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RESEARCH ARTICLE

# Economic Fluctuations and Fiscal Policy in Europe: A Political Business Cycles Approach Using Panel Data and Clustering (1996–2013)

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**Abstract** The European Monetary Union (EMU) is the only Union that allows its members to conduct their own fiscal policy, which has to be consistent with the Maastricht treaty. This paper attempts to shed light on business cycles determinants focusing on fiscal variables in EU economies, in the time period 1996–2013, using quarterly data fully capturing the on-going recession. In this context, it also acknowledges the significant role of the Quality of Institutions and of the Elections in a Political Business cycles framework. Additionally, based on the business cycles characteristics of the EU economies it explores the potential formation of clusters in the EU economy. To this end, a number of relevant econometric techniques are employed such as: HP filtering, LLC tests; Ljung-Box tests; Fourier analysis; Rolling windows; Dynamic Panel Data analysis; Toda-Yamamoto causality test, Panel Seemingly Unrelated Regressions (SUR) and *k*-means clustering. Our findings suggest that Social Benefits, Social Transfers and Gross Debt are the most significant policy variables with a counter-cyclical character, while taxation was found to have a destabilizing effect. In addition, Elections and the Quality of Institutions were found to significantly affect the key fiscal variables examined. Meanwhile, most

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peripheral countries lie in one cluster suggesting that the recent crisis has led a number of small(-er) peripheral economies to cluster together.

**Keywords** Business cycles · EU · Fiscal policy · Political business cycles · Clustering

## 1 Introduction

The European Monetary Union (EMU) is, thus far, the only Union that allows its members to conduct their own fiscal policy, which has to be consistent with the Maastricht treaty. Given that a number of EMU members such as the so-called PIIGS or GIPSI (*alphabetically*: Greece, Italy, Ireland, Portugal and Spain) are hailed to be among the most prominent victims of the recent recession, it is evident that the role of the individual economies' fiscal policy in a European context, still remains elusive.

The relevant literature suggests that business cycles volatility is an important determinant of a wide range of economic phenomena (Giovanni and Levchenko 2008), while a number of studies examine the impact of business cycles volatility on a set of key macroeconomic variables (Ramey and Ramey 1995; Gavin and Hausmann 1998; Pallage and Robe 2003; Barlevy 2004; and Laursen and Mahajan 2005). However, relatively limited research has been done regarding the impact of fiscal policy variables on business cycles fluctuations (e.g., Galli and Perotti 2003; Alesina et al. 2008).

Despite the fact that Elections and the Quality of Institutions are often (in-) directly related to fiscal policy in the so-called *Political Business Cycles*(PBC) literature (e.g., Nordhaus 1975; Rogoff and Sibert 1988; Rogoff 1990; Persson and Tabellini 1990; Aidt and Veiga 2011; Alegre 2012; Potrafke 2012; Abbott and Jones 2013; Mechtel and Potrafke 2013, De Haan et al. 2013), the impact of *Political Business Cycles* on key fiscal determinants has been inadequately acknowledged in the empirical literature.

In this framework, on the one hand, there is widespread agreement that business cycles fluctuations are often attributed to the impact of fiscal policy variables (see, for example, Lane 2003; Galli and Perotti 2003, etc.). Hence,a question of great importance is whether fiscal variables are indeed related to business cycles in the context of a monetary union, such as the EMU. On the other hand, as we have seen, elections are very often related to fiscal policy in the *Political Business Cycles'* literature (see for example Rogoff 1990; Persson and Tabellini 1990). In other words, business cycles in the EMU might be strongly related with elections in the member states. Hence, the present paper will attempt to provide an analytic framework for the conceptualization of the status of the EMU in terms of business cycles bringing together fiscal policy variables and elections.

Analytically, in this paper we will shed light on the fiscal determinants of business cycles in the EUeconomies by acknowledging the key (in-)direct role of political business cycles. In this context, following Real Business Cycles theory, we regard business cycles as deviation from trend and we extract the business cycles component for each economy. We then examine the characteristics of the business cycles extracted for each economy so as to ensure that the business cycle components are not random

walk and follow some distinctive pattern that exhibits periodicity. Next, using two panel data models we explore the fiscal determinants of business cycles in the EU economies taking into consideration the significant role of Political Business Cycles. In addition, we conduct sensitivity analysis via panel Rolling windows, while using Causality testing we explore the causality of the fiscal determinants identified by our models. Lastly, we explore the formation of potential clusters among EU economies based on their business cycles characteristics.

The paper contributes to the literature in the following ways:(a) It the first, to the best of our knowledge, that directly relates Political Business Cycles (PBC) with the key fiscal determinants of business cycles in the EMU; (b) It investigates the role of key fiscal determinants of business cycles in the EMU by decomposing the fiscal variable of government spending into capital expenditures, social transfers and social benefits, taking into account that the effects of the various components of government spending on the business cycle may differ. In this context, government revenues are also further divided into direct and indirect taxes;(c) It identifies the potential formation of clusters in the EU economy based on the business cycle that each economy exhibits; (d) It uses a wide dataset in quarterly format which includes the main EMU countries i.e., Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Holland, Portugal and Spain, as well as the economies of UK, Sweden and Denmark that belong to the EMU but do not participate in the common currency, in the period 1996–2013, fully capturing the recent recession; and (d) It provides a consistent and robust econometric framework based on advanced techniques (such as Dynamic Panel Data Analysis, Panel SUR, Toda-Yamamoto Causality and k-means Clustering) in order to tackle the research questions.

The remainder of this paper is structured as follows: section 2 provides a review of the literature; section 3 sets out the methodological framework; section 4 presents the empirical results, while section 5 analyses them; finally, section 6 concludes.

## 2 Previous Literature

### 2.1 On Business Cycles Determinants

In an early study, Razin and Rose (1994) linked business cycles to barriers on international mobility of capital and goods. Their empirical results showed that there exists a strong and significant relation between the volatility of consumption, output and investment with the degree of capital mobility and the degree of goods mobility. The reason suggested is the common nature and persistence of shocks worldwide.

After the formation of the EMU, real time data availability substantially boosted the empirical research conducted on business cycles. To this end, Easterly et al. (2001) in an attempt to investigate business cycles determinants reported that wage flexibility is not related, in a statistically significant way, with volatility. In a prominent paper, Acemoglu et al. (2003) found that weak institutions cause volatility through a number of microeconomic, as well as macroeconomic, channels. Kose et al. (2003) reported that financial integration is associated with an increase in the ratio of consumption.

Galli and Perotti (2003) suggested that the Stability Growth Pact (S.G.P.) does not influence the ability of E.U. governments to conduct effective discretionary

countercyclical fiscal policy. According to their work, discretionary fiscal policy in the EMU has become more countercyclical over time, following what appears to be a trend that affects other industrialized countries as well. Fatás and Mihov (2003) aimed at studying the effects of discretionary fiscal policy on output volatility and economic growth. Their findings give credit to the view that governments using fiscal policy as an instrument induce macroeconomic instability.Bergman (2004) studied the business cycles of various European economies for the last forty (40) years. According to the paper's findings, EMU formation increased the intensity of the cycle.

In a broader context, using data from selected economies across the world, Malik and Temple (2006) examined the structural determinants of output volatility in developing countries and especially the role of geography and institutions. They found that countries with weak institutions are more volatile. Furceri and Karras (2007) suggested a strong, statistically significant and negative relationship between country size and business cycles implying that smaller countries are subject to more volatile business cycles than larger ones.

Furthermore, Montoya and de Haan (2008) showed that there is increasing volatility in most EU countries in the period 1975–2005, attributing their finding to the Maastricht treaty. Magud (2008) argued that the effectiveness of fiscal policy depends on the fiscal fragility of the government. Also, Hakura (2009) testified that output volatility has declined across groups of non-transition countries studied over the past three decades, but has remained considerably higher in developing countries. Evidence from cross-section investigation suggests that among the key determinants of output volatility was the discretionary fiscal spending.

Canova and Pappa (2011) found that business cycles in several E.U. countries have not altered significantly after EMU formation, and thus these small changes should be attributed to the inherent characteristics of each economy. This view was also consistent with the findings by Giannone et al. (2009) who found that the characteristics of business cycles in Europe have not changed significantly. Castro (2011) showed that the institutional changes that occurred in the E.U. after 1992 were not harmful to growth. Again, recently, Kose et al. (2012) argued that world factors cannot explain business cycles in a satisfactory way, contrarily to domestic factors.

### 2.2 On Business Cycles Clustering

Our research also deals with business cycle clustering in EU. The rationale behind clustering goes back to the theory of the so-called Optimal Currency Area (O.C.A.) (e.g., Bayoumi and Eichengreen 1997a; Frankel and Rose 1998; Kenen 1969; McKinnon 1963; Mundell 1961; Tavlas 1993) according to which, the lack of an independent monetary policy could lead to a breakdown of the monetary union, if the union members exhibit non-symmetric output fluctuations.

In this framework, on the one hand Krugman (1991) argues that increasing integration would lead to regional concentration of industrial activities, which - in turn -would lead to region-specific shocks that would increase the likelihood of asymmetric shocks and diverging business cycles. See also Kalemli-Ozcan et al. (2001). On the other hand, there is the view that a removal of the trade barriers would lead to more trade such that demand shocks would be more easily transmitted. See Frankel and Rose (1998), and Coe and Helpman (1995). See also Trichet (2001), Furceri and Zdzienicka (2011). In

fact, a question of great interest directly related to the aforementioned *problematique* is the possible existence of a core–periphery type distinction among European countries' business cycles (e.g., Dickerson et al. 1998), or a possible grouping of EU-15 countries in clusters (Camacho et al. 2006).

Bayoumi and Eichengreen (1997a) were among the first that suggested the existence of four (4) groups of countries that broadly coincide with a geographical grouping, namely a central European group of countries, a northern European group, a Southern group of countries and a group of countries that chose not to participate in the Euro-area.

Artis and Zhang (1998b) showed that the most distant economies from the core of EMU are Ireland and Finland. Likewise, Spain, Italy and Portugal are set aside because of their distinctive behaviour.Crowley and Christi (2003) showed that in the time period 1983–1992, E.U. consisted of four (4) groups and a core was identified; in the 1993–2001 time span European countries formed either two (2) or four (4) clusters.Bergman (2004) found that the economic and monetary integration during the last ten (10) years has affected business cycle behaviour. Again, Crowley and Lee (2005) found that Euro-area countries fall into three clusters: high and dynamic correlations at all frequency cycles, low static and dynamic correlations with little sign of convergence and those with low static correlation but convergent dynamic correlations.Concaria and Soares (2009) identified two groups of countries in the Euroarea: the core countries consisting of Germany, France, Spain, Austria; the Benelux countries; and the periphery consisting of the rest of the countries.

## 3 Methodological Framework

### 3.1 Business Cycles Analysis

#### *3.1.1 Definition*

In this work, we regard business cycles as fluctuations around a trend, i.e., the so-called "deviation cycles", in the spirit of the seminal contributions by Lucas (1977), Kydland, and Prescott (1990), Alesina et al. (2008), Battaglini and Coate (2008), Ales et al. (2014). Hence, according to Real Business Cycles (RBC) theory, every time series can be decomposed into a cyclical component and a trend component:

$$C_t = y_t - g_t \tag{1}$$

where: $c_t$ is the cyclical component of time series, $y_t$ is the actual time series and $g_t$ is the respective trend that the time series exhibits.[1]

#### *3.1.2 Filtering*

In order to extract the cyclical component we use the Hodrick - Prescott (HP) filter, due to its widespread acceptance in the literature. The robustness of the HP de-trending

[1] Other relevant approaches for assessing the role of fiscal policy on business cycle stabilization would be to estimate the response of fiscal variables to the cycle or to assess the impact of fiscal policy on output volatility. We would like to thank an anonymous referee for pointing this out.

method is confirmed, among others, by Artis and Zhang (1997) and Dickerson et al. (1998). The parameter used for quarterly data is equal to λ=1600 (Ravn and Uhlig 2001). The trend is obtained by minimizing the fluctuations of the actual data around it, i.e., by minimizing the following function:

$$\sum_{t=1}^{T}\left(y_t-y_t^*\right)^2-\lambda\sum_{t=2}^{T-1}\left[\left(y_{t=2}^*-y_t^*\right)-\left(y_t^*-y_{t-1}^*\right)\right] \tag{2}$$

where y* is the long-term trend of the variable y and the coefficient λ>0 determines the smoothness of the long-term trend.

### 3.1.3 White Noise

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 (Q-Stat) which tests the null hypothesis of white noise for a maximum lag length k:

$$Q=n(n+2)\sum_{j=1}^{k}\frac{\widehat{p_j^2}}{n-1} \tag{3}$$

where n is the sample size, $\widehat{p}_j^2$ the sample AC at lag j, and h the number of lags being tested; for significance level a, the critical region for rejection of the hypothesis of randomness is $Q>x^2{}_{1-a,h}$ is the a-quantile of the chi-squared distribution with h degrees of freedom.

### 3.1.4 Fourier Analysis

Next, we investigate the average length of the cycle based on the Fourier-transformed function of the cycle. A periodogram is a graph of the spectral density function of a time series in the natural frequency domain. The function has the following form:

$$f(\omega)=\begin{cases} f(1-\omega), if\,\omega\in[0.5,1] \\ \frac{1}{n}\left|\sum_{t=1}^{n}x_t\exp\{2\pi i(t-1)\omega\right|, if\,\omega\in[0,05) \end{cases} \tag{4}$$

where $\omega=\frac{2\pi}{n}$ is the natural frequency and $x_t$ is the time series.

Peaks in the periodogram represent the dominant frequencies (cycles) in the dataset.

### 3.1.5 Stationarity

Finally,before turning to our model we have to investigate the stationarity characteristics of the panel data series so as to avoid *potential spurious regression effects* between the variables. We use the panel unit root test of LLC (Levin et al. 2002) which is relevant for this type of investigation. The LLC procedure has the following steps:

1st Step: Run the ADF test for each cross section on the equation:

$$\Delta y_{i,t}=\rho_i y_{i,t-1}+\sum_{L=1}^{p_i}\theta_{i.L}\Delta y_{i,t-L}+a_{m.i}d_{m,t}+\varepsilon_{i,t} \tag{5a}$$

2nd Step: Run the auxiliary regressions for each cross-section i:

$$\Delta y_{i,t} = \sum_{L=1}^{p_i} \theta_{i.L} \Delta y_{i,t-L} + a_{m.i} d_{m.t} + \varepsilon_{i,t} \tag{5b}$$

$$\Delta y_{i,t\text{-}1} = \sum_{L=1}^{p_i} \theta_{i.L} \Delta y_{i,t-L} + a_{m.i} d_{m.t} + v_{i,t} \tag{6}$$

and obtain the residuals $\widehat{\varepsilon_{l,t}}$ and $\widehat{v_{l,t}}$ respectively.

3rd Step: Standardize the residuals obtained as follows:

$$\overline{\varepsilon_{l,t}} = \frac{\widehat{\varepsilon_{l,t}}}{\widehat{\sigma_{\varepsilon_l}}}, \overline{v_{l,t}} = \frac{\widehat{v_{l,t}}}{\widehat{\sigma_{\varepsilon_l}}} \tag{7}$$

where $\sigma_{\varepsilon_i}$ is the standard error of each cross-section ADF.

4th Step: Run the OLS pooled regression:

$$\overline{\varepsilon_{l,t}} = \rho \overline{v_{l,t}} + u_{i,t} \tag{8}$$

### 3.2 Panel Data

In order toexamine the determinants of business cycles volatility, we use Dynamic Panel Models. However, before proceeding we perform a Hausman test in order to determine the specification to be used, i.e., Fixed effects or Random effects.

#### *3.2.1 Hausman Test*

The test is based on the difference between two estimates $b_1$ and $b_2$. Under Ho, $b_1$ is assumed to be consistent and efficient estimate with asymptotic covariance matrix $V_1$. The alternative estimator $b_2$, with asymptotic covariance matrix $V_2$, is consistent - but usually inefficient - both under Ho and the alternative hypothesis Ha. A large difference $b_1$ - $b_2$ between the estimates is seen as evidence against Ho, this is measured by the Mahalanobis distance, thus:

$$Ho : Var(b_1 - b_2) = V_1 - V_2 \tag{9}$$

and the Hausman statistic is:

$$H = (b_1 - b_2)^T (V_1 - V_2)^{-1} (b_1 - b_2) \tag{10}$$

which is asymptotically chi-square distributed with $k = rank(V_1 - V_2)$ degrees of freedom under Ho (Hausman and McFadden 1984; Amemiya 1985).

#### *3.2.2 Models*

As Arellano and Bond (1991) suggested, the Dynamic Panel OLS estimators do not belong to the class of efficient estimators. To this end, they derived an

efficient[2] generalized method moments (GMM) estimator for the parameters of this model. Therefore, we make use of both fixed effects Dynamic OLS and Arellano and Bond (1991) Dynamic GMM. In this context, the past history of the dependent variable are natural candidates for instruments, which is common practice in the empirical literature as of yet (e.g., West 1987).

We exclude from our analysis monetary variables since all the countries under investigation are members of the EMU and, thus, share in common monetary circulation dictated by the European Central Bank (ECB). The models, where $i = 1, .., 12$ denotes the panel dimension and $t$, denotes the time dimension, are the following:

Model 1

$$Ycycle_{i,t} = c_t + a_1 ST_{i,t} + a_2 SB_{i,t} + a_3 CE_{i,t} + a_4 DT_{i,t} + a_5 IT_{i,t} + a_6 U_{i,t} + a_7 GD_{i,t} + a_8 EMUGDPcycle_t + a_9 Ycycle_{i,t-1} + m_i \tag{11}$$

Model 2

$$\left(Ycycle_{i,t}/Y_{i,t}\right) = c_t + a_1\left(ST_{i,t}/Y_{i,t}\right) + a_2\left(SB/Y_{i,t}\right) + a_3\left(CE_{i,t}/Y_{i,t}\right) + a_4\left(DT_{i,t}/Y_{i,t}\right) + a_5\left(IT_{i,t}/Y_{i,t}\right) + a_6\left(U_{i,t}/Y_{i,t}\right) + a_7\left(GD_{i,t}/Y_{i,t}\right) + a_8\left(EMUGDPcycle_t/Y_{i,t}\right) + a_9\left(Ycycle_{i,t}/Y_{i,t}\right) + m_i \tag{12}$$

For a detailed description of the variables, see Table 9 (Section on *Data and Variables*). The variable $c_t$ denotes the intercept of the panel regression which may vary over time, while $m_i$ denotes the individual-specific effects for each economy (Wooldridge 2010).

Model 2 is normalized by dividing with the GDP. This is done in order to control, in an econometric sense, for the magnitude of the variables that enter the panel, meaning to homogenize our panel in a sense that both large and small economies in our panel analysis to have the same predictive ability over our dependent variable.

### 3.2.3 Political Business Cycle

In general fiscal policy variables are supposed to be manipulated before and after the elections in the context of political business cycles (PBC). If political business cycles are opportunistic, manipulation of fiscal policy variables can be used irrespectively of the political affiliation of the party governing. Controlling for such variables is very important and has not been used in the literature before.

[2] Alternatively, IV or biased correct LSVD estimators have been used but the results did not change significantly.

In this context, the interaction between two key Political Variables,[3] such as Elections (***ele***) and Quality of Institutions (***IQ***), with fiscal variables is of particular interest. In order to account for the influence of Political business cycles on the key fiscal variables of our model we make use of a Random Effects Panel S.U.R. model. To this end, the following system of equations is estimated:

$$SB_{i,t} = C_1 + a_{11}ele_{i,t} + a_{12}IQ_{i,t} + m_i \tag{13}$$

$$ST_{i,t} = C_2 + a_{21}ele_{i,t} + a_{22}IQ_{i,t} + k_i \tag{14}$$

$$DT_{i,t} = C_3 + a_{31}ele_{i,t} + a_{32}IQ_{i,t} + l_i \tag{15}$$

where $i = 1, ..12$ is the panel dimension, $t = 1, \ldots T$ is the time dimension and $m_i, k_i$ and $l_i$ are the individual specific effects for each economy. This system allows for a full examination of whether Elections and Institutional Quality manipulate the fundamental policy variables. The model can be used to examine carefully the politically induced business cycle, and provide useful insights into the nature of opportunistic politico – economic behavior.

### *3.2.4 Rolling Window*

Next, we use the rolling window methodology in a panel set up in order to investigate whether the respective coefficients of our proposed models are stable over time. A common technique to assess the possible change of a model's parameters is to compute parameter estimates over a rolling window of a fixed size through the sample. If the parameters change at some point during the sample, then the rolling estimates capture this instability. Using economic intuition, since the year 2000 is the landmark of EMU formation, it is natural to assume that any break in the time constancy of coefficients is more likely to occur in that year. To this end, we employ panel rolling window using a fixed length of 10–15 years by shifting the starting period from 1996 to 2001.

The rolling window is a methodology that repeats estimations using sub-samples of the total data by shifting the start (and/) or end-points with a fixed window (Zivot and Wang 2006). Consider a panel estimation with time series data using the rolling window as follows:

$$Y_{t,i} = a_i + b_i x_{t,i} + \varepsilon_i,\ i = 1, ..n \text{ and } n < T \tag{16}$$

where $n$ denotes the length of the sub-sample or window, T is the total number of observations of our panel time series, $Y_{t,i}$ denotes the dependent panel variable for each sample period, $x_{t,i}$ denotes the independent panel variable for each sample period and $\varepsilon_i$ denotes the error term of each sample period which is typically assumed to be *i.i.d.*

[3] Also, several other important factors, such as Private Investment, Corruption, Openness, Political orientation of the Government, Trade relations and Labour forms, have been considered as determinants of the key fiscal variables. Nevertheless, none of them had statistically significant effects and were, thus, dropped from all three equations.

Therefore, for each i, the rolling windows approach estimates the above model using the T-n+1 sample length.

*3.2.5 Causality Testing*

Lastly, we conduct the Toda and Yamamoto (1995) causality test to examine the causal relationship between the variables examined and the cyclical part of GDP. This technique is applicable irrespectively of the integration and co-integration properties of the system. The augmented VAR procedure proposed by Toda and Yamamoto (1995) allows for causal inference based on an augmented VAR $[VAR(s + d_{max})]$ with integrated and co-integrated processes, where $d_{max}$ is the maximal order of integration in the model. The dynamic causal relationships among the cyclical component of GDP and the aforementioned variables follow the scheme:

$$Y_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Upsilon_{t-k} + \zeta_t \tag{17}$$

where $Y_t$ is a $(n \text{—} l)$ column vector of $p$ variables, $\mu$ is a $(n \text{—} l)$ vector of constant terms, $\Gamma_i$ represents the coefficient matrices, $k$ denotes the lag length and $\zeta_t$ is *i.i.d.* and $p$ -dimensional Gaussian error with mean zero and variance matrix.

The method involves testing for the significance of the parameters of a VAR(s) model, where s is the lag length in the system. The traditional F tests and its Wald test counterpart are not valid for non-stationary processes, as the test statistics do not have a standard distribution (Toda and Phillips 1993). The lag length of the variables in the causality models are selected in accordance with the Schwartz Bayesian Information Criterion (SBIC). Since lagged dependent variables appear in each equation, their presence is expected to purge serial correlation among the error terms.

### 3.3 Clustering

We proceed by investigating the formation of clusters in EU, so as to identify the groups of countries that share similar characteristics, regarding their business cycle. Various strategies for the determination of the number of clusters have been proposed (e.g., Bozdogan 1993). The most common relocation method is *k*-means clustering (Hartigan and Wong 1978) because the distance between any two objects is not affected by the addition of new objects in the analysis (Timm 2002).

There is no standard procedure for determining the number of clusters. Among the most popular criteria to derive the optimal number of clusters in *k*-means clustering is the Calinski and Harabasz (1974) F-stopping-rule index that is based on the within cluster sum of squares of the $k$ formed clusters and the between clusters sum of squares. The formula used for Calinski–Harabasz statistic, for $k$ clusters and $n$ observations is:

$$F_{\text{Calinski-Harabsz}} = \frac{Trace(T) \Big/ (k-1)}{Trace(SSE_k) \Big/ (n-k)} \tag{18}$$

where: T is the total sum of square between clusters and is given by the expression:

$$T = \sum_{i=1}^{n} \|y_i - \overline{y}\|^2 \tag{19}$$

and $SSE_k$ is the within cluster sum of squares for cluster k (Ck) given by the expression:

$$SEE_k = \sum_{i=1}^{k} \|y_i - \overline{y_k}\|^2 \tag{20}$$

Thus, the Calinski-Harabasz F-statistic is a measure of (dis-)similarity between clusters. In other words, it measures the degree of homogeneity between groups. The larger the values of Calinski-Harabasz index, the more significant the differences among groups.

## 4 Empirical Analysis

We use quarterly data covering the period 1996Q1-2013Q4, regarding the economies of: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Holland, Portugal and Spain.[4] Table 9 (Appendix), summarizes the data and variables used in the analysis, where the panel is balanced.[5]

To begin with the result analysis, the stationarity properties of the various macro-economic variables have been checked. The LLC test was applied both on the original variables and on their first differences, whereas relevant. All variables are found stationary except for the variables of Social Transfers (ST) and Social Benefits (SB); however they are found stationary in their first differences (Table 10, Appendix).

In order to extract the cyclical components of each country's GDP and the Aggregate EMU GDP, we used the HP filter to decompose it into a trend and cyclical component. Next, the results of the Ljung and Box test on the cyclical components of GDP and Aggregate EMU GDP indicate a rejection of the null hypothesis of white noise for both variables under investigation (Tables 1 and 2).

Hence, the existence of cyclical regularities is a valid hypothesis, from an econometric perspective. Furthermore, the results of the Fourier analysis are illustrated in Fig. 4 (Appendix). In brief, a short-term cycle of approximately two (2) years is evident in most EMU economies. Also, a second mid-term cycle with a frequency of 6–8 years is present.

Next, we provide cross-correlation results between the cyclical variable of GDP and the rest of the variables that enter the model (Appendix Figs. 5, 6, 7, 8, 9, and 10). The results suggest that the dynamics of the German economy differ, compared to the rest of the EMU countries.

Now, in order to decide about the specification, we conduct the Hausman specification test (Table 3). The results show that the fixed effects model is appropriate for our investigation.

[4] In addition we use OECD quarterly data regarding the GDP of the UK, Sweden and Denmark, in 2005 prices in billions of dollars.

[5] Given that some of the data were not available, following Pesaran et al. (2004), we intra-polated the missing observations.

**Table 1** White noise test. Aggregate GDP EMU cycle

| Lags | AC | PAC | Q-stat | *p*-value |
|---|---|---|---|---|
| 1 | 0.50 | 0.50 | 71.91 | 0.00 |
| 2 | −0.07 | −0.43 | 73.23 | 0.00 |
| 3 | −0.26 | 0.01 | 92.73 | 0.00 |
| 4 | −0.27 | −0.19 | 113.95 | 0.00 |
| 5 | −0.17 | 0.00 | 122.05 | 0.00 |
| 6 | 0.08 | 0.14 | 123.91 | 0.00 |
| 7 | 0.13 | −0.14 | 128.81 | 0.00 |
| 8 | −0.06 | −0.13 | 129.71 | 0.00 |

Next, we used fixed effects analysis as described above to estimate the relationship between the fiscal variables and the cyclical component of GDP (Table 4).

Furthermore, using the rolling window approach set out earlier (Figs. 1 and 2) we tested the sensitivity of the estimated parameters. From mere visual inspection, it is clear that in both models the estimated coefficients remain practically unchanged over time.

Moreover, in order to account for the significant role of Political Business cycles, the results concerning the impact of Elections and Institutional Quality on the key fiscal variables dictated by our previous panel data analysis are presented (Table 5).

The results suggest that Election, as well as Institutional Quality, significantly affect the key fiscal variables of our model. In fact, we found no qualitative differences between OLS, and random effects panel SUR. This is an expected result because each equation contained exactly the same set of regressors. In addition, there were no significant cross-equation correlations between the error terms of each equation as can be seen in Table 6.

Finally, the Toda-Yamamoto causality test is implemented, in order to determine which variables have predictive power for business cycles volatility (Table 7).

The results suggest that Social transfers, Gross Debt, Government Capital expenditures and Direct Taxation are the variables that dictate business cycles volatility in EMU.

Finally, *k*-means clustering is implemented using a vector of all the available macroeconomic variables of our dataset for each economy. In order to determine the optimum number of clusters, we use of the Calinski -Harabasz F-statistic (Fig. 3). The results suggest the existence of four (4) clusters (Table 8).

The four (4) clusters are: (a) United Kingdom; (b) Germany and Italy; (c) France and (d) Belgium, Finland, Netherlands, Spain, Denmark, Greece, Ireland, Luxembourg, Portugal and Sweden.

**Table 2** White noise test. GDP cycle

| Lags | AC | PAC | Q-stat | *p*-value |
|---|---|---|---|---|
| 1 | 0.95 | 0.95 | 258.61 | 0.00 |
| 2 | 0.90 | −0.03 | 490.69 | 0.00 |
| 3 | 0.84 | −0.03 | 696.24 | 0.00 |
| 4 | 0.79 | −0.03 | 877.97 | 0.00 |
| 5 | 0.74 | −0.02 | 1037.21 | 0.00 |
| 6 | 0.68 | −0.07 | 1173.62 | 0.00 |
| 7 | 0.63 | −0.04 | 1288.32 | 0.00 |
| 8 | 0.57 | −0.02 | 1384.11 | 0.00 |

**Table 3** Hausman specification test

| Independent variables | Coefficients | | |
|---|---|---|---|
| | Fixed effects (b) | Random effects (B) | Difference (b-B) |
| Capital expenditure | −0.05 | −0.14 | 0.09 |
| Direct taxes | 0.55 | 0.03 | 0.52 |
| Gross Debt | −0.04 | 0.00 | −0.04 |
| Indirect Taxes | −0.08 | 0.01 | −0.09 |
| Social benefits | −1.06 | −1.06 | 0.00 |
| Social transfers in kind | 1.01 | −1.05 | 2.06 |
| Unemployement | −0.15 | 0.12 | −0.27 |
| EMU GDPcycle | 0.03 | 0.05 | −0.02 |
| Lagged GDP | 0.15 | 0.36 | −0.21 |
| Ho: No difference in coefficient | | *p*-value=0.00 | |

**Table 4** Dynamic panel data analysis

| Independent variables | Model 1 | | Model 2 | |
|---|---|---|---|---|
| | Dynamic OLS | GMM | Dynamic OLS | GMM |
| Capital expenditure | −0.05 | −0.02 | −0.05 | −0.02 |
| t-stat | −0.49 | −0.24 | −0.72 | −0.35 |
| Direct Taxes | 0.54 | 0.62 | 0.35 | 0.54 |
| t-stat | 7.36* | 8.54* | 4.22* | 6.27* |
| Gross Debt | −0.04 | −0.05 | −0.03 | −0.03 |
| t-stat | −6.29* | −7.81* | −2.86* | −5.13* |
| Indirect Taxes | −0.08 | −0.08 | −0.07 | −0.14 |
| t-stat | −0.96 | −0.96 | −0.82 | −1.77** |
| Social benefits | −1.05 | −1.02 | −0.86 | −0.81 |
| t-stat | −5.58* | −6.00* | −4.82* | −5.32* |
| Social transfers in kind | 1.01 | 0.92 | 1.01 | 0.88 |
| t-stat | 4.42* | 4.28* | 4.23* | 4.20* |
| Unemployement | −0.15 | −0.20 | −0.31 | −0.34 |
| t-stat | −0.51 | −0.68 | −4.24* | −5.03* |
| EMU GDPcycle | 0.03 | 0.03 | 0.01 | 0.01 |
| t-stat | 7.83* | 8.85* | 9.39* | 10.76* |
| lagged GDP | 0.15 | 0.10 | 0.39 | 0.35 |
| t-stat | 3.17* | 2.42* | 9.24* | 10.47* |
| Constant | −20.71 | −23.37 | −0.02 | −0.03 |
| t-stat | −5.16* | −6.07* | −2.26* | −3.46* |
| $R^2$-*adj* | 0.71 | *Wald* $\chi^2$=*863.40* | 0.69 | *Wald* $\chi^2$=*921.72* |

* denotes statistical significance at the 5 % level or higher

** denotes statistical significance at the 10 % level or higher

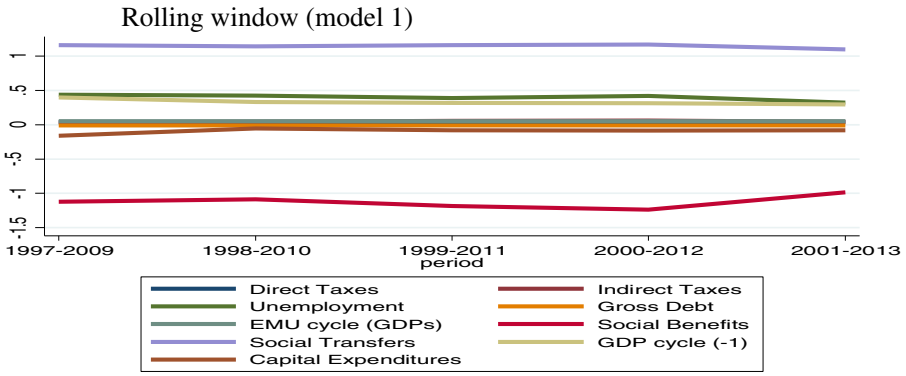



**Fig. 1** Rolling window (model 1)

## 5 Discussion

The GDP periodograms of the various EU economies are presented in Fig. 4. (Appendix). The results suggest the existence of one dominant frequency, i.e., a short-term cycle of approximately 2 years, but also a medium-term cycle of 6–8 years, in the period 1996–2013. An interesting result is that the same cycle is present even in the economies of Denmark, UK, and Sweden that do not participate in the common currency.

In Figs. 5, 6, 7, 8, 9, and 10 (Appendix), the cross correlations of the variables examined with the cyclical GDP at various lags/leads are presented. Interestingly, in Germany social benefits are negatively correlated with the GDP cycle, while the opposite is the case in France, Portugal, Greece, Italy and Spain (Fig. 5). This, in turn, suggests that social benefits are counter-cyclical for the German economy, so social benefits act as a stabilizing mechanism for Germany, while they have a pro-cyclical character for the economies of France, Portugal, Greece, Italy and Spain. The destabilization effect of social benefits could be attributed to the fact that when they are used as a fiscal policy instrument, they increase the overall government expenditures and as a result deteriorate the Current Account Balance, a result which is consistent, among others, with the work of Abbott and Jones (2013). In addition, in Germany, social benefits have an immediate effect (no lag) on the cycle of the economy, while in the economies of France, Finland, Portugal, Greece, Luxembourg, Italy and Spain a minor

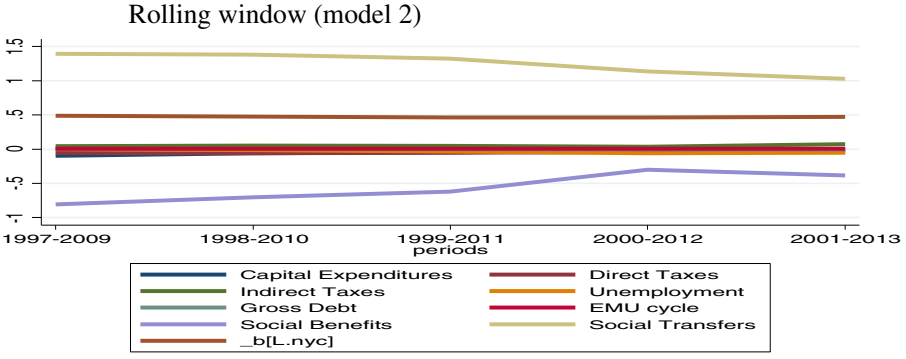



**Fig. 2** Rolling window (model 2)

**Table 5** Random effects panel SUR estimates of Political Business Cycles (PBC)

| Variables | Equation 1 (SB) | Equation 2 (ST) | Equation 3 (DT) |
|---|---|---|---|
| IQ index | 20.4 | 14.25 | 79.15 |
| *t-stat* | 2.48 | 1.93 | 1.64 |
| Elections | 0.01 | 0.02 | −0.01 |
| *t-stat* | 1.67 | 2.01 | −0.83 |
| *Intercept* | 0.01 | 0.01 | 0.13 |
| *t-stat* | 13.38 | 10.91 | 47.18 |
| Summary statistics | | | |
| *RMSE* | 0.01 | 0 | 0.03 |
| $X^2$ | 7.8 | 7.93 | 4.28 |

lead is observed, implying that spending for social benefits in these economies is an active fiscal policy instrument that leads to their destabilization.

The same picture is in line regarding social transfers in kind and GDP cycle (Fig. 6), with the German economy to exhibit a negative correlation and thus a counter-cyclical character, while in France, Finland, Portugal, Italy, Luxembourg, Netherlands and Spain, a pro-cyclical scheme is in place. Nevertheless, for the economies of Austria, Belgium, Italy, and Luxembourg social transfers in kind exhibit a minor lag, as opposed the rest of the EMU economies suggesting that in these economies spending on social transfers in kind follow their cycle with a lag.

The cross correlation between domestic and EMU cyclical output (Fig. 7) can be interpreted as the degree of synchronization of the various EMU economies with the EMU aggregate cycle. The results suggest that all countries are synchronized with the EMU cycle except for the economies of Germany and Greece. In fact, the economy of Germany exhibits a negative correlation with EMU cycle with a lead of three (3) years, suggesting that the German cycle is countercyclical to the EMU cycle and vice versa, giving credit to the view of Artis and Zhang (1997, 1999) that Germany could act as a dominant economy within the EMU. On the other hand, Greece exhibits a positive correlation with EMU aggregate, suggesting that it was hit by the EMU cycle with a lag of approximately one (1) year.

Capital government expenditures in the economies of Netherlands and Finland are positively correlated with their GDP cycle (Fig. 8) as opposed to the rest of the economies. This suggests that for these two economies, capital government expenditures are destabilizing the aggregate economic activity. Moreover, in the economies of the Netherlands, Luxembourg, Greece, Finland and Austria, government capital expenditures follow their GDP cycle with a minor lag, while the opposite holds true for the rest of the economies with the exception of Germany, where both variables are synchronized.

**Table 6** Cross-equation correlations between the error terms of each equation

| | SB | ST | DT |
|---|---|---|---|
| SB | 1.00 | | |
| ST | 0.40 | 1.00 | |
| DT | −0.05 | 0.18 | 1.00 |

**Table 7** Toda-Yamamoto test for causality

| Hypothesis tested | $X^2$ | d.f | *p*-value |
|---|---|---|---|
| SB *does not cause* GDP cycle | 2.24 | 2 | 0.33 |
| ST *does not cause* GDP cycle | 5.79 | 2 | 0.05 |
| U *does not cause* GDP cycle | 0.65 | 2 | 0.72 |
| CE *does not cause* GDP cycle | 5.88 | 2 | 0.05 |
| GD *does not cause* GDP cycle | 8.77 | 2 | 0.01 |
| EMUGDPcycle *does not cause* GDP cycle | 0.31 | 2 | 0.85 |
| DT *does not cause* GDP cycle | 5.62 | 2 | 0.06 |
| IT *does not cause* GDP cycle | 1.96 | 2 | 0.37 |

Direct taxes are countercyclical to GDP cycle (Fig. 9) for the economy of Germany, suggesting that they have a stabilizing effect, while the opposite holds for almost all the rest of the EU economies. This, in turn could be attributed to the efficiency of their taxation system and the taxation policies that have been implemented throughout the last decades. Additionally, direct taxes in the economies of Portugal, Ireland, Finland and Austria exhibit a minor lag compared to their GDP cycle suggesting that their overall taxation system is dependent on the phase of their economy, in contrast to the rest of the EMU countries.

Again, an interesting result is that Germany is the only economy where indirect taxes (Fig. 10) have a stabilizing effect, while in the rest of the EMU economies indirect taxes tend to destabilize them. This interesting finding could be attributed to the fact that Germany is the larger exporter within EMU and, thus, its economic gains from indirect taxes lead to an increase of the economy's overall current account balance and thus to a stabilization effect. On the other hand, indirect taxes in the economies of Austria, Belgium, Ireland, Luxembourg and Spain follow the cyclical movement of their economy, as opposed to the rest of the countries, suggesting that for these economies indirect taxes are considered to be an active tool for fiscal policy implementation.

We continue our investigation with the estimation of different models using Dynamic Panel Analysis (Table 4). We can see that in Model 1, using dynamic panel G.M.M., most of the variables are significant, while the model is able to capture a large part of the variance of the GDP cycle. The Social Benefits and Gross Debt are countercyclical and highly significant. Meanwhile, direct taxation, social transfers in

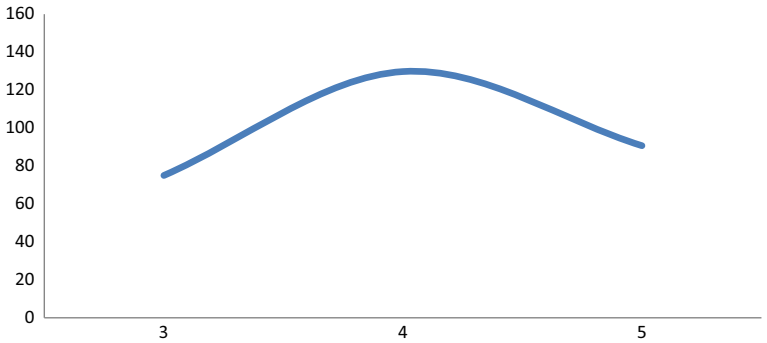



**Fig. 3** Optimum number of clusters (Calinski-Harabasz criterion)

**Table 8** Clusters

| Clusters | | | | |
|---|---|---|---|---|
| Economies | 1 | 2 | 3 | 4 |
| Austria | | | | ✓ |
| Belgium | | | | ✓ |
| Finland | | | | ✓ |
| France | | | ✓ | |
| Denmark | | | | ✓ |
| Germany | | ✓ | | |
| Greece | | | | ✓ |
| Ireland | | | | ✓ |
| Italy | | ✓ | | |
| Luxemburg | | | | ✓ |
| Netherlands | | | | ✓ |
| Portugal | | | | ✓ |
| Spain | | | | ✓ |
| Sweden | | | | ✓ |
| United Kingdom | ✓ | | | |

kind and EMU GDP cycle are found to be highly pro-cyclical and significant. The fact that Gross Debt was found to be significant and counter cyclical to GDP's cycle, could be attributed to the fact that Debt accumulation leads to credit barriers and thus to a direct influence on each economy's GDP, which is partly in line with the work of Aloui (2013), and with the fact that debt accumulation is supposed to stabilize the economy in the presence of financial integration (see, *inter alia,* Furceri and Zdzienicka 2011).

On the other hand, aggregate EMU cycle was found to be significant and pro-cyclical to GDP cycles, a finding, which could be attributed to the financial integration and trade relationship between the various EMU economies. Lastly, the significant effect of lagged GDP, that is pro-cyclical to the GDP cycle, could be attributed to the fact that the fiscal policies within EMU are implemented with respect to the overall past performance of each economy, in an attempt to be in line with the Maastricht treaty. These results are fully consistent with the ones based on dynamic panel O.L.S., since both the statistical significance of the variables as well as their respective signs and magnitudes remain, practically, unaffected.

The results of Model 2, using dynamic panel GMM, suggest that both Direct and Indirect taxation, as well as EMU cycle and Social Transfers in kind, are the main statistically significant pro-cyclical variables, while Social Benefits and Unemployment and Gross Debt were found to have a counter-cyclical character. The fact that Gross Debt and Social Benefits were not found to be statistically significant for GDP cycle can be attributed to the normalization of our model, meaning that the ratio of Debt over GDP is unable to explain the volatility of GDP, which is largely consistent with the findings of Aizenman et al. (2013).

Meanwhile, the pro-cyclical character of Social Transfers could be attributed, at least partly, to a direct effect on consumption of the groups taking part to the transfers. Now, regarding the variable of unemployment that has become statistically significant and counter-cyclical to the GDP cycle, suggests that unemployment could serve as a stabilizing

mechanism for GDP cycles, mainly due to its inverse relationship with the profiteering functioning of the economy. In another formulation, the unemployment rate is countercyclical in the sense that it is lower when the economies' health is good and higher when the economies' health is bad. These findings are fully consistent with the ones based on dynamic panel O.L.S., with the exception of Indirect Taxation, which is, now, found insignificant. In addition, the stability of our estimates regarding both the Dynamic Panel OLS and the Arellano-Bond GMM estimations are confirmed via the rolling window analysis for both models (Figs. 1 and 2) since all coefficients appear to be constant over time.

Next, turning to political business cycles (Tables 5 and 6) and the impact of elections and institutional quality on the key fiscal variables of our analysis (i.e., social benefits, social transfers and direct taxes), we found that the quality of institutions has a positive effect on all the variables which implies that a better quality of institutions leads, in the short-run, to better economic conditions and to the fact that more effective spending leads to an increase of spending towards a more fair society. Also, by considering the fact that Direct Taxes and Social Transfers are pro-cyclical we can infer that the Quality of Institutions has an indirect pro-cyclical character.

On the other hand, elections have a statistically significant impact on the key fiscal variables of our analysis. In particular, elections have a positive impact upon social benefits in an attempt of the governing party to enhance its chances of being re-elected. Nevertheless, elections have a negative effect on both social transfers and direct taxation. The positive relationship between elections and social transfers could be attributed to the reasons already mentioned with regard to social benefits. Thus, an increase of social benefits should be accompanied by an increase of social transfers, given that the total amount of government expenditures is growing before the elections, which is consistent with the same sign of elections between the variables of social benefits and social transfers in kind. Our finding is fully consistent, with the results of Potrafke (2012). Finally, as far as the effect of elections to direct taxation is concerned, the negative relationship could be attributed to the pro-electoral cycle that dictates a slight decrease of taxation as a means of enhancing the probabilities of re-election for the government party, irrespective of their political identity (e.g., Katsimi and Sarantides 2011; Efthyvoulou 2011, 2012). Now, by taking into consideration the procyclical character of Dirtect taxes and Social Transfers as well as their negative relationship with election we can infer that election have an indirect counter cyclical character.

In brief, our results regarding Elections and the Quality of Institutions, which are indirectly related to fiscal policy in the political business cycles' literature, are in line with the works - among others - by Nordhaus (1975), Rogoff and Sibert (1988), Rogoff (1990), Persson and Tabellini (1990) and Potrafke (2012), Abbott and Jones (2013), Mechtel and Potrafke (2013), De Haan et *al.* (2013). Thus, these variables could be used in a policy framework in order to manipulate business cycles volatility and synchronization in the EMU.

Turning to the causality results of Toda-Yamamoto (Table 7) we observe that Gross Debt, Social Transfers, Direct Taxation and Government Capital Expenditures are the variables that are, in principal, able to dictate the evolution of GDP cycles. Now, due to the fact that all the aforementioned variables are related to the Current Account Balance of each economy, and thus to the Maastricht stability treaty, we conclude that the treaty is able to capture the essence of business cycles by influencing the main factors that affect business cycles volatility, and thus the overall stability of each economy.

Combining the causality results with our Panel analysis results it is evident that Gross Debt is the main counter-cyclical fiscal variable which has to be used as an active fiscal policy instrument for the overall economy stabilization, while Social Transfers is the fiscal variable whose usage as a fiscal policy tool could result in the economy's destabilization.

Next, an interesting empirical finding is the distinction in core and periphery counties in EU, a finding which is reported in the majority of studies in the relevant literature. Among others, the existence of a core of countries with similar characteristics has been documented by Bayoumi and Eichengreen (1993), Dickerson et *al.* (1998), Artis and Zhang (1998a, 1998b), Crowley and Christi (2003), Massmann and Mitchell (2004), Camacho et *al.* (2006) and Concaria and Soares (2009). See also Canzoneri et al. (1996), Bayoumi and Eichengreen (1997a, 1997b) and Taylor (1995).

More precisely, according to the results of the cluster analysis performed, there exist four (4) clusters (Table 8). The first cluster consists of the economy of United Kingdom. This result could be attributed to the fact that UK is one of the largest and strongest economies in E.U., which does not belong to the common currency area. Our finding is partly consistent with the work of Kishor (2012) who studied the response of monetary policy of selected EMU countries and found that England's Central Bank was the least responsive to external shocks.

The second cluster consists of the economy of France, which is among the largest economies in the EU. Once again, the fact that France stands alone could be attributed to its dominant position within the EU, but also to its opposing policies implemented by the other two EU dominant economies, namely Germany and the UK.

In the third cluster lie together the economies of Italy and Germany. This finding should be attributed to the fact that the cycles of the two countries are synchronized through their bilateral trade activity, since Italy has the largest debt in EMU, while Germany is the largest exporter in EMU. Our analysis seems to suggest that the two economies have closely related cycles, since Italy acts as the principal (15 %) importer of German products (E.C.B. 2012), which is largely consistent with the findings of Dees and Zorell (2012).

The rest of the countries lie in the fourth cluster, the so-called "periphery", probably due to their size that is relatively small compared to the rest of the economies (Gouveia and Correia 2008), or due to the fact that the fiscal policies implemented in these economies are unable to counter-effect the monetary policies implemented by the E.C.B., at an aggregate level.

The results show that there is a core – periphery distinction in the EMU, although the core consists of three main clusters, i.e., (i) France, (ii) UK and (iii) Italy-Germany. The periphery countries tend to group together, probably as a result of the recent European crisis. This pattern does not conform to a conventional division and shows that the definition of the so-called core-periphery is more involved. In the light of recent developments after the sub-prime crisis it seems, however, that this view has indeed considerable merit. The recent economic crisis hit the various economies in different ways. First, it brought to the foreground the differing Anglo-Franco-German views on the future of the Eurozone. Second, it emphasized the different patterns of reaction to debt-related problems in Greece, Spain, Portugal and Italy. We could say that the clustering results reflect the different business cycles dynamics that each EU economy exhibits based on its size. In other words, our results conform more to a separation of

"big and small" rather than that of a "core and a periphery", in the traditional sense of the term. Therefore, the clustering approach reflects various factors which operate simultaneously and are largely consistent with what we know after the sub-prime crisis.

Summing up, the large and dominant economies of Germany, France and United Kingdom constitute the main clusters of the core of EMU. Meanwhile, most of the periphery countries lie in one cluster suggesting that the ongoing crisis has led a number of smaller economies to cluster together.

## 6 Conclusion

The purpose of this paper was threefold. First, it tried to answer some fundamental economic questions regarding the fiscal determinants of business cycles in the EU (1996–2013). Second, it acknowledged the significant role of Political Business Cycles by investigating their (indirect) role on the business cycle in the EU. Third, it made an attempt to shed light on the dynamics of the EU economy by using cluster analysis.

In brief, it is the first paper in the literature -to the best of our knowledge- that directly related Political Business Cycles (PBC) with key fiscal determinants of business cycles in the EU. It also investigated the role of key fiscal determinants of business cycles in the EU by decomposing the variable of government spending into capital expenditures, social transfers and social benefits. In this context, government revenues were divided into direct and indirect taxes. Furthermore, it identified the formation of clusters in the EU based on individual countries' business cycles. In this framework, it made use of a wide dataset in quarterly format referring to the time period 1996–2013, fully capturing the recent recession. Lastly, it provided a robust and consistent econometric framework based on a number of advanced techniques (such as Dynamic Panel Data Analysis, Panel SUR, Toda-Yamamoto Causality and *k*-means Clustering) in order to tackle the research question.

The results suggest that all EU economies share similar short-term and mid-term cycles of approximately 2 and 6–8 years, respectively. Cross-correlation results between the cyclical variable of GDP and the rest of the fiscal variables suggest that the dynamics of the German economy differ significantly, compared to the rest of the EMU countries. Furthermore, Social benefits, Social Transfers and Gross Debt were found to be the most significant counter-cyclical fiscal variables, while taxation - both direct and indirect - is the major pro-cyclical variables. This result is also consistent with the use of the Toda-Yamamoto causality test. In addition, elections and institutions seem to directly affect the key fiscal variables of our model, suggesting that manipulation of fiscal determinants is possible through political variables. In fact, both Quality of institutions and Elections seem to have an indirect pro-cyclical effect on EU business cycles. Lastly, the results of cluster analysis suggest the existence of three major core clusters including four major EU economies, while the recent crisis has led a number of small(er) economies to cluster together.

Future work on business cycles determinants, using both fiscal and monetary variables in an attempt to explain business cycles volatility, would be of great importance. In addition, controlling for EMU formation as well as for openness and corruption in a political business framework would also be an interesting path for future investigation.

## Appendix

**Table 9** Data and variables

| Variable | Description | Source | Time period |
|---|---|---|---|
| GDP | Gross Domestic Product out of which the cyclical component is extracted; | OECD, constant 2005 prices in € billions. | 1996(Q1)-2013(Q4) |
| CE | Capital expenditures | | |
| SB | Social benefits other than transfers in kind, a variable which includes on the one hand social benefits paid in cash to households by social security funds which are provided under social security schemes e.g., pensions and unemployment benefits and, on the other hand, social assistance benefits in cash payable to households by government units outside a social insurance scheme incorporating social contributions e.g., as living allowances paid by municipalities, child maintenance, etc. | | |
| ST | Social transfers in kind, a variable which consists of individual goods and services provided as transfers in kind to individual households by government units and non-profit institutions serving households (NPISHs), whether purchased on the market or produced as non-market output by government units or NPISHs | | |
| DT | Direct Taxes refer to revenues for the general government collected by individuals and enterprises | | |
| IT | Indirect Taxes refer to revenues for the general government, e.g., consumption tax | | |
| U | Unemployment is expressed as percentage (%) of labour force | | |
| GDPcycle | Cyclical component of GDP, de-trended by means of the HP filter | | |
| EMUGDPcycle | Cyclical component of the aggregate EMU GDP, extracted by means of the HP filter from aggregate EMU GDP | | |
| *IQ index* | Institutional Quality index refers to the key variables that dictate per capita economic growth to OECD countries. | CESIFO, index as percentage % | |
| *Elections* | Elections refers to a dummy variable that accounts for elections in each EMU country, taking the value of 1 in a year that elections took place and 0 elsewhere | World Data Bank | |

**Table 10** LLC Stationarity test (original & first differenced variables)

| Variable | t-stat(adjusted) | *p*-value | Stationarity |
|---|---|---|---|
| GDP | −5.43 | 0.00 | Yes |
| SB | 3.67 | 0.99 | No |
| Δ(SB) | −4.48 | 0.00 | Yes |
| ST | 0.98 | 0.83 | No |
| Δ(ST) | −0.12 | 0.00 | Yes |
| GD | −1.94 | 0.03 | Yes |
| UN | −5.26 | 0.00 | Yes |
| IT | −2.98 | 0.00 | Yes |
| DT | −4.64 | 0.00 | Yes |
| GDPcycle | −7.63 | 0.00 | Yes |
| GDPEMUcycle | −8.47 | 0.00 | Yes |
| Where Δ is the first difference operator | | | |

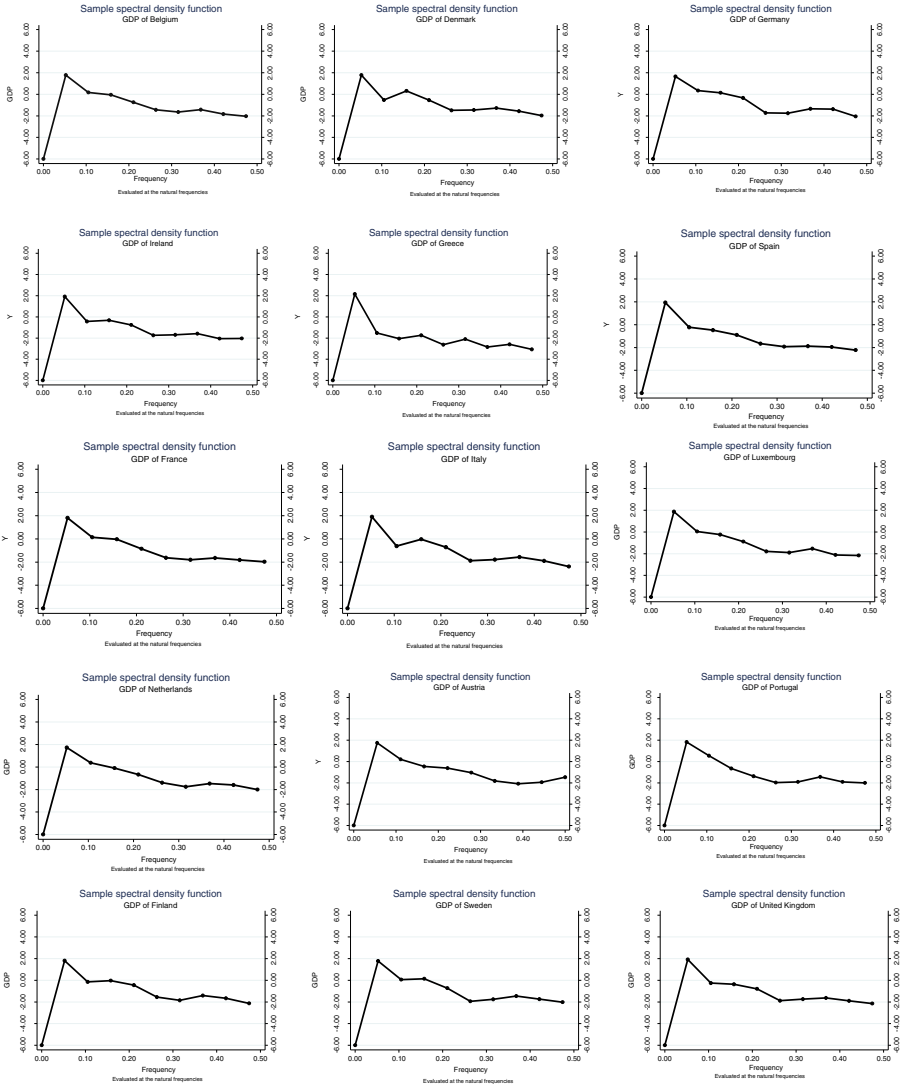



**Fig. 4** Periodograms of GDP

GDP cycle-Social Benefits

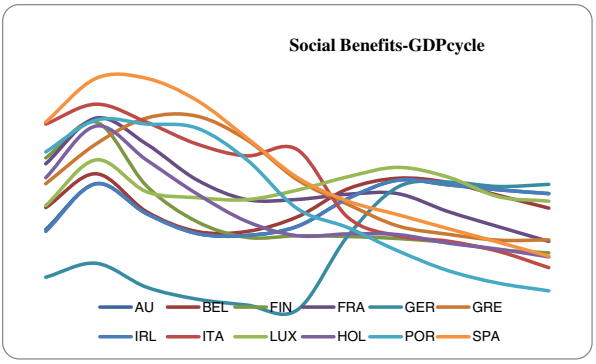



**Fig. 5** GDP cycle-social benefits

GDP cycle-Social Transfers in Kind

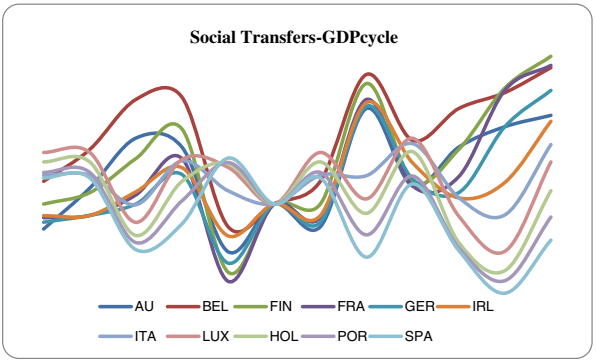



**Fig. 6** GDP cycle-social transfers in kind

GDP cycle-Aggregate EMU cycle

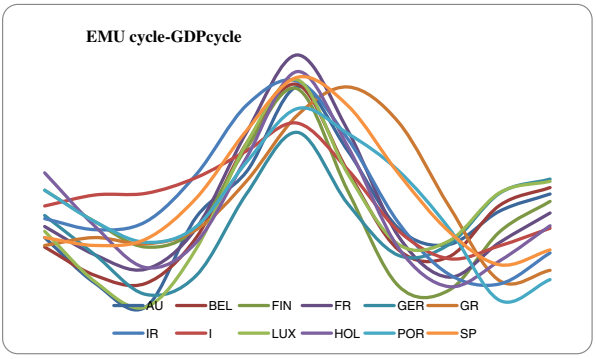



**Fig. 7** GDP cycle- aggregate EMU cycle

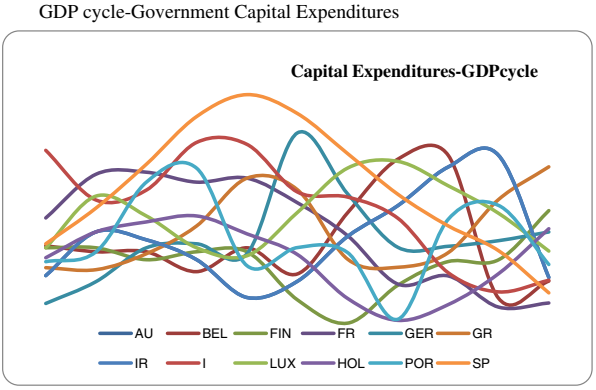



**Fig. 8** GDP cycle-government capital expenditures

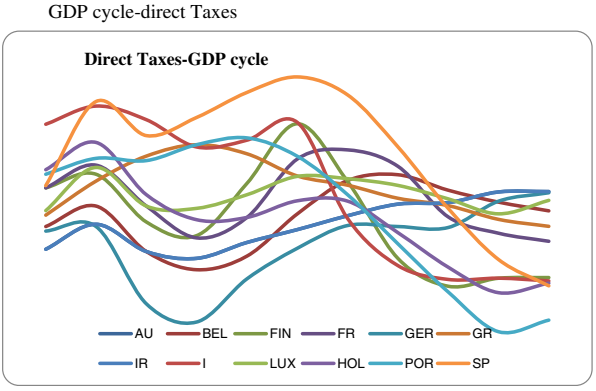



**Fig. 9** GDP cycle - direct taxes

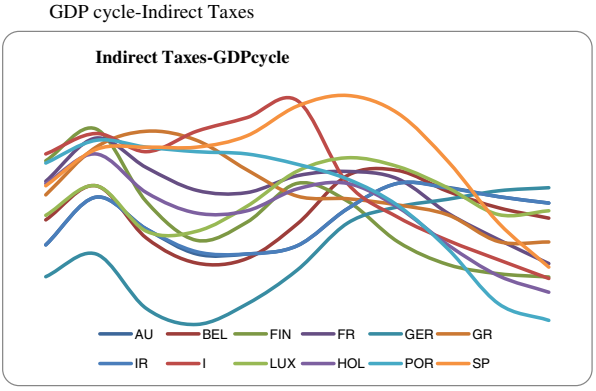



**Fig. 10** GDP cycle-indirect taxes

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## References

Abbott A, Jones P (2013) Procyclical government spending: a public choice analysis. Public Choice 154:243–258

Acemoglu D, Robinson J, Thaicharoen Y (2003) Institutional causes, macroeconomic symptoms: volatility, crises and growth. J Monet Econ 50(1):49–123

Aidt TS, Veiga FS (2011) Election results and oppotunistic policices: a new test of the rational political business cycles model. Public Choice 148:21–44

Aizenman J, Jinjarak Y, Park D (2013) Capital flows and economic growth in the Era of financial integration and crisis 1990–2010. Open Econ Rev 24:371–396

Alegre GJ (2012) An evaluation of EU regional policy. Do structural actions crowd out public spending? Public Choice 151:1–21

Ales L, Maziero P, Yared P (2014) A theory of political and economic cycles. J Econ Theory 153(C):224–251

Alesina A, Campante F, Tabellini G (2008) Why is fiscal policy often procyclical? J Eur Econ Assoc 6(5): 1006–1036

Aloui R (2013) Deep habbits and the macoreconomic effects of government debt. J Macroecon Dynam 17: 1659–1686

Amemiya, T (1985) Advanced econometrics. Harvard University Press

Arellano M, Bond S (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Rev Econ Stud 58(2):277–297, Wiley Blackwell

Artis M, Zhang W (1997) International business cycle and the ERM: is there a European business cycle? Int J Finance Econ 2:1–16

Artis M, Zhang W (1998) Core and periphery in EMU: a cluster analysis. EUI Working Paper RSC No. 98/37

Artis M, Zhang W (1998) Membership of EMU: A fuzzy clustering analysis of alternative criteria. EUI Working Paper RSC No. 98/52

Barlevy G (2004) The costs of business cycles under endogenous growth. Am Econ Rev 94(4):964–990

Battaglini M, Coate S (2008) A dynamic theory of public spending, taxation, and debt. Am Econ Rev 98(1): 201–236

Bayoumi T, Eichengreen B (1993) Shocking aspects of European monetary integration. In: Torres F, Giavazzi F (eds) Adjustment and growth in the European monetary union. Cambridge University Press, Cambridge

Bayoumi T, Eichengreen B (1997a) Ever closer to heaven? An optimum-currency-area index for European countries. Eur Econ Rev 41:761–770

Bayoumi T, Eichengreen B (1997b) Optimum currency areas and exchange rate volatility; theory and evidence compared. In international trade and finance: New frontiers for research. In: Cohen B (ed) Essays in Honour of Peter Kenen. Cambridge University Press, Cambridge

Bergman MU (2004) How similar are the European business cycles? Economic Policy Research Unit Working Paper series, 2004–13

Bozdogan H (1993) Choosing the number of component clusters in the mixture model using a new informational complexity criterion of the inverse Fisher information matrix. In: Opitz O, Lausen B, Klar R (eds) Information and classification. Springer, Berlin, pp 40–54

Calinski T, Harabasz J (1974) A dendrite method for cluster analysis. Commun Stat 3(1):1–27

Camacho M, Perez-Quiros G, Saiz L (2006) Are European business cycle close enough to be just one? CEPR Discussion Papers No. 4824

Canova F, Pappa E (2011) Fiscal policy, pricing frictions and monetary accommodation. Econ Policy 26(68): 555–598

Canzoneri M, Valles J, Vinals J (1996) Do exchange rates move to address international macroeconomic imbalances?", CERP Discussion Papers, No.1948

Castro V (2011) The impact of the European union fiscal rules on economic growth. J Macroecon 33(2):313–326

Coe DT, Helpman E (1995) International R&D spillovers. Eur Econ Rev 39(5):859–887
Concaria LA, Soares MJ (2009) Business cycle synchronization across the Euro area: a wavelet analysis. NIPE Working Papers
Crowley P, Christi C (2003) European Union Studies Association (EUSA), Biennial Conference, (8th), March 27–29
Crowley P, Lee J (2005) Decomposing the co-movement of the business cycle: a time-frequency analysis of growth cycles in the euro area. Bank of Finland Discussion Papers 12/2005
De Haan J, Jong-A-Pin R, Mierau JO (2013) Do budgetary institutions mitigate the common pool problem? New Empirical Evidence for the EU. Public Choice 156:423–441
Dees S, Zorell N (2012) Business cycles synchronization: disentangling trade and financial linkages. Open Econ Rev 23:623–643
Dickerson A, Gibson H, Tsakalotos E (1998) Business cycle correspondence in the European Union. Economica 25:51–77
Easterly W, Islam R, Stiglitz J (2001) Shaken and stirred: explaining growth volatility. In: Pleskovic B, Stern N (eds) Annual world bank conference on development economics
Efthyvoulou G (2011) Political cycles under external economic constraints: evidence from Cyprus. J Econ Bus 63(6):638–662
Efthyvoulou G (2012) Political budget cycles in the European Union and impact of political pressures. Public Choice 153:295–327
European Central Bank (2012) Competitiveness and external imbalances in the Euro area. ECB Occasional Paper No. 139
Fatás A, Mihov I (2003) The case for restricting fiscal policy discretion. Q J Econ 118(4):1419–1447
Frankel J, Rose A (1998) The endogeneity of the optimum currency area criteria. Econ J 108:1009–1025
Furceri D, Karras G (2007) Country size and business cycle volatility: scale really matters. J Jpn Int Econ 21(4):424–434
Furceri D, Zdzienicka A (2011) Financial integration and fiscal policy. Open Econ Rev 23:805–822
Galli J, Perotti R (2003) Fiscal policy and monetary integration in Europe. Econ Policy 18(37):533–572
Gavin M, Hausmann R (1998) Growth with equity: the volatility connection. In: Birdsall N, Graham C, Sabot RH (eds) Beyond tradeoffs: market reforms and equitable growth in Latin America. Inter-American Development Bank and the Brookings Institution, Washington, DC, pp 91–109
Giannone D, Michele L, Reichlin L (2009) Business cycles in the Euro area. CEPR Discussion Papers 7124, C.E.P.R. Discussion Papers
Giovanni J, Levchenko A (2008) Putting the parts together: trade, vertical linkages, and business cycle comovement. Working Papers 580, Research Seminar in International Economics, University of Michigan
Gouveia S, Correia L (2008) Business cycle synchronization in the Euro area: the case of small countries. IEEP 5(1):103–121
Hakura D (2009) Output volatility in emerging market and developing countries: what explains the "great moderation" of 1970-2003? Czech J Econ Financ 59(3):229–254
Hartigan JA, Wong MA (1978) Algorithm AS 136: a *K*-means clustering algorithm. Appl Stat 28:100–108
Hausman J, McFadden D (1984) Specication tests for the multinomial logit model. Econometrica 52(5):1219–1240
Kalemli-Ozcan S, Sorensen B, Yosha O (2001) Regional integration, industrial specialization and the asymmetry of shocks across regions. J Int Econ 55:107–137
Katsimi M, Sarantides V (2011) Do elections affect the composition of fiscal policy in developed, established democracies. Public Choice 151(1):325–362
Kenen PB (1969) The theory of optimum currency areas: an eclectic view. In: Mundell RA, Swoboda AK (eds) Monetary problems of the international economy. University of Chicago Press, Chicago, pp 41–60
Kishor KN (2012) A note on time variation in a forward looking monetary policy rule: evidence from European countries. J Macroecon Dynam 16:422–437
Kose A, Prasad E, Terrones M (2003) Financial integration and macroeconomic volatility. IMF Staff Pap 50(Special Issue):119–141
Kose MA, Otrok C, Prasad ES (2012) Global business cycles: convergence or decoupling. Int Econ Rev 53: 511–538
Krugman P (1991) Geography and trade. MIT Press, Cambridge
Kydland FE, Prescott EC (1990) Business cycles: real facts and a monetary myth. Fed Reserve Bank Minneap Q Rev 14:3–18
Lane P (2003) The cyclicality of fiscal policy: evidence from the OECD. J Public Econ 87(12):2661–2675

Laursen T, Mahajan S (2005) Volatility, income distribution, and poverty. In: Aizenman J, Pinto B (eds) Managing economic volatility and crises: a practitioner's guide. Cambridge University Press, New York, pp 101–136
Levin A, Lin CF, Chu C-SJ (2002) Unit root tests in panel data: asymptotic and finite sample properties. J Econ 108:1–22
Ljung G, Box GEP (1978) On a measure of lack of fit in time series models. Biometrika 65:297–303
Lucas RE, Jr (1977) Understanding business cycles. In: Karl Brunner K, Meltzer A (eds.), Stabilization of the domestic and international economy. Amsterdam: North Holland.
Magud NE (2008) On asymmetric business cycles and the effectiveness of counter-cyclical fiscal policies. J Macroecon 30(3):885–905
Malik A, Temple J (2006) The geography of output volatility. CEPR Discussion Paper 5516
Massmann M, Mitchell J (2004) Reconsidering the evidence: are Eurozone business cycles converging? J Bus Cycle Meas Anal 1:275–307
McKinnon R (1963) Optimum currency areas. Am Econ Rev 53(4):717–725
Mechtel M, Potrafke N (2013) Electoral cycles in active labour market policies. Public Choice 156:181–194
Montoya LA, De Haan J (2008) Regional business cycle synchronization in Europe? IEEP 5(1):123–137
Mundell RA (1961) A theory of optimum currency areas. Am Econ Rev 51(4):657–665
Nordhaus W (1975) The political business cycle. Rev Econ Stud 42:169–190
Pallage S, Robe M (2003) On the welfare cost of economic fluctuations in developing countries. Int Econ Rev 44(2):677–698
Persson T, Tabellini G (1990) Macroeconomic policy, credibility and politics. Harwood Academic Publishers, Chur
Pesaran MH, Schuermann T, Weiner SM (2004) Modeling regional interdependencies using a global error-correcting macro-econometric model. J Bus Econ Stat 22(2):129–162
Potrafke N (2012) Political cycles and economic performance in OECD countries: empirical evidence 1951–2006. Public Choice 150:155–179
Ramey G, Ramey V (1995) Cross-country evidence on the link between volatility and growth. Am Econ Rev 85(5):1138–1151
Ravn M, Uhlig H (2001) On adjusting the HP-filter for the frequency of observations. CESifo Working Paper Series 479, CESifo Group Munich
Razin A, Rose A (1994) Capital mobility: the impact on consumption, investment, and growth. In: Leiderman L, Razin A (eds) Capital mobility: the impact on consumption, investment, and growth. Cambridge University Press, Cambridge, pp 48–76
Rogoff K (1990) Equilibrium political budget cycles. Am Econ Rev 80:21–36
Rogoff K, Sibert A (1988) Elections and macroeconomic policy cycles. Rev Econ Stud 55:1–16
Tavlas GS (1993) The 'New' theory of optimum currency areas. World Econ 16:663–686
Taylor C (1995) EMU 2000? Prospects for European Monetary Union. Chatham House Papers. The Royal Institute of International Affairs
Timm N (2002) Applied multivariate analysis. Springer texts in statistics
Toda HY, Phillips PC (1993) Vector autoregressions and causality. Econometrica 61(6):1367–1393
Toda HY, Yamamoto (1995) Statistical inference in vector autoregressions with possibly integrated processes. J Econ 66:225–250
Trichet J (2001) The euro after two years. J Common Mark Stud 39:1–13
West K (1987) A specification test for speculative bubbles. Q J Econ 102:553–580
Wooldridge JM (2010) Econometric analysis of cross section and panel data. MIT Press, London
Zivot E, Wang J (2006) Modeling financial time series with s-plus. Springer, NY