important signs of a recession include a drop in trade. We distinguish between a recession and a depression. The latter is an extended and deep recession leading to an abnormal fall in output and living standards.

Furthermore, concepts like volatility and cyclicality are crucial in characterising business cycles. The amount a variable deviates from its trend is measured by the volatility and it may be quantified by the standard deviation.

One can define the type of cyclicality of a variable based on its correlation with the output gap (i.e. deviation of real observed GDP from potential GDP) to which we broadly refer to as co-movement. Hence, three types of cyclicality of a variable are defined: if its deviations from trend are positively correlated with the output gap, a variable is defined as being pro-cyclical; if its deviations from trend are negatively correlated with the output gap, a variable is defined as being counter-cyclical; finally, if

its deviations from trend are neither positively nor negatively correlated with the output gap, a variable is defined as being acyclical. In this regard, one can define a leading or lagging variable based on its correlation with future or past movements in real output: if a variable tends to anticipate future movements in GDP, it is defined as being a leading variable; if, instead, a variable tends to follow past movements in GDP, it is defined as being a lagging variable; and, finally, if a variable is positively correlated with real GDP and neither a leading nor lagging variable, it is defined as being a coincident variable.

3 MEASUREMENT ISSUES

It is important to note that we will ultimately work with *per capita* values, based on quarterly data for the variables collected from a wide range of databases (Banco de Portugal, 2015; OECD, 2016 ; INE, 2015), all of which were compiled in order to form our own. We choose to use *per capita* data in order to abstract from population fluctuations. In the course of the work we will relate macroeconomic variables, i.e. GDP, the components of expenditure (consumption, investment, and trade balance), inflation rate, unemployment, labour productivity, and real wages.[2]

Regarding the underlying calculations of the *per capita* values, the quarterly data for total population has been interpolated based on the yearly data we hold (for the period ranging from 1977 to 1995). To do so we applied a macro for Microsoft Excel with a cubic spline[3] algorithm embedded on based upon the approach developed by Jenkins (2009). This will enable us to interpolate the "missing" values on the series. As for the remaining values, we managed to collect quarterly data from the OECD database. In order to test the accuracy of the cubic spline interpolation we compared the original and the interpolated data for the period for which we have both annual and quarterly data, i.e. from 1995 to 2014, with satisfactory results[4].

In order to obtain the cyclical component for a time series, x_t, we have to detrend it first, i.e. we removed a smooth trend from the data before comparing the actual fluctuations or making any predictions. The filter helps to understand the various cycles that make up the time series. The trend of a time series

[2]The aforementioned variables can be found on an Excel spreadsheet displaying several tables with the filtered data, the volatility and the correlation for each one, all of which is made available at `https://www.dropbox.com/sh/lcgho696plbwqgj/AABJmkvKNhM0Iuc6oH3VGyWfa?dl=0`.

[3]A cubic spline is an algorithm used to fit a curve to a series of points with a piecewise series of third-order polynomials. The cubic spline is the curve defined for two adjacent internal points. This curve will pass through both points, and the slope of the curve is equal to the slope of the curve at the end points and adjacent segments. The format of the curve is a curvature that is equal for both adjacent segments and end points (Jenkins, 2009).

[4]The interpolated data shows a deviation from the real data of less than 0.001%.

variable, x_t, is denoted by $\bar{x}_t$, whilst its cyclical component is denoted by $\hat{x}_t$:

$$x_t = \bar{x}_t + \hat{x}_t \tag{1}$$

To enhance the quality of the study, we will employ four detrending procedures: the linear filter, the Hodrick-Prescott filter, the Christiano-Fitzgerald filter, and the Baxter-King filter.

First, the linear filter is a detrending method based upon moving averages. The cyclical component is defined as a two-sided moving average deviation of any specific observation from the trend line. A linear filter can be defined as follows:

$$\bar{x}_t = \tilde{a}_0 + \tilde{a}_1 t\,, \tag{2}$$

Where tildes over parameters denote estimated parameters from $\tilde{x}_t = a_0 + a_1 t + u_t$, and u_t represents a zero-mean random variable.

Second, the Hodrick-Prescott (HP) filter is one of the most well known filters and it is widely used by economists for the purpose of detrending time-series data, mostly in business cycle studies.

This filter decomposes a time series, x_t, into a trend component, $\bar{x}_t$, and a cyclical component, $\hat{x}_t$, with the objective of minimizing the distance from the original series to its trend component, penalised by $(x_t - \bar{x}_t)^2$. The filter also minimizes the curvature of the trend series, i.e. changes in growth rates are penalised by $(\Delta_{\bar{x}_{t+1}} - \Delta_{\bar{x}_t})^2$. The connection between these two objectives is governed by the parameter $\lambda \geq 0$. Hence, the HP filter is the solution to the following problem, for all $t = 1, \cdots, T$:

$$\begin{aligned} \underset{\{\bar{x}_t\}_{t=1}^{T}}{\text{Min}} \; (x_t - \bar{x}_t)^2 + \lambda \sum_{t=2}^{T-1} [(\bar{x}_{t+1} - \bar{x}_t) - (\bar{x}_t - \bar{x}_{t-1})]^2 = \\ = (x_t - \bar{x}_t)^2 + \lambda \sum_{t=2}^{T-1} (\Delta_{\bar{x}_{t+1}} - \Delta_{\bar{x}_t})^2. \end{aligned} \tag{3}$$

By setting $\lambda = 0$ we assume that $x_t = \bar{x}_t$ (i.e. there is no cyclical component, the variable is always at its trend level). The larger λ is, the larger the penalty on trend deviations from a linear specification. By this reasoning, as $\lambda \to \infty$, $\bar{x}_t$ approaches the x_t's linear time trend for x_t, obtained via an OLS estimation, i.e. the filter acts, in practice, as the linear filter above. The choice of the value for λ has to be aligned with our goal of filtering out business cycles in a certain frequency. In this essay we will use only quarterly data so our λ will be set to 1600, according to Hodrick & Prescott (1997).

Third, the Christiano-Fitzgerald (CF) filter is a band-pass filter. Its main objective is to detrend and

smooth the problem in the frequency domain. The filter uses the whole time series for the calculation of each filtered data point. The main advantage of the Christiano-Fitzgerald filter, henceforth CF, is that it is designed to work well on larger time-series - see Christiano & Fitzgerald (1999). Hence, the CF filter is calculated as follows, for $t = 3, 4, \cdots, T-2$:

$$\begin{aligned}\hat{x}_t = B_0 x_t + B_1 x_{t+1} + \cdots + B_{T-1-t} x_{T-1} + \tilde{B}_{T-t} x_T + \\ + B_1 x_{t-1} + \cdots + B_{t-2} x_2 + \tilde{B}_{t-2} x_1.\end{aligned} \tag{4}$$

Where $B_j = \frac{\sin(jb)-\sin(ja)}{\pi j}$, $j \geq 1$; $B_0 = \frac{b-a}{\pi}$, $a = \frac{2\pi}{p_\upsilon}$, $b = \frac{2\pi}{p_\wr}$. And $\tilde{B}_k$ is defined as a simple linear equation of B_j, $\tilde{B}_k = -\frac{1}{2}B_0 - \sum_{j=1}^{k-1} B_j$. Furthermore, $p_\wr$ and p_υ define the period of oscillation between which the time series data is specified, and $2 \leq p_\wr < p_\upsilon < \infty$.

Finally, the Baxter-King (BK) filter is also a band-pass filter. As in the CF filter, its main objective is to detrend and smooth the problem in the frequency domain. The main properties of this filter are the symmetry, the constant finite length and being time-invariant, which makes the filter stationary. The symmetry of the filter contributes to not introducing any phase shift so it leaves the extracted components unaffected. The only case where this property is not true is on the respective amplitude. This filter is not used in the edge of the series because it is insensitive to deterministic linear trends. Baxter & King (1977) thus suggest an approximation of a finite moving-average of order K for an ideal band-pass filter, as presented below:

$$\bar{x}_t = \sum_{j=-K}^{K} a_j L^j x_t \text{ , where } L \text{ denotes the lag operator.} \tag{5}$$

Figure 2 represents the cyclical component for the logarithm of Portuguese GDP *per capita*, from 1977 to 2014, applying the four filters above. The linear filter makes cyclical fluctuations sharper. In contrast, the other three statistical filters employed look similar and are highly correlated[5].

Regarding the measurement aspect of the variables under the scope of our study, we will use *per capita* values to smooth the comparisons between the countries and, most importantly, to abstract the variables from the fluctuations of population. Furthermore, most variables are analysed as logarithms, in order to make scaling more easily manageable. In the case of consumption, government expenditure, and investment, values will be analysed *per capita* and as logarithms. On the other hand, the real average wage and the average productivity of labour are only analysed as logarithms. Net exports are measured in proportion of GDP, and the rate of unemployment will suffer no additional manipulation.

[5]Appendix B supports this observation, presenting an extensive cross correlation analysis between all four statistical filters.

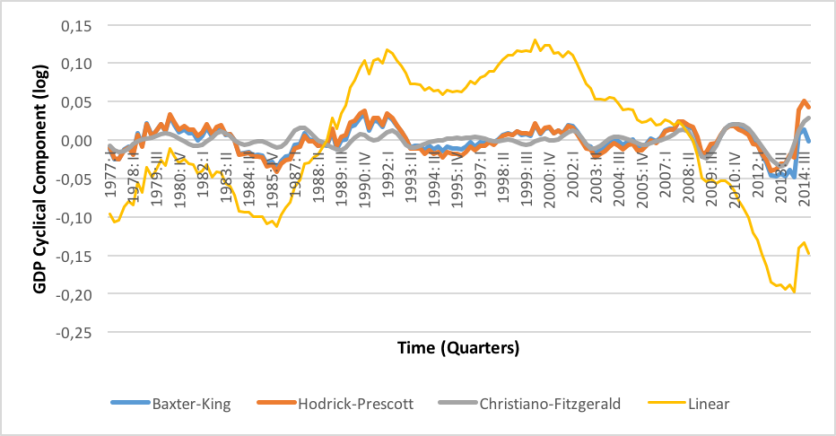

FIGURE 2: GDP Cyclical Component: BK, HP, CF, and Linear filter application, Portugal, 1977 to 2014.

4 CHARACTERISING THE PORTUGUESE BUSINESS CYCLE

An empirical study has been conducted for the Portuguese economy on the period ranging from 1977 to 2014, with the objective of determining the main features of the Portuguese business cycle.

	Linear	BK	HP	CF
$\sigma_{\hat{Y}}$	0.09	0.02	0.02	0.01
$\sigma_{\hat{C}}/\sigma_{\hat{Y}}$	1.22	1.57	1.49	2.01
$\sigma_{\hat{I}}/\sigma_{\hat{Y}}$	2.51	3.45	3.59	4.91
$\sigma_{\hat{G}}/\sigma_{\hat{Y}}$	1.28	0.87	0.86	1.12
$\sigma_{\hat{NX}}/\sigma_{\hat{Y}}$	0.39	0.69	0.68	1.12
$\sigma_{\hat{w}}/\sigma_{\hat{Y}}$	1.01	1.82	1.77	2.98
$\sigma_{(\hat{Y/L})}/\sigma_{\hat{Y}}$	4.82	6.41	6.37	8.18
$\sigma_{\hat{u}}/\sigma_{\hat{Y}}$	0.25	0.36	0.38	0.52

TABLE I: Volatilities, Portugal, 1977 to 2014.

As shown in table I, the estimated absolute volatility of GDP (Y) indicates that output deviates from its trend, on average, between 1%, as measured by the CF filter, and 9%, as measured by the linear filter, each quarter. Of the main components of GDP analysed, private consumption (C) appears to be slightly more volatile than GDP, i.e. its cyclical component has a variation that ranges from 22%, according to the linear filter, to as much as twice the volatility of GDP, as measured by the CF filter. These results may be explained by the inclusion of durable goods in C, which is six to seven times more volatile than non-durable goods.

As for government consumption (G), it shows an ambiguous behaviour, being sometimes more and sometimes less volatile than GDP, depending on the statistical filter employed. Investment (I), however, is very volatile, 2.5 to 5 times more volatile than GDP, which may be an indication of its importance in determining the Portuguese business cycle. Nonetheless, since C has a much larger relative weight in GDP than I, the fluctuations between the two are, on average and in the long run, usually equivalent.

Net exports (NX) tend to be less volatile than GDP, since its relative standard deviation is below 1 for most of the statistical filters employed[6].

Regarding the Portuguese labour market, real wage *per* worker (w) appears to be relatively more volatile than GDP, whereas average labour productivity (Y/L) is highly volatile. The unemployment rate (u) is much less variable than GDP regardless of the statistical filter employed.

	$Correlation(\hat{X}_t, \hat{Y}_t)$			
Variable X	Linear	BK	HP	CF
C	0.97	0.81	0.81	0.70
I	0.93	0.62	0.68	0.47
G	0.95	0.40	0.53	0.03
NX	-0.75	-0.33	-0.40	-0.24
w	0.77	0.46	0.52	0.35
Y/L	0.98	0.91	0.92	0.90
u	-0.95	-0.69	-0.73	-0.58

TABLE II: Contemporaneous Correlation Coefficients, Portugal, 1977 to 2014.

As shown in table II, consumption and GDP are highly positively correlated, since these two variables move together over time. Note that, for all the statistical filters employed, the correlation coefficient between consumption and GDP is always above 0.7. Therefore, consumption is strongly pro-cyclical. Investment and government consumption tend to be highly and moderately pro-cyclical respectively. Net exports, on the other hand, are noticeably counter-cyclical. The real wage is moderately pro-cyclical, whereas the average labour productivity is a highly pro-cyclical variable. Finally, the unemployment rate is a highly counter-cyclical variable, with a correlation coefficient of -0.7, as measured by the HP filter.

[6]This may be related with the fact that this variable is measured in proportion of GDP.

5 AN INTERNATIONAL PERSPECTIVE

For the purpose of this chapter we will limit our interpretation of the data to the HP filter. We choose to use this filter based on an extensive cross-correlation analysis of the cyclical component obtained with each filter for all of the variables considered for the purposes of this study. The cyclical components measured using the HP filter show near perfect correlations (between 0.8 and 1), with those produced by the BK and the CF filters, and a low positive (between 0.5 and 0.1) correlation with the linear filter[7].

As mentioned above, in order to present an international perspective of business cycles, we felt the need to compare the results achieved in the preceding section with those of other developed countries in the western world. We will thus focus on three different countries besides Portugal, in the hopes of drawing conclusions regarding the behaviour of the variables considered in our study: Spain, Germany and the USA. The countries were selected having into account the results of the cross-correlations between the macroeconomic variables tested and its impact on the Portuguese GDP (see table V).

In order to conduct our analysis we have created a dataset for the period ranging from 1995 to 2014 based on data collected from the OECD database. The period was selected taking into account the available data for all of the countries, being crucial to collect the data from one single source in order to limit eventual divergences in the treatment of the data.

	Portugal	Spain	Germany	USA
$\sigma_{\hat{Y}}$	0.01	0.01	0.02	0.01
$\sigma_{\hat{C}}/\sigma_{\hat{Y}}$	1.30	1.21	0.40	0.84
$\sigma_{\hat{I}}/\sigma_{\hat{Y}}$	4.70	3.65	3.34	4.09
$\sigma_{\hat{G}}/\sigma_{\hat{Y}}$	0.88	1.07	0.53	0.92
$\sigma_{\hat{NX}}/\sigma_{\hat{Y}}$	0.94	0.79	0.51	0.37

Note: Results concern the application of the HP filter only.

TABLE III: Relative Volatilities for Portugal, Spain, Germany, and the USA, 1995 to 2014.

As shown in table III, the absolute volatility of GDP is similar for all countries, with the exception of Germany. It should be noted that consumption for Germany and the USA is considerably less volatile

[7]See Appendix B. The Excel file is made available at: `https://www.dropbox.com/sh/lcgho696plbwqgj/AABJmkvKNhM0Iuc6oH3VGyWfa?dl=0`.

in comparison with Portugal and Spain.

	Portugal			Spain		
Variable X	$k=-4$	$k=0$	$k=4$	$k=-4$	$k=0$	$k=4$
C	0.07	0.89	0.19	0.06	0.90	0.36
I	-0.04	0.82	0.24	0.05	0.87	0.44
G	0.02	0.26	0.29	0.23	0.26	-0.17
NX	0.09	-0.51	-0.30	0.12	-0.73	-0.33
	Germany			USA		
Variable X	$k=-4$	$k=0$	$k=4$	$k=-4$	$k=0$	$k=4$
C	0.19	0.46	0.25	0.45	0.90	0.29
I	-0.07	0.85	0.24	0.20	0.95	0.44
G	0.16	-0.27	-0.19	-0.44	-0.68	-0.33
NX	0.17	0.61	-0.15	-0.15	-0.74	-0.18

Note: Values k represent lagging or leading correlation coefficients between variable X and output, where $Corr(X_t, Y_{t+k})$.
Results concern the application of the HP filter only.

TABLE IV: Correlation Coefficients for Portugal, Spain, Germany, and the USA, 1995 to 2014.

Regarding private consumption it is highly pro-cyclical in the cases of Portugal, Spain and the USA, both contemporaneously and when compared with future and past movements in GDP (four quarters lag and lead). In the specific case of Germany, consumption is also positively correlated with GDP, but with much smaller values. It is yet to be noted the significant impact of the 2008 financial crisis on the consumption correlation with GDP (four quarters lead into the future) for Portugal. In order to make these assumptions, we have created another dataset, this time for the period ranging from 1995 to 2007, for all the four countries (as presented in appendix C). We can thus state that consumption has become less correlated with future GDP, changing from 0.43 before the Great Recession to 0.19 after.

There is not much to note about investment, besides being highly pro-cyclical, showing results higher than 0.8 for all of the countries. Despite being positively correlated contemporaneously and with a lead into the future for all of the countries, the same does not happen for the past with Portugal and Germany showing negative correlations for a one year lag.

As for government consumption the values are relatively low with the particularity of being positively correlated in the cases of Portugal and Spain and negatively correlated in the cases of Germany and the USA. Therefore, G is a counter-cyclical variable in the USA and Germany, and it is pro-cyclical in the

	Spain			Germany			USA		
	$k=-4$	$k=0$	$k=4$	$k=-4$	$k=0$	$k=4$	$k=-4$	$k=0$	$k=4$
$Corr(Y_t^{PT}; Y_{t+k}^j)$	0.03	0.77	0.23	-0.15	0.57	0.22	0.20	0.40	-0.23
$Corr(Y_t^{PT}; NX_{t+k}^j)$	-0.06	-0.63	0.05	-0.31	0.17	-0.06	0.22	-0.25	0.07

Note: Y_t^{PT} denotes Portuguese GDP; Y_{t+k}^j and NX_{t+k}^j denote other economies' GDP and net exports respectively, where $j =$ (Spain, Germany, USA).
Values k represent lagging or leading correlation coefficients.
Results concern the application of the HP filter only.

TABLE V: Cross-correlation coefficients between Portuguese GDP and other economies' GDP and net exports, 1995 to 2014.

Iberian peninsula. This phenomenon has been particularly noticeable in recent years when Germany, but mostly the USA highly increased their government consumption as a way to reverse the recession and stimulate the economy. Finally, net exports are noticeably counter-cyclical with the sole exception of Germany which presents a moderately pro-cyclical value.

As shown in table V, the Portuguese GDP is highly pro-cyclical with Spain's GDP, approximately 0.8, and moderately pro-cyclical with both the German and the USA's GDP, 0.6 and 0.4, respectively.

Regarding the correlation between the Portuguese GDP and the other countries' net exports (NX), both Spain and the USA present negative correlations, highly and moderately counter-cyclical, respectively. On the other hand, Germany's net exports show a moderately pro-cyclical correlation with Portugal's GDP.

6 MACROECONOMIC ANALYSIS

6.1 Consumption

Consumption for the Portuguese economy appears to be more volatile than output (30% higher with the HP filter - see table III). Regarding the correlation coefficients between consumption and output, Portuguese consumption seems to be highly pro-cyclical. On the other hand, correlations between consumption and past ($k=-4$) and future ($k=4$) output seem negligible.

The fact that consumption for the Portuguese economy is considerably volatile and highly correlated with GDP, appears to be consistent with the traditional Keynesian consumption function. Taking GDP as a measure of current disposable income for the sake of simplicity, this might be an indication that consumption is primarily determined by current disposable income in the Portuguese economy. The correlation values translate a large co-movement between them, which implies that consumption does not

show a smoothing behaviour over the business cycle. Thereby, we believe these features are consistent with the Keynesian theory of consumption. Alternatively, considering how the Euro sovereign crisis has had a massive impact on the borrowing and saving behaviour of individuals, liquidity constraints or even precautionary saving may play an important role in determining consumption. In conclusion, we believe that Keynesian theory or the permanent income hypothesis along with binding liquidity constraints might be more applicable to the Portuguese cyclical behaviour of consumption.

In contrast, we can observe the case of the German economy, where consumption appears to be considerably less volatile than GDP (just 40% of the latter). On the other hand, considering the correlation coefficients between consumption and GDP, these values translate little co-movement between them, thus pointing towards a smoothing behaviour of consumption over the business cycle. These findings are more consistent with the permanent income/life-cycle hypothesis, since it assumes that consumption for an individual is determined by the permanent income over his or her lifetime. Apparently, this suggests that individuals try to keep their consumption approximately the same in each period to maintain stable lifestyles, attempting to smooth consumption over their lifetime.

Furthermore, it is interesting to analyse the impact of the financial crisis of 2008 on the Portuguese cyclical behaviour of consumption. In fact, for the period ranging from 1995 to 2007, consumption appears to be less correlated with current GDP. Therefore, the cyclical behaviour of consumption seems to have slightly shifted from the permanent income hypothesis towards Keynesian theory. As noted above, liquidity constraints or even precautionary saving may have played an important role in determining consumption after the crisis[8].

6.2 Investment

The results regarding the cyclical behaviour of investment appear to be similar among the countries analysed. In this respect, investment displays a highly volatile behaviour over the business cycle for all countries. As shown in table III, the Portuguese investment is the most volatile. On the other hand, investment appears to be a highly pro-cyclical variable. In fact, the US' contemporaneous correlation coefficient reaches the impressive value of 0.95. This might be an indication that investment in Portugal, as in other countries, may be determined to a large extent by the level of output of the same period. Furthermore, investment seems to be a moderately leading variable, since it appears to be fairly correlated

[8]Regarding the USA, the changes in the correlation coefficients between consumption and output are much more noticeable. We thus believe that before the crisis consumption was clearly related with Keynesian theory or the existence of liquidity constraints, disregarding future movements in GDP. Thereby, the crisis probably may have changed the behaviour of consumer spending in the USA, becoming more correlated with both current and future movements in GDP. As for Germany, consumption became less correlated with GDP after the crisis.

with future movements in GDP. Note that the correlation coefficient between investment and next year's GDP, i.e. four quarters ahead, is 0.24. On the contrary, investment is not correlated with past movements in GDP.

We might be sceptical to the point of ascribing our empirical results to the so-called *animal spirits*. This Keynesian view of the behaviour of investment assumes it depends on the real interest rate and also on instincts and spontaneous *states of mind* governed by human behaviour, and thus it considers a substantial part of cyclical fluctuations in investment as being exogenous. However, as presented above, the regularities observed over the business cycle cannot be exclusively credited, if at all, to *animal spirits*.

As presented by Romer (2012), the flexible accelerator model might thus be helpful in explaining the cyclical behaviour of investment. The flexible accelerator model postulates that capital is adjusted towards its desired level. Therefore, firms' investment follow the needs for capital over time. Each period the stock of capital adjusts partially towards its desired level. Following the neo-classical approach to investment by incorporating a Cobb-Douglas production function, and after some mathematical manipulation[9], we conclude that investment depends positively on future output and negatively on the real interest rate.

These results imply that expectations of future movements in output affect investment. Investment is thus higher when firms expect output to be higher in the future, which in turn means that expected high levels of output in the future raise demand at the present moment (supporting the result that investment appears to be a moderately leading variable, as well as being highly volatile). Moreover, firms that cannot implement all desired investment projects are rationed in financial markets, i.e. they face liquidity

[9]The flexible accelerator model assumes investment is governed by the following equation:

$$I_t = \beta(K^*_{t+1} - K_t),\ 0 < \beta < 1 \tag{6}$$

Where K^*_{t+1} denotes the desired stock of capital for the next period, and K_t denotes the stock of capital available at the beginning of the period.

Neo-classical theory assumes production is decently described by a traditional Cobb-Douglas production function as follows:

$$Y_t = A_t K_t^{\alpha} N_t^{1-\alpha},\ 0 < \alpha < 1 \tag{7}$$

Assuming, for the sake of simplicity, a perfectly competitive market, each firm equates the marginal productivity of capital to its price in order to maximise profits:

$$\frac{\delta Y_t}{\delta K_t} = \alpha A_t K_t^{\alpha-1} N_t^{1-\alpha} = \alpha \frac{Y_t}{K_t} \tag{8}$$

Hence,

$$r_t = \alpha \frac{Y_{t+1}}{K^*_{t+1}} \Leftrightarrow K^*_{t+1} = \alpha \frac{Y_{t+1}}{r_t} \tag{9}$$

Where r denotes the real interest rate (including the rate of depreciation).

As a result, substituting (9) in (6) we obtain:

$$I_t = \beta(\alpha \frac{Y_{t+1}}{r_t} - K_t) \tag{10}$$

constraints. Thus, they are more likely to invest more when their sales go up, so correlation with current output increases (which supports the fact that investment appears to be highly correlated with GDP). These effects of changes in GDP on investment are referred to as the *accelerator*.

6.3 The Labour Market

In an attempt to explain the cyclical behaviour of the Portuguese labour market, we may be tempted to associate the fact that the real average wage presents itself as a moderately pro-cyclical variable with a Walrasian labour market model determined mainly by the supply side of the market, and thus a rather elastic and stable labour supply. However, the view that labour supply is of utmost importance in explaining unemployment fluctuations appears not to fit empirical data (as shown by Altonji, 1986, and Ham & Reilly, 2002). Hence, it may happen that non-Walrasian traits of the Portuguese labour market are central in explaining its cyclical behaviour.

Moreover, our findings in table II indicate a highly counter-cyclical unemployment rate, as well as being considerably less volatile than GDP. This supports the empirical observation that, whilst being noticeably counter-cyclical, movements in unemployment tend to be smaller than movements in GDP over the business cycle, the famed Okun's law. In fact, Okun (1962) goes beyond this observation, stating that a decrease in output of about 3%, when compared with its normal growth, tends to produce a corresponding 1 p.p. increase in the unemployment rate.

In this regard, we choose to interpret our results in the light of three well known non-Walrasian labour market theories, in hopes of explaining the plausible non-Walrasian features underpinning the Portuguese labour market: efficiency-wage theories, contracting models, and finally search and matching models.

Efficiency-wage theories assume workers' effort is crucial in determining how much output is produced by firm. Moreover, according to these theories, firms do not have the ability to monitor their workers' effort, but do have monopsony power in the labour market, due to job heterogeneity. This, in turn, leads them to potentially raise wages above the market-clearing level, in an attempt to prevent their workers from shirking, creating an incentive for them to exert effort instead. This type of model usually serves well in explaining interesting features of structural unemployment.

A simple generic efficiency-wage model may help clarify some features of the cyclical behaviour of unemployment in Portugal. Assuming the effort function is determined solely by the real wage, than we conclude labour demand shifts have no effect on the real wage over the business cycle. This is due to the fact that, in this generic model, the efficient wage for each firm depends only on the effort function, which, in turn, means each firm has no incentive to set a different wage once a demand shift takes place.

Unfortunately, with regards to the Portuguese case, a simple generic efficiency-wage model of this sort does not explain the fact that the real average wage appears to be a moderately pro-cyclical variable. Instead, it implies real wage rigidity, that is, according to this model, the real wage should be more or less acyclical. This implication is too extreme and does not fit our findings concerning the cyclical behaviour of the Portuguese labour market.

A contracting model may bring up some important elements of the cyclical behaviour of the Portuguese business cycle to our discussion. Contracting models posit a crucial relationship between contracts and bargaining and the evolution of the labour market itself, further disregarding the traditional Walrasian assumptions. Thus, contracting models assume durable bonds between workers and firms in the form of long-term contracts. Firms need not have the incentives to hire new workers every single period. Consequently, assuming the existence of efficient contracts, wages do not have to adjust in order to re-establish equilibrium each period. Hence, the main implication is that, in a labour market characterised as above, provided that long-term stable bonds between firms and workers exist, the real wage may be constant over extended periods of time, i.e. contracting models conclude that the existence of real wage rigidity plays an important role in the labour market. However, as noted above, the empirical study conducted for the Portuguese labour market does not suggest the existence of real wage rigidity.

The last family of non-Walrasian labour market theories we focus on includes the search and matching models. These models may shed light on issues involving the cyclical behaviour of the labour market, and especially the characterisation of frictional unemployment. Search and matching models, as opposed to the traditional Walrasian assumptions, assume the existence of heterogeneity both among workers and jobs in the labour market. Consequently, the microeconomics of search and matching models consider the matching up process between workers and jobs as resulting of a searching process, instead of the mechanics of supply and demand in a homogeneous labour market.

Thus, search and matching models provide us some insight into the so-called frictional unemployment, in that they consider the average unemployment observed over the business cycle as being the result of an unpredictable and costly matching up process in the labour market. Nonetheless, the importance of long-term unemployment in determining movements in unemployment over the business cycle implies that it cannot be explained exclusively by frictional features of the labour market. Hence, search and matching models fail to clarify the long-term causes of persistent levels of unemployment over the business cycle.

7 CONCLUSION

The empirical study conducted has enabled us to determine and characterise the main features of the Portuguese business cycle, in the period ranging from 1977 to 2014. We conclude that economic fluctuations are noticeable among all variables under the scope of our study.

With regards to the cyclical behaviour of the main components of the Portuguese GDP, we conclude that consumption does not show a smoothing behaviour over the business cycle. This is consistent with the Keynesian theory of consumption. It is also likely that liquidity constraints exist and are binding in the Portuguese economy. This, in turn, may be a result of the effects of the Euro sovereign crisis, since it has considerably shaped the borrowing and saving behaviour of individuals.

The cyclical features of investment confirm its importance in determining the Portuguese business cycle, namely the fact that it appears to be a highly volatile variable in comparison with GDP. We further conclude that the cyclical behaviour of investment appears to be consistent with the flexible accelerator model, since it seems to be determined to some extent by expectations of future movements in output.

Likewise, the Portuguese labour market is markedly determined by economic fluctuations. However, the features of the Portuguese labour market do not fit a Walrasian labour market model, nor are they satisfactorily explained by the main non-Walrasian theories proposed. In part, this is due to the fact that the Portuguese labour market is not characterised by the existence of real wage rigidity. We thus conclude that perhaps the features of the Portuguese labour market fall in between the assumptions of these models.

REFERENCES

Altonji, J. (1986). *Intertemporal Substitution in Labor Supply: Evidence from Micro Data*. Journal of Political Economy 94: p. 176–215.

Banco de Portugal (2015). *Boletim Económico - Junho 2015 - Séries Trimestrais para a Economia Portuguesa* [Database]. Lisboa: BdP. Available at: https://www.bportugal.pt/pt-PT/EstudosEconomicos/Publicacoes/BoletimEconomico/BEAnteriores/Documents/Series_trimestrais_2015.xlsx [Date of access: 12/03/2016]

Baxter, M. & King, R. (1977). *Fiscal Policy in General Equilibrium. The American Economic Review*, Vol. 83, No. 3, p. 315-334.

Burns, A. & Mitchell, M. (1946). *Measuring Business Cycles*. 1^{st} Ed. New York: National Bureau of Economic Research, Inc..

Christiano, L. & Fitzgerald, T. (1999). *The Band Pass Filter*. International Economic Review, Vol. 44, Issue 2, p. 435–465.

Ham, J. & Reilly, T. (2002). *Testing Intertemporal Substitution, Implicit Contracts, and Hours Restrictions Models of the Labor Market Using Micro Data*. American Economic Review 92 (September): p. 905–927.

Hodrick, R. & Prescott, E. (1997). *Postwar U.S. Business Cycles: An Empirical Investigation*. Journal of Money, Credit and Banking, Vol. 29, No. 1, pp. 1-16.

Instituto Nacional de Estatística (2015). *Agregados Macroeconómicos* [Database]. Lisboa: INE. Available at: https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_cnacionais2010&perfil=220674402&INST=220616736&contexto=am [Date of access: 20/02/2016]

Instituto Nacional de Estatística (2015). *População residente (Série longa, início 1970 - N.º) por Sexo e Idade; Anual* [Database]. Lisboa: INE. Available at: https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0001223&contexto=bd&selTab=tab2 [Date of access: 20/02/2016]

Jenkins, D. (2009). *Newton Excel Bach, not (just) an Excel Blog*. https://newtonexcelbach.wordpress.com/2009/07/02/cubic-splines/ [Date of access: 13/03/2016]

Lucas, R. (1977). *Understanding business cycles*. Carnegie-Rochester Conference Series on Public Policy, Elsevier, Vol. 5(1), p. 7-29.

Okun, A. (1962). *Potential GNP: Its Measurement and Significance*. In Proceedings of the Business and Economics Statistics Section, American Statistical Association, p. 98–103.

Organization for Economic Co-Operation and Development - OECD (2016). *Population* [Database]. Available at: `http://stats.oecd.org/Index.aspx?DatasetCode=POP_FIVE_HIST#` [Date of access: 20/02/2016]

Romer, D. (2012). *Advanced Macroeconomics*. 4^{th} Ed. New York: McGraw-Hill.

Williamson, S. (2014). *Macroeconomics*. 5^{th} Ed. Pearson.

A CORRELATION COEFFICIENTS - PORTUGAL, 1977 TO 2014

	$k=-4$				$k=-1$				$k=1$				$k=4$			
	Linear	BK	HP	CF	Linear	BK	HP	CF	Linear	BK	HP	CF	Linear	BK	HP	CF
Y	0.94	0.39	0.39	-0.19	0.99	0.82	0.84	0.89	0.99	0.82	0.84	0.89	0.94	0.39	0.39	-0.19
C	0.92	0.41	0.36	-0.06	0.97	0.71	0.71	0.63	0.97	0.68	0.68	0.62	0.92	0.33	0.22	-0.08
I	0.88	0.13	0.18	-0.21	0.92	0.53	0.60	0.38	0.92	0.62	0.67	0.46	0.86	0.35	0.38	-0.06
G	0.94	0.32	0.53	0.01	0.95	0.39	0.56	0.00	0.95	0.41	0.51	0.11	0.91	0.35	0.35	0.23
Ex	0.68	0.00	-0.06	-0.06	0.76	0.27	0.24	0.24	0.79	0.32	0.33	0.24	0.80	0.11	0.24	-0.13
Im	0.91	0.18	0.20	-0.12	0.96	0.50	0.58	0.28	0.97	0.58	0.65	0.35	0.95	0.37	0.43	-0.08
NX	-0.80	-0.12	-0.16	0.18	-0.77	-0.34	-0.41	-0.16	-0.73	-0.40	-0.44	-0.26	-0.64	-0.29	-0.20	-0.13
W	0.81	0.09	0.20	-0.19	0.79	0.36	0.45	0.25	0.76	0.45	0.47	0.37	0.70	0.33	0.21	0.20
W/L	0.91	0.25	0.25	-0.23	0.97	0.72	0.74	0.76	0.97	0.76	0.77	0.83	0.92	0.33	0.26	-0.10
u	-0.90	-0.35	-0.38	0.07	-0.94	-0.67	-0.72	-0.51	-0.94	-0.63	-0.65	-0.51	-0.87	-0.25	-0.18	0.15

Note: Values k represent lagging or leading correlation coefficients between variable X and output, where $Corr(X_t, Y_{t+k})$.

TABLE A.I: Correlation Coefficients - Portugal, 1977 to 2014 (one quarter and four quarters lag and lead).

B CROSS CORRELATION COEFFICIENTS: BK, HP, CF, AND LINEAR FILTERS APPLICATION

	Linear	BK	HP	CF
Linear	1	–	–	–
BK	0.59	1	–	–
HP	0.38	0.90	1	–
CF	0.28	0.77	0.79	1

TABLE B.I: Private Consumption Cyclical Component Cross Correlation Coefficients, Portugal, from 1977 to 2014.

	Linear	BK	HP	CF
Linear	1	–	–	–
BK	0.52	1	–	–
HP	0.42	0.97	1	–
CF	0.27	0.78	0.74	1

TABLE B.II: Investment Cyclical Component Cross Correlation Coefficients, Portugal, from 1977 to 2014.

	Linear	BK	HP	CF
Linear	1	–	–	–
BK	0.26	1	–	–
HP	0.25	0.96	1	–
CF	0.14	0.75	0.69	1

TABLE B.III: Public Consumption Cyclical Component Cross Correlation Coefficients, Portugal, from 1977 to 2014.

	Linear	BK	HP	CF
Linear	1	–	–	–
BK	0.59	1	–	–
HP	0.46	0.97	1	–
CF	0.39	0.87	0.86	1

TABLE B.IV: Net Exports Cyclical Component Cross Correlation Coefficients, Portugal, from 1977 to 2014.

	Linear	BK	HP	CF
Linear	1	–	–	–
BK	0.55	1	–	–
HP	0.35	0.92	1	–
CF	0.22	0.68	0.63	1

TABLE B.V: Gross Domestic Product Cyclical Component Cross Correlation Coefficients, Portugal, from 1977 to 2014.

	Linear	BK	HP	CF
Linear	1	–	–	–
BK	0.54	1	–	–
HP	0.47	0.99	1	–
CF	0.36	0.91	0.90	1

TABLE B.VI: Wages Cyclical Component Cross Correlation Coefficients, Portugal, from 1977 to 2014.

	Linear	BK	HP	CF
Linear	1	–	–	–
BK	0.59	1	–	–
HP	0.43	0.95	1	–
CF	0.34	0.85	0.83	1

TABLE B.VII: Unemployment Rate Cyclical Component Cross Correlation Coefficients, Portugal, from 1977 to 2014.

	Linear	BK	HP	CF
Linear	1	–	–	–
BK	0.55	1	–	–
HP	0.37	0.93	1	–
CF	0.29	0.81	0.78	1

TABLE B.VIII: Average Labour Productivity Cyclical Component Cross Correlation Coefficients, Portugal, from 1977 to 2014.

C CORRELATION COEFFICIENTS: PORTUGAL, SPAIN, GERMANY AND THE UNITED STATES OF AMERICA, 1995 TO 2007

	Portugal			Spain		
Variable X	$k=-4$	$k=0$	$k=4$	$k=-4$	$k=0$	$k=4$
C	0.31	0.83	0.43	0.29	0.81	0.52
I	0.11	0.76	0.41	-0.04	0.63	0.67
G	0.21	0.24	-0.02	0.08	0.57	0.39
NX	0.03	-0.40	-0.34	0.29	-0.36	-0.60
	Germany			USA		
Variable X	$k=-4$	$k=0$	$k=4$	$k=-4$	$k=0$	$k=4$
C	0.17	0.68	0.56	0.53	0.78	0.04
I	0.04	0.72	0.61	0.17	0.93	0.47
G	0.38	0.30	0.20	-0.44	-0.40	-0.14
NX	0.31	0.20	-0.51	-0.23	-0.55	-0.02

Note: Values k represent lagging or leading correlation coefficients between variable X and output, where $Corr(X_t, Y_{t+k})$.
Results concern the application of the HP filter only.

TABLE C.I: Correlation Coefficients, for Portugal, Spain, Germany and the USA, 1995 to 2007.