

# CLUSTERING OF EU COUNTRIES BEFORE AND DURING CRISIS

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## Abstract

This paper is focused on current account analysis of EU member countries. Sustainable current account deficit can be a good predictor of country troubles such as monetary and debt crisis. With higher current account deficit domestic households are financing their consumption by foreign capital and thus the national debt is increasing. There are many different countries in the EU, but by application of cluster analysis on current account determinants we are able to make some groups of countries, which are closer in respect of these attributes and evaluate these groups on the basis of the risk level. We compare the situation before crisis (year 2008) and after/during crisis (year 2011) and compare these two period of time. We discuss the changes in clustering of EU countries during the period of structural changes. It is possible to say, that the crisis changed composition of the clusters and some, let say, developed countries (like Italy, Spain, Portugal) fell into “trouble” cluster in 2011.

**Key words:** Current account, cluster analyses, stability, economic crisis

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## Introduction

This paper is considered with stability of European Union countries. The main focus is concentrated on the current account and its possible determinant. With higher current account deficit domestic households are financing their consumption by foreign capital and thus the national debt is increasing. All chosen variables except GDP per capita and GDP growth are expressed as a share of GDP. The chosen variables are **Current account, Fiscal balance, HICP, GDP per capita, openness (expressed by share of export to GDP), Foreign direct investments, Real effective exchange rate, International reserves, GDP growth, Credit flow, Interest rate and Net international investment position**. The data are mined from database Eurostat.

We analyse EU member countries by these variables with usage of cluster analysis in two different years. The first one is 2008 as a situation before crisis and the second is 2011. We try to capture the impact of current economic crises on the cluster composition and the development of chosen variables.

The remainder of the paper is organized as follows. Chapter 1 describes a method used for our analysis, namely Ward method. Next chapter describes chosen characteristics and discuss the possible impact of the characteristics on the current account. Third chapter summarizes the results of analysis and the last section is conclusion.

## 1 The method of cluster analysis

In order to create clusters of objects we used hierarchical cluster analysis. Namely we used **Ward method (Ward-Wishart method)** which solves clustering by minimalizes of heterogeneity of the clusters. By the other words the method creates cluster by maximization intragroup homogeneity. *The Ward criterion* indicated by  $G_1$  measures homogeneity of the clusters by the intragroup square sum of deviations from cluster average.  $G_1$  is defined by relationship

$$G_1 = \sum_{h=1}^k \sum_{i=1}^{n_h} \sum_{t=1}^m (x_{hit} - \bar{x}_{ht})^2, \quad (1)$$

where  $x_{hit}$  is a value of  $i$ -th object,  $t$ -th variable in  $h$ -th cluster

$\bar{x}_{ht}$  is average value  $t$ -th variable in  $h$ -th cluster

$n_h$  is number of objects in  $h$ -th cluster

$m$  is number of variables, which characterize the objects (EU countries)

$k$  is number of clusters

The criterion for clustering originates from the idea of minimal increase of Ward criterion,  $G_1$ , in each cluster. We can this idea formalize by equation

$$\Delta G_1 = \sum_{i=1}^{n_g} \sum_{t=1}^m (x_{git} - \bar{x}_{gt})^2 - \left( \sum_{i=1}^{n_h} \sum_{t=1}^m (x_{hit} - \bar{x}_{ht})^2 + \sum_{i=1}^{n_{h'}} \sum_{t=1}^m (x_{h'it} - \bar{x}_{h't})^2 \right). \quad (2)$$

Ward method tends to eliminate small clusters and create cluster with approximately similar size. It is used only together with square of Euclidean distance. The calculation of this distance  $D$  between  $i$ -th and  $j$ -th object is based on Pythagoras

$$D_E(\mathbf{x}_i, \mathbf{x}_j) = \sqrt{\sum_{t=1}^m (x_{it} - x_{jt})^2}, \quad (3)$$

where  $\mathbf{x}_i$  represents  $i$ -th object a where  $\mathbf{x}_j$  represents  $j$ -th object.

We used many procedures in order to set optimal value of clusters. These procedures were based on knowledge of economic theory, selection of proper criteria and usage of dendrogram. The affiliation of the countries into created cluster was made by system IBM SPSS version 20.

## 2 Chosen characteristics

In order to do cluster analysis it is necessary to identify some characteristics which will describe the cluster. In this paper we have chosen characteristics which are consider with stability of EU countries in the international field. At the end we have chosen 12 different variables.

There are many papers consider with the determinants of the current account. **S. N. Brissimis, G. Hondroyannis, C. Papazoglou, N. T. Tsaveas, and M. A. Vasardani (2012)**, investigated the impact of many variables on current account of Greece economy in period of structural changes. **E. Clower and H. Ito (2011)** tested persistence of current account and its determinants on the panel of 70 countries. Other authors were focus on similar theme, namely **M. Kandil** in the paper “Determinants of cyclicalities in the current account balance: Evidence from advanced and developing countries” (2012), **C. Calderon, A. Chong, and N. Loayza** in the paper “Determinants of Current Account Deficits in Developing Countries” (2002), **P. Zanghieri and G. Rossini** in the paper “Current Account Composition and Sustainability of External Debt” (2007), **P. Zanghieri** in the paper “Current Account Dynamics in New EU Members: Sustainability and Policy Issues” (2006) and for example **D. K. Das** in the paper “Determinants of current account imbalances in the global economy: A dynamic panel analysis” (2012).

**C. Kerdrain, I. Koske, and I. Wanner** observed the efficiency of structural reform on current account imbalances. **M. Obstfeld** in the article “Does the Current Account Still Matter?” (2012) discuss the problematic of net investment international position as a main indicator of country’s troubles.

**R. Kok and B. A. Ersoy (2012)** analysed the determinants of foreign direct investments.

## 2.1 Characteristics description

All characteristics except GDP growth and GDP per capita are expressed as a share of GDP in order to better comparison between different countries.

### *Current account*

The current account of balance of payments is composed by trade balance (the difference between exported and imported goods), Balance of services (the difference between exported and imported services), Income balance (the payments to residents received from non-resident subjects minus the payments paid to non-resident subjects in residential country) and current transfers.

We can describe the current account composition on data from Czech Republic. The trade balance and the Balance of services are positive. It means that Czech Republic has higher export of its products than import of goods from abroad. But the current account is negative. It is caused by the negative Income balance. Income balance is closely connected with the Foreign direct investments (FDI). FDI as a foreign capital in Czech companies generate profit and its undivided part is considered as another investment. In balance of payment the undivided profit is accounted in Income balance as a debit. So the higher FDI, the higher is deficit of income payments.

Foreign investor will invest his money in country till he will believe that the country is stable. We touch here the problematic of sustainable current account deficit. If the deficit is too high, investor will stop invest into countries companies and it can lead to recession.

We can describe the current account from macroeconomics identity as a difference between savings and investments in given country. As it is known, savings are derived from consumption and the relationship between consumption and savings is negative. The higher consumption, the lower are savings. Consumption is affected by permanent income (the theory of permanent income) and the relationship is positive. If permanent income grows, consumption will also grow and it could lead to deficit of current account due to decreasing savings.

There are many different countries in EU with different level of development. It is supposed that less developed countries will reached higher deficit of current account. It can be explained by the theory of convergence. The developing countries catches up the developed countries as the less developed ones grow faster mainly due to sharing technologies with developed countries.

We can say that current account deficit is not bad, because this country can profit from international trade and it can lead to higher growth of economy. But the deficit should not be too high.

There are some exceptions. For example USA as a developed country has considerable deficit of current account. It is given by its highly developed financial sector. Foreign investors invest their money in many US companies which are traded on stock exchange. On the other hand China, which is still considered as a developing country, has surplus of its Current account. There are considerable amount of the free financial resources which are allocated in more developed countries such as USA.

Current account is closely connected with stability of country. And the stability can be expressed by same macroeconomics determinants. We have chosen twelve variables, which are supposed as a determinants of current account or these which are associated with stability of country. The current account is one of them and in we describe other variables more briefly in following text.

#### *Fiscal balance*

The fiscal balance is one of the more important determinants of stability of country. Higher fiscal deficit caused by decrease of taxes or increase of government spending can lead to increase of consumption. And this fact influences the current account negatively. The opposite reaction is also possible. If there are subjects in economy which are well informed and they are forward looking, these subjects will know that the taxes will have to increase in future period (because of sustainable fiscal deficit). They will increase its savings in recent period at the expense of current consumption. And the effect on the current account will be positive.

In the international point of view, the higher fiscal deficit can discourage the foreign investors which will stop to believe in stability of the country as it was seen in Greece.

#### *GDP per capita*

We have also included the parameter of output of economy. In order to compare GDP between countries in EU we have divided the GDP by population in each country. The effect on Current account can be dual again. If we will suppose that the increase in the output and thus increase in the income will be permanent, the current account will go to deficit. We have mentioned the theory of permanent income above. The temporary increase of income will have the opposite effect.

#### *GPD growth*

GDP growth is situated here as a proxy of productivity. Higher productivity will result in higher income and the impact on current account will be the same as in the case of GDP per capita. There is a question again if the increase in productivity and thus in income is permanent or temporary.

#### *Credit flow*

The credit flow serves as a proxy of development of financial sector. The higher credit flow, the higher development of financial sector is. Higher credit flow can affect the current account negatively by increase of investment (if we have on mind the equation from macroeconomic identity). The negative reaction can be also caused by increase of consumption (and by decrease of savings).

#### *Interest rates*

This variable is very close to the credit flow mentioned above. Lower interest rates means that credits are cheaper and easily reachable. The lower price of credit, the higher credits are. Interest rates are one of the monetary policy tools. In the times of recession, central banks decrease interest rates in order to boost economy by higher investments as it can be seen in present.

#### *Net international investment position*

The net international investment position (NIIP) is a difference between financial assets and financial liabilities. The countries with negative NIIP have more liabilities than asset and are thus debtor on international market. There are not too much creditors in EU. Between creditors belong Belgium, Denmark, Germany, Luxemburg, Malta, Netherland and Finland. The biggest debtors are Hungary and Portugal with more than 100% of index  $NIIP/HDP*100$ . Higher debt can discourage investors to invest their money into these countries.

#### *Inflation rate*

The rate of inflation expressed as a HICP is added into the analysis as a proxy of internal price stability of the countries. The higher inflation rate, the higher uncertainty is. And again higher uncertainty can caused stop of flow of international capital into country. Higher inflation also depreciates savings and residents will rather spend its money. It can lead to deficit of current account.

#### *Openness of economy*

The openness of economy is measured as a share of export to GDP. The country which is open more has higher possibility to get loan from abroad. This imported capital increases consumption and thus causes deficit of current account.

### *Foreign direct investments*

Foreign direct investments (FDI) represent foreign capital in residential companies with at least 10% equity holding. As we have mentioned above the current account is closely connected with FDI. The determinants of FDI are described above.

### *Real effective exchange rate*

The real effective exchange rate (REER) is used to determine an individual country's currency value relative to the other major currencies in the index, as adjusted for the effect of inflation. REER is expressed as an index, where 2005 is 100%. Depreciation makes imported goods and services more expensive and on the other hand makes export cheaper.

### *International reserve*

Holding of international reserve presents another tool of central bank monetary policy. The countries, central banks respectively, with higher amount of international reserves have a more change to intervene on the market and solve serious problems. For example Czech national bank (CNB) decreased interest rate on historical minimum and this tool is now impossible to be used to boost economy. CNB so started to speak about intervenes on foreign exchange market.

## **3 The results of an analysis**

We have been comparing two situations in two different years. The first year was chosen year 2008 as a situation before crisis and the second one was chosen 2011 as a situation during/after crisis. The claim is to compare the two year and find out the differences in clusters composition.

We can divide the countries in the EU into five different clusters. Cluster number 4 and number 5 contains only one country, two countries respectively (cluster number 4 contains Netherlands and Malta). We will so analyse only the first three one. The detail of composition is shown in following table.

**Table 1 The clusters composition**

cluster	1		2		3		4		5	
Years	2008	2011	2008	2011	2008	2011	2008	2011	2008	2011
Cluster composition	Denmark	Belgium	Belgium	Bulgaria	Bulgaria	Greece	Luxembourg	Luxembourg	Netherlands	Netherlands
	Germany	Denmark	Czech Republic	Czech Republic	Estonia	Spain		Malta		
	France	Germany	Ireland	Estonia	Latvia	France				
	Italy	Ireland	Greece	Latvia	Hungary	Italy				
	Austria	Cyprus	Spain	Lithuania	Romania	Portugal				
	Finland	Austria	Cyprus	Hungary		Slovenia				
	Sweden	Finland	Lithuania	Poland		United Kingdom				
	United Kingdom	Sweden	Malta	Romania						
			Poland	Slovakia						
			Portugal							
			Slovenia							
			Slovakia							

SOURCE: OWN CALCULATIONS

### 3.1 The cluster number one

We can say that there is one cluster of countries, which are stronger or more stable in both years. But the composition of countries is little bit different as it can be seen in table above. We can mentioned that this cluster of countries had current account surplus, smaller fiscal deficit, lower interest rates and these countries are creditors on international financial market on average.

The interesting thing is the values of credit flow. While the credit flow in 2008 was the smallest one, in 2011 this characteristic grew and became the highest. The problems caused by crises lead to restriction in lending in less stable countries. This movement can be also seen in FDI. FDI in this cluster grew in 2011 and became the highest one in comparison with other two clusters. The uncertainty could cause that investors left the countries with problems and reallocated their resource into saver investment opportunities.

The analysis revealed that Cyprus and Ireland belonged into group of the countries in the cluster number one in 2011. This result can be surprising. Both countries were rather debtor on international financial market and had higher fiscal deficit. But the Ireland had surplus of



the Current account and higher GDP per capita, Cyprus had high credit flow and both countries have higher amount of FDI in 2011.

### 3.2 The cluster number three

We can also say that there is a cluster of countries which are more threatened by some kind of problems. And as well as in the case of first cluster the composition is different. This cluster was composed by countries from Western and South Europe in 2011, whilst in 2008 there were countries from Eastern Europe. The current account deficit is higher, fiscal balance deficit is considerably high and the countries are rather debtors on international financial market on average.

The credit flow decreased in 2011 as well as the amount of FDI. The possible reasons are mentioned above. The average value of GDP growth was negative in 2011.

Czech Republic belonged to the cluster number 2 in 2008 and 2011. This cluster can be considered as an average group of countries.

### 3.3. Changes in characteristics

We can conclude changes in the average values of all characteristics during crisis. The comparison is shown in following table. The table describes the average values in all analysed countries.

**Table 1 Changes in characteristics**

Characteristics	Years		Change	
	2008	2011	absolute	relative
Current account	-4.94	-0.49	4.45	90.10%
Fiscal balance	-2.11	-4.01	-1.91	-90.51%
HICP	112.27	120.06	7.78	6.93%
HDP per capita	0.10	0.09	0.00	-1.73%
Openness	59.07	63.99	4.92	8.33%
FDI	0.57	0.64	0.07	12.09%
REER	105.74	106.89	1.15	1.09%
International reserves	0.08	0.11	0.04	46.05%
GDP growth	1.28	1.93	0.65	50.72%
Credit flow	15.76	3.25	-12.50	-79.36%
Interest rates	9.56	9.31	-0.24	-2.56%
NIIP	-0.33	-0.32	0.01	3.54%

SOURCE: OWN CALCULATIONS

The Current account deficit decreased by 90% to -0, 49 from -4, 94. Another substantial change was seen at Fiscal balance. The deterioration of fiscal balance was from -2, 11 in 2008 to -4, 01 in 2011. Due to uncertainty the amount of credit flow decreased by 79, 36%.

The increase of GDP growth in the year 2011 in comparison with the 2008 can be caused by so called base effect. The GDP decreased in most of European countries during crisis and the base from which is GDP growth (previous year) calculated in 2011 is lower. That is why the GDP growth accelerated in average in 2011.

### **Conclusion**

The claim of this paper was to investigate the impact of economic crisis on European Union countries. For this purpose we used cluster analysis where characteristics were considered with the determinants of current account. By the pool of 12 characteristics we divided the EU countries into 5 clusters where 4<sup>th</sup> and 5<sup>th</sup> cluster consisted only one, respectively two countries. Because of this reason we analysed only 3 remaining clusters. The situation before crises was expressed by the year 2008 and the situation after/during crisis was expressed by the year 2011.

Cluster number one represents countries which were more stable. Between these countries belonged Denmark, Germany, France, Italy, Austria, Finland, Sweden and UK in 2008. The situation had changed because of crisis. Belgium, Cyprus and Ireland jointed this group. The addition of Cyprus and Ireland is surprising if we keep on mind the circumstances in these countries. On the other hand Italy, France and UK left this group.

The cluster number three can be considered as a less stable group of countries. We could find here Bulgaria, Estonia, Latvia, Hungary and Romania in 2008. The economic crisis affected also this cluster. In 2011 we could find here countries like Greece, Spain, Italy, France, Portugal, Slovenia and UK. Countries Greece, Spain, Italy and Portugal faced and faces debt crisis and analysis correctly jointed these states together.

Other countries, such as Czech Republic, belonged into let say medium group. This group also consisted the biggest number of countries.

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