The Business Cycle in Euro Zone Economies (1960-2009)

Abstract

This paper investigates the business cycle in Euro-zone economies, adopting different filtering methods. We detect static and long-run relationships between cyclical components of output, by using for the first, correlations, and for the second, the Autoregressive Distributed Lag (ARDL) model proposed by Pesaran, Shin and Smith (2001). The evidence indicates that there is a core group of countries whose members are strongly linked together, comprising Germany, France, Belgium, the Netherlands and Austria. The results also imply that the German cycle is strongly linked with the Greek and Irish cycles; that the Spanish cycle is strongly linked with the French and Italian cycles; and that the Belgian cycle is strongly linked with the Finnish cycle.

1. Introduction

In this paper, we investigate business cycle relationships between countries within the European Union, particularly those in the Euro-zone. Studies over the last few years have reached the view that the business cycle is a purely monetary phenomenon. So it is both interesting and important to study a sample of those countries that have a common monetary policy and a single currency.

Because the Euro-zone economies have been having a hard time with recession just recently, with some of them showing an upturn, there are key questions that need answering. How has output fluctuated in the Euro-zone over the period in question? To what extent is there co-movement across countries in the Euro-zone? Are the cycles of different countries interrelated? Is there a link between cycles? Which countries form the Euro-zone ‘hard core’? And are there long-run correlations between their economies?

We attempt to answer these questions in our analysis, which consists of two main parts. In Part One, we detect relationships between cyclical components of output in a static context, by means of cross-correlations. In Part Two, we investigate long-run relationships, by means of the autoregressive distributed lag (ARDL) approach recommended by Pesaran and Shin (1999) and Pesaran, Shin and Smith (2001). We use quarterly data supplied by the OECD for the period 1960:1-2009:2 in respect of the following Euro Zone countries: France, Italy, Spain, Netherlands, Greece, Belgium, Portugal, Austria, Finland, Ireland and Luxembourg. We extract the cyclical component of the time series of variables by means of a number of different filters. All series, have been transformed into logarithms before being filtered.

Various authors have tried to investigate the business cycles in the European Union using different methodologies. Artis and Zhang (1997, 1999) examined whether the correlation between the business cycles in ERM countries and the cycle in Germany has increased since the formation of the ERM. Their results show that the cycles in the ERM countries are synchronizing more and more with the German cycle, suggestive of a 'European business cycle'. Lumsdaise and Prasad (2003), relying on results from seventeen OECD countries, find that especially after 1973, there is a clear European business cycle. Artis, Marcellino and Proietti (2004), too, find evidence of a distinct European business cycles, applying Markov Switching VAR models. Contrary to the above mentioned results Dickerson, Gibson and Tsakalotos (1998) find no evidence that the business cycles in the EU 12 have shown more correspondence since ERM. They suggest the existence of a commonality in the business cycles for the core countries which is not shared by the 12 EU members as a whole. Canova, Ciccarelli and Ortega (2007) identify a world cycle but demonstrate that, apart from an increase in synchronicity in the late 1990s, the evidence for a distinct European business cycle is weak. Finally, Wynne and Koo (2000) show that the cross-correlation between the business cycles of twelve US Federal Reserve districts is much higher than the cross-correlation of the business cycles of the 15 EU countries.

The paper is organized as follows. Section 2 reports evidence from static analysis. Section 3 presents econometric methods based on dynamic analysis, and illustrates their findings. The conclusions are presented in Section 5.

2. Static Analysis

2.1 Measuring Business Cycle

We begin our analysis by examining business cycle relationships between countries. Our methodology resembles that of Kydland and Prescott (1990).

Our statistical tool here is cross-correlation between cyclical components of time series derived by means of various different filters. We estimate co-movements between cyclical components of output by the magnitude of the correlation coefficient $\rho(j)$, for $j=0$. Depending on whether this coefficient is positive, zero or negative, we refer to the series as procyclical, acyclical, or countercyclical respectively. We denote degree of correlation by the adverbs "strongly" ($0.5 \le |\rho(0)| \le 1$) and "weakly" ($0.14 \le |\rho(0)| \le 0.5$); alternatively, a series may be contemporaneously uncorrelated ($0.0 \le |\rho(0)| \le 0.14$). The cutoff point 0.14 has been chosen because in our samples it corresponds to the value required to reject, at the 5% level of significance, the null hypothesis that the population correlation coefficient is zero in a two-sided test for bivariate normal random variables.

2.2 Removing Trends and Isolating Cycles - Filtering Methods

Before we can investigate business cycles in the Euro-zone, we must first remove trends and isolate the cycles. Isolation of cycles and removal of trends are interrelated concepts[1]. The main goal of detrending (methods) intended as the process of making examined series (covariance) stationary. There

[1] Indeed, for a time series obtain cyclical component/information by eliminating the permanent component (the trend). However, even after the separation of trend from cycle is accomplished, additional steps may be necessary to isolate cycles by frequency of their recurrence (Delong and Dave, 2007).

are three main filters for removing a trend from a time series; they spring from the definition of the business cycle given by Lucas (1977).

The first two approaches to trend removal are detrending and differencing.

The Nature of the Trend

For Nelson and Plosser (1982), a trend may be either deterministic or stochastic. An example of a deterministic trend is: $x_t = \alpha + bt + \varepsilon_t$ (1) a series where there are the parameters *α* and *b*, and *t* is a linear trend and ε_t is white noise [$\varepsilon_t \sim n.i.d.(0,\ \sigma_\varepsilon^2)$]. In this case, it is best to attempt linear detrending by regression. The calculated residuals are the detrended data. More generally, a time series may have a polynomial trend as $y_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + ... + a_n t^n + e_t$ where $\{e_t\}$ = a stationary process. Detrending is accomplished by regressing $\{y_t\}$ on a deterministic polynomial time trend. Our study assumes a quadratic polynomial function of time.

Linear detrending cannot be used if a trend is stochastic. An example of a series with stochastic trend is the random walk process with a drift: $x_t = \alpha_0 + x_{t-1} + \varepsilon_t$ where ε_t there is white noise [$\varepsilon_t \sim n.i.d.(0,\ \sigma_\varepsilon^2)$]. Recursive substitution yields $x_t = x_0 + \alpha_0 t + \sum_{i=0}^{t-1} \varepsilon_{t-i}$

We observe that the series contains both a linear deterministic trend $\alpha_0 t$ and a stochastic trend $\sum_{i=0}^{t-1} \varepsilon_{t-i}$. Let us begin by differencing: $\Delta x_t = x_t - x_{t-1} = (1 - L)x_t = \alpha_0 + \varepsilon_t$. Clearly, the $\{\Delta y_t\}$ sequence is stationary. Our random walk is I(1)[2].

The third standard approach[3] to decomposing a series into a trend (permanent component) and a stationary component (cyclical) is the one developed by Hodrick and Prescott (1984). Suppose now that

[2] An attractive property of an I(1) is found in Beveridge and Nelson (1981) who suggest that I(1) time series are decomposed into a permanent and a temporary (cyclical) component by applying the ARIMA methods. Therefore, the cyclical component is the difference between the observed value in each period and the permanent component.

[3] A quite large number of studies have used the HP filter as a detrending method. Fiorito and Kollintzas (1994) investigated and compared the stylized facts of business cycles in the G7. Blackburn and Ravn (1992) investigated the UK business cycles. Danthine and Girardin (1989) studied Swiss data and Backus and Kehoe (1992) compared the business cycle features both across different countries and in different periods of time.

we observe the values y_1 though y_T and want to decompose the series into a trend $\{\mu_t\}$ and a stationary component $y_t - \mu_t$. Consider the sum of the squares

$$\frac{1}{T}\sum_{t=1}^{T}(y_t - \mu_t)^2 + \frac{\lambda}{T}\sum_{t=2}^{T-1}[(\mu_{t+1} - \mu_t) - (\mu_t - \mu_{t-1})]^2$$

where λ is a constant and T is the number of usable observations.

The problem is to select a sequence $\{\mu_t\}$ that will minimize this sum of the squares. In the minimization problem, λ is an arbitrary constant reflecting the "cost" or penalty of incorporating fluctuations into the trend. Ravn and Uhlig (2002) finally defined the filter parameters as λ=1600: this must be adjusted, by multiplying it by the fourth power of the observation frequency ratios. Furthermore, the "penalty parameter" was set by Hodrick and Prescott (1997) as *λ=1600* for the US quarterly data. Kydland and Prescott (1990) proposed the same value choice as a "reasonable" choice[4] for quarterly data, noting that

"[w]ith this value, the implied trend path for the logarithm of real GND is close to the one that students of the business cycle and growth would draw through a time plot of the series."

We shall here adopt this value, as most recent studies have done.

The biggest advantage of the Hodrick and Prescott filter is that it can extract the same trend from all time series; many real business cycle models do indicate that all variables will have the same stochastic trend. However, their filter has been subject to severe criticism. Harvey and Jaeger (1993) showed that its use can generate arbitrary cycles; while Cogley and Nason (1995) proved that it can lead to business cycle periodicity, even if none is present in the original data.

d) The Baxter-King Filter.

Another standard way of extracting the business cycle component of a macroeconomic time series is the Baxter-King Filter (1999)[5]. For Baxter and King[6], the "ideal" detrending method meets six

[4] In the sense that the implied cyclical component largely agrees with "conventional wisdom" about the US business cycle.

[5] This filter has been used in several studies. The most important among them are: this of Stock and Watson (1999a), who used this filter in order to characterize the cyclical examined the stylized facts about the business cycle of the

requirements: 1) the filter must extract a specified range of periodicities, leaving the properties of the extracted component unaffected; 2) the band-pass filter must not introduce phase shift, and the filter must not change the timing of the turning points in the series under analysis; 3) the filter must be an optimal approximation to the "ideal" filter; 4) the filter must have trend-reducing properties; 5) the filter must yield business cycle components unrelated to the length of the sample period; 6) the method itself must be operational.

This removes low-frequency trend variation and smooth high-frequency irregular variation, while retaining the major features of business cycles.

The purpose of an ideal band pass filter is to isolate the components of a time series that lie within a given range of frequencies. Economic theory can help to define these frequencies. In particular, since what we are interested in is how to extract the periodic components of an economic time series associable with the business cycle, the bands can be chosen to match prior notions of the duration of the business cycle.

Burns and Mitchell (1946) found that business cycles in the United States lasted a minimum of 17 months and a maximum of 101 months, when measured peak to peak, or a minimum of 29 months and a maximum of 99 months, when measured though to though. Many studies have followed this range of frequencies, which we adopt in our own study. We also permit the upper bound on the length of the business cycle to exceed 32 quarters and to be 40 quarters. The reason for this is that it has been observed that economic cycles in the Euro-zone seem to last more than eight years. Given that there have been three recessions in the Euro-zone over the last thirty years, it is, we think, advisable to include 10-year frequencies as well in the cyclical components.

We have also adopted Baxter and King (1999)'s approximation, setting the length of the moving average to 12 quarters. So as to widen the extent of the sample as much as possible, we permit 8 quarters as the length of the moving average.

When comparing the HP filter and the BK filter we should note that, although high-frequency noise is not actually amplified by the HP filter, much of it still get past outside the business cycle frequency

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Euro Area and how these compared to the U.S. and the individual countries forming the Euro Area, this of Benetti (2001), who argued that this filter was the most adequate for the analysis of stylized facts and finally this of Massmann and Mitchell (2004), who examined the relationship between the business cycles of the 12 euro area countries.

[6] They adopted the NBER definition of the business cycle, that is, "classical" business cycles.

band. This problem can be resolved by using the BK filter, though this also has a drawback, that it tends to underestimate the cyclical component.

2.3 The Findings of Static Analysis

Table I shows contemporaneous correlation coefficients of the cyclical components for each pair of countries, using different filters.

A glance is enough to show that business cycles in Euro-zone economies are interconnected. There is positive correlation between cycles, as confirmed by all filters. The extent of positive correlation in our sample, however, varies.

The countries fall into two groups. In Group One, the cycle of each member correlates strongly with the cycles of other countries in the group. We have detected three sub-groups within this first group: 1) Germany, France, Netherlands, Belgium, Austria and Luxembourg; 2) France, Belgium, Spain (where we must make an exception for BP-detrended data) and Italy; and 3) France, Belgium and Finland.

In Group Two, each cycle correlates weakly with, or is wholly uncorrelated with, the cycles of the other countries. Here again we have detected three subgroups: 1) Greece, Portugal, Netherlands, Finland and Spain; 2) Ireland, Italy, Greece and Luxembourg; and 3) Greece, Ireland and Finland.

To get down to details, when we look at cyclical behaviour in each country separately, we observe that in Germany the cyclical component of output behaves procyclically by comparison with the cyclical components of output in all the other countries.

The cycles of Germany correlate strongly with those of Austria, Netherlands and Belgium, as we said earlier. Moreover, the cycles in Germany and Austria behave highly procyclically: an index of this is that the contemporaneous correlation coefficient is as high as 0.70. But the correlation between Germany and Finland, and Germany and Ireland, is only weakly positive.

In France, output behaves procyclically in comparison to output in all countries. The contemporaneous correlation coefficient of France is higher in respect of Italy, Belgium, Austria and Luxembourg.

The output of Italy moves along in the same direction as most other countries. The cycles of Italy have a strong positive correlation with those of Spain, France and Belgium, and a weak correlation with those of Greece, Finland and Ireland.

The contemporaneous correlation coefficient of the Netherlands is relatively low in respect of Portugal and Spain, whereas the strongest correlation of the Belgian business cycle in Belgium is with the business cycle in Netherlands, Austria, Portugal and Luxembourg.

It is noticeable that the behaviour of Greece, Ireland and Finland seems weakly correlated with, or uncorrelated with, the majority of the Euro-zone countries.

The Greek cycles fail to correlate with these of Italy, Ireland and Spain, and cycle correlation with other countries is only weakly positive. There is one exception: the German cycle and the Greek cycle appear to have fairly strong links.

The "worst" behaviour in respect of cycle correlation is Ireland's. Lastly, Finland's cyclical components of output show the weakest (lowest) correlation with a majority of countries, the French cycle excepted.

3. Dynamic Analysis

3.1 ARDL bounds testing procedure

Two major time series techniques have been developed for testing for long-run equilibrium relationships between variables: by *Johansen (1988)* and by *Pesaran, Shin and Smith (2001)*[7]. In our paper, we shall adopt the second of these.

Pesaran et al. (2001) develop a technique to test for the existence of a long-run relationship between variables irrespective of whether these are *I(1)* or *I(0)*. Their approach is essentially to estimate an unconstrained dynamic error correction representation for the variables involved and then test whether or not the lagged levels of the variables are significant. In other words, Pesaran et al (2001)'s test consists of estimating the following conditional error correction model (ECM):

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \varphi_i x_{it-1} + \sum_{i=1}^{m} \theta_i \Delta y_{t-i} + \sum_{j=1}^{m} \sum_{i=1}^{p} \omega_{ij} \Delta x_{it-j} + \varepsilon_t \qquad (1)$$

where y_t, x_{it} stand for the business cycles of Eurozone countries, $p+1$ is the number of these countries, and *m* is the number of lags (in this case, 4).

[7] We should note that the Perasan method uses a single reduced form equation in contrast with the Johansen method, where for the investigation of long-run equilibrium relationship it uses a system of equations.

The procedure is an F-test for the joint significance of the coefficients of the lagged variables levels in (1) (so that H_0: $\gamma = \varphi_i = 0$, for all $i = 1,2,....p$). Two asymptotic critical value bounds provide a test for co-integration when the independent variables are $I(d)$ (where $0 \le d \le 1$): a lower value assuming the regressors are $I(0)$, and an upper value assuming purely $I(1)$ regressors. If the test statistics exceed their upper critical values in each case, we can reject the null hypothesis, namely that there is no long-run relationship. If the test statistics fall below the lower critical values, the null hypothesis should be accepted. If the statistics lie within their bounds in each case, no firm conclusion can be drawn.

The next step is to calculate long-run parameters of variables (α_0, β_{ji} and α_i), making an estimate by OLS on the unrestrained ADL model:

$$y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i y_{t-i} + \sum_{j=1}^{p} \sum_{i=0}^{n} \beta_{ji} x_{jt-i} + \varepsilon_t \qquad (2)$$

where $\varepsilon_t \sim IID(0, \sigma^2)$.

The long-run values for coefficients can be calculated using:

$$\alpha_0^* = \frac{\hat{\alpha}_0}{1 - \hat{\alpha}_1 - \hat{\alpha}_2 - .... - \hat{\alpha}_m}, \qquad \beta_{ji}^* = \frac{\hat{\beta}_{j0} + \hat{\beta}_{j1} + ... + \hat{\beta}_{jn}}{1 - \hat{\alpha}_1 - \hat{\alpha}_2 - .... - \hat{\alpha}_m}$$

3.2 The Findings of the Dynamic Analysis

We shall now apply the econometric methods recommended by Pesaran, Shin and Smith (2001) to test for the existence or the non-existence of long-run correlations between countries' output cycles. The next step will be to estimate long-run parameters, should the hypothesis of the existence of long-run correlation be confirmed.

Since the assessment of long-term correlation depends heavily on variables' stationarity properties, we need to address the variables' order of integration with care. We shall therefore use HP-detrended data predicted to be stationary[8].

[8] The results of the augmented Dickey-Fuller test for unit roots confirm our expectations. The null hypothesis of non-stationarity of the cyclical component is rejected in every case.

We begin with a general dynamic model (1) comprising the cycles of every Eurozone economy except Luxembourg. PSS methods enable us to test for co-integration with a maximum of eleven variables only. Therefore, we have chosen to leave out the smallest country of the Eurozone.

Table II reports the results of the F-test together with the 5% critical bounds. We observe that there is evidence to support long-run correlation between the cycle of each country and the cycle of all the other ten countries. The null hypothesis (no long-run correlation) can be accepted for Spain, Finland and Italy, with four lags.

The estimated long run parameters are given in Table III. In this and the following tables, the countries in the first column are taken as a dependent variable, and the countries in the top row are taken as explanatory variables of the ADL model run in each case.

In the first of the eleven groups of the table, where the dependent variable is the cyclical component of Germany's output, we observe close positive long-run correlation between Germany and the Netherlands, and between Germany and Austria. This positive relation is also maintained, though at a less striking level, where the leader variables are the Netherlands and Austria.

The German and Finnish cycles have negative correlation, no matter whether the leader is Germany or Finland. The same negative relation can be observed between the German and Spanish cycles, and between the German and Portuguese cycles. The relationship between Germany and Ireland, and Germany and Belgium are also positive.

France has a positive relationship with a majority of countries, excepting with the Netherlands (-0.06). There is a positive long-run equilibrium correlation between the French and Portuguese cycles, which strengthens when Portugal is the leader.

In the third group, where the dependent variable is Italy, we find a positive correlation between Italy's and Belgium's cyclical components of output. The relationships between France and Spain, and between Portugal and Ireland, are also positive. The long-run equilibrium coefficient is at its highest value between the Italian and Belgian cycles, reaching 0.22.

Furthermore, we find out that there is a strong relationship between the cyclical components of output of Greece and Germany, where the long run parameters coefficient is 0.686, when leader is Greece. The same behavior is observed between Greek and French cycles. Moreover, the relation between the cyclical component of Greece and that of Portugal is positive, the value of the long run parameter is 0.41 when leader is Portugal.

Examining the seventh group, we find out that when Belgium is leader we have a positive long run relationship with the other countries, with the highest value achieved between Belgium and Netherlands.

Finally, there is also a positive long run relationship between Irish and Spanish cycle, as well as between Irish and Italian cycle.

The next step is to bring in those groups of countries in the static analysis, where members of a group have strong contemporaneous correlation, then to try to test whether the results of static analysis are confirmed in the dynamic context. Table II shows the results of the test for the existence of long-run equilibrium relationships among the countries in each group examined. All the F-values are significant, so there is evidence for long-run correlation within these groups.

Table III report the estimated long run coefficient. The results imply strong positive correlation between the French and Belgian cycles; between the German and Dutch cycles; between the German and Austrian cycles; between the Austrian and Belgian cycles; and between the Finnish and Austrian cycles when the Finland is leader.

Thus there can be observed the existence of a core or nucleus of countries closely bonded together - Germany, Belgium, Austria, France and Netherlands - and close links between one Eurozone country and specific others - France with Spain, Greece with Germany.

Summary of the Findings

The purpose of this paper has been to study the cyclical components of output for the euro area countries using static and dynamic analysis. We have found that business cycles in Eurozone countries are interconnected. The results indicate the existence of long-run relationships between cycles for the majority of the estimated group in the euro area, except for Spain, Finland and Italy with four lags. Moreover, the evidence also implies that the German cycle is strongly linked with the Greek and Irish cycles; that the Spanish cycle is strongly linked with the French and Italian cycles; and that the Belgian cycle is strongly linked with the Finnish cycle.

We conclude, finally, that there exists a core of countries closely bonded together - Germany, Belgium, Austria, France and Netherlands - and close links between one Eurozone country and specific others - France with Spain, Greece with Germany.

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Table I: Cross Correlations in output between:

		France	Italy	Spain	Netherlands	Greece	Belgium	Portugal	Austria	Finland	Ireland	Luxembourg
Germany	**HP**	0,6057	0,4122	0,3842	0,6397	0,4479	0,6398	0,4157	0,6869	0,3831	0,4113	0,6091
	BK (6, 32, 8)	0,5202	0,4697	0,4126	0,6324	0,4708	0,6234	0,4388	0,6427	0,2872	0,1218	0,5695
	BK (6, 32, 12)	0,5701	0,3811	0,3758	0,7121	0,5364	0,6451	0,4262	0,7077	0,2721	0,2711	0,6375
	BK (6, 40, 8)	0,5243	0,4678	0,4179	0,6371	0,4830	0,6320	0,44	0,6462	0,2953	0,1363	0,5808
	BK (6, 40, 12)	0,5822	0,3721	0,3709	0,7255	0,5564	0,6531	0,4274	0,7206	0,2704	0,3009	0,6515
	TQ	0,5545	0,5534	0,5624	0,7085	0,3867	0,6481	0,7351	0,6847	0,0153	0,3703	0,7404
	DS	0,4543	0,2822	0,1512	0,4758	0,2292	0,3877	0,2968	0,44171	0,2745	0,1301	0,1867
France	**HP**		0,5723	0,5593	0,5171	0,2610	0,7244	0,5752	0,6616	0,5425	0,4517	0,6381
	BK (6, 32, 8)		0,7277	0,6001	0,5152	0,2450	0,7165	0,488	0,6544	0,5032	0,1106	0,615
	BK (6, 32, 12)		0,6404	0,6779	0,5390	0,3419	0,7509	0,5986	0,7158	0,5775	0,3619	0,697
	BK (6, 40, 8)		0,7233	0,6042	0,5152	0,2542	0,7181	0,4972	0,6608	0,5109	0,124	0,6223
	BK (6, 40, 12)		0,6241	0,6920	0,5465	0,3715	0,7629	0,6251	0,7331	0,5922	0,4166	0,715
	TQ		0,8137	0,9339	0,8594	0,9097	0,9551	0,7454	0,8997	0,6535	0,645	0,2985
	DS		0,4137	0,2195	0,3455	0,1277	0,4672	0,3016	0,3605	0,1819	0,1145	0,1663
Italy	**HP**			0,5256	0,3668	0,1332	0,6077	0,4444	0,4203	0,421	0,4143	0,4295
	BK (6, 32, 8)			0,4463	0,5794	0,1166	0,6780	0,5067	0,5471	0,2699	0,3541	0,439
	BK (6, 32, 12)			0,4730	0,5180	0,1300	0,6210	0,4628	0,4113	0,3353	0,2461	0,4081
	BK (6, 40, 8)			0,4510	0,5782	0,1161	0,6780	0,5085	0,5443	0,2776	0,3674	0,4386
	BK (6, 40, 12)			0,4807	0,5103	0,1339	0,6103	0,459	0,3842	0,3512	0,3157	0,4077
	TQ			0,7653	0,7212	0,6771	0,8044	0,7093	0,736	0,5587	0,5592	0,3974
	DS			0,3253	0,1688	0,1269	0,4860	0,3607	0,3466	0,2422	0,142	0,2129
Spain	**HP**				0,2425	0,1436	0,5881	0,4667	0,4563	0,4947	0,5097	0,5671
	BK (6, 32, 8)				0,2066	0,1026	0,4874	0,2809	0,4016	0,3813	0,1925	0,5583
	BK (6, 32, 12)				0,3081	0,1872	0,5589	0,4802	0,4732	0,4113	0,3791	0,6233
	BK (6, 40, 8)				0,2096	0,1072	0,4913	0,2943	0,4062	0,3843	0,207	0,5648
	BK (6, 40, 12)				0,3276	0,1979	0,5772	0,5123	0,4873	0,4193	0,4149	0,6363
	TQ				0,8588	0,8508	0,9217	0,7177	0,8337	0,5418	0,5742	0,4016
	DS				0,1445	0,2353	0,4531	0,3942	0,176	0,239	0,1393	0,2044
Netherlands	**HP**					0,1333	0,5707	0,3061	0,5024	0,3111	0,3426	0,4696
	BK (6, 32, 8)					0,2130	0,7370	0,4032	0,6044	0,2762	0,0429	0,5245
	BK (6, 32, 12)					0,3085	0,7223	0,3371	0,6297	0,3136	0,3175	0,5641
	BK (6, 40, 8)					0,2244	0,7380	0,4043	0,6094	0,2875	0,0636	0,5316
	BK (6, 40, 12)					0,3363	0,7203	0,3322	0,6365	0,3224	0,3691	0,5755
	TQ					0,7616	0,8972	0,7936	0,8394	0,3937	0,3905	0,4505
	DS					0,0243	0,3078	0,2166	0,2331	0,2516	0,0683	0,1257
Greece	**HP**						0,2932	0,2949	0,336	0,2006	0,1676	0,28
	BK (6, 32, 8)						0,2778	0,2339	0,2437	0,0652	0,0258	0,2466
	BK (6, 32, 12)						0,3395	0,3513	0,3856	0,1256	0,1575	0,2939
	BK (6, 40, 8)						0,2887	0,2435	0,2583	0,0732	0,0342	0,2562
	BK (6, 40, 12)						0,3569	0,3761	0,4284	0,1399	0,1885	0,3129
	TQ						0,8686	0,5689	0,8158	0,6251	0,6019	0,0225
	DS						0,2145	0,229	0,1547	0,1368	0,0303	0,0746

Table I: Cross Correlations in output between:

		France	Italy	Spain	Netherlands	Greece	Belgium	Portugal	Austria	Finland	Ireland	Luxembourg
Belgium	**HP**							0,5923	0,7023	0,6147	0,4543	0,6586
	BK (6, 32, 8)							0,5357	0,6443	0,4492	0,0713	0,5811
	BK (6, 32, 12)							0,5621	0,7178	0,5696	0,2907	0,6529
	BK (6, 40, 8)							0,5426	0,6554	0,4633	0,086	0,588
	BK (6, 40, 12)							0,5758	0,7368	0,5753	0,3411	0,6691
	TQ							0,8025	0,9406	0,5827	0,6605	0,3843
	DS							0,4457	0,431	0,2774	0,2003	0,3039
Portugal	**HP**								0,5652	0,4085	0,3086	0,4556
	BK (6, 32, 8)								0,5954	0,1429	-0,021	0,3145
	BK (6, 32, 12)								0,62	0,3119	0,2593	0,4481
	BK (6, 40, 8)								0,5996	0,1524	-0,0075	0,3267
	BK (6, 40, 12)								0,6267	0,3438	0,3109	0,4734
	TQ								0,7918	0,337	0,6436	0,6106
	DS								0,2855	0,2279	0,1024	0,2138
Austria	**HP**									0,5222	0,338	0,585
	BK (6, 32, 8)									0,3924	-0,1492	0,5063
	BK (6, 32, 12)									0,4471	0,1121	0,5744
	BK (6, 40, 8)									0,4	-0,1961	0,516
	BK (6, 40, 12)									0,4623	0,172	0,5947
	TQ									0,5286	0,5901	0,393
	DS									0,2239	0,0977	0,1854
Finland	**HP**										0,4585	0,4454
	BK (6, 32, 8)										0,2276	0,3661
	BK (6, 32, 12)										0,3156	0,3927
	BK (6, 40, 8)										0,2324	0,3773
	BK (6, 40, 12)										0,3366	0,2418
	TQ										0,4401	-0,0532
	DS										0,1811	0,1532
Ireland	**HP**											0,3971
	BK (6, 32, 8)											0,1009
	BK (6, 32, 12)											0,2418
	BK (6, 40, 8)											0,0224
	BK (6, 40, 12)											0,2893
	TQ											0,15
	DS											0,1325

Source: OECD.

Note: HP: Hodrick-Prescott Filter, BK: Baxter-King Filter, DS: First Differences of logged variables,TQ: cycles are residuals from a quadratic trend.

Table II: F-statistics for testing the existence of a long-run relationship

		cyGermany	cyFrance	cyItaly	cySpain	cyNetherlands	cyGreece	cyBelgium	cyPortugal	cyAustria	cyFinland	cyIreland
cyi	Lags: 2	5,17	4,60	4,56	*3,24*	4,9	5,35	7,72	4,2	4,62	*1,83*	4,25
	Lags: 3	4,17	3,98	4,04	*2,95*	4,7	3,74	5,41	5,6	4,45	*2,64*	5,28
	Lags: 4	3,71	3,61	*2,58*	*2,88*	4,66	3,22	3,09	3,96	4,07	*3,22*	5,06

Notes: The F-statistic is used to test for the joint significance of the coefficients of the lagged levels in the ARDL-ECM. Critical value bounds for the present specification with constant, no trend, p=10 and 95 per cent level of confidence are (2.02; 3.24).

		cyFrance, cyNetherlands, cyBelgium, cyAustria, cyLuxembourg		**cyGermany, cyNetherlands, cyBelgium, cyAustria, cyLuxembourg**		**cyGermany, cyFrance, cyBelgium, cyAustria, cyLuxembourg**		**cyGermany, cyNetherlands, cyFrance, cyAustria, cyLuxembourg**		**cyGermany, cyNetherlands, cyBelgium, cyFrance, cyLuxembourg**		**cyGermany, cyNetherlands, cyBelgium, cyAustria, cyFrance**
cyGermany	Lags: 2	6,00	**cyFrance**	6,38	**cyNetherlands**	8,41	**cyBelgium**	10,34	**cyAustria**	8,95	**cyLuxembourg**	6,96
	Lags: 3	5,26		6,47		6,06		8,63		9,11		8,79
	Lags: 4	5,61		6,01		4,28		4,50		6,29		8,02

Notes: The F-statistic is used to test for the joint significance of the coefficients of the lagged levels in the ARDL-ECM. Critical value bounds for the present specification with constant, no trend, p=5 and 95 per cent level of confidence are (2.62; 3.79).

		cyItaly, cySpain, cyBelgium		**cyFrance, cySpain, cyBelgium**		**cyItaly, cyFrance, cyBelgium**		**cyItaly, cySpain, cyFrance**
cyFrance	Lags: 2	9,82	**cyItaly**	9,74	**cySpain**	6,40	**cyBelgium**	13,75
	Lags: 3	7,85		9,50		8,03		9,97
	Lags: 4	8,11		6,71		7,62		7,22

Notes: The F-statistic is used to test for the joint significance of the coefficients of the lagged levels in the ARDL-ECM. Critical value bounds for the present specification with constant, no trend, p=2 and 95 per cent level of confidence are (3.23; 4.35).

		cyFinland, cyBelgium		**cyFrance, cyFinland**		**cyFrance, cyBelgium**
cyFrance	Lags: 2	12,09	**cyBelgium**	11,24	**cyFinland**	5,40
	Lags: 3	11,63		18,92		8,04
	Lags: 4	10,42		25,48		8,05

Notes: The F-statistic is used to test for the joint significance of the coefficients of the lagged levels in the ARDL-ECM. Critical value bounds for the present specification with constant, no trend, p=2 and 95 per cent level of confidence are (3.79; 4.85).

Table III: Long-run coefficients

	ADL (m, n; 10)	**Intercept**	**Germany**	**France**	**Italy**	**Spain**	**Netherlands**	**Greece**	**Belgium**	**Portugal**	**Austria**	**Finland**	**Ireland**	**AIC**
Germany	ADL (4, 0; 10)	0,0000		0,0891	-0,0727	-0,2221	0,4196	0,0429	0,1441	-0,0347	0,4217	-0,1465	0,3898	-6,9010
France	ADL (3, 1; 10)	-0,0002	0,0143		0,1162	0,1163	-0,0615	0,0143	0,2253	0,0841	0,1400	0,0120	0,0199	-7,1540
Italy	ADL (4, 0; 10)	0,0002	-0,0826	0,1391		0,1063	0,0443	0,0490	0,2244	0,1044	-0,1117	-0,0095	0,1832	-6,8690
Netherlands	ADL (2, 3; 10)	-0,0004	0,2009	0,1114	0,1529	-0,0178		-0,0950	-0,0639	-0,1108	0,2711	0,0512	0,0141	-6,7040
Greece	ADL (3, 2; 10)	0,0002	0,6860	0,3040	-0,4158	0,0297	-0,0429		-0,2818	-0,0169	0,3185	0,0182	0,1650	-5,9130
Belgium	ADL (3, 0; 10)	0,0000	0,0141	0,0755	0,0582	0,0706	0,1509	0,0118		0,0858	0,1489	0,0754	0,0240	-7,9230
Portugal	ADL (4, 0; 10)	-0,0003	-0,3388	0,2649	-0,1441	0,2202	0,1762	0,4172	0,3744		-0,0181	0,0480	0,1072	-6,5070
Austria	ADL (4, 0; 10)	0,0000	0,2749	0,1772	-0,0731	-0,0422	0,0142	0,0048	0,1955	0,1224		0,0725	-0,0179	6,9590
Ireland	ADL (4, 0; 10)	-0,0002	0,0227	0,0871	0,1696	0,1984	0,0790	-0,0378	-0,0298	0,0115	-0,0415	0,0726		-6,2950

	ADL (m, n; 3)	**Intercept**	**Germany**	**France**	**Netherlands**	**Belgium**	**Austria**	**Luxembourg**	**AIC**
Germany	ADL (2, 3; 3)	0,0001		-0,0757	0,5573	0,0178	0,4170	0,1312	-6,8300
France	ADL (4, 2; 3)	-0,0001	0,0716		-0,1321	0,5694	0,1352	0,1110	-7,1700
Netherlands	ADL (4, 1; 3)	-0,0005	0,3970	0,3108		0,0963	0,1195	-0,0255	-6,5230
Belgium	ADL (3, 1; 3)	0,0000	0,0051	0,2444	0,1548		0,2384	0,0823	-7,8510
Austria	ADL (3, 1; 3)	-0,0001	0,2988	0,2397	-0,0201	0,2995		0,0193	-6,9600
Luxembourg	ADL (3, 1; 3)	-0,0002	0,3916	0,4593	-0,0052	0,3192	0,0510		-7,1400

	ADL (m, n; 3)	**Intercept**	**France**	**Italy**	**Spain**	**Belgium**	**AIC**
France	ADL (2, 3; 3)	-0,0003		0,0401	0,2405	0,5685	7,1423
Italy	ADL (4, 2; 3)	0,0003	0,2177		0,1848	0,1326	-6,9253
Spain	ADL (4, 1; 3)	0,0001	0,2460	0,0356		0,2888	-6,9749
Belgium	ADL (3, 1; 3)	-0,0001	0,5194	0,0986	0,1078		-7,7393

	ADL (m, n; 2)	**Intercept**	**France**	**Belgium**	**Finland**	**AIC**
France	ADL (2, 0; 2)	-0,00015		0,75610	0,04353	-7,0480
Belgium	ADL (3, 0; 2)	-0,00030	0,48884		0,13745	-7,7430
Finland	ADL (4, 0; 2)	-0,00032	0,16371	0,53421		-6,0761

Notes: AIC is Akaike Information Citeria, for model selection in the ADL specification.