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The Endogeneity of Optimum Currency Areas Criteria in the Context of Financial Crisis: Evidence from Time-Frequency Domain Analysis

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Abstract

The European integration process is theoretically supported by optimum currency area (OCA) theory which originates from debates about fixed versus flexible exchange rates, treating a common currency as the extreme case of a fixed exchange rate. The key issues of theoretical and empirical discussions in recent years are costs and benefits of adopting a common currency.

We follow the hypothesis that historically greater integration provides more highly synchronized cycles. However, the commonly used methodological approaches overestimate cyclical co-movements between the time series during the financial crisis. Our contribution is in time series decomposition elimination trend included outliers appears in the years 2007-2010.

Key words

Singular value decomposition, wavelet analysis, synchronization, euro area.

JEL: F15 - Economic Integration, C14 - Semiparametric and Nonparametric Methods

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From a theoretical point of view, a currency union is expected to increase trade and financial integration because of decrease in transaction costs and elimination of exchange-rate risk. Frankel and Rose (1998) used a panel of thirty years of data from twenty industrialized countries and they found positive effect of increased trade integration on the cross-country correlation of business cycles. They contributed that business cycles synchronization would be higher because of demand shocks or intra-industry trade. As well, they pioneered the idea of the hypothesis of endogeneity of OCA. Frankel and Rose (1998) identified significant relation between the historically greater integration and more highly synchronized cycles and they conclude that EU accession countries would be expected to meet the OCA criteria better ex post than ex ante.

The endogeneity of OCA was discussed by many authors in several branches, which are not isolated between themselves. Artis and Zhang (1997 and 1999) identified positive impact of fixed exchange rate on the business cycles synchronization, contributed by growing trade links between the EU countries. The endogeneity of symmetric shocks and trade was followed by Fontagné (1999), Fidrmuc (2004), Artis et al. (2008) and many others. Blanchard and Wolfers (2000) focused on the endogeneity of labour market institutions, Kalemli-Ozcan et al. (2003) provide empirical evidence that risk sharing within the euro area enhances specialization in production.

Assessing the endogeneity of OCA conditions in the euro area is important topic in discussion about the benefits and costs of adopting a common currency. Joining a currency area is related with loss of autonomous monetary policy and exchange rate control. The joining costs are minimized and benefits maximized with high degree of cyclical and structural synchronization (Corden, 1972). However, the hypothesis of endogeneity of OCA is in sharp contrast with the Lucas Critique. Lucas (1976) assumed that the structure of all econometric models is not applicable for policy decisions. He argued with optimal decision rules of economic agents which vary systematically without any changes in the structure of series relevant to the change in policy. Therefore, any experiments based on the historical data cannot provide the probability of the future asymmetric shocks within the euro area.

Despite the Lucas Critique arose a new area of macroeconomic empirical research – business cycle synchronization. The most common methods in this field are the unconditional correlation between the two countries in different time periods, the identification of delays various phases of business cycles, volatility of cyclical fluctuations in economic activity, stability and similarity of sudden and unexpected fluctuations in economic activity or shock responses at the regional level within the euro area (Darvas and Szapáry, 2005) or index of cyclical conformity, called Concordance Index (Harding and Pagan, 2006).

Growing literature in this area induced creation of new methodological approaches. Traditional analyses of co-movements in time domain were supplemented by frequency domain (Croux et al., 2001, Messina et al., 2009 or Fidrmuc and Korhonen, 2010) and developed into a time-frequency approaches (Rua, 2010 or Aguiar-Conraria and Soares, 2011).

We follow time-frequency domain approach and focus on the business cycles co-movements before and during the global financial crisis of 2008. The crisis period and its consequences are recently discussed in many working papers. However, the authors provide contrastively different results depending on the applied approaches. Dées and Zorell (2011) applied system of equations to identify production structures and concluded that financial integration tends to raise business cycle comovement between the EU countries. Antonakakis (2012) applied dynamic conditional correlation and identified unprecedented synchronization of business cycles between the G7. On the contrary, Gächter et al. (2012) identified divergent development of the business cycles in the euro area after the year 2008 and Filis et al. (2011) concluded that the recent financial crisis has halted and reversed the process of convergence of the business cycle synchronization in Europe. Similarly to Fidrmuc and Korhonen (2006) we consider that results of analysis are significantly influenced by the choice of method for business cycle estimation.

Blumenstein et al. (2012) compared different approaches in time-frequency domain (wavelet analysis, multiple window method using Slepian sequences, time-frequency varying autoregressive process estimation and time-frequency Fourier transform representation) to identify cyclical movements in the euro area industrial production index. They found contrasting cyclical movements in the years 2007-2010, especially two significant shocks and effects in long-term cyclical movements. This shock caused that other cyclical movements in time series were suppressed. Therefore we suppose that commonly used filtering techniques overestimate cyclical movements in time series during the financial crisis and co-movements as well. If we apply the analysis in time-frequency domain to identify OCA endogeneity, the results will be significantly biased. Generally used methodological background in time-frequency domain provides only identification of significant symmetric shock in the years 2007-2010. The problem is in trend elimination. The standard filtering techniques identify financial crisis as the business cycle. To contribute the recent methodology, we have to answer the key question, whether the financial crisis created business cycle or not.

Now, focus on the shape of the time economic activity during the financial crisis. We follow the US experiences now. The economy was affected by the subprime mortgage crisis and lost household wealth, which led to a drop in consumer spending and investment activities. Before this demand shock the US experienced rapid increase in total loans. Increased aggregate demand was followed by

increase of prices at the asset market. Thus, expansion stage with peak in the year 2007 was replaced by economic recession with the trough in the year 2009 and subsequent recovery. Thus, we provided a textbook example of business cycle with driving force in financial market deregulation, credit money creation and financial instability.

However, the drop in economic activity after the year 2008 is more than a cyclical discrepancy from the potential output. Halmai and Vasary (2012) showed that the European recession has an impact on growth through three different channels: capital accumulation, labor input and total factor productivity. Applying the production function approach they concluded that the potential growth rate both in the euro area and US falls in 2009-2010 (it is lower by 1.5% in US and by 0.8% in the euro area).

The problem is that filtering techniques provide nothing less than a well defined statistics which measures nothing that would not have a direct connection to economic theory. Therefore, the financial crisis cannot be modeled as business cycle but outlying observations.

Prior to the application of time-frequency analysis methods the input data of the industry production index is transformed by the natural logarithm and the long-term trend is removed. Instead of using common filtering techniques (e.g. Hodrick-Prescott, Kalman, Baxter-King or Christiano–Fitzgerald filter) we apply singular value decomposition to remove the long-term trend (Carvalho, Rodriguez and Rua, 2012). Our methodological contribution is in the decomposition into components which allow not only elimination of the trend but also outliers caused by financial crisis in the years 2007-2010.

The main objective of this paper is to identify changes of co-movements in time-frequency domain to verify the hypothesis of endogeneity of OCA. We focus on the crisis period during the years 2007-2010 when significant symmetric shock affected economic activity across the whole euro area. The proposed methodological approach will be applied on economic activity in the core euro area countries (Germany, France, Belgium, Austria and the Netherlands), where the hypothesis of endogeneity of OCA criteria is generally assumed. Obviously, the acceptance of the hypothesis of endogeneity in these countries is a significant contribution for the policy makers to implement unconditionally the real and nominal convergence criterions at the time of joining euro area.

Data and methods

In order to demonstrate the performance of investigated methods we used monthly data of industrial production index in the period 1958/M2-2012/M4 (volume index year 2005=100). The datasets were provided by OECD open database of short-term economic indicators. Additive decomposition is applied in the following form:

$$y_t = g_t + c_t + \varepsilon_t,\ t = 1, \dots, n \tag{1}$$

where g_t denotes long-term trend, c_t is the cyclical component and ε_t is the irregular component. For the identification of long-term trend we use singular value decomposition (SVD) (Carvalho et al., 2012).

The first step of SVD is to make trajectory matrix from the input time series $\boldsymbol{y} = (y_1, y_2, \dots, y_N)'$ of the length *N* without any missing values. The trajectory matrix T with $K \times L$ dimension and takes the form

$$T = \begin{pmatrix} y_1 & y_2 & \cdots & y_L \\ y_2 & y_3 & \cdots & y_{L+1} \\ \vdots & \vdots & \ddots & \vdots \\ y_K & y_{K+1} & \cdots & y_N \end{pmatrix}. \tag{2}$$

The parameter *L* such that $2 < L < N/2$ to embedded into initial time series $\boldsymbol{y}$ is defined by user. Consequently we apply on the trajectory matrix T SVD to obtain trajectory matrices $T_i, i = 1, \dots, L$. From an eigenanalysis of TT' we collect the eigenvalues $\lambda_1 \geq \cdots \geq \lambda_{r,}$ where $r = \mathrm{rank}(TT')$ and the corresponding left and right singular vectors, respectively denoted as U_i and V_i. We can write

$$T = \sum_{i=1}^{r} U_i \lambda_i V_{i.}' \tag{3}$$

In the following analytical step we use the wavelet transform (Mertins, 1999). The continuous wavelet transform of time series y_t with respect to the mother wavelet $\psi_{a,\tau}(t)$ is defined as

$$S_{CTW}(a,\tau) = \int_{-\infty}^{\infty} y_t \frac{1}{\sqrt{a}} \psi\left(\frac{t-\tau}{a}\right) dt, \quad a > 0, \tau \in R, \tag{4}$$

where mother wavelet takes the form $\psi_{a,\tau}(t) = \psi\left(\frac{t-\tau}{a}\right)$, τ is the time position, a is the parameter of dilatation (scale), which is related to the Fourier frequency and numerator of the fraction $\sqrt{a}$ ensures the conservation of energy.

To be the invertible transform, basis (mother wavelets) functions must be mutually orthogonal, have zero mean value and limited to finite time interval. That is

$$\begin{aligned} &i) && \int_{-\infty}^{\infty} \psi_{a,\tau}(t) dt = 0, \\ &ii) && \int_{-\infty}^{\infty} \psi_{a,\tau}^2(t) dt = 1, \\ &iii) && 0 < C_\psi = \int_0^{\infty} \frac{|\Psi(\omega)|^2}{\omega} d\omega < \infty; \quad \Psi(\omega) = \int_{-\infty}^{\infty} \psi_{a,\tau}(t) e^{-i\omega t} dt, \end{aligned} \tag{5}$$

where $\Psi(\omega)$ is the Fourier transform of $\psi(t)$. There is an inverse wavelet transformation define as

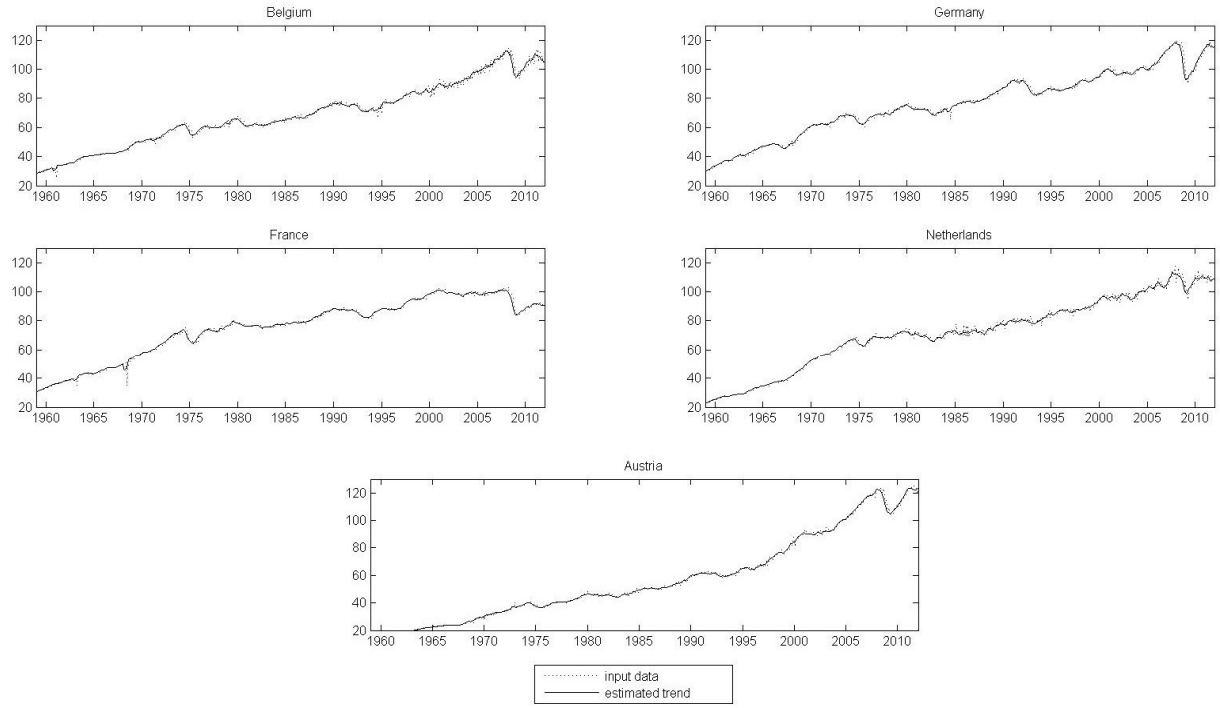
$$y_t = \frac{1}{C_\psi} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \psi_{a,\tau}(t) S_{CWT}(a,\tau) \frac{da d\tau}{a^2}. \tag{6}$$

To satisfy assumptions for the time-frequency analysis, waves must be compact in time as well as in the frequency representation. There are a number of wavelets used, such as Daubeschie, Morlet, Haar or Gaussian wavelet (Grençay et al., 2002).

Results

The used time series comprise very long time period included several significant and temporary economic recessions called crises. The singular value decomposition provides band-pass filtered output (Figure 1). Figure 1 presents input time series and estimated trend included the slow-moving component (trend) and cyclical movements with a frequency noticeably larger than 32 quarters (movements regarded outside from the range of business cycle). These two components were discarded for the subsequent wavelet analysis (Carvalho et al., 2012). Noticeably, the singular value decomposition provides an instrument to eliminate long waves from the time series caused by the most significant global crisis. We can distinguish drop in economic activity after the first oil crisis in the year 1973, EMS currency crisis in the years 1992-1993 and the last financial crisis in the years 2007-2010.

Figure 1: Singular value decomposition of industrial production index



Datasource: OECD database

Figures 2, 3 and 4 provide the co-spectrum of movements in economic activity of the selected core euro area countries. The figure presents dynamic of business cycles during the last 50 years. A few

countries show co-movements at shorter waves than assumed business cycle frequencies (range between 6 and 32 quarters or 32 and 96 months). Concretely, we can find the most significant co-movements among France, the Netherlands and Belgium. These countries were synchronized in business cycles during the oil crisis. On the contrary, lower degree of business cycles synchronization we can find in Germany and Austria. In the all selected countries we can find significant co-movements before and during the recent financial crisis, especially after the year 2004 with the centre in 2009.

Evidently, global macroeconomic shocks play important role in the business cycle synchronization. However, we did not identified symmetric shock because the symmetric declines in economic activity during the crises periods were eliminated from the input time series. The identified co-movements concentrated on the residual fluctuation only. Of course, the identified synchronization of cyclical movements is related to the macroeconomic shocks, but only as an indirect consequence sources reallocation between the economic sectors, impact of changes in macroeconomic policies or mutual integration of the Western European countries.

Figure 2: Singular value decomposition of industrial production index

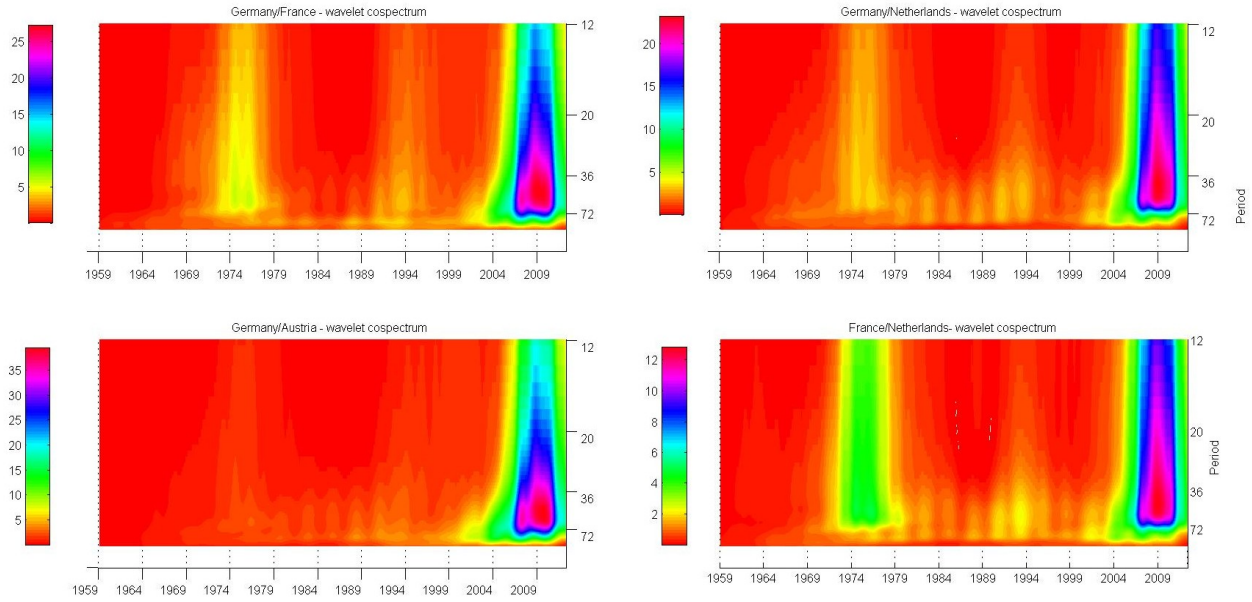
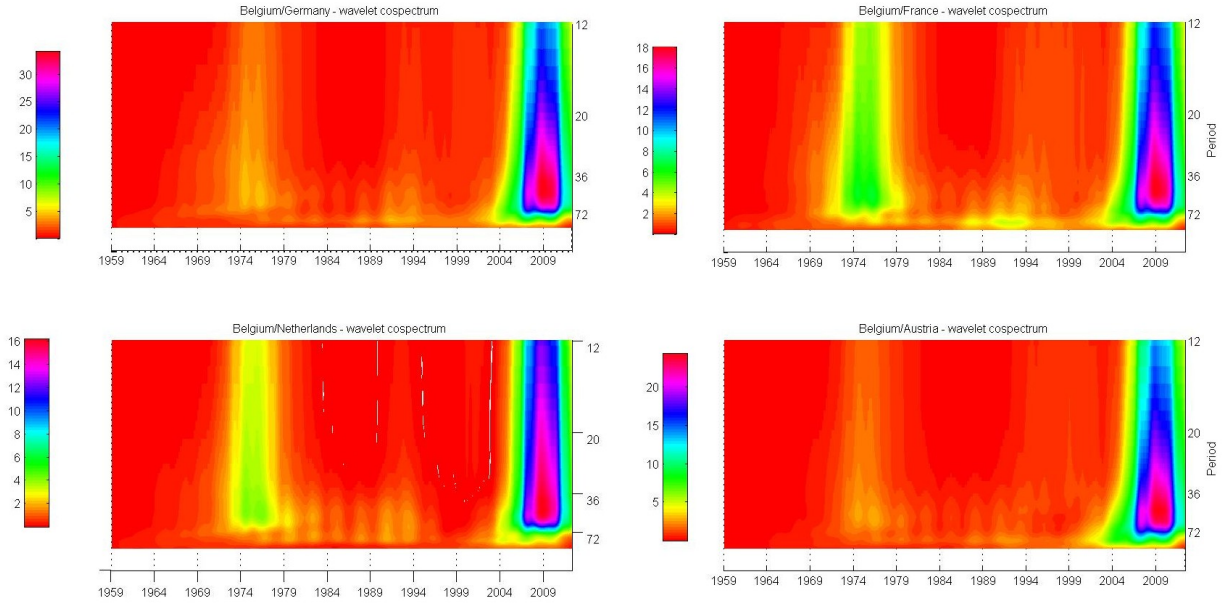
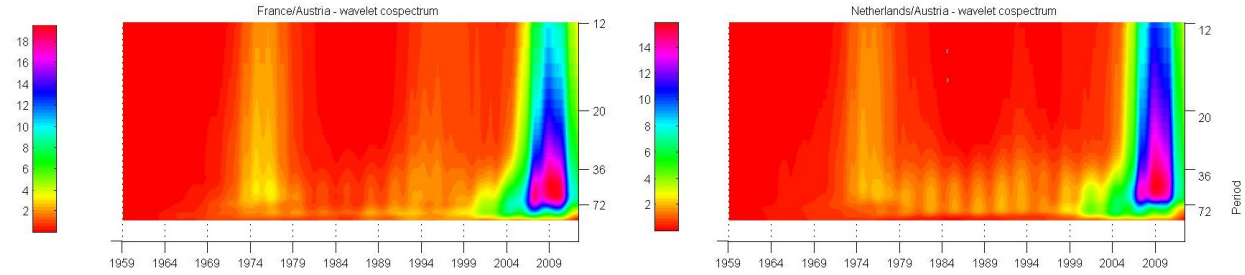


Figure 3: Singular value decomposition of industrial production index



It is generally agreed that Germany, France, Austria and Benelux countries have similar shape of the business cycle since the 70th, but it was not yet clear whether the European integration process contributed to the synchronization, especially after the euro adoption. The results of the analysis provide clear evidence that synchronization of cyclical movements in economic activity between the selected core euro area member countries significantly increased after the year 2002. The frequency of co-movements was identified shorter than 6 years in all selected countries.

Figure 4: Singular value decomposition of industrial production index



Conclusions

Modeling of fluctuations in economic activity through detrending economic time series is common in the measurement of synchrony of business cycles between the euro area member countries. There are many technical approaches applied in this area, included analysis in frequency and time-frequency domains. However, the common filtering techniques spuriously identify cyclical movements in economic activity during the deeper and longer lasting economic recessions. Therefore, we suppose that the results of the synchronization analysis are overestimated during the financial crisis. The results of co-movements in time-frequency domain subsequently identify symmetric shocks that cannot be considered as business cycle synchronization.

Our contribution is to provide alternate methodological approach to eliminate slow-moving component included drop in economic activity caused by financial crisis. Subsequent wavelet analysis identified significant increase in business cycle synchronization in the core euro area member countries after the year 2002. We cannot to conclude that financial crisis contributed or reversed the process of convergence because there are insufficient numbers of observations. However, we can confirm the hypothesis of endogeneity of OCA criteria during the last decade.

The conclusion provides important policy implications. The recent discussions deal with the spending imbalances and the sovereign debt crisis in the euro area. The focus is mostly on the periphery countries (Greece, Ireland, Portugal, and Spain) and their government debt levels. However, the consequences in terms of rescue packages and scenarios of the break-up have a simple cause. Many of the current members adopted the euro as soon as they fulfilled the Maastricht criteria which mean that their nominal convergence has been achieved. The assumptions of the OCA theory, especially the real convergence criteria, were repeatedly undervalued. The results of empirical analysis confirmed that the business cycle synchronization is historically greater in countries that better achieved the both nominal and real convergence OCA criteria. Consequently, the costs of adopting the common currency are continuously decreasing in these countries even during the financial crisis. Finally, our focus should turn to the countries where theoretical assumptions of the common currency were achieved. Thereafter we can discuss the success or contribution of the euro project.

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