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# **BUSINESS CYCLES IN GREECE (1960-2008): AN ECONOMETRIC INVESTIGATION**

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## **Abstract**

Business cycle theory has fascinated economists ever since the beginning of economics as a science. The analysis of empirical facts has often been used as basis for the testing and formulation of theoretical models of the business cycle. The purpose of this paper is to analyze the principal macroeconomic series of business cycle in Greece using relevant econometric techniques over the time period 1960-2008. We adopt a definition according to which business cycles are regarded as fluctuations around a trend, i.e. deviation cycles. The type of trend has serious implications considering it determines the propagation of shocks. We investigate the stationarity properties of time series for basic macroeconomic variables and their first differences using the augmented Dickey-Fuller test. Next, we use five different de-trending methods to

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decompose the original series into a trend and a cyclical component. Furthermore, we use spectral analysis to extract periodograms which indicate, approximately, the length of the cycle. Finally, we examine whether the various de-trended macroeconomic variables follow a cyclical pattern or if their evolution in time is white noise. The empirical results suggest that strong cyclical regularities are present. In fact our findings, regarding the cyclical patterns of the macroeconomic variables under survey and the periodization of the phases of development of the Greek economy are consistent with the findings by other researchers.

**KEYWORDS:** Macroeconomic variables, trends, filters, frequency, business cycles, Greece.

**JEL Classification:** E32, O11, C10

## **1. Introduction**

Business cycle theory has captured the attention of economists ever since the very beginning of economics as a science. Early theoreticians regarded business cycles and crises chiefly as self sustained phenomena inherent to the capitalist economic system, where each crisis fuelled the phases of recovery and boom. However, the so-called “Keynesian revolution” shifted the focus of economic theory from crises and economic fluctuations to the fight against short-term unemployment. Later on, economists altered, once again, the focus of the profession to the neoclassical models of economic growth.

Without exaggeration one could argue that during the sixties there was a feeling of generalized euphoria that economic crises and business cycles could be cured. However, the poor economic performance of the seventies shifted the attention on business cycle theory, and the effectiveness of economic policy to deal with similar phenomena was questioned during the eighties. The nineties could be characterized as a period of renewed interest in business cycles theory focusing on the role of productivity and technological change for the propagation of shocks in a (neo) Schumpeterian spirit (Kaskarelis 1993).

In this paper, we analyze the macroeconomic fundamentals of business cycle in Greece in the time period 1960-2008. We adopt a definition according to which business cycles are regarded as “deviation” cycles, i.e. fluctuations around a trend. The trend can be deterministic or stochastic. In order to investigate the stationarity properties of each time series examined, it is essential to test the

existence of unit roots in time series. In our study, we use the augmented Dickey-Fuller (ADF) test. Given that the macroeconomic series contain a trend, linear, exponential or quadratic de-trending is highly recommended. Apart from the above mentioned de-trending methods, we also apply the Hodrick-Prescott filter and the Baxter-King filter. Moreover, we use spectral analysis to extract periodograms which indicate, approximately, the lengths of business cycles based on the available data, then we test whether the various de-trended macroeconomic time series tend to follow a cyclical pattern or if their evolution in time is white noise.

The paper is organized as follows: section 2 discusses some previous studies in Greece including recent business cycles research; section 3 sets out the methodological framework; section 4 presents and discusses the empirical results; finally, section 5 concludes the paper.

## **2. Previous Studies on the Greek Economy**

In 1960, Greece was governed by the conservative party led by Constantine Karamanlis. However, elections in 1963 led to the accession to power of the Centre Union Party of George Papandreou and Karamanlis left for Paris. The newly formed government did not stay in power very long, as a ‘royal coup’ on the part of the King Constantine related to his tense relations with George Papandreou’s, finally, forced Papandreou to resign. This crisis is known as ‘apostassia’ (apostasy) and heralded a prolonged period of political instability. Ultimately, the crisis culminated on April 21st of 1967 when a coup led to a military dictatorship (junta) and a fraction of colonels seized power. The regime’s unsuccessful involvement in Cyprus in 1973 and the use of tanks to massacre student protesters at the National Technical University of Athens brought about the downfall of the dictatorship in 1974. Karamanlis returned to Greece, won the elections and his party New Democracy stayed in power until 1981. In that year, the socialist party (PASOK – Panhellenic Socialist Movement) run by Andreas Papandreou (former chairman of the University of Berkeley economics department and son of George Papandreou) won the elections with an impressive 48%, after having obtained just 13.6% in the 1974 elections. In addition, 1981 was an important year due to Greece’s accession to the European Economic Community as a full member. Andreas Papandreou remained as Prime Minister until his death in 1996, his premiership being interrupted during a 3-year interval 1990-93 when the New Democracy party governed Greece. Kostas Simitis became a leader of PASOK and won two elections (1996 and 2000). PASOK lost the elections of 2004 and since then

the New Democracy party is in power, led by Kostas Karamanlis (nephew of Constantine Karamanlis).

## *2.1 General Studies*

There is a scarcity of works which attempt to assess the performance of the Greek economy from the post-World War II period until recently. Here, the significant contributions will be presented briefly, along with some comments emphasizing on some crucial issues.

In an earlier study, Mouzelis (1977) argued that the 1960s coincided with a period when investment, especially in the manufacturing sector (chemicals, metallurgy, etc), expanded for the first time to a considerable extent. This was, according to the author, an important step towards the ‘industrialization’ of the Greek economy (Mouzelis 1977, p. 91, pp. 276-7). He also stressed out that during the pre-1974 period of rapid growth the wage share fell significantly in contrast to capital profits share (Mouzelis 1977, p. 280).

Ioakimoglou and Milios (1993), suggested the following periodization for Greece’s economic performance: (a) 1960-1973 (“the golden era of Greek capitalism”) characterized by economic boom and increasing profit rate supported by the repression of the labor movement (b) 1974-79 (“the first period of crisis”) during which high inflation rates and decreasing rates of investment persisted and a radical change in the political and social relation of forces benefited the working class (c) 1980-85 (“aggravation of the crisis”) marked by a change in government and the application of ‘left-Keynesian economics’ destined to fail due to the negative response of both the workers and the employers and, finally, (d) 1986-91 (‘some recovery of profits’) during which an increase in the marginal rate of profit on fixed capital is observed but not enough to ensure a steady increase in the profit rate. For an extension of this analysis see Ioakimoglou and Milios (2005).

Alogoskoufis (1995) separated the performance of the Greek economy of the post - 1960 period into two distinct phases, and considered the year 1974 (i.e. the end of the military dictatorship) as the turning point. In the pre–1974 period, the Greek economy was characterized by high growth rates in terms of GDP, labor productivity and Total Factor Productivity (TFP). On the contrary, the post–1974 period revealed a dramatic slowdown in most indices and the economy remained in a state of stagflation. In his 1995 writings, he indicated some signs of economic recovery but probably insufficient for a proper return to a “high growth, non-inflationary path” (Alogoskoufis 1995, p. 183).

More specifically, the author specified the change in economic policy regime that took place in 1974, as the most significant determinant of this radical turnaround. The abolishment of restrictions regarding political and civil freedoms in an economic environment characterized by a “corporatist and centralized economic management”, i.e. the acquisition of significant power by labor unions and the popular demand for redistribution policies, created a hostile business environment, non-conducive to investment and growth. The entry in the European Community (EC) which took place in 1981 did not have the positive effects of trade liberalization predicted by economic theory due to the misallocation of EC transfers to Greece “which helped hide the root causes of the problems [...] allowing domestic consumption to keep rising, despite the growth slowdown” (*ibid*, p. 157).

Tsakalotos (1998) focused on the internal and external constraints facing social-democratic parties in power which aimed at extending democracy and “promote coordination and cooperation between economic agents and groups”. The author examined the gradual transformation of the Socialist Party’s (PASOK) economic policies until its second return to power in 1993 and concluded that underlying factors were internal and not exogenous. His main argument was that “the Greek context was not propitious for introducing measures for extending democracy to the economic sphere” (Tsakalotos 1998, p. 115). Among the features hindering economic performance he mentioned the prevalence of “strong state and clientelistic relationships between politicians/political parties and the electorate” (*ibid*, p. 129) and the weakness of civil society in the Greek social formation. Furthermore, he commented on the institutional reforms initiated in 1981 and noted the lack of a coherently implemented supply-side policy in PASOK’s first term (*ibid*, p. 117). Finally, concerning the post–1993 developments he considered worthy noticing the fact that the stabilization policies did not appear to have had any adverse effect on the performance of the economy.

Bosworth and Kollintzas (2001) perceived two distinct phases in the growth patterns of the Greek economy and placed the year 1973 as their demarcation date. They accounted for external shocks occurring in all European countries and compared Greece’s performance to EU countries. However, this extension of the analysis does not alter significantly their main conclusions. The decrease in both capital accumulation and TFP rates are found to contribute significantly to the growth slowdown. Regarding TFP they found a large downward break in the early 1980s and claimed that the break in performance occurred in the early 1980s and not in 1973 (Bosworth and Kollintzas 2001, pp. 157, 160).

This periodization is consistent, in general terms, with Christodoulakis *et al.* (1996) who reached the same conclusion focusing on the reduction in industry

protection following Greece's entry in the E.U. and the impact of uncertainties about the future political situation on investment as the underlying cause for their choice of the inflexion point. This periodization is also consistent with the findings by Michaelides *et al.* (2005) who focused in their study on investment activity and stressed its low levels during the first half of the 1980s.

Bosworth and Kollintzas (2001) attempted to trace the causes for the fall-off in TFP growth. They argued that this was the result of a large number of negative developments such as “the worsening macroeconomic situation and a highly inefficient structure of the labor market” alongside the unsuccessful trade policy after E.U. accession (*ibid*, p. 168 ff.). In the first place, the authors focused on the strengthening of labor's bargaining situation and the centralized management of the economy as causes behind the deteriorating performance of the Greek economy in the post-1973 period. Also, regarding labor market structures, they pointed to the “rapid expansion of life-time government jobs in the 1980s [...] as well as the increase in the public/private relative wages in the 1980s” (*ibid*, pp. 175-6) as examples of growth-hindering processes.

Deterioration of macroeconomic environment resulting in steadily increasing budget deficits and double-digit inflation is considered as another contributing factor to the slowdown. Furthermore, Bosworth and Kollintzas (2001) did not attribute to the EC accession the deteriorating performance, a thesis which is consistent with Alogoskoufis (1995) and opposed to the conclusions reached by Giannitsis (1993). However, in relation to EC accession, they emphasized the lack of any sectors for a clear comparative advantage in industry that could be utilized in the integrated economic environment as opposed to Alogoskoufis's (1995) stress on the negative impact that EC transfers had due to the postponements they caused to the restructuring of the economy.

Tavlas and Zonzilos (2001) used econometric tests, namely the Zivot-Andrews test, to locate the point of structural break. They pinpointed the early 1980s as the inflexion year which led to the low-growth regime (*ibid*, p. 205). An important conclusion of their analysis is that a second structural break seems to have taken place in the Greek economy in 1994. The authors attributed this change to the stable macroeconomic environment created thereafter and the implementation of structural reforms (*ibid*, p. 209).

Skouras (2001) focused on the macroeconomic policy of the Socialist Governments (PASOK) through 1980s and 1990s. He located the underpinning theoretical framework of the policies followed in the 1980s to the (neo-)Marxist “dependency theories” of the 1960s and the “centre-periphery schema” as the main theoretical tool in order to explain the nature and historical development

of the Greek social formation.<sup>3</sup> He commented on the institutional reforms planned or implemented until 1985 and in a similar vein with Tsakalotos (1998), noted that “the management of their implementation was dismal” (Skouras 2001, pp. 174-5). Skouras argued that PASOK’s “biggest strategic mistake” was its ignorance of investment policies. His general view is that “economic policy was marked by a series of attempts to keep up aggregate demand and jump-start the economy. This was done by boosting private and then public consumption while ignoring investment. Thus, it may be argued that PASOK subscribed in practice to “naive Keynesianism” (*ibid*, p. 172)<sup>4</sup>.

The shift in policy was noticeable after the second return to power in 1993 named by the same author, as “the phase of embracement” due to the decisive orientation towards the EU. The drafting of the Convergence Programme determined to a large extent the macroeconomic policy pursued. Skouras commented that “PASOK significantly improved its performance in managing the economy during this phase” (*ibid*, p. 178). Reduction of the budget deficit to GDP ratio and macroeconomic stability (low inflation and interest rates) are considered as the main achievements of the macroeconomic policy. Consistent with Tsakalotos (1998), Skouras (2001) observed that in the second half of the 1990s, “macroeconomic stability was not achieved at the cost of a stagnant economy” (*ibid*, p. 179). As a result, a steady increase in profitability due to the fall in interest rates but also due to restructuring and a revival of private investment are pinpointed as distinguishing characteristics of this phase. The rise in unemployment in the same period is attributed to the “attendant restrictive monetary policy” which was dictated by the need to converge towards the Maastricht treaty targets.

Other authors focus on the macroeconomic policies followed in the 1980s after the government change which took place in 1981. For instance, Giannitsis (2005, p. 73 ff.) noted that it is difficult to find reliable economic analyses which support the economic policies of that period but argued that the criteria for its evaluation should not be strictly economic.

OECD (2002) characterized the performance of the Greek economy since the early 1990s as ‘remarkable’, stressing the prevalence of high growth rates both in output and productivity. The effective macroeconomic policies along with the liberalisation of product and financial markets were regarded as the main drivers behind this growth pattern.

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<sup>3</sup> For a critique to these approaches see Milios (1988).

<sup>4</sup> Kollintzas and Vassilatou (1996) argued that increases in the shares of government consumption have led to the worsening of the performance of the Greek economy.

Finally, a more recent OECD survey (2007) reported that Greece's growth rate since 1997 has exceeded 4.5%, ranking second after Ireland among OECD countries. The reasons for this impressive performance are (a) financial market liberalisation, (b) EMU membership, (c) growing activity in export markets in south-eastern Europe and (d) the fiscal stimulus given by the Olympic games in 2004 (see also Belegri-Roboli and Michaelides, 2007; 2008). Regarding the factors which affect productivity growth, the study suggested the need for reforms in education and the abolishment of market regulations which hinder competition (OECD 2007, pp. 9-10).

It seems that there is an agreement, in general terms, among various authors that the recent economic history of Greece since 1960 can be divided into three distinct periods: (i) The period extending from 1960 until some point in the middle 1970s where the Greek economy experienced rapid growth (ii) A "halt" lasting until about the early or middle 1990s when most economic indexes showed a marked deceleration (iii) From that point on until today the Greek economy is experiencing a period of steady growth.

Of course, in this broad periodization, the specific years of transition (turning points) cannot be specified with great accuracy. This is due to three reasons: Firstly, because the transition usually takes place in a gradual way; secondly, because there is disagreement among authors regarding their demarcation; and, finally, because econometric estimations are contingent on measurement errors and other disturbances and should not be treated as firm precise measures, given the fact that there is always some uncertainty in their estimation.

Conclusively, all authors agree that Greek economy entered a protracted period of a recession in the mid-1970s which interrupted the steady growth initiated by the wave of industrialization in the 1960s. The macroeconomic policies of the 1980s are related to this slowdown and most authors stress the absence of long-term planning. A common point of the analyses is the concentration of macroeconomic policies on the demand side and more specifically on consumption, neglecting both investments and the supply side of the economy. Also, they noted an important change in the policy regime occurring in the 1990s which led to an acceleration of growth while restoring economic stability.

## *2.2 Studies on Business Cycles*



So far, empirical research focusing on business cycles in Greece has been very limited. Most authors use Real Business Cycles (RBC) model to test for the existence of output fluctuations.

Apergis and Panethimitakis (2007) examined the stylized facts of the Greek economy over the period 1960-2003. The authors investigated the behavior of basic macroeconomic variables in respect to the business cycle. They found that consumption fluctuated procyclically just like real wages did. The later fact pointed to shocks that shifted the demand curve for labor. The same conclusions were reached when allowance was made for policy regime changes. The authors' conclusion was that real shocks drive the economy, implying that demand policies are ineffective.

Kollintzas and Vassilatos (1996) built a RBC model for Greece and investigated its ability to account for the stylized facts of post-war Greece. They concluded that the model does quite well in this respect. The model was also used to examine the effects of fiscal policy and transfers from abroad. The authors came to the conclusion that an increase in government consumption has an adverse effect on output and the productivity of factors of production although it is likely to increase foreign asset-holdings. On the other hand, an increase in the GDP share of government investment is conducive to output growth and higher productivity while lowering foreign-asset holdings. These predictions of the model led the authors to argue that the increases in the shares of government consumption, foreign transfers and domestic transfers in the post-1973 period have acted to reduce the performance of the Greek economy.

Christodoulakis *et al.* (1993) compared the cyclical behavior of the Greek economy to that of other EC economies. In their study quarterly and annual data since 1960 were used and a RBC model was chosen as the methodological framework of their analysis. The authors argued that similarities exist in the propagation mechanism for business cycles in Greece in relation to other EC countries. The policy implication of this work is that the integration of the Greek economy within the EC under a set of uniform institutions and policies should not be a problem as far as business cycle is concerned.

Kaskarelis (1993) focused on the effects of monetary policy in output. The examination of several Greek macroeconomic time series suggested that monetary policy was able to explain, to a large extent, output fluctuations.

In a similar vein, Karasawoglou and Katrakilidis (1993) investigated empirically the causal relationship between money growth, budget deficits and inflation in Greece over business cycle employing a tri-variate error-correction Granger model. The results provided evidence that deficits are inflationary when monetized.

Much recent effort has been put to investigate the question of the synchronicity of the business cycles in the EU area. This question has gained in importance in the context of the Economic and Monetary Union (EMU) where monetary policy has been delegated to the European Central Bank (ECB) and fiscal policy is restricted by the Stability and Growth Pact. The literature on the subject is becoming increasingly extensive and the results reached are worthy noticing.

More precisely, in few studies where Greece is included explicitly it seems that a lack of synchronicity of the national business cycle with that of the Eurozone emerges as the main conclusion, a finding which is, partly, inconsistent with the findings by Christodoulakis *et al.* (1993). For instance, see Montoya and Hann (2007) who pointed to the existence of a ‘national border’ effect. In a similar vein, Gallegati *et al.* (2004) found weak links among Mediterranean countries, including Greece, and the European continental area. Similar results are reached by Leon (2007) who used spectral analysis to analyse quantitatively the stochastic shocks of Greece and the Eurozone for the period 1980-2005 and concluded that the synchronization of the cycles in terms of correlation and their transmission mechanism becomes weaker over time. His results are very consistent with the findings by Gouveia and Correia (2008) and Camacho *et al.* (2006).

### **3. Methodological Framework**

The business cycle component is regarded as the movement in the time series that exhibits periodicity within a certain range of time duration. This approach is often called the “classical business cycles” approach and is based on Burns and Mitchell (1946) and the National Bureau of Economic Research (NBER). This method claims that business cycles are characterized by the “turning point” in the level of the time series which indicates, roughly speaking, the beginning of an expansionary period at the end of a recession. Another popular approach to the subject regarding business cycles as fluctuations around a trend is the so-called “deviation cycles” (Lucas 1997). The estimation of this trend for each time series is of great importance because it is necessary for the extraction of the cyclical component. In this study we adopt both of these approaches.

First, we examine the stationarity characteristics of each time series. As we know there are several ways to test for the existence of a unit root. In this paper we use the Augmented Dickey – Fuller popular methodology (ADF) (Dickey

and Fuller, 1979).<sup>5</sup> If the results suggest that the time series are stationary in their first differences then, various de-trending methods are highly suggested.

The ADF test is based on the following regression (Kaskarelis 1993):

$$\Delta Y_t = a + bt + \rho Y_{t-1} + \sum_{i=1}^m \gamma_i \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

where  $\Delta$  is the first difference operator,  $t$  is time and  $\varepsilon_t$  is the error term.

(a) If  $b \neq 0$  and  $\rho = -1$  implies a trend stationary (TS) model.

(b) If  $b = 0$  and  $-1 < \rho < 0$  implies an ARMA Box/Jenkins class of models.

(c) If  $b = 0$  and  $\rho = 0$  implies a difference stationary (DS) model where Y variable is integrated with degree one I(1). If we assume that the cyclical component is stationary, the secular component has a unit root and Y follows a random walk process (i.e. it revolves around the zero value in a random way, see Heyman and Sobel 2004, p. 263). Furthermore, if  $\alpha \neq 0$  Y follows a random walk process with a drift. The lag dependent polynomial is inserted in order to deal with the potential serial correlation of the residuals.

The trend is important for the propagation of shocks (Nelson and Plosser 1982). Linear, exponential and quadratic de-trending is highly recommended and the estimated residuals constitute the de-trended data series.

A time series  $x_t$  with a linear deterministic trend is as follows:

$$x_t = a + bt + \varepsilon_t \quad (2)$$

where  $a$  and  $b$  are parameters,  $t$  is time and  $\varepsilon_t$  is white noise.

A time series  $x_t$  with an exponential deterministic trend is as follows:

$$\log x_t = a + bt + \varepsilon_t \quad (3)$$

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<sup>5</sup> Alternatively, the test of Zivot and Andrews (1992) could have been used or some other panel unit root tests such as the IPS test (Im *et al.* 1997), the MW test (Maddala and Wu 1999), or the Choi test (Choi, 2001).

where  $a$ ,  $b$  are parameters,  $t$  is time and  $\varepsilon_t$  is white noise.

A time series  $x_t$  with a quadratic deterministic trend is as follows:

$$x_t = a + bt + ct^2 + \varepsilon_t \quad (4)$$

Where  $a$ ,  $b$ ,  $c$  are parameters,  $t$  is time and  $\varepsilon_t$  is white noise.

In addition to these methods we also use the following, widely used, alternative approaches:

#### (a) The Hodrick-Prescott Filter

The linear, two-sided HP-filter approach is a widely used method by which the long-term trend of a series is obtained using only actual data. The trend is obtained by minimizing the fluctuations of the actual data around it, i.e. by minimizing the following function:

$$\sum [\ln y(t) - \ln y^*(t)]^2 - \lambda \sum [[\ln y^*(t+1) - \ln y^*(t)] - [\ln y^*(t) - \ln y^*(t-1)]]^2 \quad (5)$$

where  $y^*$  is the long-term trend of the variable  $y$  and the coefficient  $\lambda > 0$  determines the smoothness of the long-term trend.

This method decomposes a series into a trend and a cyclical component. The parameter used for annual data is equal to  $\lambda=100$  (Hodrick and Prescott 1997, Kydland and Prescott 1990, Canova 1998).

A large number of studies have used the HP filter de-trending method for different purposes (e.g. Danthine and Girardin 1989, Blackburn and Ravn 1992, Backus and Kehoe 1992, Fiorito and Kollintzas 1994, Belegri-Roboli and Michaelides 2007). The Hodrick and Prescott Filter is able to extract the same trend from all time-series which is considered a significant advantage since many real business cycle models indicate that all variables will have the same trend.<sup>6</sup>

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<sup>6</sup> However, there are shortcomings as well in this approach. For overviews of the HP filtering method shortcomings see Harvey and Jaeger (1993), King and Rebelo (1993), Cogley and Nason (1995) and Billmeier (2004).

## (b) The Baxter-King Filter

Another popular method for extracting the business cycle component of macroeconomic time series is the Baxter-King Filter (Baxter and King 1999). The Baxter King filter is based on the idea of constructing a band-pass linear-filter that extracts a frequency range  $[\omega_{\min}, \omega_{\max}]$  dictated by economic reasoning. Here, this range corresponds to the minimum and maximum frequency of the business cycle. The algorithm consists in constructing two low-pass filters, the first passing through the frequency range  $[0, \omega_{\max}]$  (denoted as  $\bar{a}(L)$ , where  $L$  is the lag operator) and the second through the range  $[0, \omega_{\min}]$  (denoted as  $\underline{a}(L)$ ). Subtracting these two filters, the ideal frequency response is obtained and the de-trended time series is calculated:

$$y^{BP}(t) = [\bar{a} - \underline{a}]y(t) \quad (6)$$

Two of the main advantages of this approach are: first, it leaves the properties of the extracted component unaffected and, secondly, it does not change the timing of the “turning points”. There is widespread agreement that a business cycle lasts between 8 and 32 quarters and the length of the (moving) average is 12 quarters (Baxter and King 1999). This is due to the seminal works of Burns and Mitchell (1946). For a critique to this approach see Agresti and Mojon (2001). Consequently, these are the values (2 to 8 years) that we use in the de-trending methods described above.

A large number of studies have used the Baxter-King filtering method (see e.g. Stock and Watson 1999, Wynne and Koo 2000, Agresti and Mojon 2001, Benetti 2001, Massmann and Mitchell 2004).

As it is well-known, white noise does not tolerate any temporal dependence<sup>7</sup> and so its auto-covariance function is trivially equal to zero for the various lags. The sample autocorrelation function measures how a time series is correlated with its own past history. Its graphical illustration is the correlogram. In order to test for autocorrelation we use the Ljung and Box (1978) test ( $Q$ -stat) which tests the null hypothesis of white noise for a maximum lag length  $k$ . The alternative hypothesis is that at least one of these

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<sup>7</sup> Actually, white noise is a data generating process where autocorrelation is zero between lagged versions of the signal (except when lag is zero).

autocorrelations is nonzero, so that the series is not white noise. In case the null hypothesis is rejected then the underlying time series is clearly not white noise and can be considered a cycle. In case we are dealing with a trending time series, then we study and test not the raw series but its deviations from trend, i.e. the residuals from which sample autocorrelations can be computed.

Here we investigate the periodicities of business cycles assuming that the actual fluctuations of the data are chiefly of a periodic character. We are supposing that the presence of periodic elements in the given fluctuations is possible. It is the object of this section to isolate those elements and indicate the approximate length of the cycle. The length of the period in economic series may, in general, be variable. Therefore, we understand by the term “period” the average length of the cycles and the periodogram which can assist in finding these average lengths.

The period is measured by constructing a graphical illustration of the value  $R$  in the time frequency and checking for the highest pick:

$$R_i = \sqrt{a_i^2 + b_i^2}, \quad \alpha_i = \frac{2}{n} \sum_{t=1}^n X_t \cos(2\pi t/i), \quad b_i = \frac{2}{n} \sum_{t=1}^n X_t \sin(2\pi t/i), \quad i = 1, 2, \dots, m, \\ m = n/2 \quad (7)$$

where  $a_i, b_i$  are the coefficients of the Fourier-transformed function  $X_t$  (Rudin 1976).

## 4. Empirical Analysis

We applied the aforementioned econometric techniques in order to investigate empirically the cyclical behavior of macroeconomic time series in the Greek economy. The data used come from the AMECO database (Eurostat).

First, the stationarity properties of the various macroeconomic variables were checked. Table 1 shows the results of the Augmented Dickey-Fuller test regarding labor ( $L$ ), real output ( $Y$ ), consumption ( $C$ ), stock of fixed capital ( $K$ ), total factor productivity (TFP), real wages ( $W$ ), labor productivity ( $Y/L$ ) and the profit rate ( $\Pi$ ), defined as  $\Pi = \frac{Y - W}{K}$  (Duménil and Lévy 2004, p. 26).

Except for the profit rate, all other macroeconomic variables are found to be non-stationary<sup>8</sup>. Then the stationarity of their first differences was tested. In Table 2 the results are presented. The first differences of most macroeconomic variables are found to be stationary, as it was expected, except for consumption and labor productivity.

The next step was to de-trend the macroeconomic variables. The five types of de-trending approaches, presented in section 3.3, were used and the time graphs of the residuals are depicted in Fig. 1. Furthermore, the results from the analysis based on the correlograms for the various macroeconomic variables are shown in Tables 3-8. The results of the Ljung/Box test indicate a rejection of the null hypothesis of white noise for all the de-trended macroeconomic variables under examination. In other words, the existence of cyclical regularities is a valid hypothesis from an econometric viewpoint. At this point, it should be mentioned that the trends of all macroeconomic variables, with the exception of profit rate where the pattern is not clear, show evidence of a clear upward movement.

The distinct phases of development of the Greek economy can be discerned in the graphs. For instance, the cyclical component of the gross domestic product shows a clear upward trend from the start of the 1960s until 1973 (Fig. 1a) with the years 1962 and 1967 providing exceptions to this continuous rise, a finding which is consistent with Ioakimoglou and Milios (1993, 2005). The effect of the 1973 oil price shock is clear in the de-trended series, irrespectively of the filter used. After that, the de-trended GDP recovers its previous levels by the end of 1970s. From 1980 onwards the continuous fall of GDP from its trend is obvious. The slow GDP growth during the 1980s relative to Greece's own post-

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<sup>8</sup> The absence of a trend for the profit rate for the Greek manufacturing sector has been documented by Lianos (1992) for the period 1960-1983.

war performance has been noted by many authors (e.g. Stournaras 1992) and has often been attributed to the policies followed after the electoral victory of PASOK in 1981 which neglected investment (Skouras 2001, Michaelides *et al.* 2005).

On the other hand, other studies attempt to locate the cause of this slowdown to structural characteristics of the Greek society. More specifically, it has been noted that the period of acceleration (1960-1973) intensified to a socially unacceptable degree the extent of income inequalities (Mouzelis 1977). After the restoration of democracy in 1974 there was public demand for redistribution policies and labor unions acquired power that could no longer be mitigated by the authoritarian mechanisms of the previous regime. The policies followed after 1981, characterized by efforts to redistribute income, were to a large extent an expression of this underlying social transformation (Papademos 2001). The implementation of such policies and the institutional arrangements formulated by the new government has been criticized by several authors (e.g. Skouras 2001, Tsakalotos 1998). In a similar vein, it has been noted that the slowdown of the Greek economy which started from the mid-1970s could be attributed to “external” determinations of the economic system (Dumenil 1978) and more precisely to the strengthening of the bargaining power of trade unions (Ioakimoglou and Milios 1993). Fig. 1a shows that the slump of the 1980s persists until the first half of the 1990s. Since 1996 the economy has entered a protracted period of upward movement for the de-trended GDP. The reversal is caused to a large extent by a restoration of sufficient rates of accumulation of capital. In the period from 1996-2004 Greece is found to be first among the EU countries in the rate of investment in mechanical equipment (Ioakimoglou and Milios 2005).

On the other hand, the cyclical component of the employed workforce is depicted in Fig. 1b. From the beginning of the period under survey, since the early 1970s, it is moving downwards and remains approximately stable in the post-1973 period. The 1980s mark clearly a distinct period in its evolution as all de-trending methods point to a sharp increase in 1981 and a settling in high levels lasting throughout the whole decade. However, the year 1990 is found to be a clear inflexion point where the de-trended employed workforce decreases to a large extent. The years 1997 and 2001 which are very close to elections in Greece amount to two years of negative shock for cyclical employment. Since then it seems that an upward trend prevails (see Ioakimoglou and Milios 2005). Interestingly, all filtering methods agree to a considerable degree to the evolution of the cyclical behavior adding to the reliability of the conclusions that can be reached from the statistical analysis.



The de-trended Consumption (Fig. 1c) is characterized by a more stable behavior. It seems to have reached a minimum at the end of the 1980s and since then, except from a negative shock in 1999 it is rising. Regarding the cyclical component of the capital stock, it seems that a low point was reached in 1967 and then continuous positive rates of growth led to the attainment of a maximum value in 1980 (Fig. 1d). Then, a steady decreasing movement lasted until the end of the 1990s. The collapse of the private sector investment occurring in the 1980s has been attributed by Skouras (2001, p. 172) to PASOK's victory in the elections of 1981 and a hostile environment towards the private sector. Since then a rising trend appears to dominate the de-trended capital stock.

The residual component of TFP is said to quantify the cyclical evolution of technological innovation (Fig. 1e). As it was expected from previous studies presented earlier, the period 1960-1973 was characterized by rapid growth in the industrialization of the Greek economy and this development is shown clearly in the de-trended TFP evolution. Mouzelis (1977, p. 277) attributed the qualitative leap of Greece's industry to the attraction of foreign investment in dynamic sectors of manufacturing such as chemicals and metallurgy. After the oil price shock in 1973, a period of stagnation ensued that lasted until the late 1970s. A sharp decline around 1980 is captured by all filtering techniques and could be attributed to a collapse of investment which took place after 1981 (Skouras 2001) and an ensuing stagnation of technological change. A negative deviation of TFP from its trend persisted in the 1980s while the recovery of positive growth rates is clear since the second half of the 1990s.

The cyclical component of wages (Fig. 1f) is constantly rising during the period 1960-1973 interrupted temporarily by the oil price shock of 1973. From the late 1970s until the first half of the 1980s the de-trended wages reached historically high levels. The stabilization program undertaken during the years 1985-87 had an adverse effect on cyclical wages as all de-trending techniques indicate. A downward trend lasted throughout the first half of the 1990s reaching a trough in around 1995. Since then an increase in the cyclical component of wages has been sustained<sup>9</sup>.

Labor productivity ( $Y/L$ ) increased steadily in the time period 1960-1973 (Fig. 1g). The shock of 1973 put an end to this rise and during the rest of the 1970s it remained approximately stable. The beginning of the 1980s showed a

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<sup>9</sup> For an examination of the long-term trends of labor's share in income see Milios and Ioakimoglou (2005). For the period 1960-1973 it is also discussed in Mouzelis (1977).

very steep deterioration which prevailed for the rest of the decade although with slower rates. A low end was reached in the mid-1990s and an upward movement characterizes its evolution since then. From a mere visual inspection of the graphs in Fig. 1g and Fig. 1e it is obvious that the time patterns of labor productivity and TFP are very closely linked with each other. This observation is consistent with the noted improvement in the investment performance in Greece (see e.g. Ioakimoglou and Milios 2005) and the resulting renewal of production technology.

Finally, as regards the de-trended profit rate (Fig. 1h), it reached historically high levels in 1973<sup>10</sup> and then it was adversely affected by the negative macroeconomic environment of the 1970s. A quick downward movement occurred at the beginning of the 1980s and the cyclical profit rate remained at low levels until the 1990s. This period of continuous negative deviation of profitability from the trend has been attributed by Giannitsis (1993) to the reduction in the degree of protection which took place over the 1974-86 time span. The author's main argument is that the liberalisation of trade worsened the competitive position of Greek industries and led to a profit squeeze for domestic industries<sup>11</sup>. However, in contrast to Giannitsis (1993), Bosworth and Kollintzas (2001, p. 171 ff.) argued that it is not clear whether a large trade shock attributed to the EU accession process can be considered as a significant influence on the development of the Greek economy for the post-1973 period. The interpretation of the negative deviation of the profit rate from its trend due to the underlying social conditions as was put forward in the examination of the GDP evolution is an alternative. As is the case with most other macroeconomic indices, clear upward movements appear in the beginning both of the 1990s and the 2000s. The cyclical profit rate does not show any clear trend since the first years of the 2000s.

The periodograms reveal the periodicity of the cycles and are shown in Figs. 2-9. The de-trended real GDP seems to follow a short-term cycle (2 years), two mid-term cycles (5 and 9 years) and two long-term ones (12 and 16 years respectively) (Fig. 3). In fact, the long wave (16 years) which is the dominant and most acute as it can be seen in Fig. 3 coincides with the periodization of the Greek economy analysed earlier (i.e. 1960 - mid 1970s, mid 1970s - early 1990s, early 1990s - 2008) and confirms the empirical findings by most of those relevant studies. The spectral content of the cyclical component of TFP (Fig. 6) exhibits local maxima at the frequencies of 3, 6, 10 and 15 years.

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<sup>10</sup> For an extensive analysis of the determinants of profitability from a Marxian perspective see Milios *et al.* (2002, pp. 145-189).

<sup>11</sup> Stournaras *et al.* (2005) analysed the lack of competitiveness of Greek exports for the period 1980-2004.

Again, this is consistent with our analysis of the distinct phases of the Greek economy. Accordingly, the de-trended labor productivity is characterized by the same frequency peaks (Fig. 8) giving credit to the previous observation that cyclical movements of TFP and labor productivity seem to be synchronized, to a great extent. The cycle of the profit rate is characterized by periodicities of 3, 7 and 10 and 15 years. In fact, its second most significant period (15 years) is consistent with the aforementioned periodization.

Finally, an interesting observation is that most macroeconomic time series exhibit, roughly speaking, a similar pattern characterized by periodicities exhibiting a short term cycle (approximately 3 years), a mid-term cycle (approximately 10 years) and a long term cycle (approximately 16 years). These results can be interpreted by economic theory as indications for the existence of various types of cycles with different lengths (i.e. periods) that are also synchronized within the total economy, in the sense that they affect almost equally all the macroeconomic variables under survey.

## **5. Conclusion and policy insights**

This paper analyzed the principal macroeconomic series over the business cycle in Greece in the time period 1960-2008 using relevant econometric techniques. We adopted a definition according to which business cycles are regarded as fluctuations around a trend, i.e. deviation cycles. In order to investigate the stationarity properties, we tested the existence of unit roots in the time series. The augmented Dickey-Fuller test results suggested that most series are stationary in their first differences. Given that the macroeconomic series contained a trend, linear, quadratic and exponential de-trending was highly recommended. Also, we applied the Hodrick-Prescott and the Baxter-King filters. Furthermore, we extracted periodograms which showed, approximately, the length of the cycle. Finally, we examined whether the various de-trended macroeconomic variables followed a cyclical pattern or their evolution was white noise. The empirical results suggested that strong cyclical regularities are present. Actually, our findings regarding the periodization of the phases of development of the Greek economy were found to be consistent, in general terms, with the findings by other researchers. Of course, the search for a causal explanation of the economic cause of the business cycle regularities detected could be a good example for future investigation.

Meanwhile, our research results can have significant policy implications since economic policy has placed increasing emphasis on business cycles. More precisely, when a macroeconomic variable such as output deviates from its long

term trend then, in simple terms, current production is above or below what the economy could normally sustain.

The results from this study provide us with useful insights in relation to Greece's monetary and fiscal policies. First, business cycles are regarded as deviations from the long term economy's potential and are an important part of monetary policy formulation. Indeed, in cases where the inflation targeting framework is used, the cyclical component is the most important determinant of how "loose" or "tight" the monetary policy should be in order for the inflation target to be obtained at maximum growth. Thus, the concept of business cycles is an important link between real economy and inflation. In this context, the cyclical component provides a useful way of thinking about inflationary pressure and affects to a large extent the country's policy-making process as an input into economic projections.

The other important implication of the findings of this study has to do with budget deficit. Just like in the case of monetary policy, the business cycle regularities detected in this study question the thesis that there is room for the government to run a budget deficit, without causing economic fluctuations. Due to the strong cyclical behavior of most macroeconomic variables, it would be more appropriate if the fiscal expansion was aimed at those expenditures that would not lead to acute fluctuations in the economy.

As a final conclusion, we would say that it is clear that, so far, the use of expansionary fiscal and monetary policies in the Greek economy has caused, at least partly, acute economic fluctuations. This being the case, the focus should be directed at social and structural issues which could reverse the situation.

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## Appendix 1: ADF Statistics

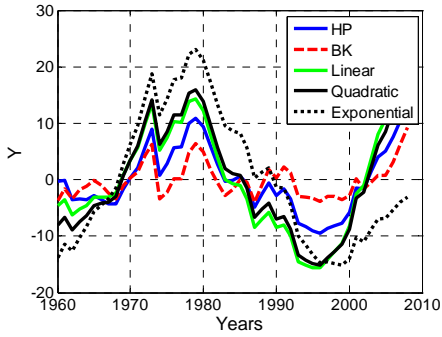
**Table 1:** Original Variables

COUNTRY	VARIABLE	LAGS	T-STAT	PROBABILITY	STATIONARY
GREECE	L	0-10	2.197469	0.9999	NO
	Y	0-10	2.068819	0.9999	NO
	C	0-10	1.176580	0.9976	NO
	K	1-10	1.126858	0.9972	NO
	TFP	0-10	-2.237329	0.1962	NO
	W	1-10	0.326710	0.9774	NO
	Y/L	0-10	-0.983346	0.7522	NO
	PROFIT RATE	0-10	-3.227509	0.0243	YES

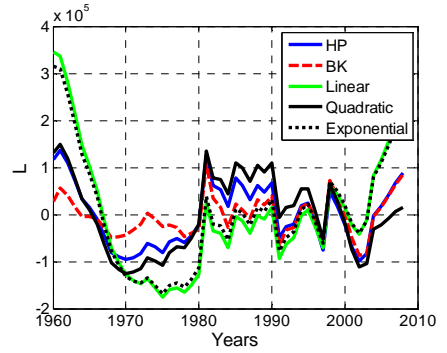
**Table 2:** First Differenced Variables

COUNTRY	VARIABLE	LAGS	T-STAT	PROBABILITY	STATIONARY
GREECE	$\Delta L$	0-10	2.197469	0.0330	YES
	$\Delta Y$	0-10	2.068819	0.0441	YES
	$\Delta C$	0-10	1.312691	0.1957	NO
	$\Delta K$	1-10	17.10366	0.0000	YES
	$\Delta TFP$	0-10	-2.237329	0.0300	YES
	$\Delta W$	1-10	2.406293	0.0203	YES
	$\Delta Y/L$	0-10	-0.983346	0.3305	NO
	$\Delta PR$	0-10	-3.227509	0.0023	YES

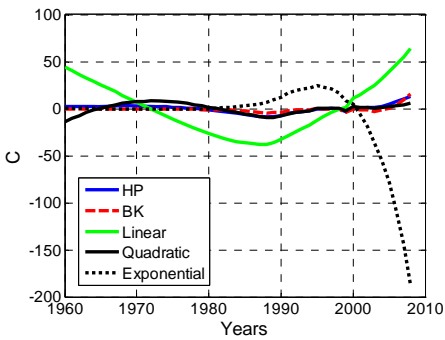
## Appendix 2: Business Cycles Regularities



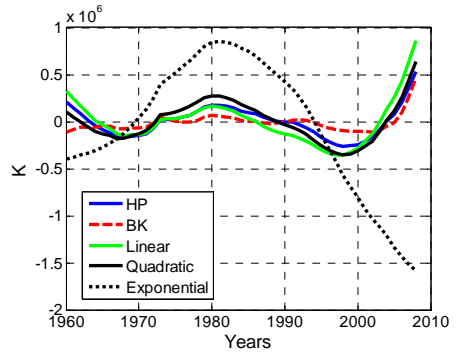
(a)



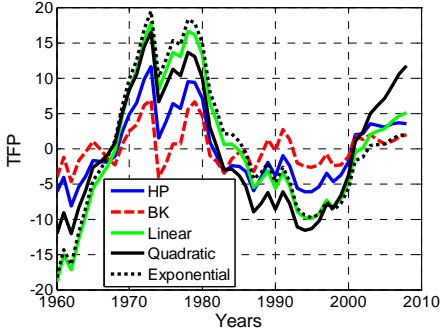
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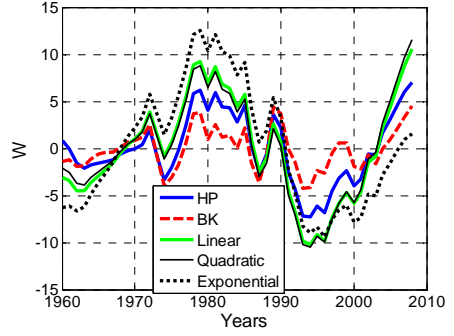
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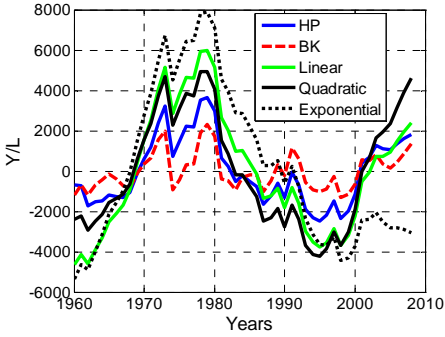
(d)



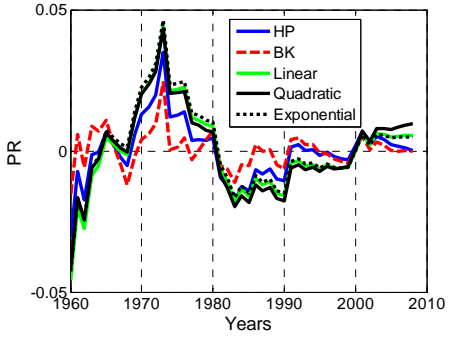
(e)



(f)



(g)



(h)

**Figure 1:** De-trended time series

### Appendix 3: Correlograms and White Noise Tests

<b>50 OBSERVATIONS</b>				
LAG	AC	PAC	Q-Stat	Prob
1	0.796	0.796	33.643	0.000
2	0.605	-0.080	53.461	0.000
3	0.440	-0.045	64.172	0.000
4	0.340	0.067	70.716	0.000
5	0.227	-0.109	73.701	0.000
6	0.096	-0.133	74.246	0.000
7	-0.012	-0.034	74.254	0.000
8	-0.085	-0.026	74.699	0.000

**Table 3:** White Noise test for L

<b>DE-TRENDED SERIES 50 OBSERVATIONS</b>				
LAG	AC	PAC	Q-Stat	Prob
1	0.902	0.902	43.182	0.000
2	0.813	-0.004	78.986	0.000
3	0.691	-0.223	105.41	0.000
4	0.570	-0.088	123.75	0.000
5	0.448	-0.052	135.34	0.000
6	0.335	-0.032	141.97	0.000
7	0.210	-0.153	144.63	0.000
8	0.075	-0.185	144.98	0.000

**Table 4:** White Noise test for Y

<b>DE-TRENDED SERIES 50 OBSERVATIONS</b>				
LAG	AC	PAC	Q-Stat	Prob
1	0.911	0.911	43.988	0.000
2	0.822	-0.038	80.630	0.000
3	0.721	-0.127	109.39	0.000
4	0.611	-0.110	130.50	0.000
5	0.498	-0.085	144.84	0.000
6	0.388	-0.050	153.76	0.000
7	0.261	-0.180	157.88	0.000
8	0.157	0.035	159.41	0.000

**Table 5:** White Noise test for C

<b>DE-TRENDED SERIES 50 OBSERVATIONS</b>				
LAG	AC	PAC	Q-Stat	Prob
1	0.915	0.915	44.471	0.000
2	0.823	-0.096	81.129	0.000
3	0.724	-0.085	110.12	0.000
4	0.617	-0.107	131.62	0.000
5	0.506	-0.083	146.44	0.000
6	0.398	-0.058	155.79	0.000
7	0.293	-0.050	160.99	0.000
8	0.193	-0.057	163.29	0.000

**Table 6:** White Noise test for K

<b>DE-TRENDED SERIES 50 OBSERVATIONS</b>				
LAG	AC	PAC	Q-Stat	Prob
1	0.885	0.885	41.528	0.000
2	0.781	-0.007	74.573	0.000
3	0.635	-0.250	96.898	0.000
4	0.501	-0.052	111.11	0.000
5	0.377	-0.005	119.33	0.000
6	0.269	-0.020	123.61	0.000
7	0.146	-0.176	124.89	0.000
8	0.009	-0.206	124.90	0.000

**Table 7:** White Noise test for TFP

<b>DE-TRENDED SERIES 50 OBSERVATIONS</b>				
LAG	AC	PAC	Q-Stat	Prob
1	0.922	0.922	45.076	0.000
2	0.814	-0.234	80.997	0.000
3	0.697	-0.098	107.84	0.000
4	0.579	-0.053	126.77	0.000
5	0.462	-0.068	139.11	0.000
6	0.351	-0.045	146.38	0.000
7	0.229	-0.170	149.54	0.000
8	0.101	-0.125	150.17	0.000

**Table 8:** White Noise Test for W

<b>DE-TRENDED SERIES 50 OBSERVATIONS</b>				
LAG	AC	PAC	Q-Stat	Prob
1	0.895	0.895	42.539	0.000
2	0.794	-0.040	76.673	0.000
3	0.663	-0.206	100.96	0.000
4	0.538	-0.051	117.32	0.000
5	0.415	-0.052	127.27	0.000
6	0.298	-0.065	132.50	0.000
7	0.175	-0.119	134.36	0.000
8	0.047	-0.145	134.50	0.000

**Table 9:** White Noise Test for Labor Productivity

<b>DE-TRENDED SERIES 50 OBSERVATIONS</b>				
LAG	AC	PAC	Q-Stat	Prob
1	0.712	0.712	26.926	0.000
2	0.648	0.286	49.704	0.000
3	0.445	-0.197	60.641	0.000
4	0.343	-0.043	67.280	0.000
5	0.219	-0.018	70.059	0.000
6	0.164	0.030	71.645	0.000
7	0.075	-0.063	71.988	0.000
8	-0.046	-0.212	72.119	0.000

## Appendix 4: Periodograms for Time Series

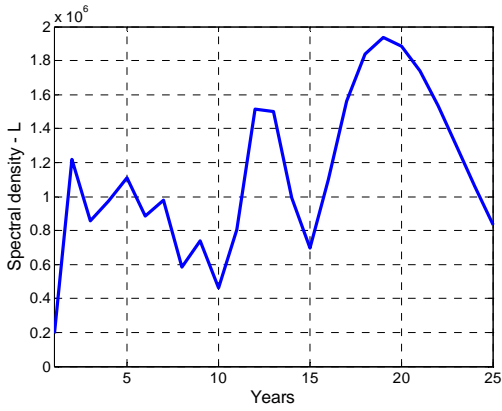


Figure 2: Periodogram for L

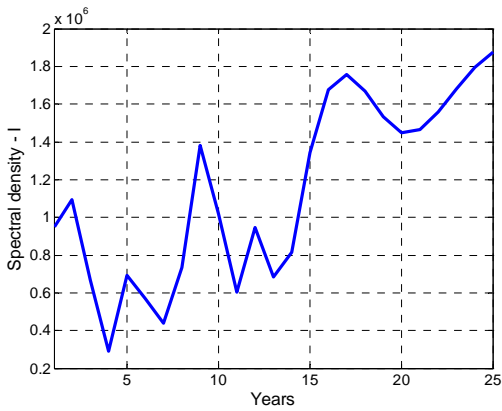
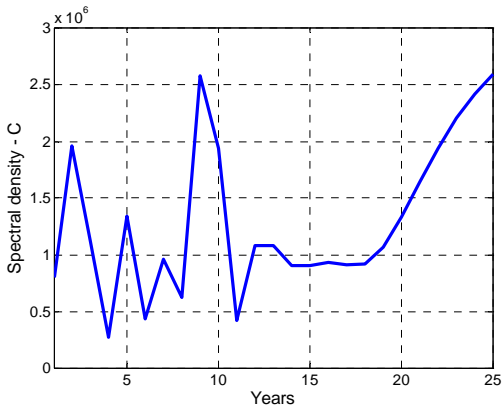
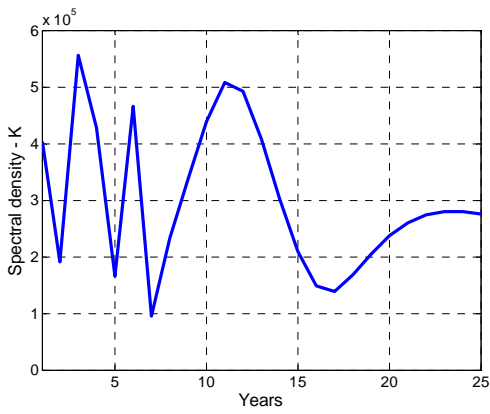


Figure 3: Periodogram for Y

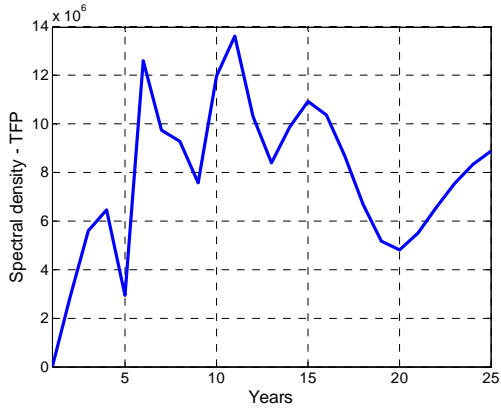




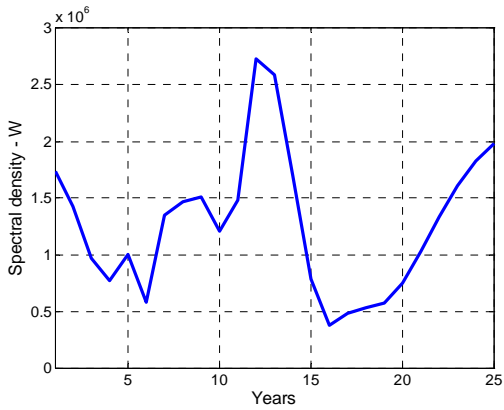
**Figure 4:** Periodogram for C



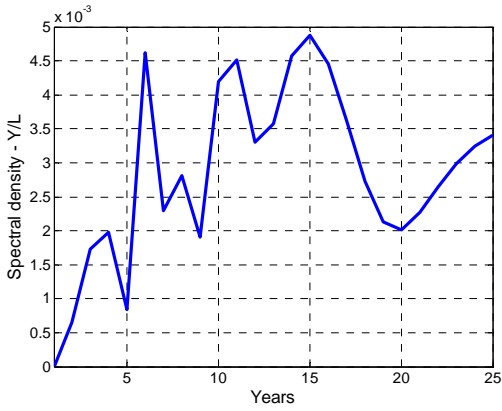
**Figure 5:** Periodogram for K



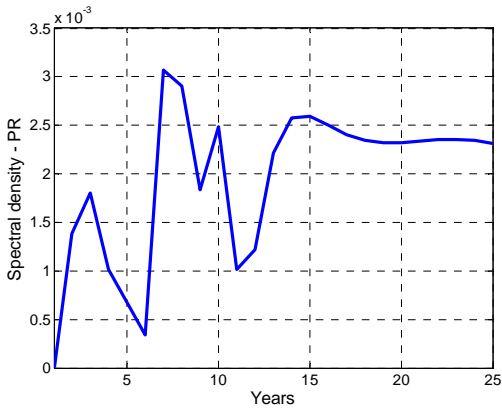
**Figure 6:** Periodogram for TFP



**Figure 7:** Periodogram for W



**Figure 8:** Periodogram for labor productivity



**Figure 9:** Periodogram for profit rate