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The Determinants of Economic Fluctuations in Greece: An Empirical Investigation (1995-2014)[1]

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Abstract: In this work, we investigate the determinants of the Greek Business Cycle in the time period 1995-2014. To this end, we make use of a wide dataset in a quarterly format, which contains all the major macroeconomic and financial variables that have had a certain impact on the Greek economy. We apply a number of relevant econometric techniques such as filtering, Fourier analysis, white noise tests, unit root tests, structural breaks tests, backward regression and rolling windows analysis. Our findings show that the Greek business cycle exhibits two structural breaks, one in 2004 (Q3) and one in 2011(Q4). In the sub-period 1995-2004, the 10-year bond-yields and the elections were found to have a pro-cyclical character on the Greek Business Cycle, while the formation of EMU was found to have a counter-cyclical effect. In the time period 2005-2012, Greek credit and imports were found have a strong pro-cyclical impact, while the overall EU-17 Business Cycle and the Troika had a countercyclical impact on the Greek economy. Further research on the implications of the Greek crisis for other countries would be important.

Introduction

AnOECD (2002) survey characterized the performance of the Greek economy since the early 1990s as 'remarkable', focusingon the existenceof high growth rates. The effective macroeconomic policies along with the opening-up of product and financial markets were regarded as the main drivers behind this growth pattern. In brief, the reasons for this impressive performance were: (a) financial market liberalisation, (b) E.M.U. membership, (c) growing activity in export markets in south-eastern Europe, and (d) the fiscal stimulus given by the 2004 Olympic Games (Belegri-Roboli and Michaelides 2007).

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In 2010, as a result of international and local factors, the Greek economy faced a severe economic crisis. In fact, it experienced the second highest budget deficit and the second highest debt to GDP ratio in the EU, which in combination with the high borrowing costs, resulted in a severe crisis (Charter, 2010). Since then, a number of measures have been implemented in the country by the so-called "Troika" (ECB-EU-IMF).

In this work, we aim to investigate the determinants of the Greek business cycles in the time period 1995-2014, in attempt to identify the structural causes of the downturn of the Greek economy that led to the tremendous recent crisis. To this end, we make use of a wide dataset in a quarterly format, which contains all the major macroeconomic and financial variables that have had a certain impact on the Greek economy.

Methodology

We regard business cycles as fluctuations around a trend (i.e. "deviation cycles"), in the spirit of Lucas (1977), Kydland, and Prescott (1990)).A popular method for extracting the business cycle component is the Baxter-King (BK) filter (Baxter and King 1999) and a large number of studies have used it, as of yet (e.g. Stock and Watson 1999 , Massmann and Mitchell 2004). In order to test whether the cycles extracted are not mere random walk processes, we test for white noise using the Ljung and Box (1978) test.Next, we investigate the average length of the cycle based on the Fourier-transformed function of the cycle.

Trade and interest rates are among the most important variables that are found to affect the business cycle (Holland and Scott 1998; Baxter and King 2004; Bower 2006). We make use of (i) imports (IM) and exports (EX) of the Greek economy to capture its trade relationships, and of (ii) the 10-year bond yields (BY) to capture the cost of money. Furthermore, we use the Greek Foreign Direct Investments (FDI) in line with the works of Bernake et *al.* (2000) and Dietrich (2002) and Faia (2003). The use of credit (CR) is consistent with the work of Kiyotaki and Moore (1997), while the use of Debt (DT) is in line with the works of Minsky and Vaughan (1990), and Ziemann (2012). Additionally, the use of unemployment (UN) is in line with Cristiano et *al.* (2013). Lastly, the dummy variables capturekey events that have had a certain impact on the Greek economy.

In order to select the determinants of Greek business cycles (Ycyclegr), we performed OLS backward elimination to the set of all the variables that enteredtheoriginal multiple linear regression model, using 10,000 bootstrapped

replications. For the selection of the variables we also used the Bayes information criterion (BIC) introduced by Schwartz (1978),asBreiman and Freedman (1983) and Speed and Yu (1992) have shown that BIC is an optimal criterion in finite samples. We test for the possible existence of a structural break in the variables using the Clemente, Montañés and Reyes (1998) structural break test, which includes an unknown endogenously determined break. We also investigate the existence of outliers using the Bacon outliers (Billor et *al.*2000). For stationarity testing, we use the Phillips-Perron(PP)test because no *a-priori* specification of thelag length is required. Also, in order to assess potential multi-collinearity among the independent variables, we calculate the correlation matrix.Furthermore, we assess the normality of the residuals, using the Jarque-Bera normality test (1987). Finally, we assess the whether the residuals of the selected model are homoscedastic using White's (1980) test.

Empirical Analysis

The data used in our analysis come from the OECD database and are in quarterly format covering the period 1995(Q1)-2014(Q3) perfectly capturing the recent recession. All the variables are in billions of Euros, in 2005 prices, with the exception of the variables that represent percentage points.

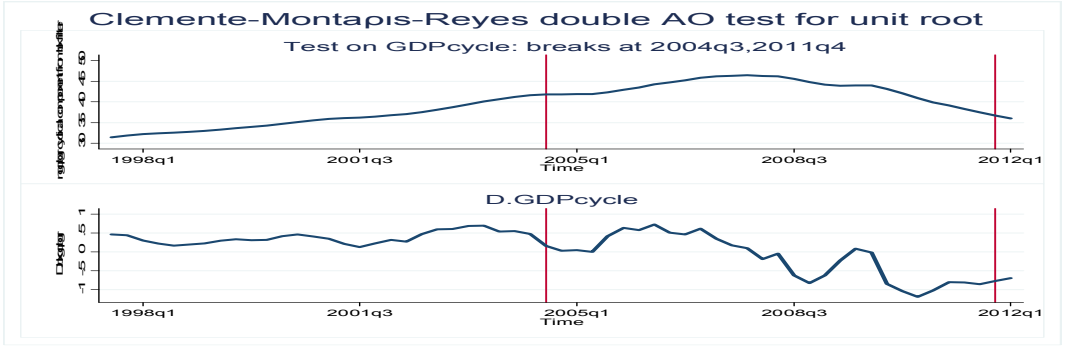
We start by testing for the existence of structural breaks. The results of Clemente, Montañés and Reyes (1998) test are presented in Table 1, while its graphical representation is presented in Figure 1.

Table 1: Clemente-Montanes-Reyes test for Greek GDP cycle(Ycycle)

	du1	**du2**	**ϱ-1**	**Con tant**	**Optimal Break point**
Coefficient	8.25	-8.46	-0.12	34,84	2004(Q3), 2011(Q4)
t-stat	10.46	-6.7	-2.37		
p-value	0	0	-5.49 (5% critical value)		

The results presented in Table 1 and Figure 1, clearly indicate the existence of two structural breaks in2004(Q3) and 2011(Q4).

Figure 1: Structural Break Test for Greek GDP cycle



Following common practice, we split our sample into two sub-periods. The first covers the period 1995(Q1)-2003(Q4) and the second covers the period 2005(Q3)-2011(Q4). We omitted the period 2003(Q4)-2005(Q2) because it may exhibit abnormalities.

We test for the possible existence of outliers.

Table 2: Bacon Outliers test, 1995(Q1)-2003(Q4)

	Ycycle-GR	Ycycle-EU17	C	DT	UN	FDI	IM	EX	BY
Outliers at 5% level of significance	0	0	0	2000(Q1), 2003(Q2), 2003(Q3)	0	0	0	0	0

The results presented in Table 2 suggest that Greek Debt exhibits outliers in 2000(Q1), 2003(Q2) and 2003(Q3) and these observations are excluded from the series. The rest of the time series do not exhibit outliers at the 5% level.

We continue our analysis by extracting - by means of Baxter King filtering - the business cycles components of the Greek GDP and of the EU-17 GDP, using a moving average specification of three (3) quarters, a minimum business cycle period of 6 quarters and a maximum of 32 quarters (Baum et *al.* 2007). Next, we test the Business Cycle for white noise.

Table 3: White noise test of Ycycle for Greece and EU17, 1995(Q1)-2003(Q4)

	Ycycle- Greece	Ycycle- EU17
Q-stat	28.87	30.47
p-value	0	0

The results of Table 3 suggest that both cycles show some distinctive pattern since the null hypothesis of white noise is rejected in both cases. In this context, we examine the periodicities of the cyclical components using Fourier analysis (periodograms).

Figure 2: Periodograms of Greek GDP cycle and EU-17 GDPcycle, 1995(Q1)-2003(Q4)

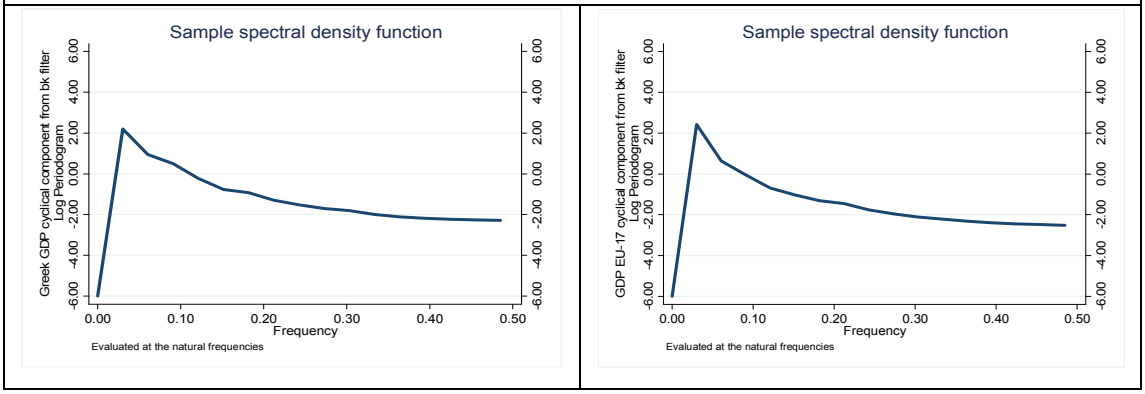


Figure 2 suggests that both cycles exhibit a dominant periodicity at a natural frequency which corresponds to 4-6 quarters i.e. 1,5 years.

Next, we proceed by examining the stationarity characteristics of the time series.

Table 4: Phillips Perron Unit root test, Original Variables1995(Q1)-2003(Q4)

Variable	p-value	Newey-West Lags	Stationarity
CR	0,85	3	No
DT	0,99	3	No
UN	0,23	3	No
FDI	0,11	3	No
IM	0,84	3	No
EX	0,14	3	No
BY	0,41	3	No

Table 5: Phillips Perron Unit root test, First Differences1995(Q1)-2003(Q4)

Variable	p-value	Newey-West Lags	Stationarity
CR	0	3	Yes
DT	0	3	Yes
UN	0	3	Yes
FDI	0	3	Yes
IM	0	3	Yes
EX	0	3	Yes
BY	0	3	Yes

According to the results in Table 4, all the variables have a unit root and are not stationary in levels; however they are stationary in differences (Table 5). Therefore, we proceed to backward selection using stationary variables.

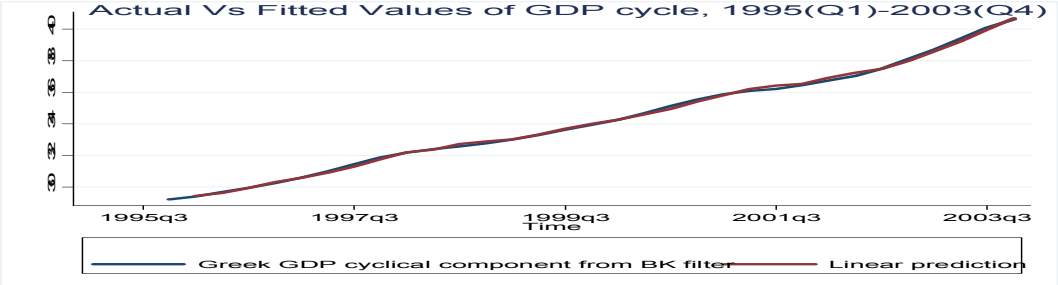
Table 6 presents the model obtained via 10,000 bootstrapped replications, while Table A.2 (Appendix) presents in detail the steps of the backward elimination process as well as the BIC values for each step.Note that the lag of the dependent variable has been included in the independent variables in order to purge autocorrelation of the residuals.

Table 6: Final model selection using 10,000 replications, 1995(Q1)-2003(Q4)			
Variables	**Coefficients**	**z-stat**	**p-value**
GDPcycle(-1)	1.03	134.3	0
EMU	-0.12	-1.94	0.05
GE	0.1	1.97	0.05
BY	0.05	1.7	0.09
Intercept	-0.84	-3.32	0
Wald	23590.1		
R-squared adj	0.99		

The empirical results suggest that the Greek business cycle is positively and statistically significantly affected the Greek elections (GE) and the 10-year bond yield, while it is negatively and statistically significantly affected by the formation of the EMU. This, in turn, implies that the EMU formation acted as a stabilizer of the Greek cycle, while both elections and 10-year bond yields havehada pro-cyclical character.

Additionally, the values of the BIC criterion (Table A.2, Appendix), suggest that the selected model exhibits the lowest BIC. Also, the adjusted R-squared statistic is very high, indicating that the model is capable of capturing almost perfectly the variance of the Greek business cycle. The almost perfect fitting ofthemodel is illustrated in Fig. 3.

Figure 3: Actual Vs Fitted values of GDP cycle



Also, there is no evidence of serious multi-collinearityamong the dependent variables (Table A.3, Appendix). The Jarque-Bera normality test suggests that the null hypothesis of normality of the residuals cannot be rejected (Table A.4, Appendix). Lastly, the results suggest that we cannot reject the null hypothesis of homoscedasticity (Table A.5, Appendix).

4.2 Empirical Analysis: Sub-period 2005(Q3)-2011(Q4)

Following the same procedures, we begin our analysis by testing for the possible existence of outliers.

Table 8: Bacon Outliers test, 2005(Q3)-2011(Q4)

	Ycycle- GR	Ycycle-EU17	C	DT	UN	FDI	IM	EX	BY
Bacon Outliers at 5% level of significance (p-value=0.05)	0	0	0	0	0	0	0	0	0

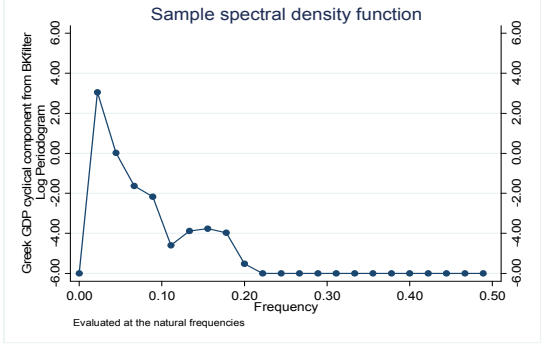
The results in Table 8 suggest that all our time series are free of outliers at the 5% level of significance. Next, we extract the business cycles components of the Greek GDP and the EU-17 GDP, using the parameter values analysed earlier (Baum et *al.*2007).We continue by testing for white noise.

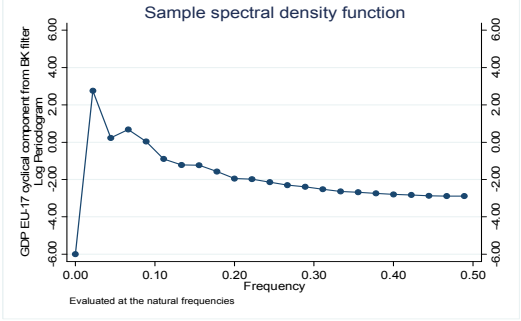
Table 9: White noise test of Ycycle for Greece and EU17, 2005(Q3)-2011(Q4)

	Ycycle- Greece	Ycycle- EU17
Q-stat	22.71	21.48
p-value	0	0

The results in Table 9 clearly suggest that the null hypothesis of white noise is rejected. In this context, we investigate their periodicities using Fourier analysis.

Figure 5: Periodograms of Greek GDP cycle and EU-17 GDPcycle, 2005(Q3)-2011(Q4)





The results in Figure 5 indicate that the Greek GDP cycle exhibits a short run cycle with periodicity of 4-6 quarters, i.e. 1,5 year as well as a medium run cycle with periodicity of 12-16 quarters i.e. 3-4 years. On the other hand, the EU-17 cycle exhibits a short run cycle of also 4-6 quarters i.e. 1,5 years while another cycle is present with periodicity of 8-10 quarters, i.e. 2,5 years.We proceed by examining the stationarity characteristics of the data.

Table 10: Phillips Perron Unit root test, Original Variables2005(Q3)-2011(Q4)

Variable	p-value	Newey-West Lags	Stationarity
CR	0.35	2	No
DT	0.97	2	No
UN	0.97	2	No
FDI	0	2	Yes
IM	0.32	2	No
EX	0	2	Yes
BY	0.97	2	No

Table 11: Phillips Perron Unit root test, First Differences2005(Q3)-2011(Q4)

Variable	p-value	Newey-West Lags	Stationarity
CR	0.03	2	Yes
DT	0	2	Yes
UN	0	2	Yes
IM	0	2	Yes
BY	0.1	2	Yes

According to the results of in Table 10, most of the variables exhibit unit roots with the exception of Greek FDI and Greek Exports. Nevertheless, according to Table 11, all variables were found to be stationary in their first differences at the 10% level.

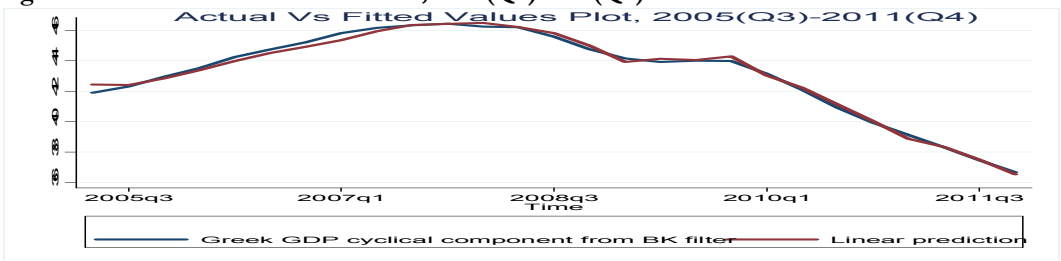
We proceed to the backward selection of our model using stationary variables. Table 12 presents the selected model, obtained after 10,000 bootstrapped replications, while Table A.6 (Appendix) presents the steps of backward elimination and the respective BICvalues for each step.Note that the lag of the dependent variable isincluded in the independent variables in order to purge autocorrelation of the residuals.

Table 12: Final model selection using 10,000 replications, 2005(Q3)-2011(Q4)			
Variables	**Coefficients**	**z-stat**	**p-value**
Ycycle(-1)	0.958	26.32	0
Ycycle EU-17	-0.002	-2.07	0.04
Tr	-0.928	-3.91	0
CR	0.492	2.25	0.02
IM	0.103	2.24	0.03
Intercept	6.082	3.04	0
Wald	2490.31		
R-squared adjusted	0.99		

]The results of our backward selection indicate that EU-17 business cycle and the so-called "Troika" (Tr) have a statistically significant negative impact on the Greek cycle, and hence exhibit a counter-cyclical character.

On the other hand, the Greek Credit andthe Greek Imports have a statistically significant positive impact on the Greek cycle, which in turn means that they exhibit a pro-cyclical character. Additionally, the values of Bayes information criterion in Table A.6 (Appendix), suggest that the best model exhibits the lowest BIC. Also, the adjusted R-squared statistic is very high, indicating that the model is capable of capturing almost perfectly the variance of the Greek cycle. The excellent fitting of the model is illustrated in Fig. 6.

Figure 6: Actual Vs Fitted Values Plot, 2005(Q3)-2011(Q4)



The results suggest that there is no evidence of seriousmulticollinearityamong the independent variables. We continue by testing for the normality of the residuals (Table A.8, Appendix) as well as for homoscedasticity of the residuals (Table A.9, Appendix). The results suggest that both hypotheses cannot be rejected.

Conclusions

In this work, we investigated the determinants of the Greek business cycles, in the time period 1995-2014. To this end, we made use of a wide dataset in a quarterly format, which contained all the major macroeconomic and financial variables that could,potentially, affect the Greek economy.

Our empirical findings showthat the Greek business cycle exhibits two structural breaks: one in the third quarter of 2004, and one in the fourth quarter of 2011. In the sub-period 1995-2004, the 10-year bond-yields and the elections were found to have a pro-cyclical character on the Greek business cycle, while the formation of EMU was found to have a counter-cyclical character. In the second sub-period of 2005-2012, the Greek credit and the Greek imports were found have a strong pro-cyclical character, while the overall EU-17 business cycle and troika seem to have a countercyclical character on the Greek economy.

Our work contributes to the literature in the following ways: (a) It the first, to the best of our knowledge, that use a large dataset in quarterly format, for the investigation of the determinants of the Greek business cycle, in the time period 1995-2014; (b) It employs a number of relevant state-of-the-art econometric tests; (c) It acknowledges the significant role of elections on the Greek business cycle. Further research focusing on the implications of the Greek crisis for other countries in Europe would be important.

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Appendix

Table A.2: BIC and Steps of Backward elimination (10,000 bootstrapped replications),1995(Q1)-2003(Q4)			
Steps of Backward elimination	**Omitted Variables in each step**	**P-value>P**	**BIC**
1	**None**	-	-19.568
2	**FDI**	0.925	-19.229
3	**EX**	0.947	-22.684
4	**IM**	0.921	-26.13
5	**CR**	0.847	-29.524
6	**DT**	0.635	-31.941
7	**UN**	0.374	-34.377
8	**Ycycle EU-17**	0.401	-36.763

Table A.3: Correlation matrix, 1995(Q1)-2003(Q4)			
Dependent Variables	**BY**	**EMU**	**GE**
BY	1	-	-
EMU	-0.18	1	-
GE	0.03	0.23	1

Table A.4: Jarque-Bera Normality test, 1995(Q1)-2003(Q4)	
Chi-squared	1.16
P-value	0.57

Table A.5: White's Heteroscedasticity test, 1995(Q1)-2003(Q4)	
White's LM statistic	3.99
P-value	0.13

Table A.6: BIC and Steps of Backward elimination (10,000 bootstrapped replications),2005(Q3)-2011(Q4)			
Steps of Backward elimination	**Omitted Variables in each step**	**P-value>P**	**BIC**
1	**None**		31.444
2	**UN**	0.977	28.213

3	**PSI**	0.959	25.046
4	**FDI**	0.853	25.681
5	**DT**	0.773	22.823
6	**BY**	0.772	19.931
7	**GC**	0.654	17.058
8	**EX**	0.213	16.416
9	**ELE**	0.325	14.86

Table A.7: Correlation matrix, 2005(Q3)-2011(Q4)

Dependent Variables	Ycycle EU-17	IM	CR	Troika
Ycycle EU-17	1	-	-	
IM	-0.16	1	-	
CR	0.05	0.28	1	
Troika	0.56	-0.19	0.07	1

Table A.8: Jarque-Bera Normality test for the residuals, 2005(Q3)-2011(Q4)

Chi-squared	0.15
P-value	0.92

Table A.9: White's Heteroscedasticity test, 2005(Q3)-2011(Q4)

White's LM statistic	0.26
P-value	0.87