

Business Cycle Analysis of the Core and Periphery Countries in the EMU

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Abstract

The article deals with business cycles of selected European countries for the long period of time – since 1960. The group of analyzed countries is represented by the member states of the Economic and Monetary Union. The analyzed group of countries contains both members sharing the single common currency euro and selected countries that decided to keep their national currency. The article examines development of business cycles during a long period of time. This will be done by the Hodrick-Prescott approach to a detrending of time series. Symmetries in business cycles are finally analysed by comparing the business cycles of the EMU member states. Then its possible to analyze whether there is any core and periphery within the EMU according to the business cycles or not.

Keywords: *business cycle, correlation, European economics and monetary Union, Eurozone, Hodrick-Prescott filter*

JEL Classification: E00, E32, E42

Introduction

Nowadays the Eurozone undergoes the most complicated time since its establishment. Is the Economic and Monetary Union (EMU) sustainable in the long run? Critics often say that the Eurozone is too heterogeneous, exactly they point out that the Eurozone is not optimum currency area. The so called *Theory of Optimum Currency Areas* (OCA) is the main theoretical approach focused on country's membership in the monetary union. The OCA theory defines various criteria which fulfilment should minimize costs of entering monetary union. When the monetary union fulfils these criteria, then it should be optimum currency area sustainable in the long run. However the criteria are often not

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unambiguous. Moreover these criteria often lead to different conclusions. The works of Mundell (1961), McKinnon (1963) and Kenen (1969) are very well known and compose the basis of the OCA theory. They emphasise role of factor mobility – especially labour mobility, openness of the economy and diversification of production.

On the other hand according to the Eichengreen (1991) “An optimum currency area is an economic unit composed of regions affected symmetrically by disturbances and between which labor and other factors of production flow freely“. Eichengreen clearly emphasises the role of economic disturbances that affect members of the currency union. In 1992 Bayoumi and Eichengreen (1992) published paper analysing supply and demand shocks within the EU. They found out that there are core countries with higher shocks synchronization when compared to the periphery countries.

Recent paper dealing with the monetary unions stress the importance of shocks symmetry and business cycles synchronization (i.e. Furceri and Karras, 2008). The higher is the correlation of business cycles within the monetary union, the lower is the need for flexible exchange rate. The lower are the costs of being member of the currency union. Within this paper we focus right on the business cycle correlation.

The main aim of the paper is to analyze if there is a core and a periphery within the EMU members, according to the business cycle correlation or not. This potential core can be characterized by a higher correlation of business cycles within countries that form such core. The existence of such core is important regarding realization of common monetary policy, that could be oriented more on the development of the core (assuming that the core countries are the key European economies). In addition we assume that potential economic disturbances would affect these core countries more symmetrically than prospective periphery countries. Used methodology is specified hereinafter.

The Economic and Monetary Union was created in three stages. As a turning point we consider the last third stage, when the exchange rates were irrevocably fixed¹ and the euro was introduced in a noncash payment system. Right three countries (the United Kingdom, Denmark and Sweden) refused to join the third stage and these three EU member states still use their national currency today. The UK and Denmark negotiated opt-out clause and they are not obliged to adopt the euro anymore. Sweden has not yet started to participate in ERM II mechanism and hence does not fulfil the convergence criteria for entering the Eurozone. Special case is Greece. This country wanted to join the third stage of the EMU, but did not fulfil the necessary criteria. Greece fulfilled the criteria

¹ The conversion rates between national currencies and the Euro were established.

subsequently and joined the other countries.² Since 2002 when the twelve national currencies already ceased to exist, four other member states of the EU adopted the euro. These countries were: Slovenia (2007), Cyprus and Malta (2008) and Slovakia (2009). We will not pay attention to these countries in this paper, regarding their relatively recent entrance to the European union. Moreover we will not pay any attention to countries staying outside the Economic and Monetary Union as e.g. the Czech Republic. For further information on the czech business cycle synchronization you can see e.g. Helísek (2009). Comparison of the economic situation of countries that should access the Eurozone in future can be found in Židek (2008).

This paper deals with the business cycle analysis of the EMU member countries. All member countries of the European Union are member countries of the Economic and Monetary Union as well. However some of them have got permanent or provisional exceptions from the euro adoption and for that reason are not members of the Eurozone. This analysis focuses on the EU 15 countries (the 12 “original” Eurozone countries and the UK, Denmark and Sweden).

The paper is divided into two main chapters. The first one deals with the business cycle analysis of the twelve Eurozone countries. The second one focuses on the three countries that decided not to adopt the euro and to retain their own national currencies – the UK, Denmark and Sweden. All countries are analysed for the long period – since 1960 till 2008.

Business Cycle Analysis of the Eurozone Countries

A correlation analysis is a frequently used technique for an assessment of a business cycle likeness. In this paper we will analyse business cycles by the Hodrick-Prescott approach to a detrending of given time series. This technique allows us to make a decomposition of time series and separate trend from cycle in such series. Thus when we use data for a real GDP³ we get detrended output, which we are able to compare. According to Hloušek and Polanský (2007) “probably the biggest disadvantage of HP filter is that the filter deflect end (initial as well) values”. This disadvantage should not influence our results significantly as this inaccuracy is partly diminished by using moving correlations. Another disadvantage is that the HP filter does not take into account structural changes in economy, if these changes are not gradual. As we analyse the countries for long period of time this findings also should not influence our results significantly.

² Later was proved that there were some data manipulation to fit the convergence criteria in Greece.

³ We work with quarterly, seasonally adjusted data that are at constant prices.

In order to find a possible core and a periphery among the EMU members, we will analyse time series for the twelve original Eurozone member countries.⁴ As a benchmark, allowing us to compare our results with rest of the world, the United States of America were chosen. Results of the analysis are shown in the following 0.

Figure 1

The Business Cycle Correlation During 1960 – 2008 (HP filter for $\lambda = 1\ 600$)

	AT	BEL	FIN	FRA	GER	GRE	IRL	ITL	LX	NL	PT	ES	USA
AT													
BEL	0.68												
FIN	0.44	0.59											
FRA	0.67	0.74	0.56										
GER	0.73	0.63	0.29	0.61									
GRE	0.42	0.31	0.19	0.37	0.54								
IRL	0.17	0.34	0.37	0.39	0.31	0.17							
ITL	0.34	0.58	0.36	0.56	0.36	0.12	0.31						
LX	0.61	0.66	0.40	0.63	0.64	0.33	0.31	0.38					
NL	0.52	0.60	0.21	0.51	0.65	0.19	0.27	0.50	0.50				
PT	0.57	0.60	0.40	0.60	0.42	0.32	0.28	0.44	0.45	0.32			
ES	0.41	0.54	0.45	0.57	0.34	0.11	0.44	0.50	0.56	0.16	0.46		
USA	0.18	0.23	0.12	0.33	0.30	0.40	0.18	0.19	0.38	0.37	0.26	0.18	
EZ	0.76	0.83	0.52	0.86	0.85	0.47	0.44	0.71	0.72	0.65	0.63	0.62	0.36
<i>EZ – G</i>	0.67	0.83	0.58	0.89	0.64	0.36	0.46	0.83	0.67	0.56	0.66	0.71	0.34
<i>EZ – F</i>	0.75	0.82	0.49	0.79	0.88	0.48	0.44	0.71	0.71	0.66	0.61	0.61	0.35
<i>EZ – F, G</i>	0.62	0.81	0.56	0.78	0.61	0.34	0.46	0.88	0.64	0.54	0.65	0.72	0.33

Note: EZ – Eurozone (12), EZ – G – Eurozone without Germany, EZ – F – Eurozone without F, EZ – F, G – Eurozone without Germany and France.

Source: OECD (1960 – 2008); author's calculation.

We divide the analysed countries into few groups. We do so on the basis of results of our business cycle analysis. In order to find out any changes in business cycle correlation of analysed countries over time, we divided the analysed period of time to the two shorter periods. The first one covers the years from 1960 until 1984 (the 1st period) and the second one covers the years from 1985 until 2008 (the 2nd period). All correlation coefficients for these two periods are shown in the 0 and the 0.

Moreover we take into account data for the Eurozone trade to better understand the relationships among the countries. We focus on a share of each country on the total EU trade and the total Eurozone trade. Further more for better demonstration of correlation development we also computed and depicted moving correlations for the analysed period. The length of moving correlations was set to 40 quarters, it means 10 years.

⁴ Regarding relatively recent entrance of Slovenia, Cyprus and Malta to the Eurozone, we do not work with time series for these countries.

In this paper we work with two basic groups of countries – the core and the periphery. Countries that belong to neither of these two groups are called as “other countries”.

The *core* covers countries with the highest level of correlation coefficients to the Eurozone as a whole. This potential core can be characterized also by a high correlation of business cycles within countries that form such core. Furthermore the other EMU countries demonstrate increasing values of their correlations right with the core countries over time. These are fundamental characteristics of the EMU core.

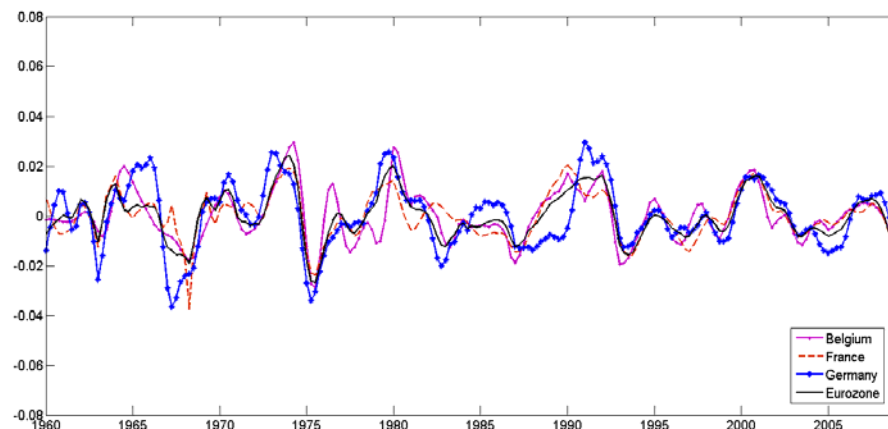
On the other hand, there could exist also a group of the *periphery* countries. Such countries could be characterized by a lower correlation to the Eurozone, comparing with other countries. We will analyse if there is any convergent process of the periphery to the Eurozone and its countries. We will as well try to find out if there is any potential “periphery business cycle” among the countries that form it.

Core Countries

As we mentioned hereinbefore, there is a core within the EMU countries that is formed by the two most important economies of the European union – France and Germany and one small economy – Belgium. The business cycles of these countries are shown in the 0. Why we classify these three countries as the core countries?

Figure 2

**The Cyclical Component of GDP for the EMU Core During 1960 – 2008
(Detrended by the HP Filter for $\lambda = 1\ 600$)**



Source: OECD (1960 – 2008); author's calculation.

When we look at the 0, we see that *France* is the country which correlation to the Eurozone is the highest among all the Eurozone countries. Nevertheless french correlation is not significantly higher than correlations of a majority of analysed countries. When we analyse cross correlations of the Eurozone countries, we find out that right correlations with France belong to the highest among almost all countries. Hence France belongs to the core without any doubt. Even though the correlation of the French business cycle to the Eurozone is little bit higher than the German one⁵ (although the difference between values of these coefficients is from the statistical point of view not significant), *Germany* is the most important economy of both the Eurozone and the European Union. According to the data from 2007 almost 28% of the total EU export was originated in Germany (see 0), with approximately 12% of the total EU export originated in France and Netherlands (ranked as the 2nd and 3rd most important EU export countries).

Figure 3

Shares of the EMU Countries on Both the EU and Eurozone Total Export

Country	Share of (in %)		Country	Share of (in %)	
	EU	Eurozone		EU	Eurozone
	total export			total export	
Austria	3.4	4.0	Luxembourg	0.5	0.6
Belgium	9.0	10.6	Netherland	11.5	13.5
Finland	1.9	2.2	Portugal	1.1	1.3
France	11.5	13.5	Spain	5.3	6.2
Germany	27.6	32.4	United Kingdom	9.2	X
Greece	0.5	0.6	Denmark	2.1	X
Ireland	2.5	3.0	Sweden	3.5	X
Italy	10.3	12.1	Total	100	100

Source: OECD (2007).

Now let's focus on the smallest country within this core – *Belgium*. Belgium is a member of the European Union since its establishment in 1951. However the reasons behind the Belgian position within the EMU, according to the business cycle correlation, is not as clear as it was in case of France and Germany. The most probable reason is again economic partnership with the two most important EU economies – France and Germany and generally it is high openness of Belgium. Belgian most important trade partner is Germany. Belgium is the second important export partner of France, within the whole European Union.

Belgian correlations to the both Eurozone and single Eurozone countries belong between the highest. Belgian business cycle is highly correlated to the Eurozone one over the whole analysed period. The correlation coefficients are high

⁵ Especially since the 90's as you can see on the 0.

for both the whole Eurozone (0.83) and the Eurozone without France (0.82), without Germany (0.83), without both these countries (0.81) and without Belgium as well (0.82). At the same time its business cycle is very close to the ones of Germany and France.

How was the cyclical development of the core countries with the Eurozone over time? Let's start with *Belgium*. There was a tiny increase in correlation to the Eurozone over time. The most significant increase in correlations were with Ireland and Spain (compare the 0 and 0).

There was also small decrease in correlation just with one country – Luxembourg. We must notice that correlations of all core countries with Luxembourg have decreased little bit over time. According to the moving correlations (see 0) there was a little drop in the Belgian correlation to the Eurozone during the 70's. At the beginning of the 80's the correlation grew and since that time it is steadily high.

Figure 4

The Business Cycle Correlation During 1960 – 1984 (HP Filter for $\lambda = 1\,600$)

	AT	BEL	FIN	FRA	GER	GRE	IRL	ITL	LX	NL	PT	ES	USA
AT													
BEL	0.63												
FIN	0.56	0.58											
FRA	0.62	0.64	0.43										
GER	0.72	0.66	0.47	0.66									
GRE	0.44	0.28	0.23	0.39	0.60								
IRL	-0.21	0.01	0.02	0.04	0.15	0.16							
ITL	0.28	0.51	0.24	0.48	0.30	0.07	0.16						
LX	0.57	0.74	0.58	0.67	0.70	0.36	0.30	0.39					
NL	0.39	0.57	0.08	0.43	0.61	0.16	0.03	0.29	0.46				
PT	0.53	0.55	0.28	0.49	0.41	0.35	0.06	0.38	0.43	0.22			
ES	0.23	0.37	0.37	0.38	0.22	0.03	0.24	0.45	0.55	-0.08	0.24		
USA	0.16	0.19	-0.10	0.34	0.47	0.46	0.13	0.19	0.45	0.40	0.30	0.19	
<i>EZ</i>	0.71	0.79	0.53	0.83	0.87	0.50	0.17	0.68	0.79	0.58	0.56	0.47	0.45
<i>EZ-G</i>	0.60	0.77	0.48	0.82	0.65	0.35	0.17	0.84	0.73	0.48	0.58	0.58	0.37
<i>EZ-F</i>	0.70	0.79	0.52	0.75	0.88	0.50	0.20	0.69	0.78	0.59	0.55	0.47	0.45
<i>EZ-F, G</i>	0.54	0.75	0.45	0.68	0.59	0.31	0.20	0.90	0.68	0.45	0.56	0.61	0.35

Note: EZ – Eurozone (12), EZ – G – Eurozone without Germany, EZ – F – Eurozone without F, EZ – F, G – Eurozone without Germany and France.

Source: OECD (1960 – 1984); author's calculation.

In a case of *Germany*, the level of its correlation to the Eurozone has almost not changed over time. Its correlation has increased with Ireland significantly and on the other hand it has little decreased with Greece and Luxembourg. What happens with the correlation coefficient to the Eurozone when we compute the Eurozone without Germany? As we expect, the coefficient decrease, but the drop

(from 0.85 to 0.64) is higher than in the French case (from 0.86 to 0.79). Even these differences are small, they are stable over time and we can estimate little bit higher influence of the German cycle to the Eurozone one.

Figure 5

The Business Cycle Correlation During 1985 – 2008 (HP Filter for $\lambda = 1\ 600$)

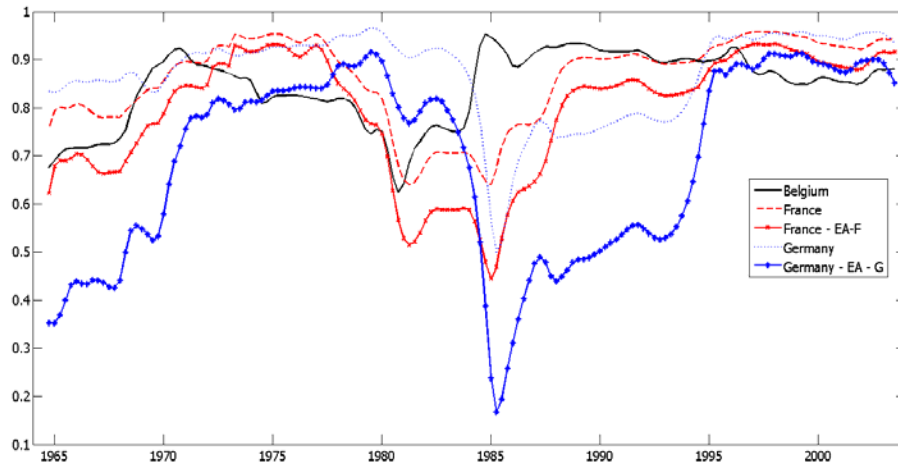
	AT	BEL	FIN	FRA	GER	GRE	IRL	ITL	LX	NL	PT	ES	USA
AT													
BEL	0.78												
FIN	0.33	0.62											
FRA	0.79	0.89	0.68										
GER	0.76	0.60	0.09	0.55									
GRE	0.38	0.45	0.18	0.42	0.37								
IRL	0.67	0.72	0.63	0.72	0.53	0.25							
ITL	0.55	0.81	0.64	0.82	0.52	0.37	0.65						
LX	0.69	0.53	0.23	0.59	0.51	0.29	0.34	0.38					
NL	0.81	0.66	0.41	0.67	0.75	0.31	0.60	0.53	0.59				
PT	0.67	0.72	0.60	0.80	0.46	0.26	0.60	0.65	0.50	0.56			
ES	0.75	0.81	0.56	0.83	0.56	0.36	0.68	0.67	0.59	0.61	0.90		
USA	0.25	0.37	0.56	0.37	-0.18	0.12	0.33	0.19	0.21	0.31	0.14	0.18	
EZ	0.86	0.89	0.54	0.91	0.82	0.47	0.75	0.84	0.62	0.80	0.78	0.85	0.17
EZ – G	0.80	0.92	0.70	0.97	0.62	0.45	0.77	0.89	0.59	0.72	0.84	0.89	0.32
EZ – F	0.86	0.87	0.48	0.85	0.87	0.47	0.74	0.82	0.60	0.81	0.75	0.83	0.11
EZ – F, G	0.79	0.92	0.69	0.93	0.64	0.46	0.77	0.90	0.57	0.73	0.83	0.89	0.29

Note: EZ – Eurozone (12), EZ – G – Eurozone without Germany, EZ – F – Eurozone without F, EZ – F, G – Eurozone without Germany and France.

Source: OECD (1985 – 2008); author's calculation.

Figure 6

Moving Correlations of the Core Countries to the Eurozone



Note: The length of moving correlations is 40 quarters (10 years).

Source: OECD (1960 – 1984); author's calculation.

Also the *French business cycle* became more synchronized with the Irish one. The reason behind is a clear convergence process of Ireland.⁶ Generally there was a modest convergence process of the French cycle with the most Eurozone countries. As we can see on the 0, the correlation to the Eurozone was rising till the end of the 70's, then there was a drop (not as significant as in a case of Germany). Since the second half of the 80's the correlation of the French cycle has increased.

The correlation within the core

The data for the whole analysed period suggest that the business cycles of the core countries are highly cross correlated. Comparing the cyclical development of the core countries we see very small, insignificant, decrease of business cycle synchronization between Germany and France and also Germany and Belgium. Synchronization of business cycles between France and Belgium increased.

The other EMU countries demonstrate the fastest increasing values of their correlations right with these core countries over time.

The core and the USA

When we look at the correlation of these three core countries to the American business cycle, we realize that the values are very similar (for the whole analysed period) – low. There is almost no correlation of these countries with the USA. While the correlation with France has almost not changed and with Belgium has little bit increased, with Germany there was a significant drop. During the first analysed period the correlation of the German and the American business cycle was strong. As we can see on the data from the second period, it has considerably decreased to almost no correlation in effect. Since the second half of the eighties the correlation of the USA with Germany is the lowest among the all Eurozone countries.

Our analysis confirmed the existence of the core countries within the EMU. Not surprisingly these countries are the most important EU economies – Germany and France. Belgium is also part of the core. Existence of the core might imply heterogeneity of the EMU. To confirm this assumption, we need to find out if there exists the periphery within the EMU.

Periphery Countries

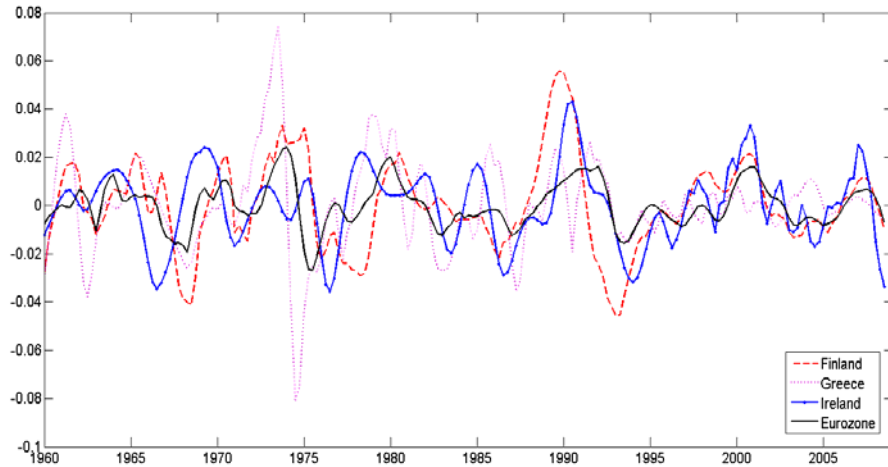
On the other hand we can also define a group of *periphery countries*. Results of our analysis place among this periphery right three EMU countries – Finland, Greece and Ireland. Even if these countries may seem to be in the same position,

⁶ We will discuss it hereinafter.

the reality is quite different. The business cycles of the periphery countries and the Eurozone are shown in the 0.

Figure 7

The Cyclical Component of GDP for the EMU Periphery During 1960 – 2008
(Detrended by the HP Filter for $\lambda = 1\ 600$)



Source: OECD (1960 – 2008); author's calculation.

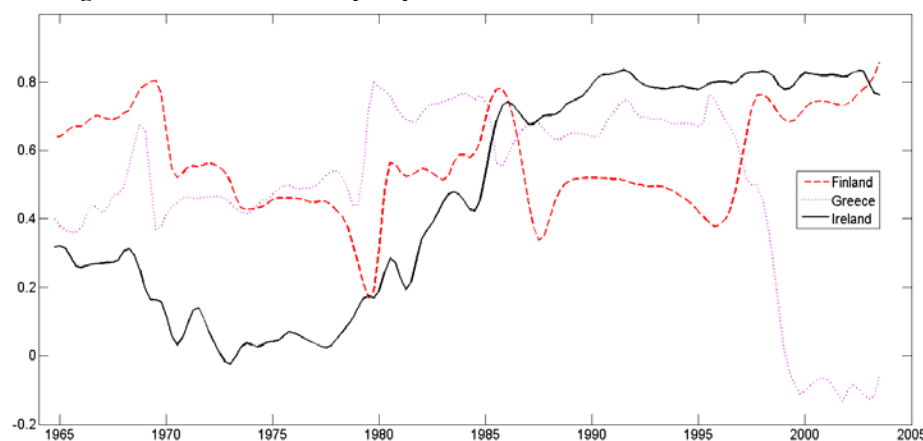
Even if we can say that the *Greek* business cycle is correlated to the Eurozone one, the level of the correlation (to the Eurozone and to its individual countries as well) belongs among the smallest within the Eurozone countries. The correlation is not as high as in case of other EMU countries despite the fact that among the Greek most important EU trading partners belong both Germany and France.⁷ Moreover when we look at the Greek business cycle we find out no convergent process over time. As we can see on the following Figure 8, during the last years the synchronization of the Greek business cycle with the Eurozone has decreased considerably. But it is quite short time to draw any conclusion.

Ireland has a special position both within this group of periphery countries and the Eurozone as a whole. The reason behind is an obvious convergence process that has Greece underwent. As it is apparent on the data presented in the 0 and the 0, it is also shown in the Figure 8 that especially since the 90's the Irish business cycle is much more correlated to the Eurozone than it was before. Ireland is becoming much more synchronized with the Eurozone even if its most important trading partner, standing outside the Eurozone, is the United Kingdom.

⁷ Just only 1% of German trade goes from and to Greece. It's quite low value, in comparison with Austria (9.4%) and Belgium (6.6%) OECD (2007).

To conclude this, Ireland has abandoned its periphery position and is no more part of the periphery. Here we classify this country as a periphery now, just because we analyse data since 1960.

Figure 8
Moving Correlations of the Periphery Countries to the Eurozone



Note: The length of moving correlations is 40 quarters (10 years).

Source: OECD (1960 – 2008); author's calculation.

Last from the periphery group is a Nordic country *Finland*. There is a quite similar development in this country as it was in Greece. We again measured correlation of the Finnish business cycle to the Eurozone one, but in comparison with other countries it is among the lowest values and it has been not changing over time. The reason behind is probably high correlation with Germany. Whilst since 60's until the 1st half of the 80's there was a correlation of the Finish and the German business cycle, since the 2nd half of the 80's there is no correlation. When we look at the 0, we see that the Finish correlation to the Eurozone without Germany is higher what confirms above mentioned idea. On the other hand its business cycle is highly synchronized with the French one.⁸

There is something which have Finland and Ireland in common. Since their entrance to the European union, the correlation of their business cycles with the Eurozone has increased. Finland is a member country of the EU "just" since 1995 and since that there is a convergent process to the Eurozone. The decrease of the Greek business cycle synchronizain with the Eurozone might imply divergence from its countries. The divergence started at the 2nd half of the 90's when

⁸ In spite of the fact that more important trade partner for Finland is Germany (almost 25% of the Finish trade that is with Germany, with France just 6.6%). See 0.

countries were preparing themselves to the EMU membership. Reason of this is probably inside the Greek economy.

Correlation within the periphery

Let's have a look at the business cycle correlation within this periphery. The highest cross-correlation is between Finland and Ireland. The business cycle correlation of these two countries has grown during the 2nd analysed period, probably due to convergence process in Ireland. The correlations between Finland and Greece and also between Greece and Ireland has almost not changed over the analysed time. We can conclude that there is no higher synchronization of business cycles within the periphery and hence no "periphery business cycle" has appeared. Moreover the trade among these three countries is rather low as these countries are not important trade partners for each other within the EU. The most important trading partner for both Greece and Finland is Germany, but for Ireland it is the United Kingdom.

The periphery and the USA

What about the cyclical synchronization of these countries with the USA? Synchronization of the American business cycle with the Greek business cycle has decreased over time. We must add that the high correlation (especially during the 70's and 80's) has changed over time to almost no correlation nowadays.⁹ The American – Irish synchronization of business cycles has increased little bit over time, but the change was not significant.

There was an interesting development with Finland. While the correlation with the Eurozone has not changed over time, the correlation with the USA has increased from no correlation to strong one (from -0.10 to 0.56).

Other Countries

Spain and Portugal are often considered to be a periphery in the European Union, but according to our analysis they are not. We don't judge them as a part of the periphery as their business cycles are highly correlated to the Eurozone for the whole analysed period. These countries have underwent convergence process to the Eurozone and its countries over time. Convergence process was observed as well in Netherlands, Italy and Austria. On the other hand among the analysed countries is one, which business cycle was more synchronized with the Eurozone during the 1st half of the analysed period.

⁹ As we mentioned before, the same happened between the American and the Germany business cycles.

To see the difference in levels of correlation with other Eurozone countries, we computed sums of correlation coefficient for each country. Then we compared these sums for the 1st and the 2nd analysed period. So the values in the 2nd column of the 0 present, let say, cumulative correlations of each country with the rest of the Eurozone members during the 1st analysed period. The penultimate column shows the change in the cumulative correlations that we got by comparing the 1st and the 2nd analysed period. As we can see the most significant increase in the correlations with other countries was in Ireland.

Figure 9

Sum of Correlation Coefficients of Each Country with the Rest of the Eurozone (12)

	1960 – 1984	1985 – 2008	Change	1960 – 2008
Austria	4.75	7.20	2.44	5.56
Belgium	5.54	7.59	2.05	6.28
Finland	3.85	4.97	1.12	4.27
France	5.24	7.75	2.51	6.23
Germany	5.50	5.69	0.18	5.52
Greece	3.06	3.64	0.58	3.07
Ireland	0.96	6.39	5.43	3.36
Italy	3.54	6.59	3.05	4.46
Luxembourg	5.73	5.24	-0.49	5.48
Netherlands	3.16	6.49	3.33	4.43
Portugal	3.95	6.72	2.77	4.57
Spain	2.99	7.33	4.34	4.55
USA	3.18	2.84	-0.34	3.14

Source: OECD (1960 – 2008); author's calculation.

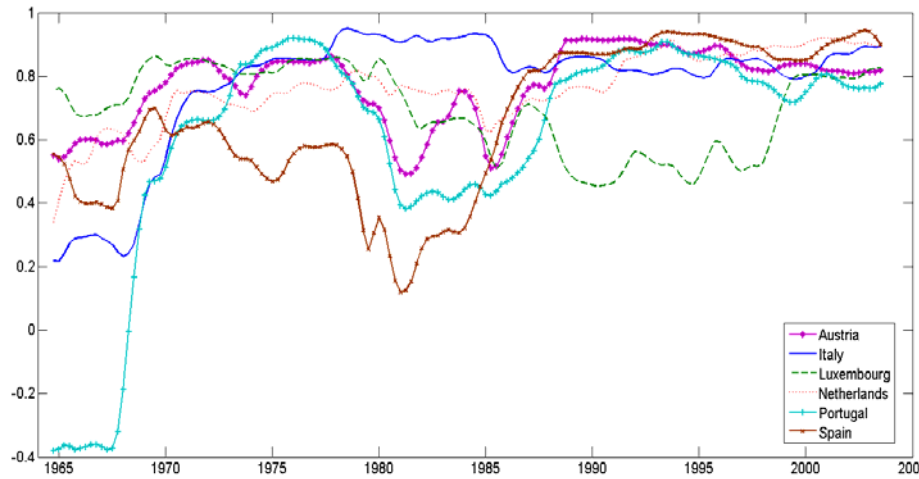
The convergence process was obvious in *Spain*. For the whole analysed period, the Spanish business cycle is highly correlated to the core countries; relatively the lowest correlation is with Germany. The reason is low correlation of the Spanish cycle to the German one during the 1st analysed period. Since the 2nd half of the 80's of the 20th century we can see a convergence of the Spanish business cycle to the German one. Synchronization of the Spanish business cycle with all analysed countries has increased over time, with one exception – Luxembourg. With this country it has almost not changed. There exist also very strong correlation between the Spanish and the Portuguese business cycle (correlation coefficient is 0.9 for 1985 – 2008). On the other hand the smallest correlation is between the Spanish and the Greek business cycle.

The convergence of *Portugal* is not as fast as it was in the Spanish case. When we compare the synchronization of the Portuguese cycle and the Spanish cycle to the Eurozone, we see that during the 70's and 1st half of the 80's was higher the correlation of the Portuguese cycle (see 0). Since that time the synchronization of the Spanish business cycle is higher. As we mentioned hereinbefore, there was an increase in the cyclical synchronization between Spain and

Germany. This happened not in Portugal and maybe this was the reason behind the slower convergence process in the country.

Figure 10

Moving Correlations of the Selected EMU Countries to the Eurozone



Note: The length of moving correlations is 40 quarters (10 years).

Source: OECD (1960 – 2008); author's calculation.

The most significant increase in the cross correlation was measured with Ireland, probably thanks to the increase of synchronization to the Eurozone of both these countries. On the basis of the data since the 2nd half of the 80's, the Portuguese cycle was least correlated with Greece and most correlated to the Spanish cycle.

The situation in *Netherlands* is quite similar to the ones of above mentioned countries, but there was no decrease in the correlation to the Eurozone during the 1st half of the 80's as was in Spain and Portugal. The Dutch business cycle has become more synchronized with the cycle of France, but this is probably not the main reason behind its convergence. When we look at the 0 and the 0, we see that the Dutch correlation to the Eurozone is almost not changed when we compute it to the Eurozone without the France. When we compute the Dutch correlation to the Eurozone without Germany we see little decrease, what may imply higher dependence of this country's business cycle on Germany rather than on France.¹⁰ As is seen from the 0, the Dutch correlation to the Eurozone business

¹⁰ According to the data from 1997, Netherlands was the second most important trade partner of Germany – 16.8% of the total German trade. The most important trade partner of Germany was France (16.96% of the total German trade) OECD (2007).

cycle increases steadily over time. On the basis of the data from 0 and the 0 we can conclude stable increase of correlations to the all analyzed EMU countries.

Italy is one of the countries with the highest synchronization of its business cycle to the Eurozone (see the 0). Its correlation has also increased over time both to the Eurozone and its countries. As it is apparent from the 0, the synchronization of the Italian cycle to the Eurozone one did not decrease during the 80's as happened in other countries. When we look at the correlation of the Italian business cycle with other Eurozone countries (see the 0), we realize that one of the lowest value is measured with Germany (accompanying Austria). Italian correlation to the Eurozone even more increases when we compute correlation to the Eurozone without Germany (see 0) and little bit more when we take out France. Anyway the Italian correlation to the Eurozone without Italy decreases (to 0.44 for the whole analyzed period) obviously and that's why we don't classify this country as a part of the core. For the whole analysed period (as well as since the 2nd half of the 80's) the highest synchronization of the Italian business cycle was observed with France and Belgium. The lowest one was with Greece.

In spite of being a member country of the EU just since 1995, the *Austrian* business cycle is highly correlated to the Eurozone. The reason behind is probably very close economic relationship of this country with Germany. Germany is absolutely the most important trade partner of Austria among the all EU countries. Almost 61 % of Austrian "export" to the EU countries goes right to Germany. So this close economic partnership has surely influenced the high correlation of the Austrian and the Germany business cycles over time. During the 1st analysed period (1960 – 1984) the Austrian cycle was highest correlated right with Germany and since 1985 Germany remains among the countries with highest correlation to the Austrian business cycle.

Over time the highest increase in correlation was with Ireland (from zero to strong correlation), Spain, Netherlands and Italy. From strong to weak has decreased the correlation of business cycle with Finland.

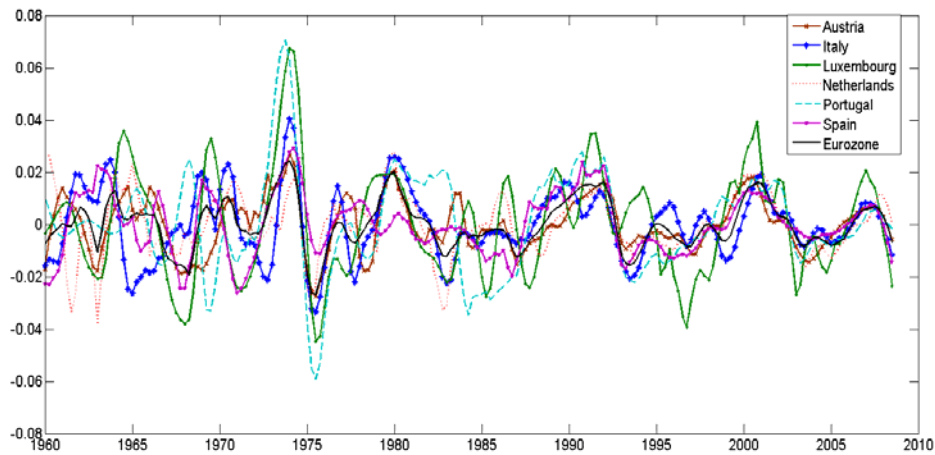
Within the analysed group of countries, there is just one with decreasing correlation of its business cycle to the Eurozone business cycle and to the most of individual countries as well. This country is *Luxembourg* (see the 0). It is so even though the most important trading countries of Luxembourg are the three core countries. For the whole analysed period its correlation to the Eurozone is even little bit higher than the ones of above mentioned countries (see the 0). Comparing the data from the 0 and the 0 we see decrease of cyclical synchronization of Luxembourg instead of convergence process of the above mentioned countries. The highest decrease in the cross correlations were measured with Finland (from strong to weak correlation) and with Belgium and Germany.

There was a little increase in a cyclical synchronization with Austria, Netherlands and Portugal.

In comparison with other countries, the drop in synchronization was obvious mainly during the 90's (see the 0 and the 0). Since the end of the 90's we see slow increase in the correlation to the Eurozone. If this trend persists we can expect higher cyclical synchronization of Luxembourg in the near future.

Figure 11

The Cyclical Component of GDP for the Selected EMU Countries During 1960 – 2008 (Detrended by the HP Filter for $\lambda = 1\ 600$)



Source: OECD (1960 – 2008); author's calculation.

The Correlation to the USA

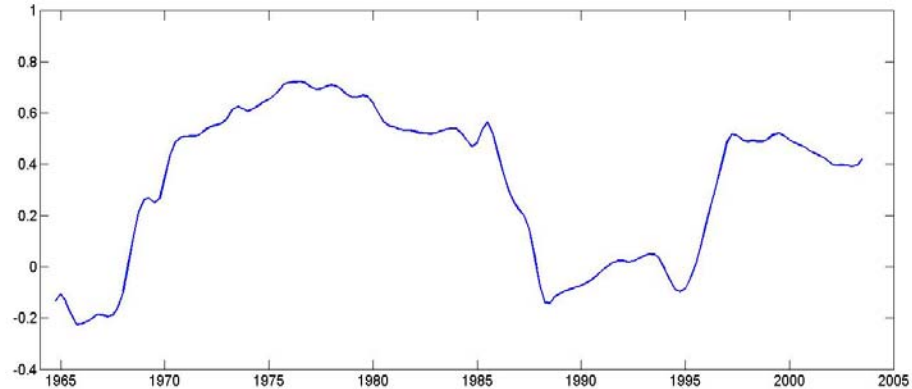
The cyclical synchronization of these countries to the USA has almost not changed over time (compare the 0 and 0). Although there were little changes in correlations with Austria (increase), Netherlands and Portugal (decrease), these changes were so small that the synchronization of cycles has all in all not changed. Synchronization has also not changed with Italy and Spain. Only with Luxembourg we observe change from almost strong correlation (0.45) to almost no correlation (0.21).

Generally synchronization of the Eurozone countries with the USA is weak and has almost not changed over the analysed time. Data from the 0 and 0 show that the correlation of the American business cycle to the Eurozone was higher in the 1st analysed period (1960 – 1984). This is apparent from the next 0 as well. Especially the 1st half of the 90's was the time when there were no synchronization of the American and the Eurozone business cycle. As we see, since 1995 the

correlation to the Eurozone has again increased. Since that time there exists synchronization of these business cycles.

Figure 12

Moving Correlations of the USA to the Eurozone



Note: The length of moving correlations is 40 quarters (10 years).

Source: OECD (1960 – 2008); author's calculation.

The EMU Members with their National Currencies

Denmark, Sweden and the United Kingdom decided not to join the third stage of the EMU and they still use national currencies.¹¹ Let's focus on their correlation to the Eurozone and its individual countries as well. As a benchmark, allowing us to compare our results with rest of the world, the United States of America were chosen. As we can see on the 0, the business cycle of the *United Kingdom* is more synchronized with the American business cycle than with the Eurozone one. The correlation to the Eurozone has even decreased from strong correlation during the 1st analysed period to weak correlation since the 1985. The correlation has especially decreased, from strong to no correlation, with Austria, Germany, Greece and Luxembourg. Smaller drop in the cyclical synchronization was with Netherlands. On the other hand, the cyclical synchronization with Finland has increased and these two business cycles are now strongly correlated. The synchronization with Italy has increased as well, but not as significantly as with Finland. As we can see on the 0, the drop in correlation to the Eurozone was particularly obvious during the 80's and 1st half of the 90's, since that we observe unambiguous increase of the correlation.

¹¹ As we mentioned hereinbefore we work with the EU-15.

Figure 13

The Business Cycle Correlation of the UK, Denmark and Sweden During 1960 – 2008 (HP filter for $\lambda = 1\ 600$)

	AT	BEL	FIN	FRA	GER	GRE	IRL	ITL	LX	NL	PT	ES	USA	EA
1960 – 2008														
UK	0.32	0.35	0.44	0.48	0.30	0.41	0.24	0.23	0.43	0.32	0.41	0.25	0.60	0.43
DK	0.40	0.37	0.15	0.33	0.49	0.44	0.11	0.19	0.41	0.37	0.19	0.16	0.51	0.45
SW	0.38	0.59	0.69	0.42	0.35	0.11	0.36	0.34	0.35	0.44	0.14	0.29	0.06	0.48
1960 – 1984														
UK	0.46	0.33	0.16	0.51	0.55	0.55	0.23	0.14	0.63	0.42	0.43	0.21	0.61	0.54
DK	0.47	0.44	0.17	0.49	0.62	0.56	0.08	0.15	0.55	0.37	0.30	0.24	0.54	0.57
SW	0.29	0.47	0.58	0.14	0.38	0.05	0.05	0.15	0.37	0.42	-0.12	0.01	-0.12	0.33
1985 – 2008														
Y	0.00	0.39	0.82	0.44	-0.24	-0.02	0.28	0.49	0.06	0.09	0.36	0.33	0.61	0.23
DK	0.24	0.25	0.14	0.11	0.24	0.08	0.17	0.30	0.14	0.38	-0.05	0.03	0.44	0.24
SW	0.54	0.75	0.80	0.74	0.31	0.27	0.65	0.76	0.33	0.50	0.58	0.66	0.46	0.69

Source: OECD (1960 – 2008); author's calculation.

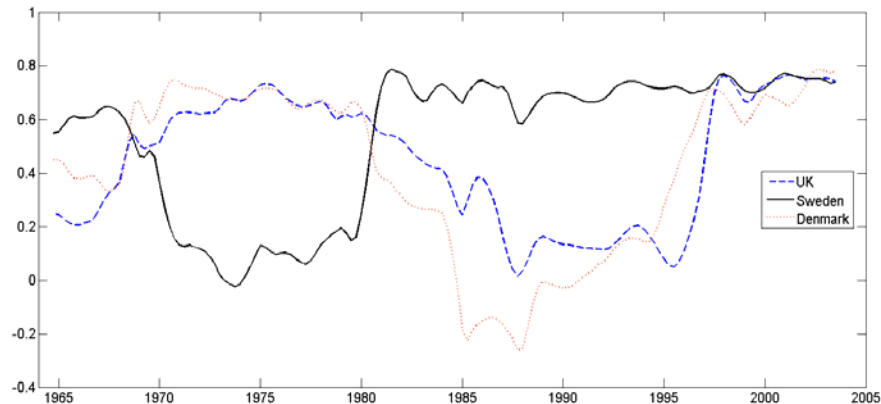
Synchronization of the *Danish* business cycle to the Eurozone cycle is almost the same as it was between the United Kingdom and the Eurozone. Even the development over time is almost the same. Comparing the two analysed periods we see, that the cyclical synchronization was higher in the 1st analysed period (see 0). The most significant drops in correlations of business cycles were with France, Germany, Greece, Luxembourg and Portugal. The 0 shows that the development of the Danish correlation to the Eurozone was almost the same as the development of the British one. The same was also the drop during the 80's and beginning of the 90's.¹²

Business cycle synchronization of Denmark and the United Kingdom both to the Eurozone and individual countries are the lowest among the all EU 15 countries, they are even lower than the correlations of the periphery countries. This is due to the drop in correlation with the Eurozone since the 2nd half of the 80's.

The last one of this trio is *Sweden*. The development of the cyclical synchronization of Sweden was quite different when compared with the United Kingdom and Denmark. There was also drop in the correlation to the Eurozone, but in the different time – during the 70's. Since the 80's we observe rise in the correlation and from that time the cyclical synchronization is high. The 0 confirms these results as we see there higher correlations to the Eurozone and individual countries as well in the 2nd analysed period. Synchronization increased especially with France, Italy, Portugal and Spain. The correlation to the USA has increased as well.

¹² The same drop of the correlation to the Eurozone happened also to the United States of America.

Figure 14
Moving Correlations of the UK, Denmark and Sweden to the Eurozone



Note: The length of moving correlations is 40 quarters (10 years).

Source: OECD (1960 – 2008); author's calculation.

Generally these three countries has, together with Finland, the highest correlations to the USA since the 1985. Their most important trading partner within the EU is Germany. The trade with each other is important for these countries. The UK is among the most important trading partners of both Sweden and Denmark. Although closer trade relationship is between Sweden and Denmark, the development of the Danish and the British business cycles is closer.

Test of Significance of Correlation Coefficients

To support our results we performed the test of significance of correlation coefficients. The correlation coefficients of individual countries with the Eurozone were examined using t-statistics. The results of these tests are shown in the following 0. As you can see, all correlations for the whole analysed period (1960 – 2008) are statistically significant at the 5% level of significance.

We also examined the significance of the correlation coefficients for the 1st and 2nd part of our analysed period. There were two cases in which the statistical significance was not proved. The first one is the correlation of the Irish and the Eurozone business cycles in the 1st analysed period. Anyway there was measured no correlation of these business cycles so this result has no impact on our analysis. The same goes for the correlation between the USA and the Eurozone since 1985 that was as well not proved.

Figure 15

Significance of Correlation Coefficients of Each Country with the Eurozone

	Correlation to the Eurozone During								
	1960 – 2008			1960 – 1984			1985 – 2008		
	tcrit	tstat	sign.	tcrit	tstat	sign.	tcrit	tstat	sign.
AT	16.36	1.972	yes	10.11	1.984	yes	16.50	1.986	yes
BEL	20.86	1.972	yes	12.97	1.984	yes	19.25	1.986	yes
FIN	8.53	1.972	yes	6.11	1.984	yes	6.22	1.986	yes
FRA	23.24	1.972	yes	14.62	1.984	yes	20.80	1.986	yes
GER	22.66	1.972	yes	17.69	1.984	yes	13.85	1.986	yes
GRE	7.43	1.972	yes	5.67	1.984	yes	5.09	1.986	yes
IRL	6.88	1.972	yes	1.75	1.984	no	11.10	1.986	yes
ITL	13.96	1.972	yes	9.1	1.984	yes	14.91	1.986	yes
LX	14.55	1.972	yes	12.59	1.984	yes	7.56	1.986	yes
NL	12.03	1.972	yes	7.1	1.984	yes	12.85	1.986	yes
PT	11.25	1.972	yes	6.71	1.984	yes	11.93	1.986	yes
ES	11.05	1.972	yes	5.34	1.984	yes	15.73	1.986	yes
USA	5.37	1.972	yes	4.92	1.984	yes	1.66	1.986	no
UK	6.68	1.972	yes	6.43	1.984	yes	2.29	1.986	yes
DK	6.99	1.972	yes	6.85	1.984	yes	2.34	1.986	yes
SW	7.65	1.972	yes	3.47	1.984	yes	9.15	1.986	yes

Note: Tstat – t – statistics, tcrit – critical value (significance level 5%), sign. – significant – if yes, then the correlation coefficient is statistically significant.

Source: OECD (1960 – 2008); author's calculation.

Conclusion

We can estimate an existence of the EMU core on the basis of our analysis. We suppose that Belgium, France and Germany form the core of the Economic and Monetary Union. Germany has the key role within this core. It influences the Eurozone business cycle significantly. Countries with close economic relation to Germany demonstrate increasing correlations of their business cycles to the whole Eurozone.

We are also able to define the EMU periphery. We classify right three countries among the periphery – Greece, Finland and Ireland. Ireland has underwent an obvious convergence of its business cycle correlation to the Eurozone. On the other hand we observed almost no long term convergence of the Greek and the Finish cycles to the Eurozone. The decrease of the Greek business cycle synchronization with the Eurozone might imply divergence from its countries. The divergence started at the 2nd half of the 90's when countries were preparing themselves to the EMU membership. Reason of this is probably inside the Greek economy.

In this paper we also focused on the business cycle development of the three countries that refused to join the third stage of the EMU creating. The Swedish business cycle is synchronized with the Eurozone. Synchronization of the UK and Denmark with Eurozone has decreased during the 2nd analysed period. This

happened mainly thanks to decrease in correlation with Germany. This confirms the essential role of the German economy within the whole EMU.

We can see that the Eurozone is quite heterogeneous monetary union. Moreover some countries have started to diverge, especially countries with no tight ties to Germany. Having tight ties with Germany is important for countries that will probably join the Eurozone in future. The core countries influences the Eurozone development significantly and hence the monetary policy of ECB probably more fits to these countries. This heterogeneity might jeopardize stability of the whole Eurozone.

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