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Analysis of European Countries' Vulnerabilities through Statis Methodology

by

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BIOGRAPHICAL NOTE

Catarina Lourenço Soares was born on 25th of August 1990 and is a native of Pedroso, municipality of Vila Nova de Gaia, Oporto district. She finished the secondary school in the scientific-technical course of account management, economics field, in Colégio Internato dos Carvalhos. However, the feeling that her journey was not finished together with a willingness to learn and improve her skills, made her join the Porto School of Economics in the degree of economics, without truly knowing specifically what an economist was. She graduated in Economics, in 2011, and with a passion for this area, joined the Master's Degree of Economics in the specialization of Economic Analysis.

She has complemented her higher education with other activities no less important to her personal development. She is fluent in English and has knowledge of Spanish. But as in these languages only the words change, she embraced another challenge - Mandarin, not for professional reasons but for the sheer challenge. Currently, she is taking an internship at Deutsche Bank and teaches Maths and English tutorials.

This dissertation represents the conclusion of one more stage of my life with a sense of mission accomplished…

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ABSTRACT

The subprime crisis, originated in the United States of America in August 2007, quickly became a global financial crisis, affecting a large number of countries, including mainly the European economies. Europe also faces a crisis of public debt, particularly since the beginning of 2010, having the Greek debt served as a "fuse".

In this economic context, it becomes imperative to identify, analyse and discuss the main economic weaknesses that contribute to the widely and differentially smite of the European countries.

In this sequence, this study aims to know which the main vulnerabilities of these countries are and what conclusions can be drawn. For this purpose, inspired by the early warning systems, thirty-one variables are analysed through the Statis methodology. This methodology allows us to analyse simultaneously multiple data tables, determining a common structure among the European countries.

Accordingly, we concluded that the years 2002-2004, 2006-2007 and 2009-2011 have, in general, been identified as the most similar, seeming the year of 2008 to be a "turning point" between them. In this sense, the Statis methodology highlighted the economic developments in the period 2002-2011 and allowed to obtain interesting conclusions about what have twenty-seven European countries in common, after all, and what differentiate them to each other.

CONTENTS

Tables

Figures

PREFACE

Issing (2011), page 6, states that *"(...) the crisis was anything but a surprise when it arrived, it was, so to speak, a "crisis foretold"*." In this sequence, which vulnerabilities do the countries of the European Union, the largest economic and political union in the world, have in their economies? What have these countries of similar and different? What binds twenty-seven different economies? Why is the present global financial crisis affecting them so differently? Due to its actuality and scientific relevance, this study focuses on this issue.

Therefore, through the analysis of the vulnerability indicators present in early warning systems, which are intended to predict the occurrence of a crisis in a certain time horizon, we want to know which the main vulnerabilities of European countries are and what conclusions can be drawn. For this purpose, a methodology of conjoint analysis of data tables is used – the Statis methodology - introduced in L'Hermier des Plantes (1976) and later developed by Lavit (1988) and Lavit *et al.* (1994). This methodology allows to analyze simultaneously multiple data frames, determining a common structure between individuals and/or observed variables.

Subsequently, Chapter 1 is about the recent global financial crisis. It also provides a brief description of the response given by the economic policy, the similarities that can be found with previous crises as well as between the U.S. economy and European countries' economies. In the end, this chapter focuses on the early warning systems, models that inspired this thesis. Here is made a small description of their goals and developments.

Chapter 2 begins with a brief reference to Principal Components Analysis methodology which is the basis methodology of the Statis. Then the Statis methodology is described along with a presentation of the data here used and a preliminary analysis of it.

The chapters 3, 4 and 5 exploit the conclusions that can be drawn by the application of Statis and Dual Statis methods to variables collected for the twenty-seven European countries during the period 2002- 2011, and which feature macroeconomics, public sector, competitiveness, debt and, financial and private sector, respectively. Chapter 6 concludes.

CHAPTER 1

The Recent Global Financial Crisis and Some Considerations About Early Warning Systems

1.1 The recent financial crisis

The recent financial crisis, the first global financial crisis since the Great Depression in 1929 (Claessens *et al.*, 2010) and now considered the most harmful since it[1], is in the words of Rose *et al.* (2012, pg. 3) *"notable for a number of reasons including, most obviously, its severity and speed"*. Thus, the subprime crisis started in the U.S. in 2007, quickly became a global crisis, leading to a worldwide recession (Bordo *et al.*, 2010). Schwartz (1987) warned that the origin of a financial crisis is a banking crisis and this crisis is not an exception (Bordo *et al.*, 2010).

Global growth, stable inflation, productivity growth and low interest rates; it was, according to the International Monetary Fund (IMF, 2009), the world economic context in the years preceding the crisis. However, fairy tales do not exist in real life, and therefore, the high global growth obscured what is called as global imbalances. The current account surpluses of the Asian countries (especially China and oil-exporting countries) triggered a US' current account deficit (Eichengreen, 2004; Reinhart *et al.,* 2008b and Diamond *et al.,* 2009) and contributed to low interest rates (IMF 2009).

The high demand in the U.S. led to the creation of new financial instruments riskier than what was expected (IMF, 2009), contributing to a greater fragility of the financial system. Some of these instruments were used to finance the bubble in real estate and were acquired by investment banks and other financial institutions, against short-term debt. This is considered one of the main causes of the crisis (Diamond *et al.*,

[1] Studies such as Bordo *et al*. (2010) report the Great Depression as the worst crisis happened so far, getting the recent financial crisis in the second place. It is, however, worth stressing that some studies may have truncate errors, due to effects of the recent crisis in the years following the year of the study.

2009). However, Rose *et al.* (2012) argue that the weak regulation was not only present in the securitization and indicates the poor financial regulation, not only in U.S., but also internationally. This is also advocated by IMF (2009) which adds failures in macroeconomic policies and a dispersed supervision.

But how has the recent financial crisis developed?

1.1.1 From the U.S. subprime crisis to the global crisis

In the US, in the years preceding the crisis, there was a sharp increase in house prices and other asset markets, especially in stock market (Reinhart *et al.,* 2008b and Rose *et al.,* 2012). This was triggered by expansionary monetary policy conducted by the Federal Reserve and other incentives from the government to house purchase (Reinhart *et al.,* 2008b; Diamond *et al.,* 2009 and Bordo *et al.,* 2010).

These booms in real estate and stock market were also associated to the fast credit growth (Claessens *et al.,* 2010), as in previous crises (Reinhart *et al.,* 2008b), but this time concentrated in a market: the subprime (Claessens *et al.,* 2010). The mortgage market was very dependent on the houses' prices, as they serve as a collateral asset, giving the capital needed to pay the loan by its owner, serving as guarantee (Claessens *et al.,* 2010 and Diamond *et al.*, 2009). However, these mortgages were also granted to subprime borrowers, i.e., borrowers with low means of payment, creating investment portfolios very exposed to a price decline (Claessens *et al.,* 2010).

The increase in credit and the innovation generated by the financial sector contributed to an increase in household debt, particularly after 2000 (Claessens *et al.,* 2010). This made them vulnerable to macroeconomic conditions, as the slowdown in economic activity, decline in house prices and changes in credit conditions, and was responsible for the transmission of the crisis from the financial sector to the real sector, hampering the response of the political authorities (Claessens *et al.,* 2010).

The securitization and creation of new financial instruments allowed a credit expansion, but had also increased the fragility of the financial sector, since it contributed to the lack of transparency (Buiter, 2007) and liquidity once house prices began to decline (Claessens *et al.*, 2010). The demand of securities with AAA rating by international investors had propitiated that, with the use of securitization, mortgages could have started to be transacted in the market, making them net (Mortgage-backed

securities - MBS). Thereby, they were transacted with other mortgages from other areas and began to give rise to other instruments, which could subsequently be separated and traded with others (Diamond *et al.*, 2009). Many of these new instruments, such as Asset-Backed Securities (ABS), Collateralized Mortgage Obligations (CMO), Collateralized Loan Obligation (CLO) or Collateralized Debt Obligation (CDO), were evaluated with AAA rating (Diamond *et al.,* 2009 and Claessens *et al.,* 2010). The use of securitization and the use of the "*originate to distribute*" generated agency problems, bringing consequences for final consumers and increasing systemic risk.

This was exacerbated by the gap shown in the rating process. These agencies assessed the instruments based only on the general information collected, ignoring other detailed information about the solvency and credibility, fomenting weak monitoring of the debtors, and giving an underestimation of the financial products' risk (Diamond *et al.,* 2009 and Claessens *et al.*, 2010). Other justifications for the poor assessment, as overconfidence by the rating agencies in relation to their own abilities (Coval *et al.,* 2009) or conflicts of interest (IMF, 2009), are likely to be found in the literature.

The credit boom had also provided another consequence. Transactions which arise out of the banking regulations had also started to grow. The so-called "*shadow banking system*" was comprised by investment banks, hedge funds, money market funds, mortgage lenders and other financial institutions and acted out of banking regulation[2] and without the necessary supervision, contributing to the increase in systemic risk (IMF, 2009), but giving high profits (Claessens *et al.,* 2010).

In the summer 2007, due in part to a contraction in monetary policy, interest rates rose and house prices began to decline, causing defaults especially in subprime or near-prime mortgages (Reinhart *et al.,* 2008b; Claessens *et al.* 2010 and Rose *et al*., 2012). The complexity of these new instruments, besides affecting the liquidity of the market and reducing the securitization, combined with a lack of transparency in the balance sheets of financial institutions, led to adverse selection problems, given the difficulty in recognizing which institutions were "healthy" (Claessens *et al.,* 2010). This was transmitted to other financial and real estate markets in the U.S. and affected the

[2] Different types of financial institutions were regulated differently. Thus, opportunities for regulatory arbitrage had been exploited by the shadow banking system, leading to highly leveraged institutions (IMF, 2009).

interbank market, particularly after August 2007 (Lenza *et al.,* 2010). Additionally, it had a negative effect on consumption, given the leverage of households and the contraction in credit, leading to a decrease in activity and profits of the business sector, rising unemployment, more mortgage defaults and the slowdown of economic activity (Claessens *et al.,* 2010).

The transmission to other countries was boosted by financial integration. As Claessens *et al.* (2010) pointed out, not only had financial integration increased the efficiency and international risk sharing, but it had also eased contagion of international financial shocks. The instruments originated in the U.S. were owned by private investors, institutional and public sectors of many countries, since it seemed to have an attractive combination between risk, returns and liquidity (Claessens *et al.,* 2010 and Rose *et al.,* 2010). In particular to the financial sector, these instruments were very attractive given their profitability, despite their risk[3]. However, since they were new financial instruments, it was difficult to assess whether the profitability offered was excessive given their risk or a premium by inherent risk (Diamond *et al.,* 2009).

The first phase of crisis' transmission was through these direct exposures, causing problems in the U.S. financial system and starting to spread to the European's, evidenced by the problems faced in Germany (IKB in July 2007) and France (BNP Paribas in August 2007) (Claessens *et al.,* 2010 and Rose *et al.,* 2010). The leverage in the financial sector, both in U.S. and in Europe, limited it to absorb losses and provoked a decline in confidence and the increase of risk between counterparties (Claessens *et al.,* 2010 and Rose *et al.,* 2010). Additionally, the credit deterioration caused ratings' declines (Claessens *et al.,* 2010).

The second phase of the crisis' transmission was through the asset market (Claessens *et al.,* 2010). Leveraged financial institutions and with losses due to the decline in the price of ABS, resorted to the market in order to obtain funds, generating liquidity shortages (Davis, 2008 and Claessens *et al.,* 2010), the freezing of the capital markets, further decline in stock prices and exchange rate fluctuations, leading to a

[3] Other reasons were also pointed in the literature for the high demand of these new instruments, despite their risk. Among them, the incentive systems (evaluation of CEOs in accordance with annual profits), internal control and compensation systems (especially in the case of traders), which led to excessive risk taking by traders and managers in order to take advantage of the profitability's differential between the new instruments and other AAA assets (Diamond *et al.,* 2009 and IMF, 2009). Rose *et al.* (2012) and Buiter (2009) also suggest the lack of ethical, moral and quality governance in institutions.

sharp drop in confidence (Claessens *et al.,* 2010). In the summer of 2008 as referred in Mishkin (2011, pg. 5), the crisis seemed to be controlled, since *"the subprime sector constituted only a small part of the capital market and the losses in MBS, although substantial, appeared to be managed"*. On 15th September 2008, the fourth largest U.S. investment bank - Lehman Brothers - declared bankruptcy, due to subprime market's exposure (Mishkin, 2011), giving a systemic dimension to the crisis.

The third phase of the crisis' transmission was due to concerns about solvency after this event (Claessens *et al.,* 2010). Mishkin (2011) and Lenza *et al.* (2010) pointed the near collapse of AIG on 16 September 2008, the pursuit of the Reserve Primary Fund on the same day and the difficulties in approving the Trouble Asset Relief Plan (TARP) in the U.S., as causes that, in addition to the bankruptcy of Lehman Brothers, had increased turbulence in financial markets and turned the subprime crisis global.

These events highlighted the excessive risk taking, the fragility and lack of transparency of the financial system (Mishkin, 2011). The high losses of financial institutions, forced them to deleverage, increasing the sale of assets, encouraging more asset price declines and the need for recapitalizations (Claessens *et al.,* 2010). Heightened the tensions in financial markets, mainly in money market (Lenza *et al.,* 2010), the spreads of interest rates of the euro, dollar and pound sterling rose to historic levels (Lenza *et al.,* 2010 and Mishkin, 2011) and confidence has globally reduced dramatically (Claessens *et al.,* 2010).

The crisis also spread through the real channel. As Bordo *et al.* (2010, pg. 4) highlighted *"international crises are inevitably associated with recessions"*. Enhanced by the decline in demand in many advanced economies, given the recession in these countries, and the deterioration of international trade, exports declined, leading to a worldwide recession (Claessens *et al.,* 2010 and Bordo *et al.,* 2010).

1.1.2 The response of economic policy

Different monetary policy instruments were used by Central Banks in response to the economic recession which has arisen, especially, after the collapse of Lehman Brothers, including standard and non-standard measures (Lenza *et al.,* 2010). In some periods it was also possible to find concerted actions between them. Some of these measures are highlighted below.

Before Lehman Brothers' bankruptcy, the authorities clashed with problems as the reduction of confidence, increase in risk aversion and difficulties in obtaining liquidity. Thus, the interventions of the European Central Bank (ECB), the Federal Reserve and the Bank of England, aimed to provide liquidity to the banking sector and to support banking intermediation in the money market (Lenza *et al.,* 2010). The ECB allowed the Euro Area' banks to mobilize the amount of liquidity required and conducted additional refinancing operations (Lenza *et al.,* 2010), even though continuing to pursue its strategy of inflation targeting (Eichengreen, 2012). The Bank of England increased the list of eligible assets, including ABS, and the maturity of some operations. Additionally, it launched the Special Liquidity Scheme, which allowed a swap between illiquid assets for Treasury Bills up to three years. The Federal Reserve provided additional liquidity through its normal operations and increased the maturity of discount window operations. It also launched unconventional measures, such as the development of the Term Auction Facility (TAF) and the possibility of purchasing Treasury Securities with illiquid assets as collateral. Additionally, some financial institutions had to be rescued, as Bear Stearns which failed to have access to short-term financing or in converting their long-term assets at a fair price, and was bought by JP Morgan (Lenza *et al.*, 2010).

After the collapse of Lehman Brothers more interventions were needed (Claessens *et al.,* 2010), given the increase in spreads in the money market (Lenza *et al.,* 2010). Liquidity and solvency problems worsened and the price of financial institutions and companies declined, causing impairment losses. Banks became reluctant to lend, either by credit risk, by maintaining sufficient liquidity to them or to seize possible investment opportunities, requiring the intervention of central banks and guarantees provided by governments (Diamond *et al.,* 2009).

The balance sheets of central banks had expanded as well as their compositions (Lenza *et al.,* 2010). Bailouts were needed, as the insurer AIG and European banking groups Fortis and Dexia, and reorganizations, as in the UK banking sector (Claessens *et al.,* 2010 and Lenza *et al.,* 2010). Other measures were taken by central banks in addition to the cut in the reference interest rates.

The ECB adopted measures to enhance credit, as liquidity-providing in longer-term, in fixed rate with full allotment or in foreign currency, expanded the list of eligible assets and launched a program to buy mortgage bonds (Lenza *et al.,* 2010 and

Eichengreen, 2012). The Federal Reserve, through TAF conducted loans and began to remunerate bank reserves, launched programs to purchase assets and carried out swaps with other central banks, among others (Lenza *et al.,* 2010). The Bank of England increased the purchase of securities, launched programs with longer-term maturities and banks increased the use of the deposit facility (Lenza *et al.,* 2010). Central banks of emerging countries also had to face problems, given the trade-off between the increase of liquidity and capital outflows (IMF, 2009).

All these crises' responses caused concerns about the possible excess of liquidity in the financial market and inflation. However, in the opinion of Mishkin (2011), the loans provided by the Central Banks were at a higher rate than the market and the low confidence on the economy contributed to the reduction of the liquidity in excess. Mishkin (2011) reported another problem: the increase in the size of banks (some caused by mergers and acquisitions), the bailouts of Bear Stearns and AIG, and the recession caused by the collapse of Lehman Brothers, led to the increase in the number of institutions "*too-big-to-fail*". This can cause excessive risk-taking by institutions (Mishkin, 2011), besides it exacerbates the economic situation of a country if a rescue is needed (Demirguc-Kunt *et al.,* 2009 and Mishkin, 2011).

The crisis had also led to a response via fiscal and structural policies. Nauschnigg *et al.* (2011) describe several policies used in Europe. Programs to assess vulnerabilities in the financial sector and measures to improve financial supervision are examples of policies used before the bankruptcy of Lehman Brothers. After its collapse, initiatives were launched to support the financial system and the Economic Recovery Plan was launched in order to optimize the policies adopted by the European Union, in which guidelines for national policies were included, among others.

After the beginning of the sovereign debt crisis, due to fears of Greece's default, loans were granted, fiscal consolidation programs agreed on, the Stability and Growth Pact reinforced, supervisory authorities created and the European Financial Stability Facility (to be replaced by European Stability Mechanism) created, among others.

The economic downturn, the bailouts and fiscal stimulus had a large budgetary impact in many countries (Mishkin, 2011). As Reinhart *et al.* (2009) and Mishkin (2011) pointed out, after a financial crisis there was a considerable increase in public debt, increasing the risk of a sovereign default. Mishkin (2011, pg. 24) also states that

"having public accounts in order will be a top priority for governments all around the world."

But, using the recognized words of Reinhart and Rogoff (2008a) "*this time is different*" or as said by Bordo *et al.* (2010, pg. 3) "*the description of the recent crisis leaves a feeling of deja vu*"?

1.1.3 This crisis' similarities with previous crises and among countries involved

There are several similarities liable to be found between this crisis and previous crises, particularly in the evolution of home prices, market asset prices, current account, GDP, public debt and financial liberalization (Reinhart *et al.* 2008b).

In the study of Reinhart *et al.* (2008b) it can be seen that there is a sharp increase before the crisis in housing prices and in the stock market, similar to previous crises. The increase of house prices even exceeds the five major crises[4] and the increase in real terms in the price of stock market is also higher than the "*Big Five*" and lasts for longer, perhaps due to stimulus from the Federal Reserve (Reinhart *et al.,* 2008b).

The current account deficit in the U.S., which corresponded to two thirds of the surplus of the current account worldwide, was also higher than the "*Big Five*" (Reinhart *et al.*, 2008b). As Diamond *et al.* (2009) reported the savings of some countries translate into deficits in others. Rose *et al.* (2012) concluded that more pronounced current account deficits and fewer reserves contribute to the countries' vulnerability.

Similarly, the growth of GDP per capita before the crisis was higher than the "*Big Five*", being, however, the most severe recession in the U.S. since World War II (Reinhart *et al.,* 2008b and Mishkin, 2011). In previous episodes, there was also an increase in public debt, which happened in the U.S., although it had increased more slowly.

Finally, in relation to financial liberalization, even though the U.S. had not had liberalization de *jure*, there was liberalization *per fact*. The new entities contributed to increase the vulnerability in relation to shocks, and technological progress reduced transaction costs and increased innovation in financial markets (Reinhart *et al.,* 2008b).

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[4] The "*Big Five*" include Finland (1991), Japan (1992),Norway (1987), Sweden (1991) and Spain (1977).

Given economic similarities, the conclusions drawn for the U.S. could be extended to some European economies (Reinhart *et al.,* 2008b and Claessens *et al.,* 2010). UK, Spain, France, Sweden and Ireland, for example, experienced a sharp rise in prices in the respective real estate markets (Reinhart *et al.,* 2008b; Diamond *et al.,* 2009; Claessens *et al.,* 2010 and Issing, 2011) and a high leverage of families (Claessens *et al.* 2010). These five European countries even had a bubble above the U.S. and the "*Big Five*". Diamond *et al.* (2009) add Netherlands to the list of countries that had bubbles in the housing market.

The sharp increase in credit attacked UK, Spain and other countries in Eastern Europe (Claessens *et al.,* 2010). Knedlik *et al.* (2012) also identified this problem in Portugal, Ireland and Netherlands, especially after the introduction of the Euro. In contrast, Greece, Finland and Italy had the lowest ratios of private debt to GDP. According to Eichengreen (2012), while in Ireland credit served mainly to finance the bubble in the housing market, in Portugal it was to consumption. Jorda *et al.* (2011) argued that financial leverage increases the vulnerability of economies to shocks. Problems in the banking sector, either due to the lack of liquidity, as in the UK with Northern Rock, whether due to exposures to mortgage backed securities, such as Germany, France, Belgium, Netherlands, Italy and Switzerland appeared in Europe (Bordo *et al.,* 2010).

The lack of discipline in the public accounts, a bit all over Europe, is identified in Issing (2011). Knedlik *et al.* (2012) reported problems in Spain and Ireland in the construction industry, which caused a large increase in unemployment, as an aggravating of the public accounts of these countries.

Deficits in the current account are also likely to be found in Portugal, Greece, Italy and Spain (Knedlik *et al.,* 2012). Eichengreen (2012) reported that the European countries, especially those in the periphery, have been losing competitiveness since 2002, and savings have decreased. Moreover, Rose *et al.* (2012) identified weaknesses in the regulatory level not only in the U.S., but also in the UK, for example.

Finally, Reinhart *et al.* (2009) identified UK, Ireland, Spain, Austria and Hungary as countries with a banking crisis. In the study of Reinhart *et al.* (2011), the existence of banking crises can trigger debt crises, so the current euro debt crisis would not be a surprise.

1.2 Early warning systems: goals, structure and evolution

Reinhart and Rogoff (2008a) analyzed financial crises, in particular domestic and foreign debt, inflation, banking, currency crises and currency debasement. This study covered 66 countries, representing approximately 90% of the world income, where among them, only 17 countries can be considered as not having suffered episodes of default or restructuring. Reinhart and Rogoff (2008a, pg. 6) even conclude that *"several defaults on external debt are the norm in all regions of the world, even including Asia and Europe"*. For the other types of financial crises the figures were not very different.

A similar conclusion is found in the study of Bordo *et al.* (2010). These authors identified several financial crises in the period between 1800 and 2008: five periods with banking crisis, nine periods with currency crisis and a period with a twin crisis (currency and banking crisis). They also concluded that the effects of a banking crisis are more harmful than in a currency crisis, due to recessions and associated spillovers. In Reinhart and Rogoff (2009), it is possible to corroborate the damaging effects in income, unemployment, public revenues and debt, housing market as well as the price of other assets, caused by banking crisis.

Despite all financial crises occurred in the past, the surprise and difficulty created by the nineties – the speculative attacks in Europe (1992-1993), the Mexican crisis ("*tequila crisis*" in 1995) and the Asian crisis (1997-1998) – triggered an interest in predicting the occurrence of them through the early warning systems (Edwards, 1996; Berg *et al.,* 1999a; Krugman, 2000; Feldstein, 2002; Berg *et al.,* 2004 and Yucel, 2011). This is extended to the International Monetary Fund, where several models that attempt to forecast crisis are developed and where it is given attention to models developed by other entities (Berg *et al.,* 2004 and Arduini *et al.,* 2012).

1.2.1 The essence and evolution of Early Warning Systems

Early warning systems (EWS) are models whose aim is to forecast the occurrence of a particular crisis (currency, banking or debt) in a given time horizon, using a particular statistical method and certain variables as indicators of vulnerability. These models can also monitor indicators, collecting the "*signals*" when they exceed certain values (Berg *et al.*, 1999a; Goldstein *et al.*, 2000; Berg *et al.*, 2004; Baldacci *et al.,* 2011 and

Candelon *et al.,* 2012). Thus, they highlight the vulnerabilities to which more attention should be paid, as they are contributing to the likelihood of a crisis or are above a certain critical value (Goldstein *et al.,* 2000).

These models process the information without any judgment and without being subjected to opinions in relation to the past, which is pointed out by Berg *et al.* (1999a) and Berg *et al.* (2004) as an advantage. Additionally, these models can be applied to several countries at the same time, being a more efficient way to assess the vulnerabilities in relation to the analysis of each particular country (Berg *et al.,* 1999a).

The EWS have been changing according to the characteristics of the different crisis. First generation models emphasize the use of inconsistent macroeconomic policies which result in loss of reserves, making the devaluation inevitable, could even occur an exchange rate attack (Flood *et al.,* 1999; Berg *et al.,* 1999a; Krugman, 2000; Mulder *et al.,* 2002; Berg *et al.,* 2004 and Ari, 2012). These models explain currency crises in Latin America (as in Mexico in 1973-1982 or Argentina in 1978-1981).

However, the policy authorities face a trade-off between the defense of the exchange rate and the effects on the economy of this process (as in terms of unemployment), could they opt to let the exchange rate depreciate. Here, the existence of expectations can trigger speculative attacks, which also makes it difficult to forecast crises. This issue falls within the second-generation models (Flood *et al.,* 1999; Berg *et al.,* 1999a; Krugman, 2000; Berg *et al.,* 2004, Mulder *et al.,* 2002 and Ari, 2012). These models are applied to the European crisis of 1992-1993.

In the nineties, with the Asian crisis, a third generation of EWS began to be developed (Krugman, 2000 and Feldstein, 2002). These countries did not have the traditional imbalances of previous crises, since these were concentrated in the private sector, particularly in banking and non-financial sector. In the years preceding the crisis, the high investment by the private sector was partly financed by external debt, in short-term maturities and in foreign currency, making the country vulnerable to these (Mulder *et al.,* 2002 and Ari, 2012). Financial liberalization verified in the 1990s helped to aggravate the situation (Roubini *et al.,* 2004).

1.2.2 Some considerations in the development of an Early Warning System

The development of a EWS requires several choices, including the statistical methodology to be used, variables of vulnerability and the time horizon which are intended to forecast.

In the literature, it is common to find EWS with different time horizons. For example, the model of Kaminsky, Lizondo and Reinhart (1998) attempts to predict the occurrence of a crisis among the next 24 months, a characteristic shared with the model of Berg and Pattillo (1999b). The model Goldman Sachs GS Watch (Ades *et al.,* 1999) has a time span of three months and the Model Credit Swiss First Boston (Berg *et al.,* 2004) a time horizon of one month. Thus, as summarized by Berg *et al.* (2004, pg. 5), *"the choice of the forecast horizon depends on the objectives of the user."*

Models developed in the private sector usually have a shorter time horizon, while if they have the purpose to be used by policy authorities (such as by the International Monetary Fund) larger horizons will be preferential, since they allow an evaluation and response by the authorities (Berg *et al.,* 2004; Goldstein *et al.*, 2000 and Candelon *et al.*, 2012). Although the private sectors' models have lower horizons, their predictions are often incorporated in investment decisions of investors, justification for the supervision of these models by authorities (Berg *et al.,* 2004 and Goldstein *et al.,* 2000).

Moreover, in a given time horizon indicators can, however, give the first signal with different lags and dependent on the type of crisis that it is trying to forecast. This is evident in the study of Goldstein *et al.* (2000) about the signals approach. Using the same indicators to predict a currency crisis and a banking crisis, in the case of a currency crisis, indicators send the first signal earlier than in a banking crisis.

Another choice intrinsic to the process of EWS's development is the selection of the methodology. Berg *et al.* (1999a) identified three main groups of methodologies. The first is focusing the study in a particular crisis or a group of simultaneous crises, helping to identify the vulnerabilities of the countries in the study. The authors pointed out the model of Sachs *et al.* (1996) as an example. Sachs *et al.* (1996) studied the occurrence of currency crises in 1995 in twenty-two developing countries after the Mexican crisis and pointed out three major vulnerabilities: high real appreciation, low

level of reserves and a credit boom. However, it only allows explaining the crises analyzed, not being possible to extend to other crises, countries or even horizons.

In the "*indicators approach*" or "*signal approach*", used in the recognized model of Kaminsky *et al.* (1998), a group of indicators (simple or composite) is considered and control limits computed, and whenever the limits are overpassed an alert *sign* is sent. In that model were identified vulnerabilities related to reserves, real exchange rate, real interest rate, export growth, monetary aggregates and domestic credit. According to Goldstein *et al.* (2000), this methodology has been effective in the pre-crisis vulnerabilities' recognition. Knedlik *et al.* (2012) have proved the effectiveness of macroeconomic indicators, as domestic demand, inflation, unemployment, fiscal deficit and current account, among other debt indicators in predicting debt crises, like the current crisis in Europe. They have studied eleven countries of the Economic and Monetary Union and warning signals were issued for five countries: Greece, Portugal, Ireland, Spain and Italy. According to these authors, the use of these macroeconomic indicators complements the limits of the ratio of public debt and budget deficit set in the Stability and Growth Pact.

The last methodology identified by Berg *et al.* (1999a) is the use of models for determining the probability of a country, or group of countries, of suffering a crisis somewhere in a given period of time. Berg *et al.* (1999a) identified *probit* binary choice models and the widely used *logit* methodology (Berg *et al.*, 2004). The model Developing Country Studies Division, developed by *Berg et al.* (1999), is an example of a *probit* model. In this model vulnerabilities related to current account, growth in exports, reserves, short-term debt to reserves ratio and real exchange rate are identified. The model of Goldman Sachs uses the *logit* methodology to analyze variables such as export growth, real exchange rate, credit growth to the private sector, real interest rate and stock prices, among others (Ades *et al.,* 1999 and Berg *et al.,* 2004).

More recently, other methodologies have been used, which could exemplify the difficulty in predicting crises and the long research needed to the development of these models. The study of Yucel (2011) identifies several methodologies, such as VAR models, cluster analysis, factor analysis and binary choice models, among others. It also emphasized the popularity of binary *logit* models, discriminant analysis and signal extraction. The models developed by Rose and Spiegel (2010, 2011 and 2012), for

example, use the MIMIC (Multiple-Indicator Multiple-Cause) methodology to analyze variables related to current account, reserves, short-term external debt, bank credit, real exchange rate, stock market and regulation of the credit market.

Goldstein *et al.* (2000) make clear the need of a high number of different indicators used in EWS, since it should consider a large number of different variables from different economic areas, given the difficulty in predicting the possible origins of vulnerabilities. This may explain the difficulty in predicting financial crises and the surprise that can be caused by the omission of indicators of areas that later it is realized necessary but not included, as illustrated by the case of the lack of indicators of the financial and corporate sector balance during the Asian crisis (Goldstein *et al.,* 2000 and Mulder *et al.,* 2002).

Following this, there are several indicators possible to be found in EWS, accordingly to the imbalances that they aim to reflect. One example is that relating to possible macroeconomic imbalances, such as the gross domestic product and its composition, industrial production, unemployment, inflation, monetary aggregates, public debt and fiscal deficit, and sovereign debt interest rate, among others. Generally, these are the most widely used. Other variables are those relating to the exchange rate and interest rates, nominal and real, and the external position, such as current account, reserves, exports, imports and foreign debt.

Nonetheless, Arduini *et al.* (2012) argued that EWS which use only macroeconomic variables such as real exchange rate or international reserves, have a poor performance in forecasting currency crises during the Great Recession as well as an even worse performance in predicting the Asian crises.

Another group of variables are those related to the financial sector, including, for example, private debt, domestic credit, bank deposits and bank's nonperforming loans. Taylor (2012) described the importance of credit in the economy and, on a wider scale, to a crisis. According to this author, the private credit may be a better predictor of a crisis, when compared to the current account deficit and the fiscal deficit. They also have pointed out that in countries which experienced a credit boom, the recession after the crisis is worse, in terms of growth, inflation, credit and investment, especially when the public accounts were uncontrolled, since the state cannot bail out the economy.

The case of the scoreboard for detecting macroeconomic imbalances used by the European Commission can be considered an example of a EWS, as indicated by Knedlik (2012). This scoreboard uses ten variables – net international investment position, current account, export shares, nominal labour costs, government debt, unemployment rate, house prices, real effective exchange rate, private debt and private credit flow – and is intended to detect macroeconomic imbalances and competitiveness losses early (European Commission, 2012).

Indicators related to market expectations are also used, as differential exchange rates as well as bond spreads, and contagion, as the number of recent crises in other countries, geographical variables and bilateral trade between two countries in total trade (Rose *et al.* 2010).

Recently, microeconomic indicators and legal indicators began to find a place among the variables above (Goldstein, 2000; Mulder *et al.,* 2002 and Mulder *et al.,* 2012). Some examples are the variables net income, current assets by current liabilities, book value, short-term debt for long term debt and the rights of creditors and shareholders (Mulder *et al.,* 2002 and Mulder *et al.,* 2012). According to the study of Mulder *et al.* (2002), these indicators together with macroeconomic indicators play an important role in prevention and severity of the crisis.

Another decision is how the indicators are incorporated in the model. Therefore they can be used single or in composite indicators, in level, ratio, growth rate or relative to their trend (Berg *et al.* 2004).

1.2.3 Limitations and the need for future developments

EWS can then be defined as models that are intended to predict the occurrence of crises. As a result, the word "model" also brings several limitations. Multiple problems may arise in their formulation, otherwise the occurrence of a crisis would cease to be something as problematic, and would start to be predictable *ex-ante*. Thus, the problems can arise in the sense that each crisis is different, making it difficult to predict which areas are vulnerable, or it can arise intrinsically as in terms of methodology or even at the level of the indicators used (or lack thereof) or how they are incorporated.

Berg *et al.* (2004) pointed out that the choice of the method used is an empirical decision, which somehow reflects the difficulty or even the lack of an assertive

methodology. These authors also indicate the difficulty in obtaining data for certain countries or time periods, an opinion shared by Mulder *et al.* (2002) and Mulder *et al.* (2012), especially in relation to the variables of corporate's balance sheet.

Another difficulty, according to Rose *et al.* (2010, 2011), is modeling the intensity of the crisis, as well as the spillover effects, since especially the latter, may be non-linear. These authors also pointed out the fact that certain variables or macroeconomic events could well describe the economic situation of a country and its vulnerabilities, but could not be as important or relevant to other countries in the sample, an opinion shared by Davis *et al.* (2011) and Ari (2012). Goldstein *et al.* (2000) complement this view, that is, for these authors there may be important facts for a country in a given period of time not included in the model.

Another problem is the choice of crises, countries or time periods to calibrate the developed model. Berg *et al.* (1999a) reported that these should be similar to the crises the model was formulated to. However, it also leads to another limitation. For a EWS to be useful, it should allow forecasting crises after its formulation and even with other sample (Goldstein *et al.* 2000, Berg *et al.* 2004, Rose *et al.* 2010, 2012). Here, it is inherent the fact that it is easier to formulate a model after the occurrence of the crises, since we can study what vulnerabilities have contributed to them.

Additionally, the determination of the cut-off limit, i.e., the value from which a warning shall be issued, since according to the predictions of the model there will be a crisis somewhere in its horizon, is of great importance and difficulty (Berg *et al*., 2004 and Candelon *et al.,* 2012). For Berg *et al.* (2004), the optimal value is known only *ex-post* and lower values can lead to false alarms. Candelon *et al.* (2012) also complement this idea, since they consider that with lower values attributed to the cut-off, crises will be more easily identified, but it will also have a higher number of false alarms (when the model has predicted the occurrence of a crisis and this is not realized).

Taking into account the limitations of these models, Berg *et al.* (1999a, 1999b) argued that, even so, these models help to identify countries that are (more) vulnerable to crises.

Finally, it may be evidenced that, in most studies, these models have the goal to forecast currency crises, having a great importance to predict the occurrence of another crisis, as banking crises.

CHAPTER 2

Methodology and description of the data

This chapter begins with a brief description of the methodology used in this study. The main aim of this study together with the countries, variables and years under study are then presented. This chapter concludes with a preliminary analysis of the data set.

2.1 Statis methodology

The Statis methodology ("*Structuration de Tableaux à Trois Indices de la Statistique*") was firstly introduced by L'Hermier des Plantes (1976) and later developed in Lavit (1988) and Lavit *et al.* (1994).

Principal Components Analysis, firstly introduced by Pearson (1901) and later developed in Hotelling (1933), is a factorial method of data analysis and the basis methodology of Statis. Principal Components Analysis allows to detect which individuals are similar, using the Euclidean distance, and which variables are correlated, through the linear correlation coefficient, transforming a set of correlated variables into a set of uncorrelated variables, called principal components. This methodology is applied to two-dimensional quantitative data tables and represents the maximum of information contained in a given data table with the minimum loss possible, paying special emphasis to the graphical representations in plans. Geometrically, it provides a new set of orthogonal axes, in which the coordinates of each observation for each of the new axes are the coordinates of the principal components.

In contrast, Statis methodology allows to analyse simultaneously multiple quantitative data tables, collected at different time or space horizons. In the first case – same individuals but not necessarily the same variables – the method is called Statis. This method emphasizes the positions of individuals and aims to verify whether there exists a common structure to the different data tables. In the second case – the same variables but not necessarily the same individuals – the method is called Dual Statis,

and studies the relationships between variables, verifying whether the correlations between them are stable in the different data tables. Both methods can be used when the data tables have the same variables and the same individuals.

The Statis methodology consists in three phases: Interstructure, Intrastructure and representation of the trajectories of the individuals or variables as well as the decomposition of the squared distances between objects.

In the first phase – Interstructure - a global comparison of the multiple data tables is done, in order to identify similarities and differences that arise between them. It is thus necessary to define a representative object for each data table which is the matrix of scalar products between their individuals. As the representative objects are defined, it matters to get the distance between these objects which is, in Statis method, obtained through the Hilbert-Schmidt scalar product. Here, the shorter the distance and the higher the scalar products, the closer the data tables are.

This allows calculating the scalar products between objects, which coincides with the vector correlation coefficient, denoted by RV coefficient (Robert and Escoufier, 1976), when the objects are weighted by their norms. RV coefficients represent the cosine of the angle formed by the vectors generated by each data table's representative object and the origin, and lies between zero and one. In the last case, the distance between those two objects is null by which the structure of individuals of the corresponding tables is similar. The representation of objects based on the principal components analysis of the matrix of RV coefficients is called non-centred Interstructure Euclidean Image. Another alternative representation is the Centred Interstructure Euclidean Image, which allows visualising the proximities between objects. Therefore, this phase puts in evidence the differences and similarities between the data tables, but not which individuals are responsible for.

The Intrastructure phase aims to summarize the data tables on a single table, representative of the common structure between the data tables, called the compromise. The construction of the compromise results from a linear combination of the representative objects, weighted by their coordinates on the first axis of the Interstructure Euclidean Image. The individuals' coordinates on the axes, obtained in a principal components analysis based on the compromise object, are called principal components.

It is possible then to represent in factorial plans the individuals and variables, and how closer individuals or variables are in this representation, more similar they are. In order to interpret and give a meaning to the axes and the positions of the individuals within axes, it is calculated the correlation between each principal component and the variables considered in the study. Thereby, the Statis method highlights a common structure among individuals, while the Statis Dual method evidences a common structure among variables.

Lastly, through the decomposition of the squared distance between pairs of objects in per cent of individuals or variables' contribution, it is possible to identify which individuals or variables have contributed more to the differences among data tables.

Another way to highlight it is the representation of the trajectories on the compromise axes. Each trajectory describes the movements of each individual over the study's horizon, showing the evolution of each one along the compromise axes, and it is interpreted according to the evolution of a fictitious individual whose values are the averages of the variables – the compromise point.

Thus, a trajectory slightly enlarged and defined around it corresponds to an individual or variable with an evolution similar to the average evolution. In contrast, a very broad trajectory with significant displacement or irregularity reflects a change in the structure of the individual or variable over the study's horizon that differs from the average trend. Through the correlations between the variables and each compromise axis, a meaning to the individuals' evolution can be found.

2.2 Variables and countries analysed

In the present study the twenty-seven member states of the European Union are considered - Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the UK – and studied in the years 2002, 2004 and 2006 to 2011.

Our aim is to determine a common structure among the different countries as well as to analyse the evolutionary trends of each one through the Statis methodology. For this purpose thirty-one variables are used, mainly macroeconomic, of five entities'

databases - the International Monetary Fund, World Bank, Eurostat, the European Commission and the Organization for Economic Cooperation and Development.

In order to enrich and make the analysis more interesting, the variables were divided into five groups - Macroeconomics, Public Sector, Competitiveness, Debt, and Private and Financial Sectors, as indeed it is usual among early warning systems studies.

Following this, the group of Macroeconomic variables (see Table 2.1) is inspired by the Keynesian theory, according to which the gross domestic product is obtained through the sum of consumption, public expenditures, investment and exports minus imports. In this group four other variables of interest and economic importance were also considered: savings, inflation, unemployment rate and GDP per capita.

Macroeconomic Variables	
Gross domestic product (GDP)	Public revenues (T)
Gross domestic product *per capita* (YPC)	Investment (IN)
Unemployment rate (U)	Savings (S)
Inflation rate (PI)	Exports (X)
Consumption (C)	Imports (M)
Public expenses (G)	

Table 2.1 - Macroeconomic variables considered in the study.

Recently, one of the problems that have haunted the majority of European countries relates to the stabilization and reduction of the public debt. This relative stabilization depends on the government budget, the difference between the interest rate required for the country and the growth rate of the product as well as other adjustments on it. Additionally, according to the IS-LM model, countries have three possible ways of financing public deficits: via taxes, debt accumulation and monetary emission, whose effects can be felt negatively on inflation. Thus, in this group some of variables identified above were considered, as public revenues and public expenses, in order to emphasize this issue (see Table 2.2).

Public Sector

Long-term sovereign interest rates (ILP)	Government budget (SO)
Short-term interest rates (ICP)	Public debt (DP)
Public expenses (G)	GDP growth rate (YG)
Public revenues (T)	Inflation rate (PI)

Table 2.2 - Variables that feature the public sector.

The third group of variables is intended to analyse the external competitiveness of economies. The real effective exchange rate is an indicator of a country's external competitiveness and takes into account the productivity and the labour costs of that country as well as the country and external's inflation. The lower its value (considering the exchange rate set by the certain) the more competitive the country is and usually higher its exports, with positive effects on the trade balance and in its share of exports in world trade. Thus, this group has the variables indicated in Table 2.3.

Competitiveness

Shares of exports in world trade (QE)	Effective exchange rate (RER)
Exports (X)	Labour costs (CT)
Imports (M)	Terms of trade (TT)
Trade balance (TB)	Productivity (P)

Table 2.3 – Group of variables of country's competitiveness.

Balance of Payments records the transactions with foreign countries. If the country's net debt is positive, i.e., the sum of the current account and capital account is negative, there is a negative change in the international investment position, increasing external debt. The international investment position of a country comprises financial assets minus financial liabilities to the rest of the world. International reserves are assets of the central banks used in the fulfillment of financial obligations. Thus, these were the variables chosen to characterize the external debt of each economy (see Table 2.4).

Debt

Current account (CA)	Capital account (BK)
Balance of goods and services (TB)	Reserves (R)
Current transfers (TC)	International investment position (IIP)

Table 2.4 - Group of variables of external debt.

The private and financial sector can also be a source of economic problems, as it is evident in the case of the Asian crisis already described. Thus, another important economic aspect relates to the financial competitiveness of the countries and their ability to attract foreign investment. The portfolio investment and direct investment are variables that can characterize this fact.

The portfolio investment includes mainly the transactions in financial markets, such as stocks. This type of foreign investment is more liquid and more volatile too, whilst foreign direct investment has usually a longer-term perspective. It includes buying domestic companies by foreign economic agents or the creation of new ones, being therefore less liquid.

However, the great scarcity of microeconomic variables for all the countries considered, limited the choice of variables to those presented in Table 2.5.

Private and financial sector	
Shares traded (AT)	Private capital flows (FCP)
Market capitalization (CM)	Investment (IN)
Ratio of portfolio investment to direct investment (PDI)	Savings (S)

Table 2.5 - Private and financial sectors' variables.

Appendix 1 gives more information about the aforementioned variables, as their source, description and definition.

2.3 Previous data treatment

After obtaining the necessary variables to this study through the download of the databases mentioned above and shown in Appendix 1, it was necessary to organize them into eight different data tables for each group of variables since the analysis is done for the years 2002, 2004, 2006, 2007, 2008, 2009, 2010 and 2011. This was conducted in Excel in order to create a matrix for each year and variable's group, considering the countries in the rows and variables in the columns.

Additionally, an analysis of the quality of data was also made, in order to check if all values were filled and were with no missing data, a fact which made impracticable the use of other variables previously considered. Once the variables have different units

of measure, it was still necessary to standardize the data in order to give equal weight to all variables of all data tables of the study, regardless their scales or dimensions.

All the subsequent analysis was performed using the software of data analysis SPAD, version 7.3, as well as Excel as an additional software support.

2.4 Preliminary analysis of the data set

In Tables 2.6 to 2.17 some descriptive statistics for the years 2002 and 2011 are indicated in order to ascertain whether there were major changes between the beginning and the end of the period considered.

	GDP	YPC	U	PI	C	G	T	IN	S	X	M
2002	1362.6	119944.3	8.8	3.5	77.9	43.5	41.0	21.8	20.5	52.0	51.6
2011	**1583.9**	**138811.3**	**10.2**	3.4	77.4	**46.1**	**42.2**	19.8	19.4	**64.1**	**61.5**

	ILP	ICP	DP	SO	YG	QE	TB	RER	CT	TT	P
2002	5.7	5.3	49.2	-2.5	3.0	1.5	0.3	92.9	92.3	99.4	90.8
2011	5.3	1.9	**64.6**	-3.9	1.8	1.3	**2.5**	**107.6**	**119.4**	99.4	**94.9**

	CA	TC	BK	R	IIP	AT	CM	PDI	FCP
2002	-1.3	-2.3	0.002	14379.6	-15.8	33.6	43.1	0.4	11.3
2011	**-0.5**	-16.0	**0.008**	**26706.6**	-32.7	27.4	35.9	0.02	10.8

Table 2.6 - Average of the variables.

Accordingly, starting by the analysis of the variables' average in 2002 and 2011, shown in Table 2.6, it can be concluded that the average of GDP and GDP *per capita* (YPC) increased in 2011 in relation to the average in 2002, although, on average, there has been a slowdown in growth, visible by the decrease of the average of GDP's growth (YG). The differences in the average of the variables consumption (C), inflation rate (PI), investment (IN), savings (S), unemployment (U) and those of private and financial sectors (AT, CM, PDI, FCP) featured a typical behaviour in crisis situations.

The average of public expenses (G), public debt (DP) and public revenues (T) in 2011 were higher, on average, than in 2002, contrarily to government budget (SO). The behaviour of the first two variables and of the government budget could be due to the crisis scenario that countries go through. This may similarly explain the behaviour of the public revenues, since many European countries are making an effort of fiscal consolidation, apparently via public revenues. The averages of interest rate for long (ILP) and short (ICP) terms in 2011 were, on average, lower than in 2002. Hence the

differentiation in countries' interest rates required by investors in recent years was not reflected in 2011.

Additionally, the average of the labour costs (CT) increased in 2011 when compared to 2002, although productivity (P) has also increased. The average of exports (X) and imports (M) increased, on average, but the averages in 2011 of share of exports in world trade (QE) were lower and real effective exchange rate (RER) were higher than in 2002, so in 2011 European countries, probably, on average, have lost competitiveness in the world market. The averages of the current transfers (TC) and international investment position (IIP) decreased in 2011 compared to 2002, in contrast to the averages of trade balance (TB), current account (CA), capital account (BK) and reserves (R).

	GDP	YPC	U	PI	C	G	T	IN	S	X	M
Maximum											
2002	19443.7	1910925.9	19.7	22.5	91.2	54.9	54.8	32.3	32.6	140.7	121,1
2011	22178.2	2220931.0	21.6	5.8	92.0	56.7	54.8	28.8	27.8	176.5	145,3
Minimum											
2002	4.7	2314.1	2.6	0.3	58.4	32.1	29.5	13.6	12.6	21.1	24,5
2011	5.5	3439.3	5.4	1.8	47.7	34.4	31.4	10.3	4.7	25.1	29,8
Median											
2002	231.4	22678.9	8.6	2.4	77.4	44.3	39.6	21.3	21.0	47.4	51,1
2011	269.7	25044.1	8.5	3.3	78.4	46.9	41.4	20.1	20.5	57.3	54,0

	ILP	ICP	DP	SO	YG	QE	TB	RER	CT	TT	P
Maximum											
2002	8.7	27.3	105.1	4.1	6.9	8.9	19.6	111.2	105.4	107.4	164,2
2011	15.7	6.6	165.4	4.2	8.3	8.2	31.2	138.6	167.8	125.3	169,0
Minimum											
2002	4.2	3.3	5.7	-8.8	0.0	0.04	-13.5	77.1	65.7	91.3	29,4
2011	2.6	0.9	6.0	-12.8	-7.1	0.04	-8.1	83.5	100.1	92.3	44,3
Median											
2002	5.1	3.5	51.8	-2.1	2.5	0.6	-1.2	93.2	92.3	100.1	100,2
2011	5.0	1.4	65.2	-3.9	1.7	0.6	0.7	103.6	113.9	97.8	94,8

	CA	TC	BK	R	IIP	AT	CM	PDI	FCP
Maximum									
2002	10.5	44.3	0.0	51170.6	100.4	147.7	116.4	28.6	266.5
2011	8.5	12.3	0.1	92646.5	107.8	122.2	118.7	11.7	223.8
Minimum									
2002	-10.6	-31.1	-0.01	151.7	-65.2	0.9	4.6	-22.3	-18.2
2011	-10.4	-207.7	0.00	194.9	-105.9	0.2	3.8	-7.0	-43.1
Median									
2002	-2.1	-0.1	0.001	9563.3	-20.1	8.9	34.4	0.4	3.2
2011	-1.2	-1.9	0.003	15251.9	-49.3	9.3	19.72	0.06	2.59

Table 2.7- Median, maximum and minimum values of the variables.

As the variables are defined in different units of measurement and some variables have positive and negative values, we decided not to compute the coefficient of variation as a dispersion measure, but we represent their boxplots in Figure A.1, Appendix 2, that allow us to analyze their dispersion. They highlight some variables with outliers, but it does not seem to impede the analysis. In Table 2.7 and 2.8 are also indicated the median, minimum and maximum values and the Fisher skewness coefficients for each variable, respectively.

Taking these into consideration, the dispersion of GDP, GDP *per capita* (YPC), inflation rate (PI), short-term interest rate (ICP), labour costs (CT), current transfers (TC), portfolio investment to direct investment (PDI) and private capital flows (FCP) was lower, visible by their smaller difference among quartiles, as it is shown in the boxplots. Additionally, excluding outliers, inflation rate (PI), investment (IN), short-term interest rate (ICP) and trade balance (TB) are variables whose dispersion seems to have a higher decrease, whilst the dispersion of savings (S), imports (M), public debt (DP), long-term interest rates (ILP), real effective exchange rate (RER), capital account (BK), international reserves (R) and international investment position (IIP) seems to have a higher increase between the years 2002 and 2011.

It is also possible to conclude that most of the variables have positive asymmetric distribution (see Table 2.8), i.e. most of the observations are concentrated on the left, with a long tail to the right, being frequent the small values. The variables inflation rate (PI) and short-term interest rate (ICP) in 2002, and GDP and GDP *per capita* (YPC) are the most asymmetric. Additionally, there are variables whose asymmetries in 2002 and 2011 are opposite which may be due to the economic turmoil of recent years.

	GDP	**YPC**	**U**	**PI**	**C**	**G**	**T**	**IN**	**S**	**X**	**M**
2002	**4.77**	**4.78**	0.93	**4.11**	-0.70	-0.16	0.41	0.64	0.58	1.63	1.20
2011	**4.72**	**4.78**	0.95	0.44	-1.71	-0.16	0.17	-0.24	-0.83	1.51	1.15
	ILP	**ICP**	**DP**	**SO**	**YG**	**QE**	**TB**	**RER**	**CT**	**TT**	**P**
2002	1.25	**4.13**	0.55	-0.17	0.42	2.15	0.63	0.08	-1.76	-0.45	-0.06
2011	2.16	2.33	0.81	-0.27	-0.67	2.65	2.14	0.88	1.93	2.74	0.42
	CA	**TC**	**BK**	**R0**	**IIP**	**AT**	**CM**	**PDI**	**FCP**		
2002	0.33	0.71	0.53	1.16	1.63	1.41	0.90	0.86	5.05		
2011	-0.01	-4.07	1.94	0.91	0.73	1.36	1.32	1.94	4.50		

Table 2.8 – Fisher skewness coefficients.

The kurtosis coefficient (Table 2.9) indicates that the majority of the variables have a distribution more elongated than the normal distribution. Only the variables

public expenses and public revenues have distributions flatter than the normal distribution. Additionally, there are variables which, in 2002, showed a flat distribution, evolving to an elongated distribution in 2011, or vice versa, which may be indicative of economic changes.

	GDP	YPC	U	PI	C	G	T	IN	S	X	M
2002	23.88	23.82	0.62	19.04	1.25	-0.98	-0.68	0.41	0.96	3.93	2.05
2011	23.47	23.80	0.54	0.12	6.25	-0.44	-0.95	0.56	-0.06	3.71	2.01
	ILP	**ICP**	**DP**	**SO**	**YG**	**QE**	**TB**	**RER**	**CT**	**TT**	**P**
2002	0.73	18.92	0.44	0.35	-0.90	5.02	0.48	2.32	5.38	0.58	-0.68
2011	5.98	4.61	1.14	1.04	3.95	8.61	5.77	0.26	3.28	9.82	0.34
	CA	**TC**	**BK**	**R**	**IIP**	**AT**	**CM**	**PDI**	**FCP**		
2002	-0.28	4.79	1.05	0.69	4.31	0.72	-0.05	9.23	25.99		
2011	0.09	18.75	3.89	-0.31	0.03	0.95	1.00	11.31	22.34		

Table 2.9 - Kurtosis coefficients.

Finally, it is interesting to analyze the linear correlation coefficients between the several variables, shown in Tables 2.10 to 2.17, for each group of variables considered.

	GDP	YPC	U	PI	C	G	T	IN	S	X	M
GDP	**1**										
YPC	**0.99**	**1**									
U	-0.17	-0.20	**1**								
PI	0.03	0.05	0.10	**1**							
C	-0.03	-0.08	0.46	0.13	**1**						
G	0.35	0.34	-0.25	-0.38	-0.17	**1**					
T	0.14	0.15	-0.33	-0.38	-0.35	**0.91**	**1**				
IN	0.10	0.12	0.25	0.13	-0.16	-0.26	-0.29	**1**			
S	-0.07	-0.02	-0.29	-0.06	**-0.83**	0.27	0.50	0.25	**1**		
X	0.01	0.09	-0.30	-0.08	-0.70	-0.14	-0.06	0.09	0.52	**1**	
M	0.02	0.11	-0.15	-0.02	-0.52	-0.27	-0.23	0.24	0.39	**0.96**	**1**

Table 2.10 – Linear correlation coefficients among macroeconomic variables in 2002.

	GDP	YPC	U	PI	C	G	T	IN	S	X	M
GDP	**1**										
YPC	**0.99**	**1**									
U	-0.03	-0.03	**1**								
PI	0.02	0.04	0.16	**1**							
C	-0.09	-0.14	0.26	0.07	**1**						
G	0.14	0.14	-0.26	-0.54	0.17	**1**					
T	0.37	0.38	-0.45	-0.39	-0.03	**0.86**	**1**				
IN	-0.03	-0.03	-0.04	0.43	-0.20	-0.36	-0.10	**1**			
S	0.08	0.10	-0.33	0.10	-0.64	-0.16	0.17	0.66	**1**		
X	0.09	0.16	-0.17	-0.03	**-0.82**	-0.28	-0.11	-0.06	0.35	**1**	
M	0.08	0.16	-0.13	0.05	-0.74	-0.35	-0.16	0.01	0.33	**0.98**	**1**

Table 2.11 – Linear correlation coefficients among macroeconomic variables in 2011.

In the group of macroeconomic variables (Tables 2.10 and 2.11), the variables GDP and GDP *per capita*, as expected, show a strong positive correlation in the years 2002 and 2011. The variables public expenditures (G) and public revenues (T) also show a high positive correlation in these years, indicating that, in general, the states need resources to finance public expenses or the increase in investment by the state in the economy provided more income to him. The increase in exports (X) is accompanied with the increase in imports (M) in 2002 and 2011. These may be due to a strong connection between countries in international trade or to satisfy domestic consumption, the latter may explain the high negative correlation between consumption (C) and exports (X) evidenced in 2011.

	ILP	**ICP**	**DP**	**SO**	**G**	**T**	**YG**	**PI**
ILP	**1**							
ICP	0.48	**1**						
DP	-0.32	-0.21	**1**					
SO	-0.14	-0.20	-0.22	**1**				
G	-0.33	-0.30	0.54	-0.14	**1**			
T	-0.38	-0.37	0.43	0.29	**0.91**	**1**		
YG	0.50	0.28	-0.59	0.04	-0.73	-0.69	**1**	
PI	0.42	**0.92**	-0.17	-0.05	-0.38	-0.38	0.29	**1**

Table 2.12 - Linear correlation coefficients of the public state's variables in 2002.

	ILP	**ICP**	**DP**	**SO**	**G**	**T**	**YG**	**PI**
ILP	**1**							
ICP	0.17	**1**						
DP	0.60	-0.16	**1**					
SO	-0.41	0.36	-0.47	**1**				
G	-0.06	-0.28	0.50	0.02	**1**			
T	-0.26	-0.05	0.19	0.52	**0.86**	**1**		
YG	-0.60	0.01	-0.69	0.46	-0.28	-0.01	**1**	
PI	0.19	0.47	-0.31	0.13	-0.54	-0.39	0.25	**1**

Table 2.13 - Linear correlation coefficients of the public state's variables in 2011.

In the case of public sector's variables (Tables 2.12 and 2.13), only public revenues (T) and public expenses (G) exhibit a high correlation in the two years, as shown by the group of variables mentioned above. In 2002, the variable short-term interest rate (ICP) showed a high positive correlation with inflation rate (PI), which may be due to the inflation premium demanded by investors or due to the fact that the interest rate considered is a nominal rate.

	QE	TB	X	M	RER	CT	TT	P
QE	**1**							
TB	0.22	**1**						
X	-0.29	0.60	**1**					
M	-0.42	0.36	**0.96**	**1**				
RER	0.28	0.15	-0.17	-0.25	**1**			
CT	0.36	0.37	0.01	-0.11	0.78	**1**		
TT	0.29	0.35	-0.07	-0.21	0.22	0.47	**1**	
P	0.43	0.78	0.33	0.11	0.27	0.53	0.47	**1**

Table 2.14 - Linear correlation coefficients of the competitiveness' variables in 2002.

	QE	TB	X	M	RER	CT	TT	P
QE	**1**							
TB	0.03	**1**						
X	-0.27	**0.82**	**1**					
M	-0.34	0.71	**0.98**	**1**				
RER	-0.43	-0.09	0.22	0.30	**1**			
CT	-0.34	-0.19	0.05	0.13	0.76	**1**		
TT	-0.22	-0.05	0.03	0.05	0.52	**0.80**	**1**	
P	0.33	0.66	0.33	0.20	-0.48	-0.53	-0.33	**1**

Table 2.15 - Linear correlation coefficients of the competitiveness' variables in 2011.

In this group of variables (Tables 2.14 and 2.15), exports (X) and imports (M) have a strong positive correlation, already discussed above. In 2011, exports and trade balance (TB) showed a high positive correlation, which economically makes sense, since the increase (decrease) in exports contributes positively (negatively) to the trade balance. In this year, the variables labour costs (CT) and terms of trade (TT) also showed a high positive correlation, which may indicate an influence of labour costs in the price of exports.

	CA	TB	TC	BK	R	IIP	CA	TB	TC	BK	R	IIP
CA	**1**						**1**					
TB	**0.82**	**1**					0.65	**1**				
TC	-0.41	-0.27	**1**				-0.23	-0.13	**1**			
BK	-0.63	-0.53	0.13	**1**			-0.14	-0.25	-0.04	**1**		
R	0.11	0.05	-0.41	0.02	**1**		0.15	-0.12	-0.33	0.04	**1**	
IIP	0.67	0.62	-0.26	-0.65	-0.04	**1**	0.59	0.46	0.13	-0.42	0.12	**1**

Table 2.16 - Linear correlation coefficients of the external debt' variables in 2002 (left) and 2011 (right).

Regarding the variables of the group of external debt (Table 2.16), it can be seen that only current account (CA) and trade balance (TB) show a high positive correlation in 2002, meaning that the evolution of trade balance, one of the components of the current account, had an important role to the evolution of current account.

	AT	CM	PDI	FCP	IN	S	AT	CM	PDI	FCP	IN	S
AT	**1**						**1**					
CM	**0.72**	**1**					**0.73**	**1**				
PDI	-0.02	-0.06	**1**				0.01	0.04	**1**			
FCP	-0.17	0.37	-0.01	**1**			-0.19	0.40	0.04	**1**		
IN	-0.23	-0.34	-0.06	0.08	**1**		-0.20	-0.23	0.06	0.08	**1**	
S	0.19	0.39	-0.26	0.55	0.25	**1**	0.04	0.17	-0.08	0.27	0.66	**1**

Table 2.17 - Linear correlation coefficients of the private and financial sectors' variables in 2002 (left) and 2011 (right).

Finally the variables of private and financial sectors (Table 2.17) do not have meaningful correlation coefficients between them, except the variables shares traded (AT) and market capitalization (CM) in 2002 and 2011, which show a high correlation coefficient.

CHAPTER 3

Macroeconomic Variables

This Chapter introduces the conclusions obtained by the application of the Statis and Dual Statis methods to the countries under study, considering the macroeconomic variables' group.

Firstly the results of Statis method are presented with the main objective of describing the principal conclusions about the similarities and evolution of the European countries described by the variables considered. Then the conclusions of the Dual Statis method are presented in which information about the evolution of the variables here analysed is provided.

3.1 Conclusions of the Statis method

The application of the Statis method aims to find a common structure representative of the similarities between the countries within this group of variables.

Initially, the findings from the results of interstruture are drawn, followed by the definition of a compromise. Finally, we analyse the contribution of each country to the distances between the data tables' representative objects as well as the trajectories of each, indicative of the evolutionary trends.

Interstructure

In the first phase of the Statis method we define a representative object of each data table, which is the matrix of the scalar products between individuals, corresponding to each year under study. Then a global comparison between normed objects is done, in which we conclude what years are more similar and what are more different.

Regarding that, through the analysis of the RV coefficients and Hilbert-Schmidt distances (Table 3.1), it can be concluded that the years 2002 to 2006, the years 2006 and 2007 with 2004 and 2008, and 2009 to 2011, are the closest; while the pairs of

years 2002/2011, 2006/2010 and 2007/2010 are the most different. Thus the year of 2008 seems to be a "turning point" between them.

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	1							
2004	**0.952**	1						
2006	**0.901**	**0.945**	1					
2007	0.875	**0.915**	**0.972**	1				
2008	0.853	0.880	**0.927**	**0.954**	1			
2009	0.830	0.857	0.830	0.830	0.883	1		
2010	0.804	0.821	0.802	0.810	0.859	**0.930**	1	
2011	0.797	0.823	0.831	0.840	0.884	**0.899**	**0.915**	1

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	0							
2004	**0.308**	0						
2006	**0.446**	**0.330**	0					
2007	0.500	**0.413**	**0.236**	0				
2008	0.542	0.490	**0.382**	**0.305**	0			
2009	0.583	0.535	0.584	0.583	0.484	0		
2010	0.625	0.598	0.629	0.617	0.530	**0.373**	0	
2011	0.637	0.595	0.581	0.566	0.481	**0.449**	**0.411**	0

Table 3.1 - Matrices of the RV coefficients (above) and Hilbert-Schmidt distances (below).

This is not surprising, because we know, ex-post, that the sins of the subprime crisis, which erupted in 2007, started to have huge consequences in 2008, so the similarities between post crisis years (2009, 2010 and 2011) and pre crisis years could be explained by this, even as the dissimilarities between these groups.

A similar conclusion can be done through the representation of the Centred Interstructure Euclidean Image (Figure 3.1) in the plan defined by the first and second axes [1, 2], where a shorter distance between two years indicates a stronger similarity between them. Here, the first two axes explain, approximately, 68% of the total variance. With this graphical analysis, we can roughly divide the years into three main groups: 2002-2004, 2006-2007 and 2009-2011, with the year of 2008 being more distant from the others or, as stated, the "turning point" year.

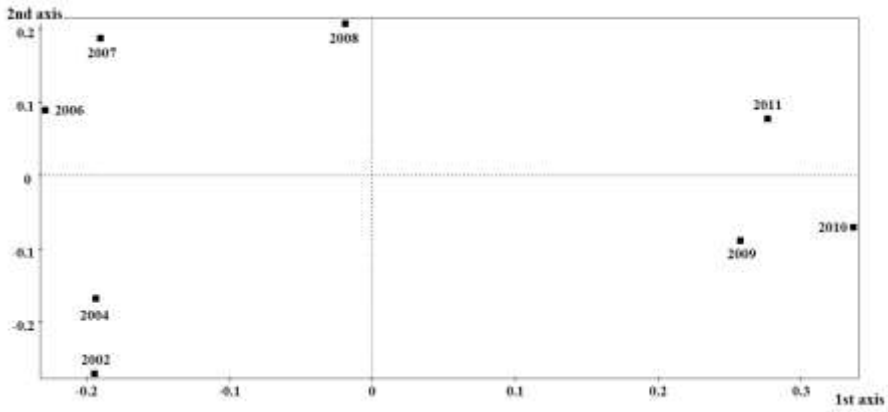

Figure 3.1 – Centred Interstructure Euclidean Image in the plan [1, 2].

Intrastructure

In this phase we obtain a compromise object defined as a linear combination of the years' representative normed objects, weighted by the coordinates of the objects on the first axis of the Interstructure Euclidean image. If the compromise describes adequately the data it is possible to graphically represent the countries in the plan. In order to be able to expound a meaning to the positions of the individuals we then calculate the correlations between the compromise axes and the variables.

	2002	2004	2006	2007	**2008**	2009	2010	2011
Scalar products	0.930	0.955	0.957	0.955	**0.961**	0.936	0.920	0.926
HS distances	0.373	0.301	0.294	0.300	**0.280**	0.359	0.401	0.384

Table 3.2 – Scalar products and distances among data tables' representative objects and the compromise object.

Therefore, through the analysis of the scalar products and the Hilbert-Schmidt (HS) distances (Table 3.2), not only can we conclude that all objects are highly correlated to the compromise object, as in general distances are low and scalar products high, proving that it is possible to find a common structure; but also are the "turning point" year of 2008 the closest to the compromise object, and the year of 2010 the furthest one.

	1st Axis	**2nd Axis**	**3rd Axis**	**4th Axis**	5th Axis	6th Axis	7th Axis	8th Axis
Eigenvalues	**0.635**	**0.58**	**0.425**	**0.211**	0.128	0.102	0.067	0.05
Inertia (%)	**27.20**	**24.82**	**18.19**	**9.04**	5.46	4.35	2.88	2.13
Cumulative Inertia (%)	**27.20**	**52.02**	**70.21**	**79.24**	84.71	89.06	91.94	94.07

Table 3.3 – Eigenvalues, inertia and cumulative inertia of the first eight axes.

Table 3.3 shows the eigenvalue associated to each axis, the inertia of each axis and the cumulative inertia. Applying the Cattel and Pearson criteria, we decided to retain the first four axes, which explain 79.24% of the total variance.

Countries' compromise Euclidean image in the plan defined by the first and second axes [1, 2], in the plan defined by the first and third axes [1, 3] and in the plan defined by the first and fourth axes [1, 4] are represented in Figures 3.2, 3.3 and 3.4, respectively. But what do those countries have in common? Why are they similar to some and different from others? In Table A.2, Appendix 3, the linear correlation coefficients between the variables and the four axes are revealed. As it was stated in the beginning of this chapter, these allow to explain the position of the individuals within the axes.

The individuals pointed out on each axis, next and in the following chapters, are the ones who most contribute to the formation of the axis and are chosen so that the sum of their contributions to the axis is, approximately, 80%. In addition, all individuals selected for the axis are well represented on that axis or in a principal plan and have a contribution greater than the average contribution of a country.

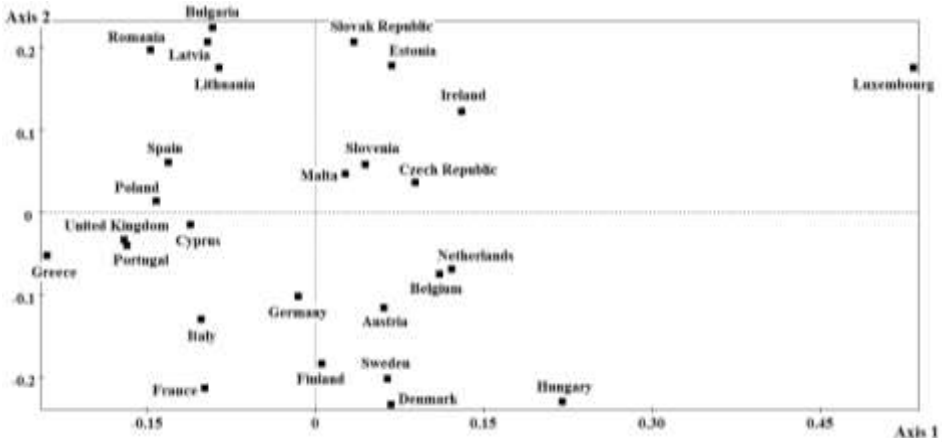

Figure 3.2 – Compromise's Euclidean Image in the plan [1, 2].

The countries with the greatest relevance on the first axis are Luxembourg, Greece, Hungary, United Kingdom (UK) and Portugal (see Figure 3.2). Thereby, the first axis makes a distinction between Greece, Portugal and UK (negative coordinates) with the countries Luxembourg and Hungary (positive coordinates). This axis is negatively correlated with the variable consumption (C) and positively correlated with exports (X) and imports (M), during all period. Thus**, the first axis is an indicator of the trade's destination**. It discriminates countries with higher domestic trade - Greece,

Portugal and UK – from countries with higher external trade – Luxembourg and Hungary. Moreover, this axis is also positively correlated with savings in 2002-2007, meaning that Luxembourg and Hungary's savings were above the average in those years, in contrast to Greece, Portugal and UK's.

The second axis (see Figure 3.2) differentiates Denmark, Hungary, France, Sweden and Finland (negative coordinates) with Bulgaria, Latvia, Romania, Slovakia, Estonia, Lithuania and Luxembourg (positive coordinates). The second axis is negatively correlated with the variables public expenses (G) and public revenues (T), during all period. Therefore, **this axis indicates public activeness in the economy**, differentiating countries whose States have more intervention in the economy - Denmark, Hungary, France, Sweden and Finland - from countries whose States have a more passive approach - Bulgaria, Latvia, Romania, Slovakia, Estonia, Lithuania and Luxembourg. Besides that, this axis also has a positive correlation with inflation rate (PI) in 2006, so the last seven countries could have had a problem with inflation in that year or, at least, it was above the average.

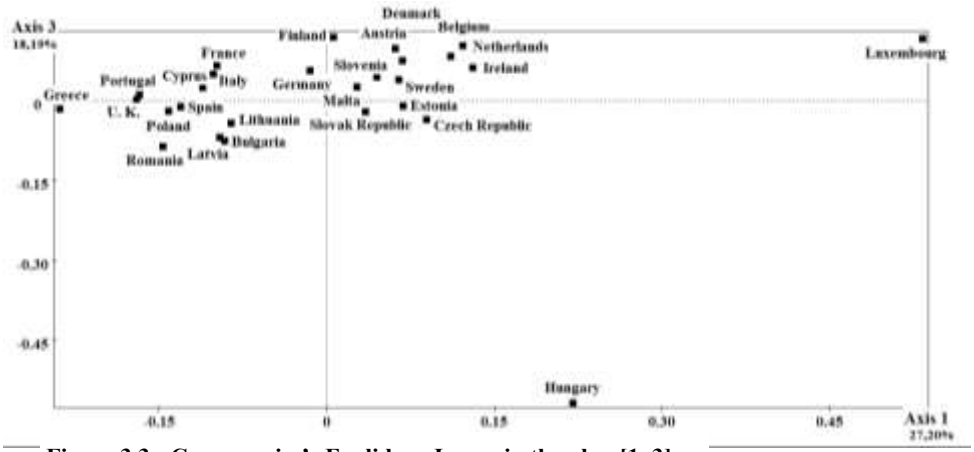

Figure 3.3 - Compromise's Euclidean Image in the plan [1, 3].

Only Hungary (negative coordinate) is evidenced in the third axis (see Figure 3.3). **Third axis points out countries' income.** It was found a negative linear correlation between the third axis and the variables GDP and GDP *per capita* (YPC), during all period; ergo the income of Hungary was above the average in this period.

Finally, the fourth axis (see Figure 3.4) contradistinguished Spain, Latvia, Czech Republic, Estonia and Austria (negative coordinates) to Malta, Cyprus, UK, Greece and Lithuania (positive coordinates). Fourth axis has a negative correlation with the variables savings and investment, in 2008-2011. So, **this axis opposes countries with**

more private intervention in the economy – Spain, Latvia, Czech Republic, Estonia and Austria – **to countries whose investment and savings were under average** – Malta, Cyprus, UK, Greece and Lithuania, in 2008-2011.

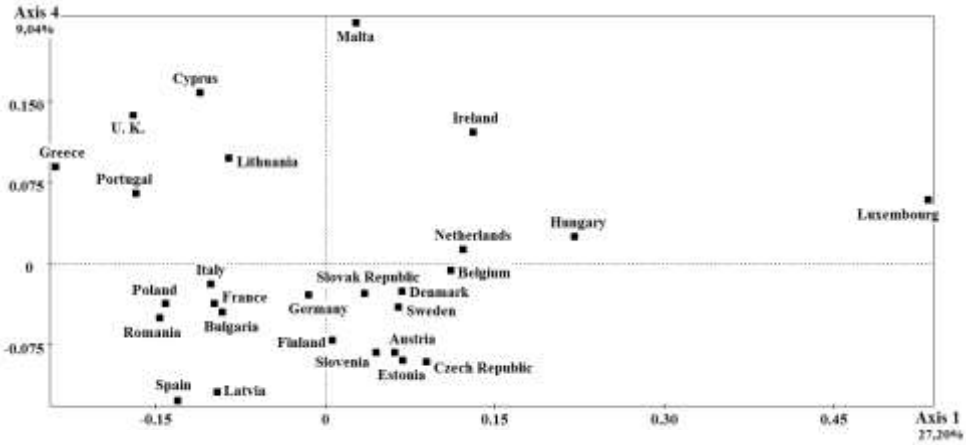

Figure 3.4 - Compromise's Euclidean Image in the plan [1, 4].

Contribution of the countries to the differences between years and their trajectories

The decomposition of the sum of squared distances between pairs of normed objects into percentage of countries' contributions (Table 3.4) allows to stand out which countries have contributed more to the differences between the various years of the period 2002-2011: Romania (10.8%), Ireland (10.1%), Bulgaria (8.3%), Luxembourg (6.6%), Latvia (6.5%), Estonia (6.0%) and Poland (6.0%). Figure 3.5 shows the trajectories in the plan [1, 2], in which is explained 52.02% of the total variance. Although the representation of the trajectories is only approximated, their irregularities are clearly shown.

In contrast, Austria, Belgium, Czech Republic, Denmark, France, Italy, Netherlands, Slovak Republic and UK are plainly more regular, as it can also be seen by their small contributions to the sum of squared distances' decomposition (among 0.8% and 2.13%). Consequently, their trajectories are closer to the compromise object.

The first axis is negatively correlated with consumption and positively correlated with exports and imports. Thus, as the trajectory evolution of Cyprus, Finland, Greece and Portugal is from the right to the left side, it can indicate a substitution of external trade to domestic trade, in contrast to Germany, whose trajectory evolution is from the

left to right side. Sweden has a more elongated down to up trajectory in relation to the second axis, which can indicate a diminution of the activeness of Sweden's state in the economy, as the second axis is negatively correlated with public expenses and public revenues.

The rest of the countries have some years with instability, as it can be concluded by the analysis of the squared distances decomposition. Hungary has a more irregular period among 2006/2007, Slovenia among 2008/2011, Malta among 2004/2007 and 2006/2007 and Spain among 2006/2008 and 2007/2008 (see Table 3.4). Lithuania has a relatively small contribution to the sum squared distances' decomposition, but for some years its contribution is higher, especially between 2004/2006 (5.1%) and 2009 with the years 2006-2011 (among 6.8% and 11.7%).

In the interstructure phase, the differences between three pairs of years were highlighted: 2002/2011, 2006/2010 and 2007/2010. Therefore, it is now possible to point out which countries are more responsible for that: Bulgaria, Estonia, Ireland and Romania. Greece, Luxembourg and Poland also have a high contribution associated to the differences in 2002/2011, likewise this last country and Latvia in 2006/2010.

	Sum Squared Distances' Decomposition	Decomposition of the Squared Distances							
		02/11	04/07	06/07	06/08	06/10	07/08	07/10	08/11
Austria	1.6	2.0	1.3	0.7	1.0	1.6	1.3	1.4	3.0
Belgium	1.1	1.5	1.6	1.2	1.0	1.0	2.0	1.4	1.0
Bulgaria	**8.3**	**5.6**	**10.3**	**7.5**	**5.8**	**7.6**	**9.9**	**9.5**	**9.7**
Cyprus	2.5	3.7	1.6	3.2	3.4	1.4	2.4	1.6	5.3
Czech Republic	2.1	1.8	0.8	0.8	2.9	2.6	3.4	2.4	1.5
Denmark	1.6	1.1	2.0	1.8	2.4	1.0	3.7	1.0	2.0
Estonia	**6.0**	**5.4**	4.0	3.7	**6.6**	**5.5**	**7.5**	**5.7**	**5.2**
Finland	2.1	3.4	1.8	1.3	1.0	1.7	0.9	1.4	1.6
France	2.1	2.0	1.9	1.6	2.2	2.3	2.4	2.3	1.8
Germany	2.0	1.5	1.9	1.8	2.3	2.7	1.3	2.2	2.4
Greece	**5.1**	**9.3**	2.0	3.4	5.0	4.7	3.9	3.8	**5.8**
Hungary	2.5	0.8	3.8	**6.2**	1.3	2.5	4.1	3.2	2.0
Ireland	**10.1**	**8.1**	4.4	4.8	**11.2**	**16.9**	**8.6**	**17**	**7.2**
Italy	0.8	1.0	0.9	0.7	0.8	0.6	1.2	0.8	0.8
Latvia	**6.5**	2.6	**7.3**	**7.9**	**5.3**	**8.7**	**7.4**	**9.7**	**6.0**
Lithuania	4.4	2.0	**6.6**	4.7	3.2	3.0	3.7	4.0	3.0
Luxembourg	**6.6**	**12.4**	**7.3**	**6.9**	**5.0**	3.8	3.2	3.3	**7.2**
Malta	2.6	2.0	**6.2**	**7.8**	2.9	1.8	2.4	1.5	2.3
Netherlands	1.4	1.1	1.1	3.1	1.6	1.6	1.6	1.3	1.6
Poland	**6.0**	**6.2**	**6.9**	**5.5**	**10.2**	**6.1**	**6.8**	4.1	3.2
Portugal	2.0	2.8	1.8	1.7	2.3	1.4	2.4	1.2	1.3
Romania	**10.8**	**11.1**	**11.8**	**7.8**	**6.4**	**12.6**	4.2	**12.1**	**11.4**
Slovakia	2.6	2.7	6.0	6.7	2.5	1.4	1.6	1.5	1.4
Slovenia	1.9	2.6	1.1	3.5	3.2	0.9	2.3	1.2	6.0
Spain	3.0	3.4	1.4	3.3	7.4	2.2	8.9	2.6	2.6
Sweden	2.7	2.3	2.6	1.5	1.6	3.4	1.1	2.5	3.1
UK	1.5	1.3	1.7	1.0	1.5	1.0	1.8	1.1	1.7

Table 3.4 – Decomposition of the sum of squared distances and decomposition of the squared distances into percentage of individuals' contributions.

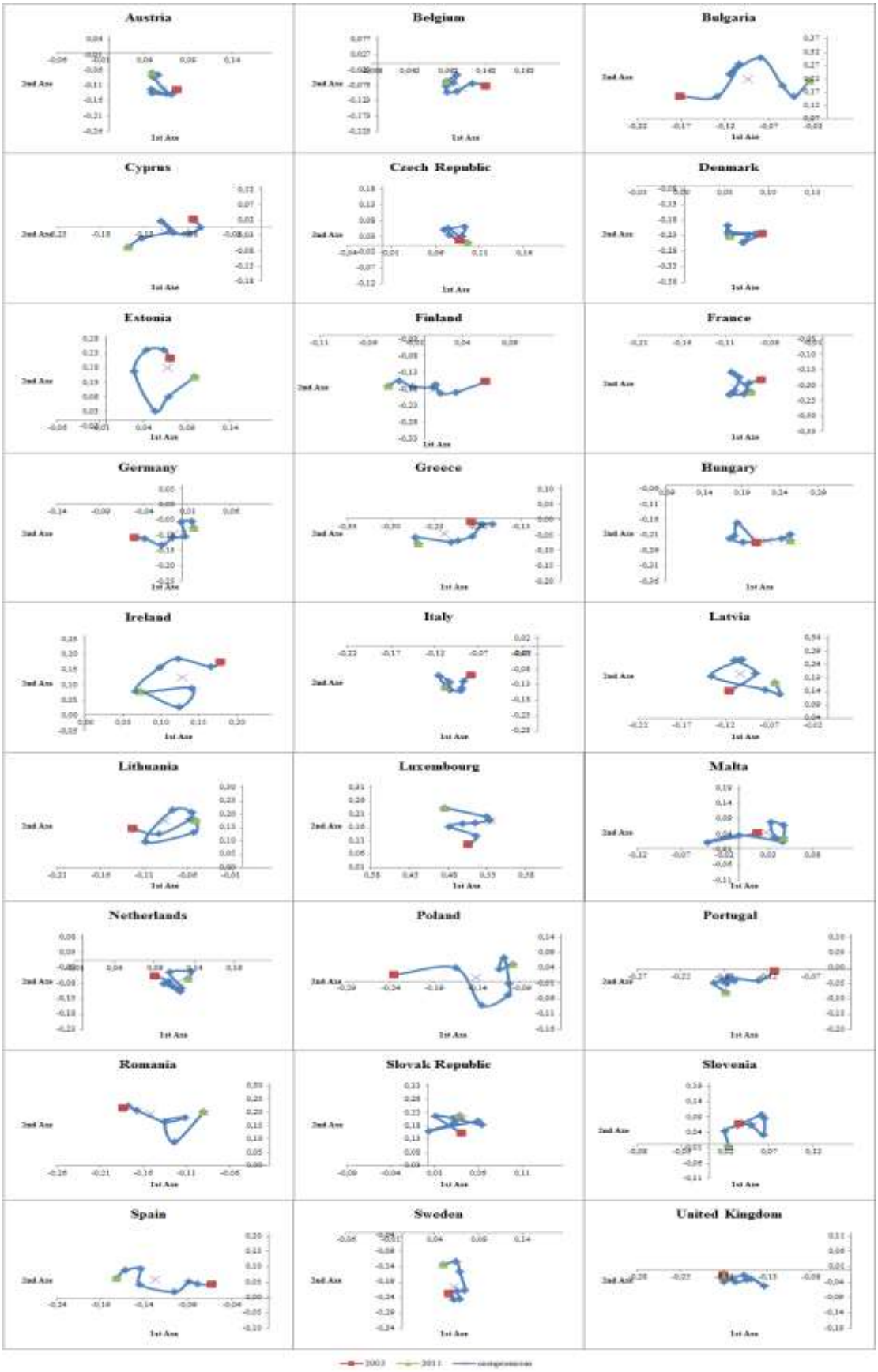

Figure 3.5 – Countries' trajectories in the plan [1, 2].

3.2 Results of the Dual Statis method

This method is similar to the Statis one, but it emphasises the variables' analysis instead of the individuals', allowing us to find a common structure and to describe the variables evolution.

Interstructure

Here, the representative object of each data table is the correlation matrix. Considering the matrix of distances between the years' representative objects, indicated in Table 3.5, we can conclude that all distances between years are relatively low, although the most similar years are 2002-2004, 2006-2008 and 2009-2011. In contrast, the year of 2006 seems to be more different from 2010-2011. This last year, jointly with 2002, is also more distant from 2007.

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	0							
2004	**1.087**	0						
2006	1.967	**1.376**	0					
2007	2.218	1.607	**0.940**	0				
2008	1.869	1.450	**0.952**	**1.002**	0			
2009	1.824	1.843	2.197	2.004	1.699	0		
2010	1.939	1.987	2.349	2.122	1.949	**1.081**	0	
2011	1.800	1.922	2.291	2.387	1.893	**1.385**	1.564	0

Table 3.5 - Matrix of the distances between years' representative objects.

Figure 3.6 shows the Centred Interstructure Euclidean image, which allows to draw identical conclusions to those obtained with Hilbert-Schmidt distances. Considering that, we can roughly divide the years in three main groups: 2002-2004, 2006-2008 and 2009-2011.

These conclusions are quite similar to those obtained in the Statis method, however, here it seems that 2002 and 2004 are more different from the rest of the years, instead of the year 2008. Thus, it is possible that the evolution of the variables could start to deteriorate since 2004, giving signs of the European countries' economic divergence.

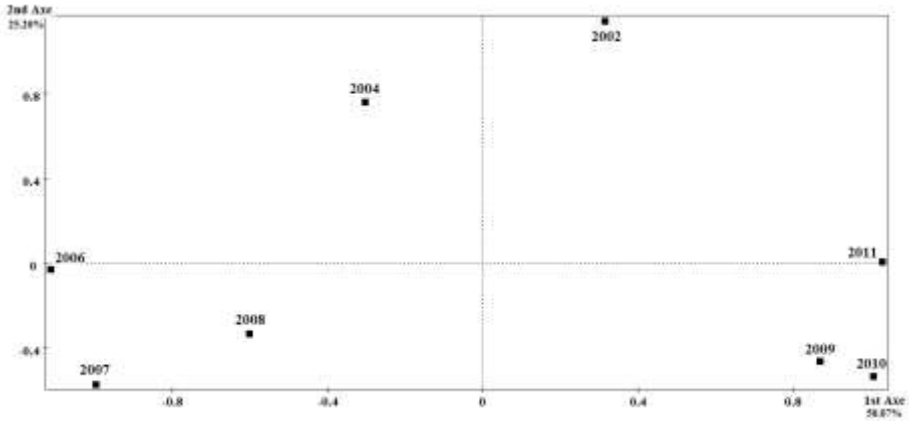

Figure 3.6 - Centred Interstructure Euclidean Image in the plan [1, 2].

Intrastructure

Table 3.6 identifies the scalar products and distances between years' representative objects and the compromise object. Regarding this, 2008 is the closest year to the compromise object and 2011 the furthest one.

	2002	2004	2006	2007	**2008**	2009	2010	2011
Scalar products	23.463	24.286	24.732	24.426	24.017	22.461	22.339	23.494
Distances	1.256	0.961	1.195	1.225	**0.888**	1.158	1.342	1.367

Table 3.6 – Scalar products and distances among data tables' representative objects and the compromise object.

	1st Axis	**2nd Axis**	**3rd Axis**	**4th Axis**	5th Axis	6th Axis	7th Axis	8th Axis
Eigenvalue	**3.056**	**2.774**	**2.011**	**1.152**	0.959	0.442	0.368	0.142
Inertia (%)	**27.78**	**25.21**	**18.28**	**10.48**	8.71	4.02	3.35	1.29
Cumulative Inertia (%)	**27.78**	**53.00**	**71.28**	**81.75**	90.47	94.49	97.84	99.12

Table 3.7 – Eigenvalue, inertia and cumulative inertia of the first eight compromise axes.

The eigenvalue, inertia and cumulative inertia of each axis are indicated in Table 3.7. Taking it into consideration, we have decided to retain the first four axes in which 81.75% of the total variance are explained. The variables pointed out on each axis were chosen regarding their correlation with the principal component and are well represented on that axis or in the principal plan.

Following this, in the first axis (see Figure 3.7) the variable consumption (C) (negative coordinate) is opposed to the variables imports (M) and exports (X) (positive coordinates). Therefore, **the first axis is an indicator of trade's destination** and it contradistinguishes the domestic trade and the external trade of the countries.

In relation to the second axis (see Figure 3.7), two variables are pointed out: public expenses (G) and public revenues (T) (positive coordinates). Thus, **the second axis is an indicator of the public activeness in the economy.**

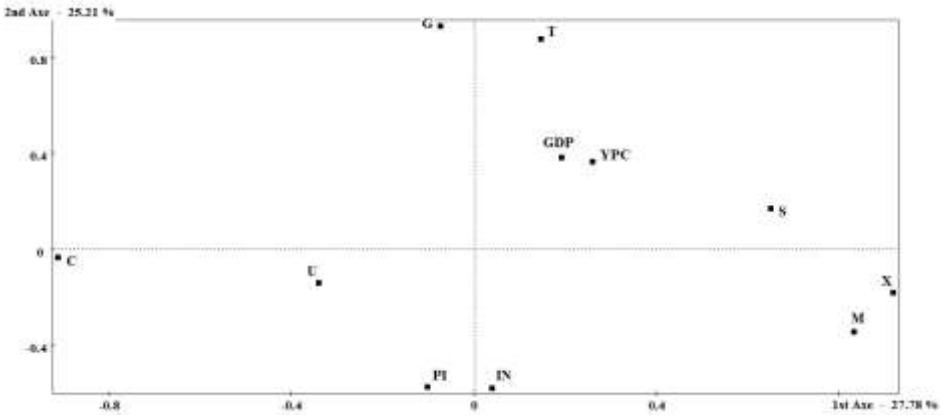

Figure 3.7 - Compromise's Euclidean Image in the plan [1, 2].

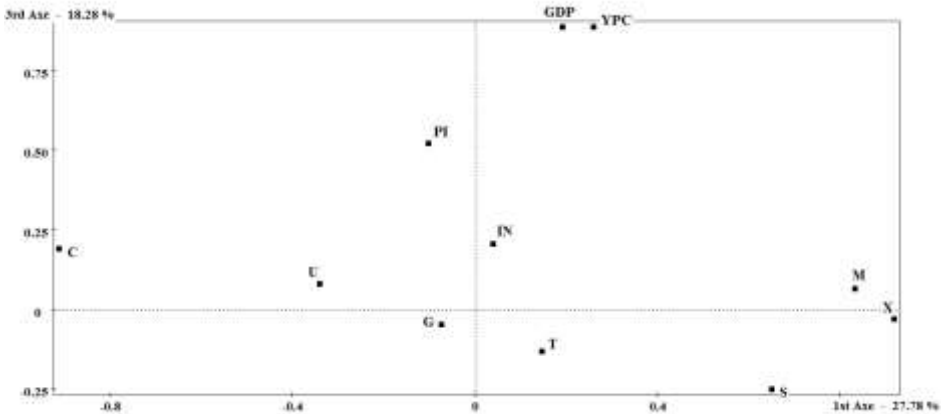

Figure 3.8 - Compromise's Euclidean Image in the plan [1, 3].

Thereafter, **third axis in an income's axis** (see Figure 3.8), as GDP and GDP *per capita* (YPC) are distinguished in this axis (positive coordinates), whereas countries with higher income are opposed to those whose income is lower.

Finally, investment (IN) and savings (S) (positive coordinates) are highlighted in the fourth axis (see Figure 3.9). Hence**, this axis evidences countries with higher investment and savings**, thus with higher investment activeness in the country itself.

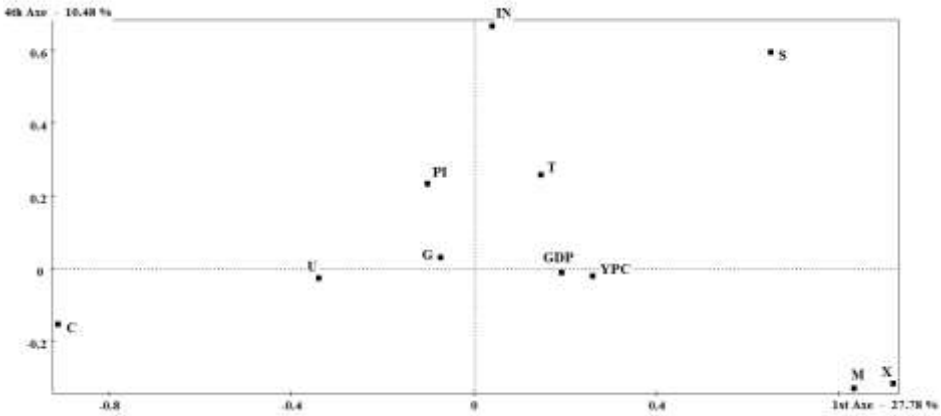

Figure 3.9 - Compromise's Euclidean Image in the plan [1, 4].

Contribution of the variables to the difference between years and their trajectories

The decomposition of the sum of squared distances between pairs of objects into percentage of variables' contributions allows to detect the variables whose correlations with the others are unstable: investment (17.3%), inflation rate (17.0%), savings (13.9%), unemployment rate (10.9%), public expenses (9.9%) and public revenues (9.6%). These variables also have trajectories more distant from the compromise object, as can be seen in Figure 3.10, where the first two axes explain 53% of the total variance.

Exports, GDP, GDP per capita and imports have a low contribution to the sum of squared distances' decomposition (among 2.8% and 5.2%), as a result they are more stable and their trajectories are closer to the compromise object. Only in 2002/2009 and 2002/2011, the variable consumption has some instability, evidenced by its high contribution to the decomposition of the squared distance between those years (10.9% and 11.4%, respectively).

Analysing now the most distant years evidenced in the interstructure phase – 2006 with 2010-2011, and 2007 with 2002, 2010 and 2011 – it is possible to achieve that inflation rate, public revenues, investment, savings, public expenses and unemployment rate are the most responsible for that. Inflation rate, investment, public revenues, public expenses, unemployment rate and savings are the main responsible for the deviation between 2006 and the other two years, jointly with imports in 2006/2010. Unemployment rate, inflation rate, public expenses, public revenues, savings and investment are the most responsible for the differences between 2007 with 2002, 2010 and 2011, jointly with consumption in 2007/2002 and imports in 2007/2010.

	Sum Squared Distances' Decomposition	Decomposition of the Squared Distances				
		06/10	06/11	07/02	07/10	07/11
GDP	4.5	4.6	3.0	4.9	3.8	4.3
YPC	4.0	3.8	2.7	4.5	3.0	3.8
U	**10.9**	**6.4**	**10.1**	**16.3**	**10.1**	**12.0**
PI	**17.0**	**24.8**	**12.7**	**15.8**	**15.2**	**11.2**
C	5.0	2.0	4.3	**6.0**	2.1	3.1
G	**9.9**	**12.5**	**10.5**	**9.6**	**13.0**	**9.0**
T	**9.6**	**16.0**	**13.4**	**5.5**	**14.2**	**9.4**
IN	**17.3**	**12.8**	**18.1**	**22.8**	**18.0**	**21.3**
S	**13.9**	**8.2**	**21.2**	**9.7**	**12.6**	**23.6**
X	2.8	1.9	0.6	1.9	1.5	0.2
M	5.2	**7.1**	3.5	3.2	**6.5**	2.1

Table 3.8 – Sum square distances' decomposition and squared distances' decomposition into percentage of variables' contribution.

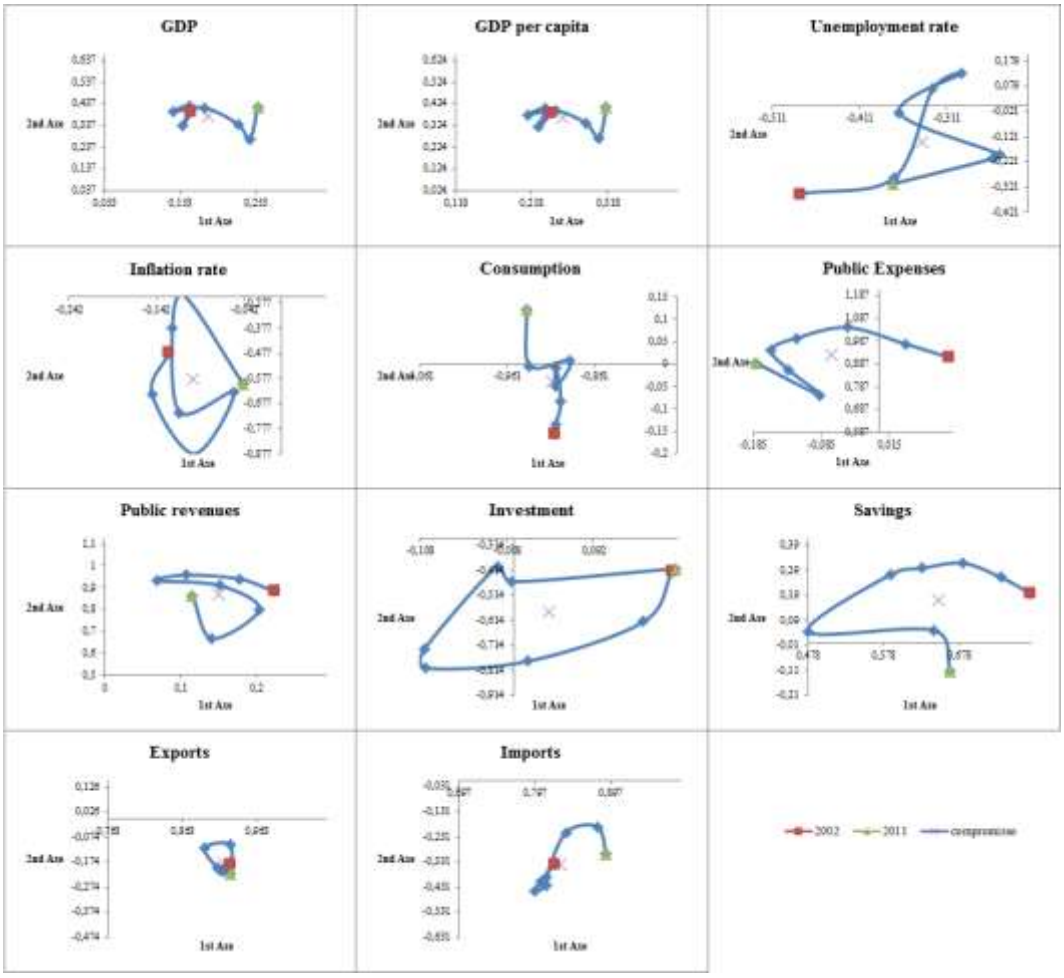

Figure 3.10 - Trajectories of each variable in the plan [1, 2].

CHAPTER 4

Competitiveness and External Debt

This Chapter indicates the conclusions obtained by the application of the Statis and Dual Statis methods, considering the competitiveness and external debt variables' groups.

In each subchapter the results of Statis method are firstly presented with the main objective of studying the similarities and evolution of the European countries within the variables considered. Then the conclusions of the Dual Statis method are presented in which is provided information about the evolution of the variables here analysed.

4.1 Competitiveness

It is undisputed that competitiveness is crucial if a country wants to have a position in the international market. According to this, European Union was settled with the main objective of promoting trade within the European countries and of reducing barriers to free trade. But are all European countries at the same level of competitiveness?

In this subchapter not only do we intend to study the similarities and differences between these countries, but we also try to justify those differences.

4.1.1 Conclusions of the Statis method

Statis method allows us to "group" years and countries if they are similar or distinguish otherwise, finding a common structure. We begin by pointing out the conclusions which can be drawn in the interstructure analysis, followed by the intrastructure and decomposition of distances between data tables' representative objects into percentage of countries' contributions.

Interstructure

RV coefficients between years' representative objects are, in general, high and distances low (Table 4.1). In spite of this, 2006 to 2008, 2008-2009 and 2009 to 2011 are the most similar years, as the distances among them are the lowest and the RV coefficients the highest ones, whilst 2002/2006, 2002/2010 and 2002/2011 are the furthest ones.

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	1							
2004	0.895	1						
2006	0.817	0.846	1					
2007	0.836	0.889	**0.944**	1				
2008	0.851	0.913	**0.932**	**0.986**	1			
2009	0.83	0.873	0.897	0.925	**0.944**	1		
2010	0.818	0.875	0.846	0.875	0.908	**0.968**	1	
2011	0.804	0.859	0.832	0.864	0.893	**0.949**	**0.990**	1
	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	0							
2004	0.458	0						
2006	0.604	0.555	0					
2007	0.573	0.471	**0.333**	0				
2008	0.546	0.417	**0.368**	**0.166**	0			
2009	0.584	0.505	0.455	0.388	**0.334**	0		
2010	0.604	0.500	0.555	0.500	0.430	**0.255**	0	
2011	0.626	0.531	0.580	0.522	0.462	**0.320**	**0.143**	0

Table 4.1 - RV coefficients (above) and distances (below) between data tables' representative objects.

Through the representation of the two dimensional Centred Interstructure Euclidean Image (Figure 4.1), in which the first two axes explain, approximately, 70% of the total variance, we can roughly divide the years into three groups, bearing in mind the distances between them: 2002-2004, 2006 to 2008, and 2009 to 2011.

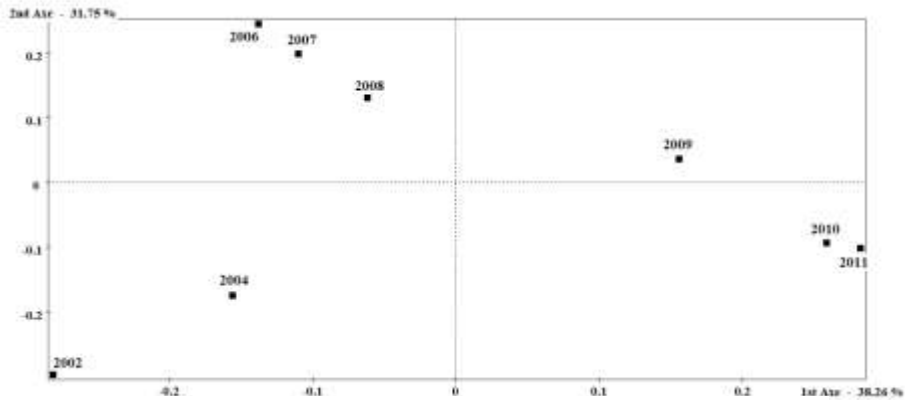

Figure 4.1 - Centred Interstructure Euclidean Image in the plan [1, 2].

Those findings are not surprising and are linked to the economic evolution. The real effective exchange rate (Figure 4.2) is frequently used to compare the competitiveness of countries, since it takes into account the differences in productivity and production costs plus the effects of the exchange rate. If we analyse it, it can be concluded that since 2004, European countries began to face a sharp difference in this variable. These differences are even more pronounced from 2006 to 2008, whereas from 2009 to 2011 it does not appear to be as accented as in the previous years, despite of continuing to be noticed a huge gap between European countries.

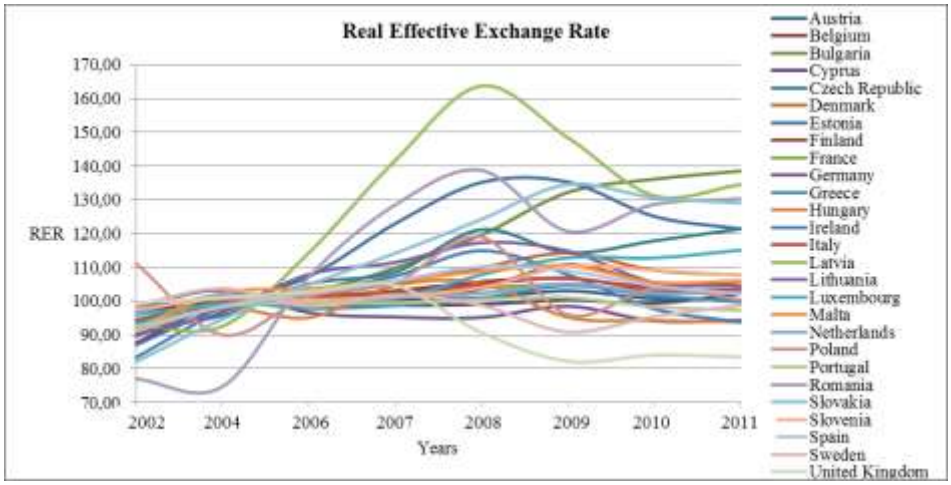

Figure 4.2 – Real effective exchange rate of the European countries.

Intrastructure

Scalar products between the compromise object and data frames' representative objects are in general high and distances low, so it is possible to find a common structure (Table 4.2). Even though the years of 2008 and 2009 are the closest to the compromise object, and the year of 2002 the furthest one.

	2002	2004	2006	2007	**2008**	**2009**	2010	2011
Scalar products	0.900	0.941	0.937	0.964	**0.978**	**0.973**	0.959	0.947
Distances	0.447	0.345	0.356	0.269	**0.210**	**0.234**	0.288	0.326

Table 4.2 - Scalar products and distances among the compromise object and data tables' representative objects.

As the first three axes explain, approximately, 80% of the total variance, we have decided to retain them to do the analysis. In order to give a meaning to countries' position within the compromise axes, the correlations between the variables here analysed and those axes are shown in Table A.3, Appendix 3.

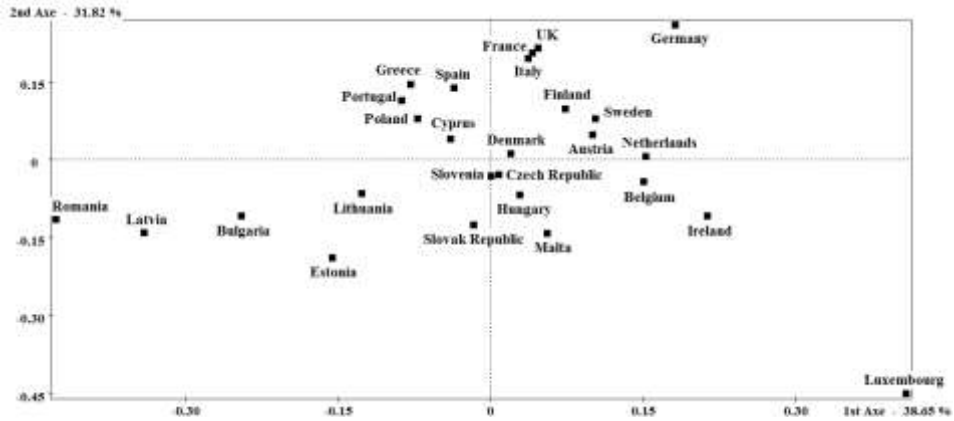

Figure 4.3 - Compromise's Euclidean Image in the plan [1, 2].

Hence, first axis (see Figure 4.3) opposes Romania, Latvia and Bulgaria (negative coordinates) with Luxembourg, Ireland and Germany (positive coordinates). The first axis is positively correlated with productivity (P) and trade balance (TB), during all period, and negatively correlated with real effective exchange rate (RER) in 2004-2011. Therefore, this axis distinguishes countries whose productivity and trade balance are higher, although their labour costs (CT) evolution were also high in 2002-2004 as well as their real effective exchange rate in 2004 – Luxembourg, Ireland and Germany – with countries whose real effective exchange rate was higher in 2006-2011, or in other words, countries that faced a loss in the external trade competitiveness in that year, probably then accentuated by the labour costs, as they are negatively correlated in 2006 to 2011 – Romania, Latvia and Bulgaria. Thus, **this axis indicates which countries have better conditions to face the competition in external trade and that is effectively reflected in the trade balance.**

Second axis (see Figure 4.3) opposes Luxembourg and Estonia (negative coordinates) with Germany, France, UK and Italy (positive coordinates). Hence, this axis has a strong negative correlation to exports (X) and imports (M) and a positive correlation with shares of exports in world trade (QE). It opposes countries with higher exports and imports – Luxembourg and Estonia – to countries whose imports and exports are lower than average, but their shares of exports in world trade higher than average – Germany, France, UK and Italy. Ergo, **this axis seems to be an indicator of the participation in external trade.**

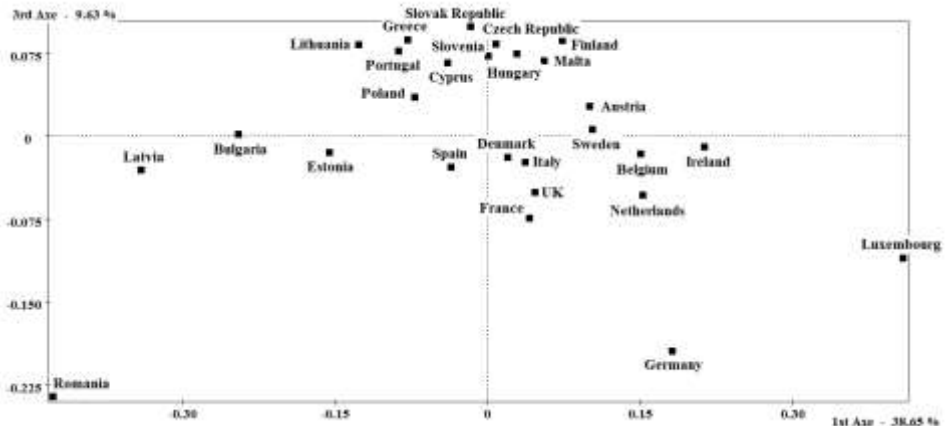

Figure 4.4 - Compromise's Euclidean Image in the plan [1, 3].

Finally, Romania, Germany and Luxembourg (negative coordinates) are opposed to Greece, Slovakia and Lithuania (positive coordinates) in third axis (see Figure 4.4). Third axis has a relatively high negative correlation with terms of trade (TT) in 2007-2011 and share of exports in world trade (QE). **Thus, this axis discriminates countries with lofty international trade importance** (measured by share of exports in world trade) **and with higher external sustainability, caused by the higher price of exports in relation to imports** (demonstrated by the terms of trade) - Romania, Germany and Luxembourg – with countries in the opposite situation - Greece, Slovakia, Lithuania.

Countries' contribution to the differences between years and their trajectories

Through the decomposition of the sum of squared distances between normed objects, it is possible to conclude that Latvia (17.1%), Romania (16.7%), Luxembourg (6.9%), Bulgaria (6.4%), Ireland (6.2%), Lithuania (6.1%) and Poland (5.5%) are the countries whose contributions to the differences of the structure in the period 2002-2011 are higher. Their trajectories are also more irregular and further from the compromise object, as it is expected and is shown in Figure 4.5, in which the first two compromise axes explain 70.47% of the total variance.

In contrast, Germany (2.4%), Sweden (2.2%), UK (2.1%), Italy (1.4%), Portugal (1.2%), Slovenia (1.1%), Belgium (1.1%), Netherlands (1.0%), Austria (0.9%), Denmark (0.9%), Spain (0.8%), France (0.7%) and Czech Republic (0.7%) are more "stable" in this period, as their contributions are lower and their trajectories closer to the compromise object.

Estonia (4.9%), Finland (3.3%) and Slovak Republic (2.8%) also do not have a high contribution to the structure's difference, though they have a higher contribution to the differences of some pairs of years. Finland has a contribution of 6.1% to the differences between 2002/2009, the same with Slovak Republic but for the years 2002/2008. Furthermore, this last country has a significant contribution to 2002/2007´s differences (12.0%). Estonia has a higher contribution especially in relation to the years of 2007, 2008, 2009 and 2010: 2004/2007-2009, 2007/2008-2011, 2008/2010-2011, 2009/2010-2011 and 2010/2011 (between 5.6% and 10.5%).

Cyprus (2.3%), Hungary (2.2%), Greece (1.8%) and Malta (1.3%) do not have a significant contribution neither to the structure differences nor to the pairs of years' differences, but their trajectories are irregular. In the case of Greece and Hungary, their trajectories show a left to right evolution in relation to the first axis. As this axis is positively correlated with productivity and trade balance, during all period, that suggests a tendency to increase within these variables. The same situation is observed for Cyprus, but relative to the second axis, that has a strong negative correlation to exports and imports. Thus, this can indicate a tendency to a decrease of Cyprus' external market participation. The trajectory of Malta only shows an unusual evolution during 2006/2004 and 2006/2007, even though it has a small contribution, in average, to the differences of all years and 2006 (2.6%).

In the interstructure phase, three pairs of years were pointed out as the furthest ones: 2002/2006, 2002/2010 and 2002/2011. Thus, by the analysis of the decomposition of the squared distances between pairs of normed objects, we can conclude that Bulgaria, Lithuania, Poland and Romania, already highlighted in the analysis of the sum squared distances' decomposition, are the countries whose contributions to the differences between those years are higher. Latvia and Luxembourg also have a high contribution in 2002/2006 and 2002/2011, respectively.

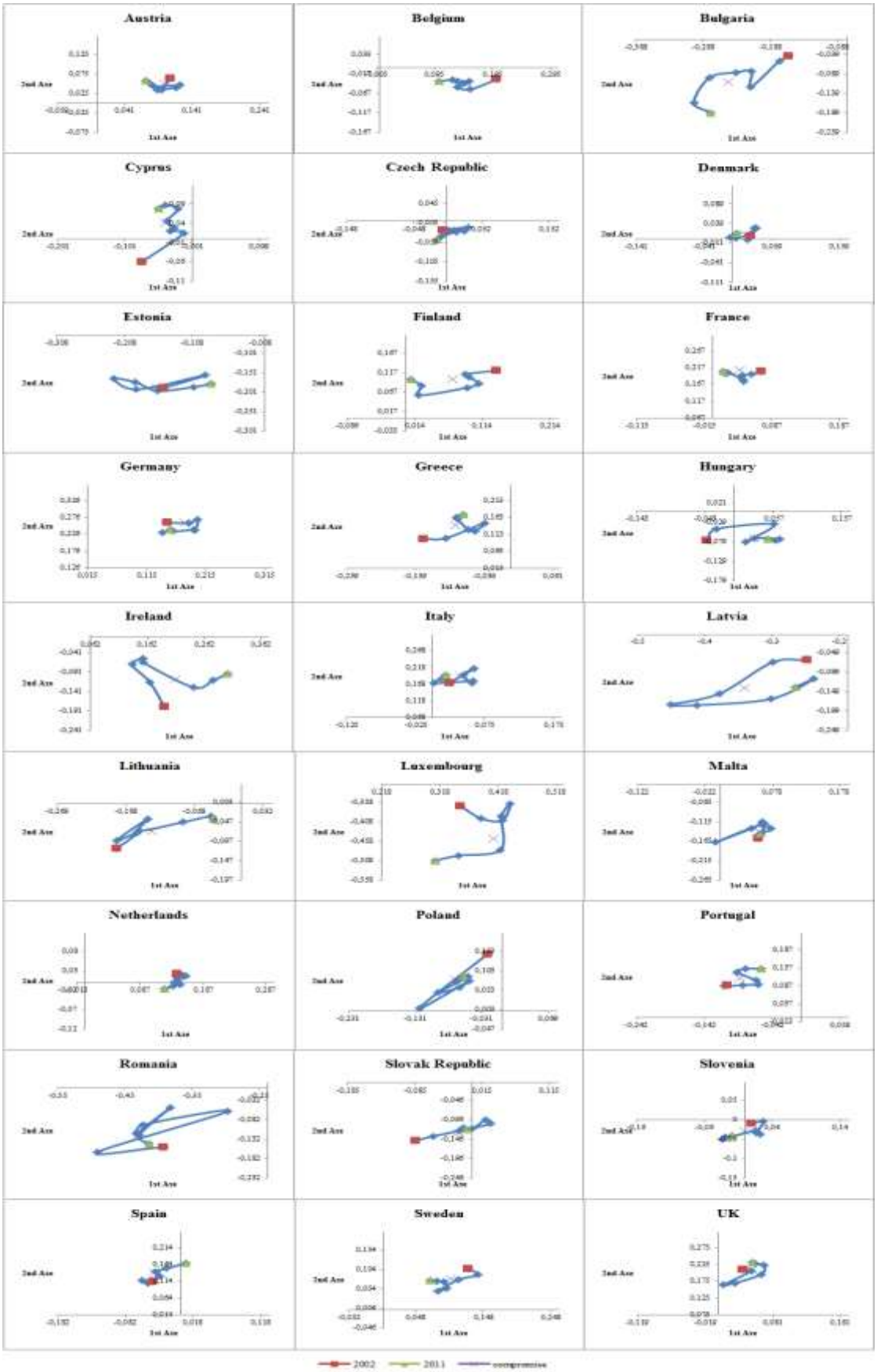

Figure 4.5 - Countries' trajectories in the plan [1, 2].

4.1.2 Results of the Dual Statis method

Throughout the previous subchapter, we have studied the similarities and differences among European countries' competitiveness and calculated the linear correlation coefficients between variables and the compromise axes, in order to find a meaning to the countries' position. Here, we want to study further the relation between variables and their evolution.

Interstructure

Regarding the Hilbert-Schmidt distances among correlations matrices (Table 4.3), it is possible to conclude that, in general, they are small. Regardless of this, 2002/2004, 2007/2008 and 2008 to 2011 are the most similar years, as their distances are lower.

Notwithstanding, 2002/2006, 2004 with 2006, 2007 and 2008 are the furthest years or, in other words, the most different ones.

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	0							
2004	**1.012**	0						
2006	3.312	3.520	0					
2007	3.503	3.614	1.155	0				
2008	3.406	3.507	1.186	**0.446**	0			
2009	3.125	3.200	1.606	1.446	**1.096**	0		
2010	3.210	3.272	1.786	1.410	**1.040**	**0.613**	0	
2011	3.224	3.267	1.733	1.387	**1.058**	**0.894**	**0.378**	0

Table 4.3 - Distances between data tables' representative objects.

Centred Interstructure Euclidean Image shows identical conclusions. Figure 4.6 represents it in the first two axes, in which 92% of the total variance is explained. According to their proximity, we can grossly group the years as 2002-2004, 2006 to 2008, and 2009 to 2011.

In Statis method identical conclusions were found and have been already discussed.

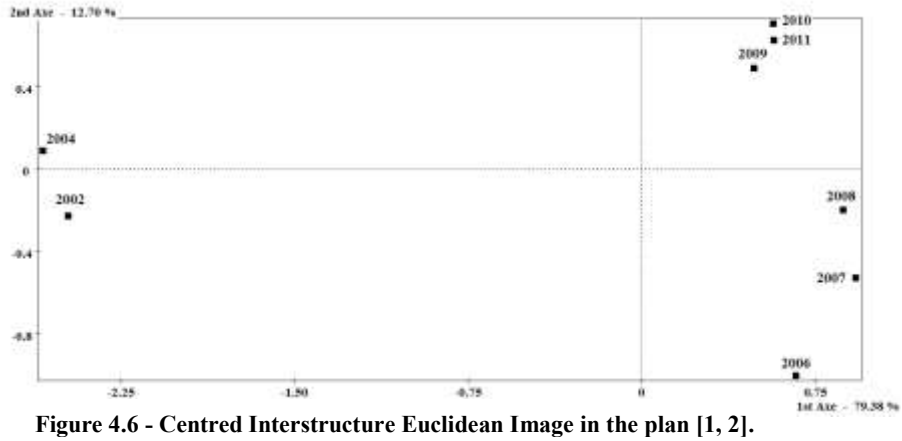

Figure 4.6 - Centred Interstructure Euclidean Image in the plan [1, 2].

Intrastructure

In respect to the distances between the compromise object and representative objects (Table 4.4), 2009 and 2010 are the closest years to the compromise object, while 2002 and 2004 the furthest ones.

	2002	2004	2006	2007	2008	**2009**	**2010**	2011
Scalar products	13.976	14.238	16.443	17.859	17.782	17.081	17.597	17.612
Distances	2.532	2.634	1.317	1.184	0.958	**0.879**	**0.915**	0.933

Table 4.4 - Scalar products and distances between the compromise object and data tables' representative objects.

Considering the eigenvalues, inertia and cumulative inertia of each compromise axis, the first three axes explain 82.73% of the total variance, so we have decided to retain them to do the analysis.

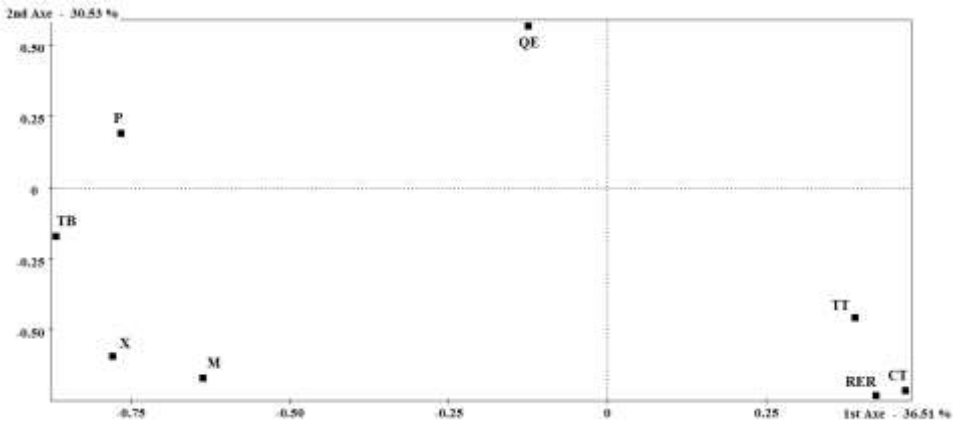

Figure 4.7- Compromise's Euclidean Image in the plan [1, 2].

Here, the first axis (see Figure 4.7) is associated to trade balance (TB), exports (X), productivity (P) and imports (M) (negative coordinates), or in other words, this axis

evidences countries with higher trade balance, external activeness (measured by imports and exports) and higher productivity. Therefore, **this axis is an indicator of the competitiveness and activeness of countries in the external market.**

The second axis (see Figure 4.7) discriminates the variables exports (X), imports (M), real effective exchange rate (RER) and labour costs (CT) (negative coordinates) with share of exports in world trade (QE) (positive coordinates). Ergo, **this axis is an indicator of countries' trade efficiency**, as it opposes countries with higher activeness in external market (higher imports and exports), but whose labour costs are higher, being less competitive (higher real effective exchange rate), to countries that even though their exports and imports are lower, have a high importance in the external trade (higher share of exports in world trade).

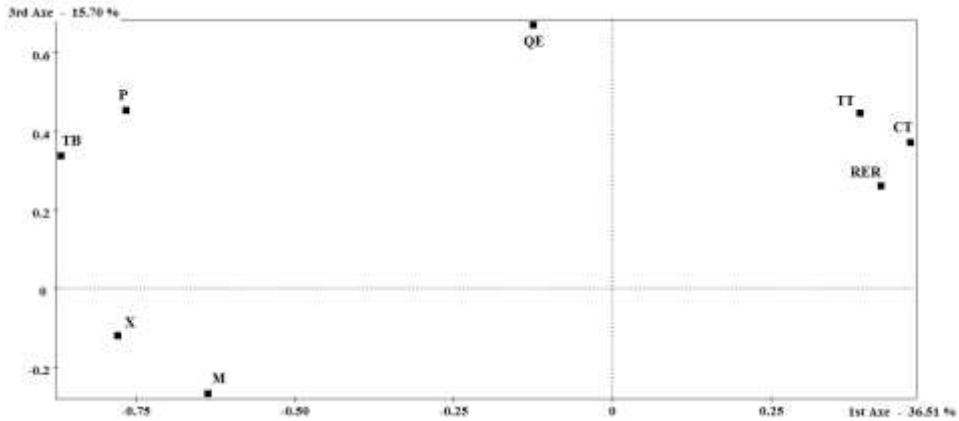

Figure 4.8 - Compromise's Euclidean Image in the plan [1, 3].

Finally, third axis evidences the variable share of exports in world trade (QE) (see Figure 4.8). Thus, **this axis highlights countries with lofty international trade importance** (measured by share of exports in world trade).

Contribution of the variables to the differences between years and their trajectories

The majority of the variables here analysed has a high contribution to the differences among pairs of years, which can be evidenced by the sum of squared distances between pairs of normed objects: productivity (20.3%), labour costs (20.1%), real effective exchange rate (17.4%), trade balance (13.2%), terms of trade (12.9%) and share of exports in world trade (10.3%). Therefore, the evolution of these variables within the

period 2002-2011 appears to be unstable, showing changes in the competitiveness of the countries hereby analysed. This is as well shown in the variables' trajectories, shown in Figure 4.9, in which the first two compromise axes explain 67% of the total variance.

Imports and exports have a lower contribution to the differences between years, which can be evidenced by their contributions to the decomposition of the sum of squared distances (4.0% and 1.8%, respectively) and the more proximity among their trajectories and the compromise object. Nevertheless, imports have a high contribution for the differences among some pairs of years, especially between 2006 with 2009 and 2010 (14.7% and 10.3%), 2008 with 2009 and 2010 (9.5% and 9.6%), and 2010/2011 (18.2%).

In the interstructure phase, four pairs of years were highlighted as the most distant ones: 2004 with 2006, 2007 and 2008, and 2002/2006. Therefore, it is now possible to point out which variables have a higher contribution to those differences: share of exports in world trade, trade balance, real effective exchange rate, labour costs, terms of trade and productivity are, with no surprise, the ones whose contributions are higher to those differences, jointly with imports in 2002/2011.

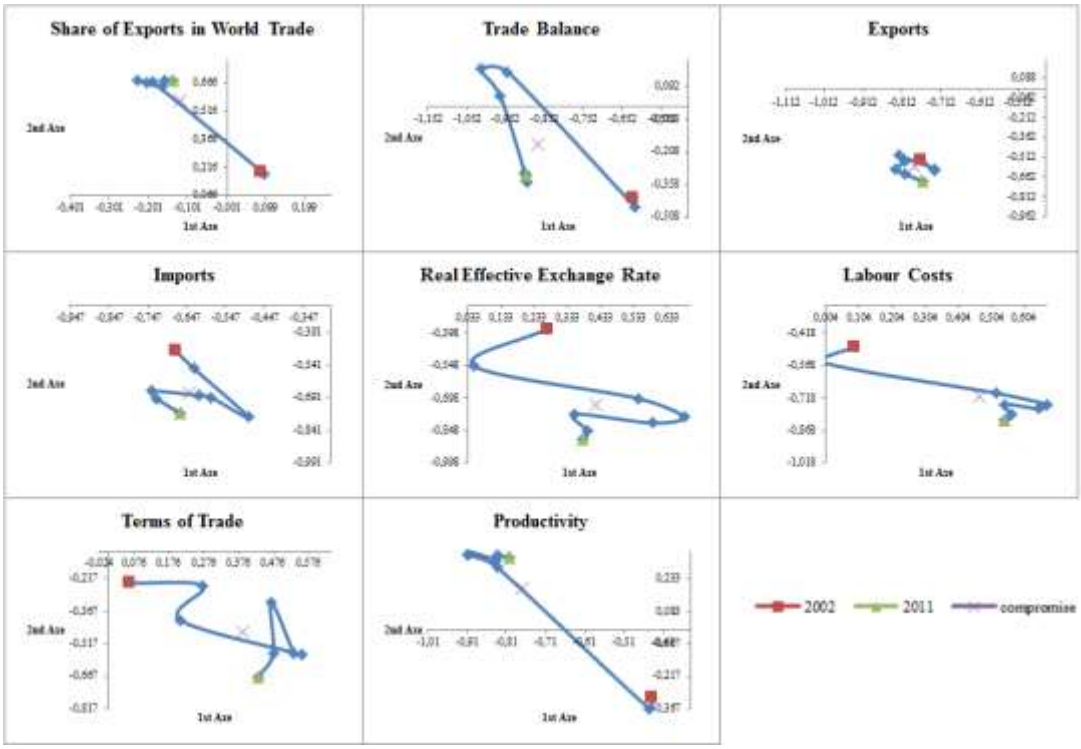

Figure 4.9 - Each variable trajectory in the plan [1, 2].

4.2 External Debt

In this study, we have already discussed macroeconomic, public sector and competitiveness of the European countries. In this chapter we intend to study the similarities and differences between these economies, but this time taking into consideration six variables that feature the countries' external debt. Accordingly, the conclusions of the Statis method are first presented, followed by the Dual Statis method.

4.2.1 Conclusions of the Statis method

This method allows us to find a common structure between European countries' debt, identifying differences and similarities. Firstly, the results of the interstructure and intrastructure phases are indicated, followed by the analysis of the distances' decomposition between data tables.

Interstructure

Analysing RV coefficients and Hilbert-Schmidt distances between data tables' representative objects (Table 4.5), it is evident that the closest years are 2004-2007, 2007/2008 and 2009-2011, whilst the most distant ones are 2002/2009 and 2002/2011.

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	1							
2004	0.805	1						
2006	0.724	**0.923**	1					
2007	0.745	**0.895**	**0.911**	1				
2008	0.738	0.879	0.866	**0.928**	1			
2009	0.634	0.815	0.776	0.789	0.851	1		
2010	0.659	0.819	0.766	0.777	0.832	**0.950**	1	
2011	0.658	0.807	0.749	0.783	0.827	**0.890**	**0.963**	1

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	0							
2004	0.624	0						
2006	0.744	**0.393**	0					
2007	0.714	**0.458**	**0.421**	0				
2008	0.724	0.492	0.518	**0.379**	0			
2009	0.856	0.608	0.669	0.650	0.545	0		
2010	0.825	0.602	0.684	0.668	0.579	**0.318**	0	
2011	0.827	0.622	0.708	0.660	0.588	**0.470**	**0.272**	0

Table 4.5 - RV coefficients (above) and distances (below) between data tables' representative objects.

A similar conclusion is obtained with the two-dimensional representation of the Centred Interstructure Euclidean Image (Figure 4.10), where the first two axes explain, approximately, 67% of the total variance. Throughout this, we can roughly divide the years into three groups: 2002, 2004-2008 and 2009-2011, being 2002 the most distant one.

Therefore, it seems that, one more time, the year of 2008 divides two groups of years – 2004-2008 and 2009-2011; but it is interesting that the interstructure has noted differences between 2002 and the remaining pre-crisis years.

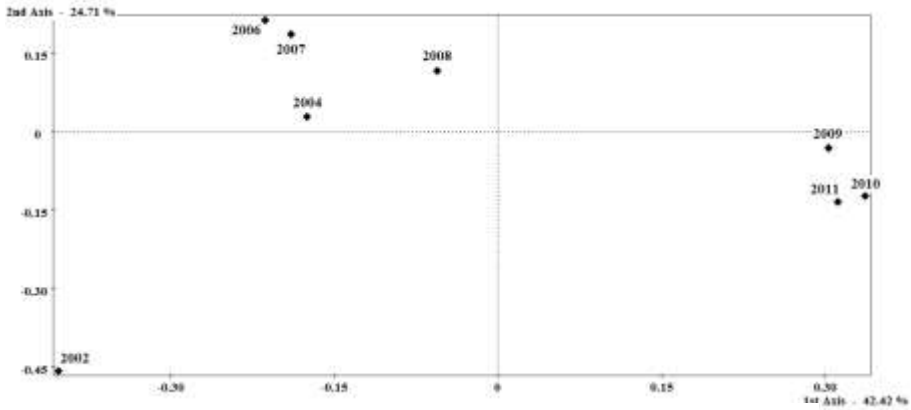

Figure 4.10 - Centred Interstructure Euclidean Image in the plan [1, 2].

In the last chapter, we have highlighted an increasing discrepancy of the real effective exchange rate between the European countries, which may express a divergence among those economies. This divergence may have, in especial, negative effects on the balance of payments of countries that become less competitive, making them also less attractive for investment. As the Statis methodology identifies similarities and differences between countries and variables, this will be further studied.

Intrastructure

	2002	**2004**	2006	2007	**2008**	2009	2010	2011
Scalar products	0.810	**0.949**	0.919	0.934	**0.947**	0.918	0.926	0.913
Distances	0.617	**0.320**	0.404	0.363	**0.325**	0.405	0.385	0.416

Table 4.6 - Scalar products and distances among different data tables.

In Table 4.6 scalar products and distances between the compromise object and the different data tables' representative objects are indicated. Although they are, in general, high and low, respectively, proving it is possible to find a common structure of the

European countries' debt; 2004 and 2008 are the closest to the compromise object, and 2002 the furthest one.

Following this, as the first four axes explain, approximately, 84% of the total variance, we have decided to retain them to do the analysis. In order to find a meaning to the countries' position within the compromise axes, the linear correlation coefficients between the six variables here considered and each axis were calculated and are shown in Table A.4, Appendix 3. This will also be further studied in the Dual Statis method.

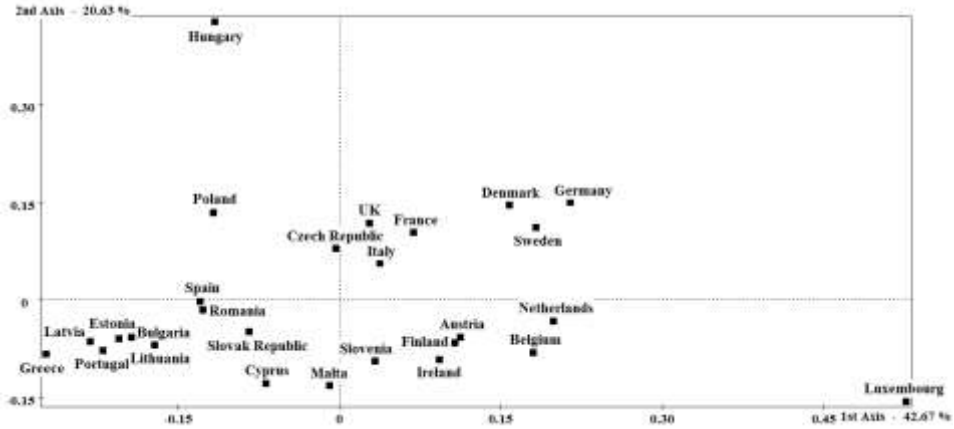

Figure 4.11 - Compromise's Euclidean Image in the plan [1, 2].

According to these, first axis (see Figure 4.11) opposes Greece, Latvia, Portugal, Estonia and Bulgaria (negative coordinates) with Luxembourg, Germany, Netherlands, Belgium and Sweden (positive coordinates). It has a strong positive correlation with trade balance (TB) and international investment position (IIP), during all years, even as with current account (CA), and a negative correlation to capital balance (BK). Thus, Luxembourg, Germany, Netherlands, Belgium and Sweden have had a trade balance, international investment position and current account above the average, in contrast with a capital account lower than average. Contrarily, Greece, Latvia, Portugal, Estonia and Bulgaria have seen their capital account above the average, but a trade balance, international investment position and current account lower than average. Consequently, **this axis opposes countries' current foreign assets (measured by trade balance, current account and international investment position) with countries' capital transfers that do not give rise to a future flow of income payments in return (measured by capital account).**

Second axis (see Figure 4.11), which is positively correlated with international reserves (R) and negatively correlated with current transfers (TC) in 2004 to 2011,

opposes Luxembourg, Cyprus and Malta (negative coordinates) with Hungary, Denmark, Germany and Poland (positive coordinates). Therefore, Hungary, Denmark, Germany and Poland have had international reserves above the average, whilst Luxembourg, Cyprus and Malta have had current transfers above the average, in the respective years. Thus, **this axis seems to oppose countries' assets accumulation by them in contrast to assets received from other countries and without counterpart.**

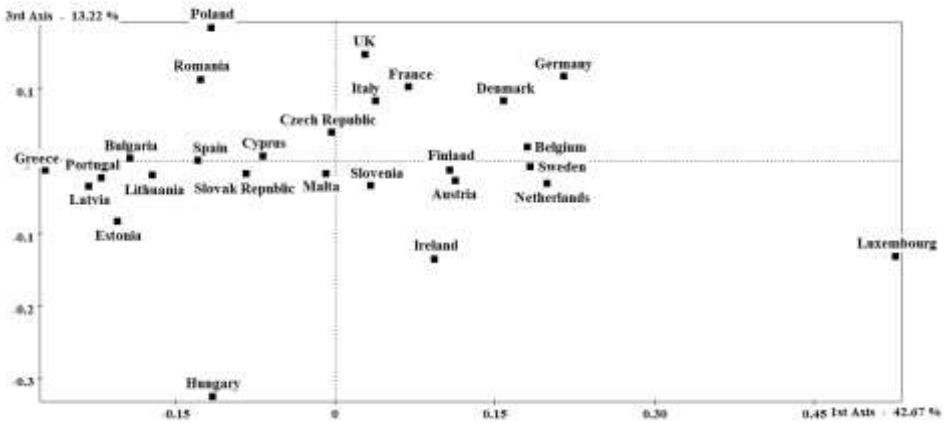

Figure 4.12 - Compromise's Euclidean Image in the plan [1, 3].

In third axis (see Figure 4.12), Hungary and Luxembourg (negative coordinates) are distinguished from Poland, UK, Germany, Romania and France (positive coordinates). Third axis has a relatively high positive correlation with reserves (R) and current transfers (TC). Thus, **this axis opposes countries with high current transfers and reserves** - Poland, UK, Germany, Romania and France– to countries in the opposite situation - Hungary and Luxembourg.

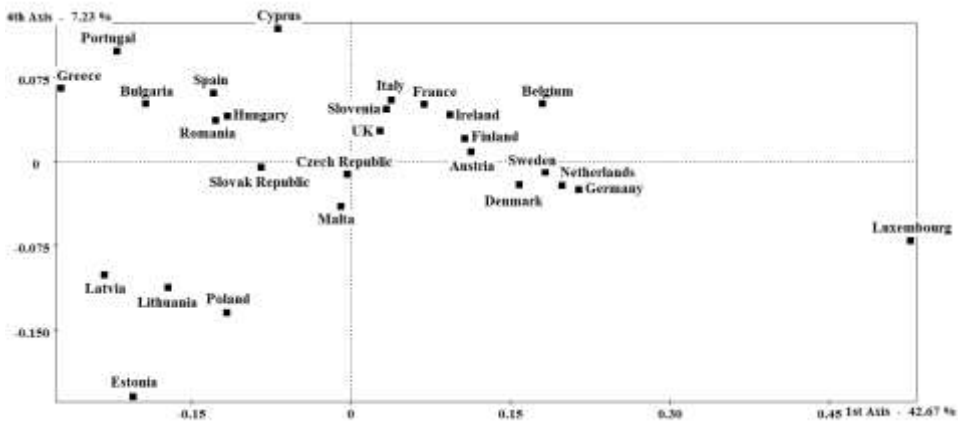

Figure 4.13 - Compromise's Euclidean Image in the plan [1, 4].

Finally, fourth axis (see Figure 4.13) opposes Estonia, Poland, Lithuania, Latvia and Luxembourg (negative coordinates) with Cyprus and Portugal (positive coordinates). **It only seems to be negatively correlated with capital (BK) account in 2009 to 2011**, whereby Estonia, Poland, Lithuania, Latvia and Luxembourg have had a capital account above the average in those years, contrarily with Cyprus and Portugal, whose capital account has had lower than average.

Contribution of the countries to the differences between years and their trajectories

Taking into consideration the decomposition of the sum of squared distances between objects, Luxembourg (11.6%), Hungary (8.1%), Latvia (6.8%), Estonia (6.9%), Bulgaria (6.8%), Greece (5.7%), Cyprus (5.0%), Portugal (4.8%), Poland (4.6%) and Malta (4.5%) are the countries more responsible for the structure's difference in the period 2002-2011, as their contributions are higher. This is corroborated by the representation of these countries' trajectories, evidenced by the distance among the compromise object and each trajectory. Figure 4.14 shows the trajectories in the plan [1, 2], in which those axes explain 63.3% of the total variance.

In contrast, Austria, Belgium, Czech Republic, Germany, Ireland, Italy, Lithuania, Romania, Slovakia, Spain, Sweden and UK have trajectories more regular, proved by how close their trajectories are to the compromise object and their small contribution to the pairs of years' differences (among 0.9% and 3.9%).

Finland, Netherlands, France, Denmark and Slovenia do not also have a high contribution to the structure's difference (among 1.4% and 3.4%), but it is interesting to analyse their trajectories. The trajectories of Finland, Slovenia and France seem to have a right to left trend in 2002-2011 in the positive side of the first axis. As this axis is positively correlated with trade balance, current account and international investment position, it indicates a decrease in these variables. Contrarily, Netherlands has a left to right trend in the positive side of this axis, indicating an increase in these variables. Denmark has also had a trend to increase but in relation to the second axis, indicating a trend to a reserves' increase.

Bearing in mind the pairs of years 2002 with 2009 and 2011, considered the furthest in the interstructure phase, it is now possible to indicate which countries explain those differences. Hence, through the decomposition of the squared distances between pairs of objects, it can be concluded that those differences are mainly due to Greece, Hungary, Luxembourg and Portugal, jointly with Estonia and Poland whose contributions for the differences between 2002/2011 are also high.

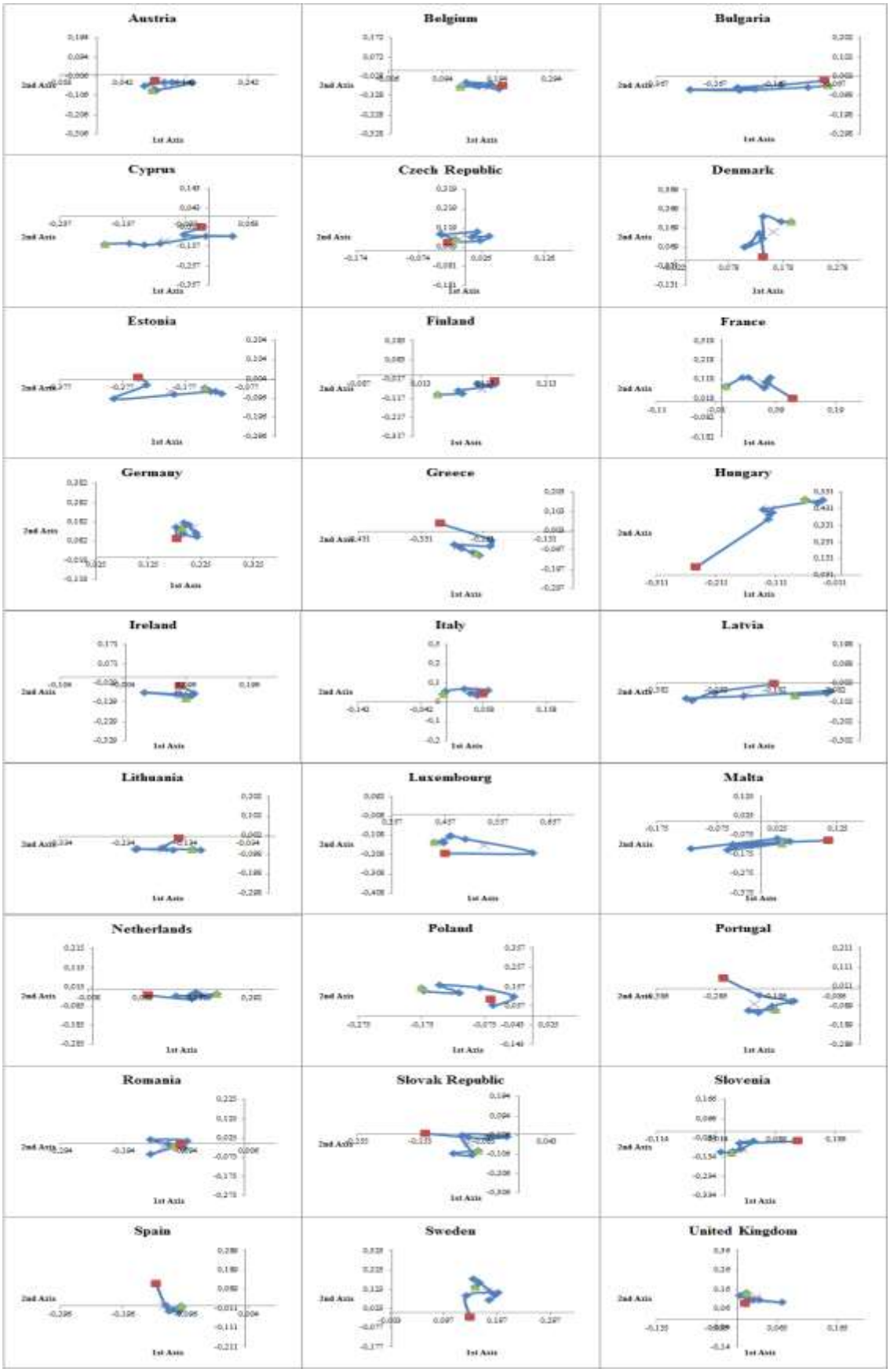

Figure 4.14 - Countries' trajectories defined in the plan [1, 2].

4.2.2 Results of the Dual Statis method

This method allows to study the evolution of the debt variables here analysed, as well as to complement the findings obtained in Statis method. We begin to analyse the results of the interstructure, followed by the intrastructure and decomposition of the squared distances.

Interstructure

Beginning by the analysis of the scalar products, not presented here, and distances (Table 4.7) among correlation matrices, we can identify the pairs of years 2004/2006, 2004/2008 and the years 2009 to 2011, as the most similar ones, because they have smaller distances. In contrast, 2009 with 2002 to 2006 are the most different years.

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	0							
2004	1.081	0						
2006	1.183	**0.533**	0					
2007	1.228	0.956	0.739	0				
2008	0.958	**0.574**	0.770	0.818	0			
2009	1.301	1.390	1.332	0.960	1.274	0		
2010	1.084	1.290	1.187	0.784	1.100	**0.416**	0	
2011	1.211	1.377	1.248	0.789	1.136	**0.501**	**0.236**	0

Table 4.7 - Distances between correlation matrices.

Figure 4.15 represents the two dimensional Centred Interstructure Euclidean Image in the plan defined by the first and second axes, where is explained, approximately, 59% of the total variance. Hence, we can grossly group the years as 2002; 2004-2008 and 2009-2011. Notwithstanding, identical conclusions were obtained in Statis method.

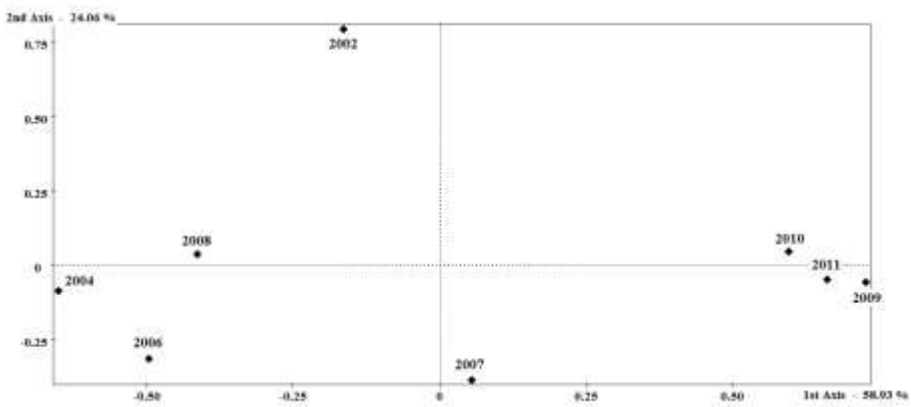

Figure 4.15 - Centred Interstructure Euclidean Image in the plan [1, 2].

Intrastructure

Table 4.8 shows the scalar products and distances between the compromise object and the correlation matrices. Although, in general, scalar products are high and distances low, 2007 and 2008 are the closest years to the compromise object, whilst 2002 and 2009 the furthest ones.

	2002	2004	2006	**2007**	**2008**	2009	2010	2011
Scalar products	11.08	11.542	11.121	10.586	11.405	9.432	9.721	9.557
Distances	0.827	0.713	0.666	**0.515**	**0.575**	0.800	0.608	0.693

Table 4.8- Scalar products and distances among the compromise object and data tables' correlation matrices.

Towards eigenvalues, inertias and cumulative inertias of the compromise axes, we have decided to retain the first four axis in which approximately 91.8% of the total variance are explained.

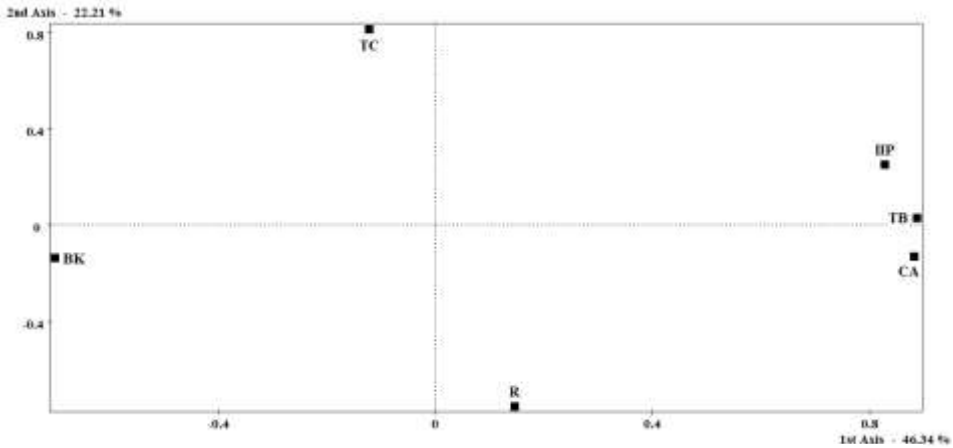

Figure 4.16 - Compromise's Euclidean Image in the plan [1, 2].

Hence, first axis (see Figure 4.16) evidences current account (CA), trade balance (TB) and international investment position (IIP) (positive coordinates). Thus, **this axis is an indicator of foreign assets accumulated by countries.**

Second axis (see Figure 4.16) opposes current transfers (TC) (positive coordinate) with international reserves (R) (negative coordinate). Therefore, **this axis opposes countries' assets accumulation by them in contrast with assets received from other countries and without counterpart.**

Third axis (see Figure 4.17) **distinguishes international reserves** (R) **and current transfers** (TC) (negative coordinates)**.** Thus, this axis seems to oppose countries with higher type of these assets to countries whose current transfers and international reserves are lower.

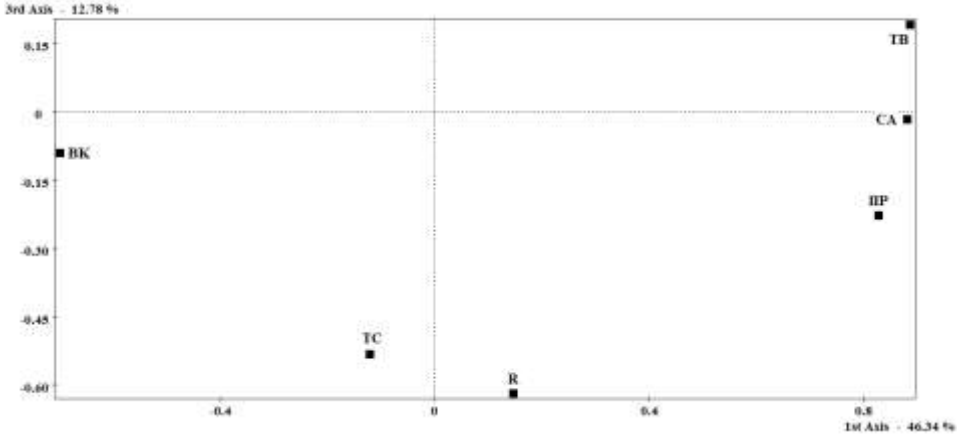

Figure 4.17 - Compromise's Euclidean Image in the plan [1, 3].

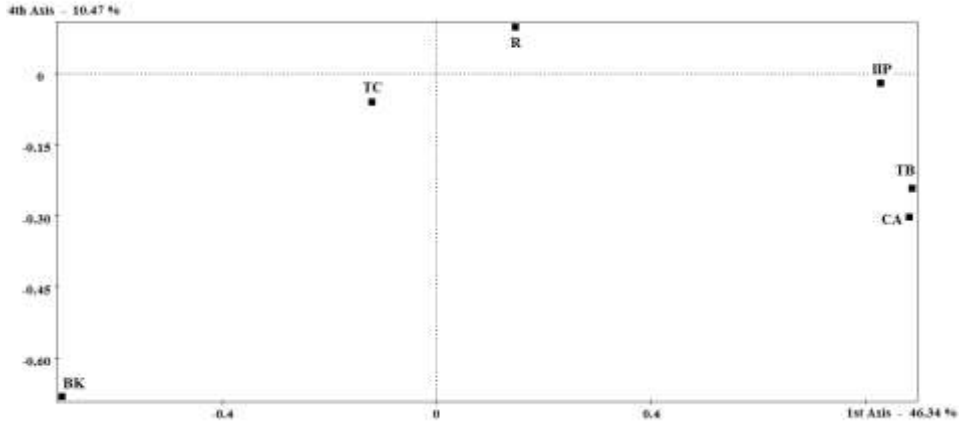

Figure 4.18 - Compromise's Euclidean Image in the plan [1, 4].

Fourth axis (see Figure 4.18) also highlights countries' assets, but in this case relatively to capital account (BK) (negative coordinate). Therefore, **this axis evidences which countries have a capital account above the average.**

Contribution of the variables to the differences between years and their trajectories

The decomposition of the sum of squared distances between objects indicates that all variables have, in general, a high contribution to those differences among years (between 7.2% and 28.3%). Capital balance (28.3%) and current account (22.7%) are the variables with higher contribution. Although trajectories are only an approximate representation, the high contributions to the differences between years can be seen by the distances between each trajectory and the compromise object. Figure 4.19 shows the trajectories in the plan [1, 2], in which those axes explain 68.6% of the total variance.

Certain variables have some pairs of years whose contributions to the differences between them are lower. For instance, current account's contribution in 2004/2006 and 2006/2008 was 0.8% and 2.7%, respectively, or international investment position's contribution in the pairs of years 2004/2008, and 2006/2007 which were 2.6% and 1.4%. Trade balance, current transfers and, especially, international reserves have more years whose contributions to the differences among data tables are lower. Trade balance's contributions were 4.3%, 3.3% and 1.9% in 2002/2006, 2002/2008 and 2006/2008, respectively, while current transfers have a low contribution to the differences of 2004/2007, 2004/2009, 2006/2007 and 2008/2011 (between 0.5% and 3.4%). International Reserves is the variable which has more pairs of years with low contribution to their differences (among 2.7% and 4.4%): 2002 with 2009-2011, 2004/2007, 2004/2009, 2008/2009 and 2008/2011. Only capital balance does not have a pair of years whose absolute contribution is lower.

In the interstructure phase three pairs of years were distinguished as the most distant ones: 2009/2002, 2009/2004 and 2009/2006. According to the decomposition of the squared distance between objects, all variables were responsible for that as their contributions were high in those pairs of years. Only international reserves and current transfers have a small contribution in 2009/2002 and 2009/2004, respectively.

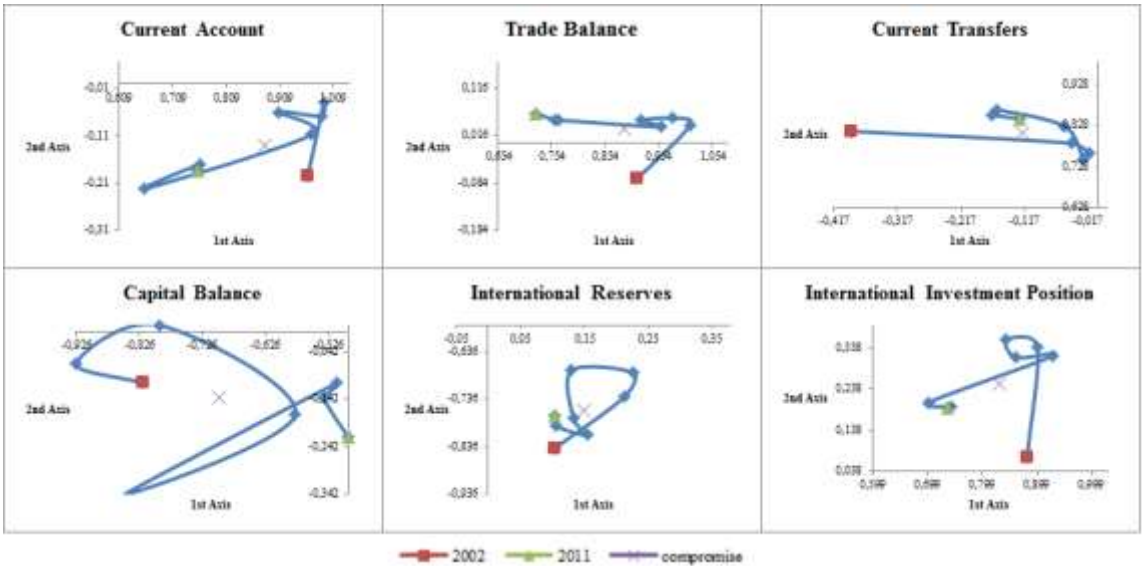

Figure 4.19 - Variables' trajectories in the plan [1, 2].

CHAPTER 5

Public, Private and Financial Sectors

This chapter specifies the conclusions obtained by the application of the Statis and Dual Statis method, bearing in mind the public, private and financial sectors variables' groups.

In each subchapter are firstly presented the results of Statis method with the objective of finding the similarities and the evolution of the European countries within the variables herein considered. Then, the conclusions obtained through the Dual Statis method about the evolution of the variables here analysed are presented.

5.1 Public Sector

In this subchapter we intend to study the similarities and differences between European countries, but this time taking into consideration eight variables that feature the public sector. According to this, the conclusions of the Statis method are first presented, followed by those obtained in the Dual Statis method.

5.1.1 Conclusions of the Statis method

This method allows us not only to find a common structure between European countries' states, but also to explain those similarities and differences. Firstly, the results of the interstructure and intrastructure phases are undertaken; followed by the analysis of the distances' decomposition between data tables' representative objects.

Interstructure

Beginning by analysing the RV coefficients and the distances (Table 5.1), it is possible to conclude that the most similar years are 2002-2004, 2004-2006, 2006-2008 and 2008-2009, whilst the most different ones are 2002/2010 and 2002/2011.

	2002	2004	2006	2007	2008	2009	2010	2011
2002	1							
2004	**0.858**	1						
2006	0.821	**0.935**	1					
2007	0.745	0.836	**0.914**	1				
2008	0.783	0.828	**0.846**	**0.878**	1			
2009	0.649	0.725	0.741	0.801	**0.874**	1		
2010	0.557	0.645	0.640	0.623	0.741	0.726	1	
2011	0.567	0.636	0.653	0.662	0.739	0.739	0.814	1

	2002	2004	2006	2007	2008	2009	2010	2011
2002	0							
2004	**0.533**	0						
2006	0.598	**0.359**	0					
2007	0.714	0.573	**0.414**	0				
2008	0.659	0.587	**0.555**	**0.494**	0			
2009	0.838	0.741	0.719	0.631	**0.502**	0		
2010	0.941	0.842	0.848	0.868	0.72	0.741	0	
2011	0.931	0.853	0.833	0.822	0.722	0.723	0.611	0

Table 5.1 – RV coefficients (above) and distances (below) between data tables' representative objects.

A similar conclusion is obtained with the representation of the centred interstructure Euclidean image (Figure 5.1), where the first two axes explain, approximately, 60% of the total variance. According to this, we can roughly divide the years into three groups: 2002 to 2006, 2007 to 2009 and 2010-2011.

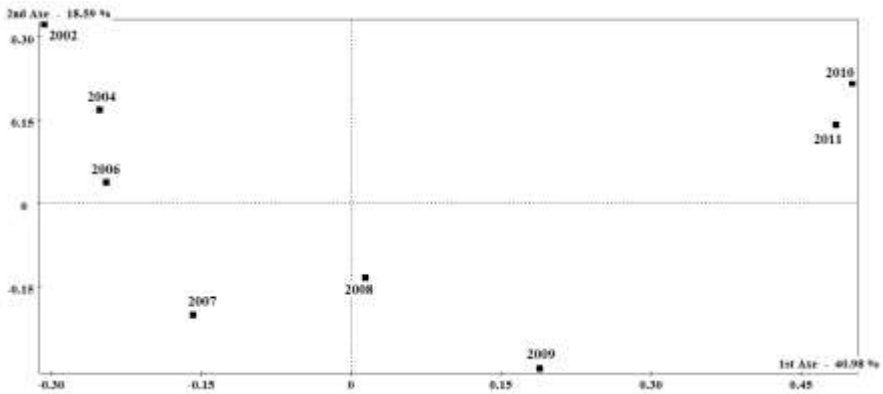

Figure 5.1 - Centred Interstructure Euclidean Image in the plan [1, 2].

This is not surprising because we know, ex-post, that some European countries started to have problems with public indebtedness early, with Portugal, Germany, France, Cyprus, Slovak Republic, Greece, Netherlands, Malta and Italy experiencing excessive deficit procedures between 2002 and 2005. As the crisis erupted in 2008, in 2009 thirteen European countries experienced excessive deficit procedures, so the similarities between 2008 and 2009 may be due to that. In order to contain the effects of

the crisis, several measures were undertaken by the European countries to promote economic growth. In the beginning of 2010, as the crisis spillovers got worst and with public accounts unbalanced, a public debt crisis started in Europe. Therefore, those three groups of years are connected to these economic events.

Intrastructure

Regarding Table 5.2, we conclude that scalar products and distances between the compromise object and the different data frames' representative objects are, in general, high and low, respectively, whereby it is possible to find a common structure of the European countries' public state.

Regarding this, 2006 and 2008 are the closest to the compromise object, in contrast with the public debt European crisis' started year of 2010 which is the furthest one.

	2002	2004	**2006**	2007	**2008**	2009	2010	2011
Scalar products	0.848	0.918	**0.931**	0.918	**0.948**	0.885	0.806	0.815
Distances	0.552	0.406	**0.372**	0.405	**0.323**	0.480	0.624	0.608

Table 5.2 – Scalar products and distances among data tables' representative objects and the compromise object.

Concerning the eigenvalue, inertia and cumulative inertia of each axis, we have decided to retain the first four axes, in which approximately 81% of the total variance is explained. In order to give a meaning to the countries' position within the compromise axes, the correlations between the eight variables here considered and each axis were calculated, and are shown in Table A.6, Appendix 3.

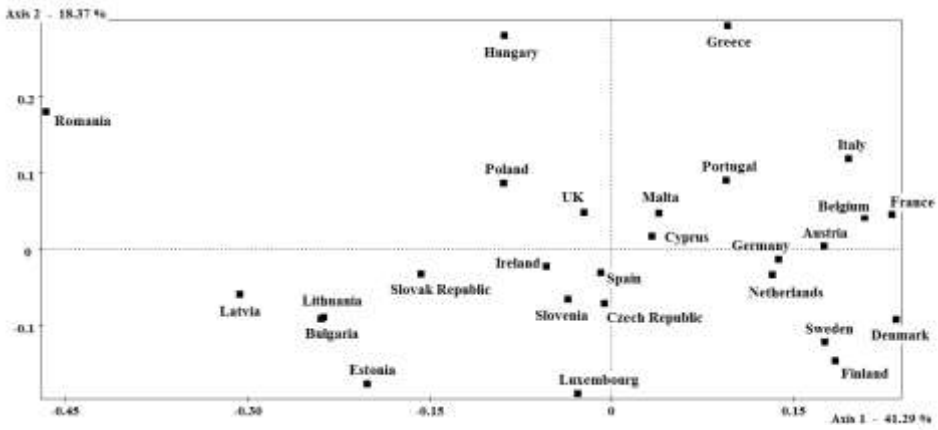

Figure 5.2 - Compromise's Euclidean Image in the plan [1, 2].

According to this, in the first axis (see Figure 5.2) Romania, Latvia, Bulgaria, Lithuania and Estonia (negative coordinates) are opposed to France, Denmark, Belgium, Austria, Finland, Italy and Sweden (positive coordinates). The first axis has a strong positive correlation to public expenses (G) and public revenues (T), during almost all years, and a strong negative correlation to short (ICP) and long (ILP) terms interest rate, inflation rate (PI) and GDP growth rate (YG), during some years. Thus, Romania, Latvia, Bulgaria, Lithuania and Estonia have a GDP growth rate in 2002-2006, short and long terms interest rates in 2008-2009 and an inflation rate in 2004-2008 and 2011 above the average, in contrast with public expenses and revenues lower than average. Contrarily, France, Denmark, Belgium, Austria, Finland, Italy and Sweden have public expenses and revenues above the average, and short and long terms interest rates, even as a GDP growth rate and inflation rate, lower than the average, in the respective years. Consequently, **this axis opposes countries whose public intervention in the economy (measured by public revenues and expenses) is higher, with countries whose public intervention in economy is lower, but their interest rates, inflation and GDP growth rate are higher**.

Luxembourg, Estonia, Finland and Sweden (negative coordinates) are opposed to Greece, Hungary, Romania and Italy (positive coordinates) in the second axis (see Figure 5.2). It is positively correlated with public debt (DP) and negatively correlated with government balance (SO) in 2002 to 2009. Therefore, Luxembourg, Estonia, Finland and Sweden have a government balance above the average in 2002 to 2009, whilst Greece, Hungary, Romania and Italy have a public debt above the average in all period. Hence, **this axis seems to be an indicator of public indebtedness.**

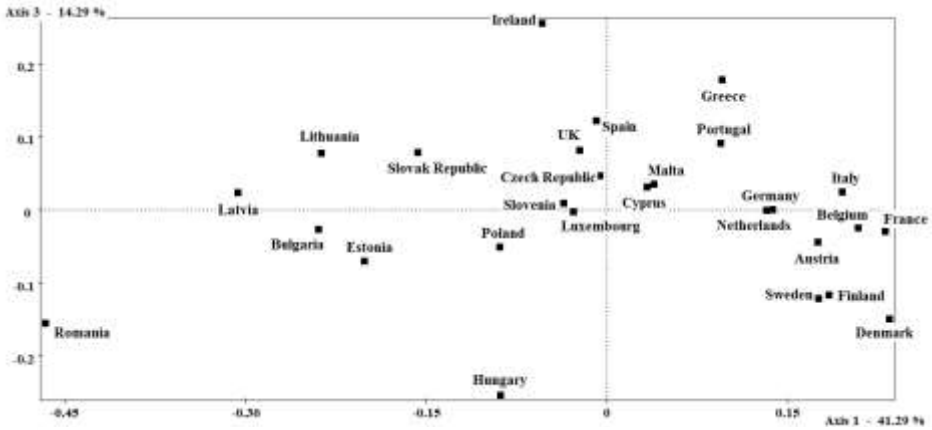

Figure 5.3 - Compromise's Euclidean Image in the plan [1, 3].

The third axis (see Figure 5.3) opposes Hungary, Denmark, Romania, Finland and Sweden (negative coordinates) with Ireland, Greece and Spain (positive coordinates). Third axis is negatively correlated with government balance (SO) in 2008 to 2011, as well as with public revenues (T) in 2009-2011. Thereby, Hungary, Denmark, Romania, Finland and Sweden have a government balance, in 2008-2011, and public revenues, in 2009-2011, above the average in contrast with Ireland, Greece and Spain, whose government balance and public revenues are lower than the average. Thereafter, **this axis is an indicator of the public accounts sustainability, mainly financed with public revenues.**

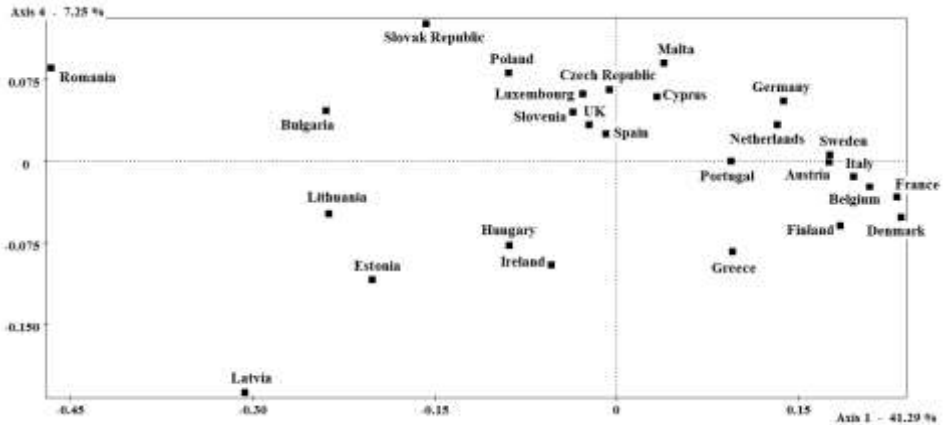

Figure 5.4 - Compromise's Euclidean Image in the plan [1, 4].

Finally, fourth axis (see Figure 5.4) opposes Latvia, Ireland, Greece, Hungary and Estonia (negative coordinates) to Slovakia, Malta and Romania (positive coordinates). **It only seems to be positively correlated with GDP growth (YG) in 2008-2009**, whereby Slovakia, Malta and Romania had a GDP growth rate above the average in 2008-2009, in contrast with Latvia, Ireland, Greece, Hungary and Estonia.

Contribution of the countries to the differences between years and their trajectories

Taking into consideration the decomposition of the sum of squared distances between normed objects, Ireland (12.0%), Greece (11.4%), Romania (10.9%), Latvia (8.2%), Hungary (7.9%) and Estonia (6.7%), are the countries more responsible for the structure's difference in the period 2002-2011, as their contributions are higher. This is corroborated by the representation of those countries' trajectories, pointed out by the distance among the compromise object and each trajectory, as shown in Figure 5.5, where the first two compromise axes explain 60% of the total variance.

Although the contributions to the structure's difference of Lithuania (4.7%), Bulgaria (4.0%), Slovak Republic (3.5%), Sweden (3.2%), Slovenia (2.8%), Poland (1.8%), Malta (1.8%), and Cyprus (1.6%) are not as higher as the countries' contribution evidenced above, their trajectories note some instability, proved by the distance among each compromise object and trajectory. Thus, this can be connected to these countries' contribution to the differences of merely some pairs of years.

Regarding this, Bulgaria has a high contribution to the differences among 2004/2006 (7.6%), and 2008 with 2004 (7.0%), 2002 (9%), 2006 (8.3%) and 2007 (10.1%), while Slovenia contributes more to the differences among 2002 with 2004 (8.3%), 2006 (9.6%), 2008 (7.6%) and 2011 (7.9%). Cyprus has a significant contribution to the differences between the year of 2004 with 2006 (5.8%) and 2007 (6.8%), Poland among 2004/2006 (9.2%), whilst Sweden has to the differences among 2008 with 2010 (6.3%) and 2011 (5.9%). Malta has a significant contribution to the differences of 2002/2004 (6.8%), whereas Slovakia has a major contribution to the differences between more years: 2002 with 2007 (6.9%) and 2008 (6.3%), 2004 with 2007 (7.1%) and 2008 (6.2%), 2006 with 2008 (7.8%) and 2007 (9.1%). Lithuania has a higher contribution to the differences among all years and 2009 (8.5% to 15.8%).

Czech Republic, Finland, France, Luxembourg, Netherlands and UK have trajectories more regular, proved by how close their trajectories are to the compromise object and their small contributions to the pairs of years' differences (between 0.6% and 2.6%). Austria, Belgium, Denmark, Germany, Italy, Portugal and Spain do not also have a high contribution to the structure's difference (among 1.1% and 2.8%), but it is interesting to analyse their trajectories. The trajectories of Austria, Belgium, Denmark,

Germany and Italy seem to have a right to left trend in 2002-2011 in relation to the first axis. As this axis is positively correlated with public expenses and public revenues, during almost all years, it can indicate a decrease in those variables within that period. Portugal and Spain have an uptrend trajectory in relation to the second axis, which is positively correlated with public debt, evidencing an increase in this variable.

Bearing in mind the pairs of years 2002 with 2010 and 2011, considered the furthest in the interstructure phase, it is now possible to indicate which countries explain those differences. Hence, through the decomposition of the squared distances between pairs of normed objects, it can be concluded that those differences are mainly due to Estonia, Greece, Ireland and Romania, jointly with Slovenia whose contributions for the difference between 2002/2011 are also high.

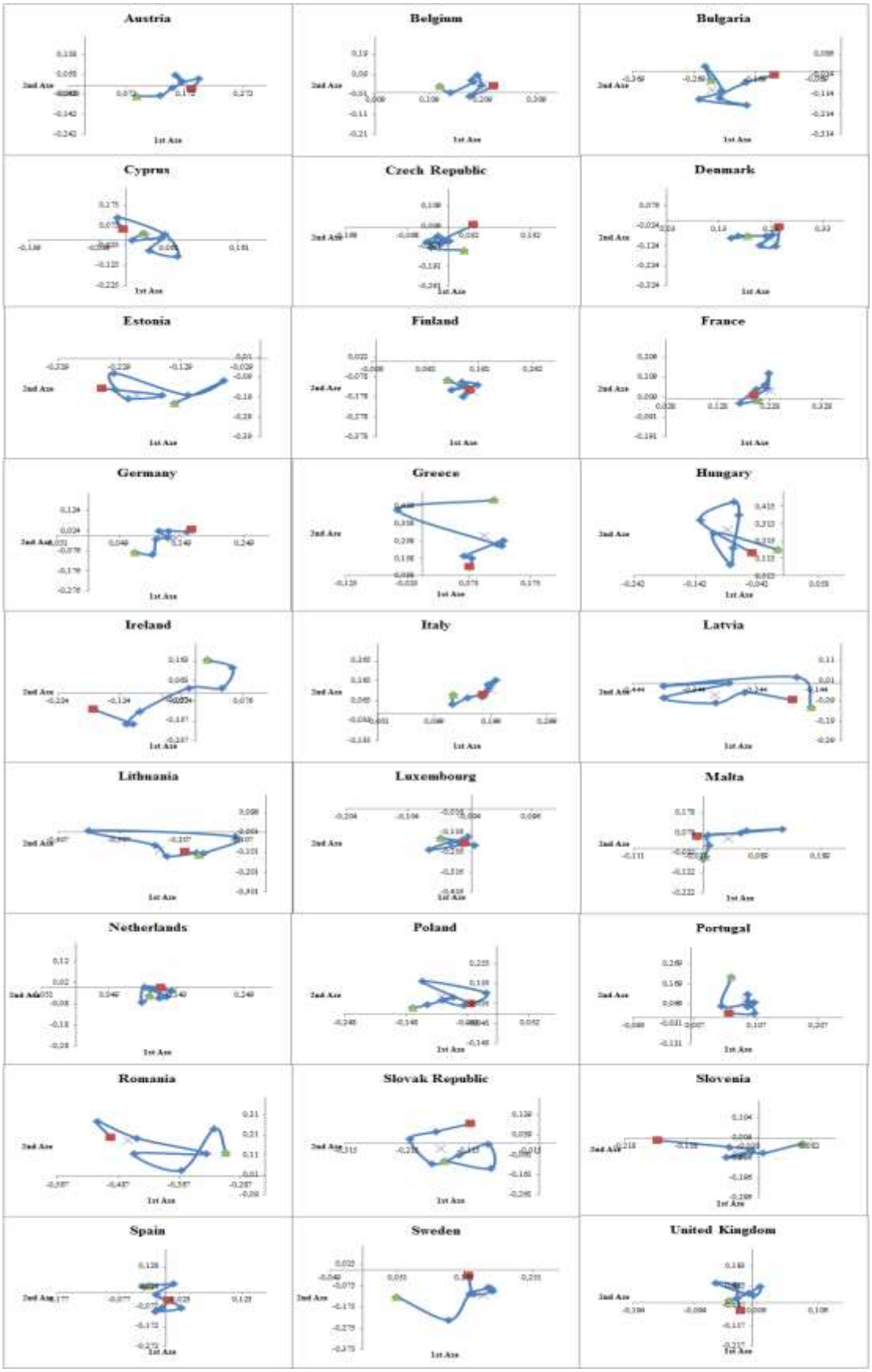

Figure 5.5 - Trajectories of each country in the plan [1, 2].

5.1.2 Results of the Dual Statis method

This method allows us to study the evolution of the variables here analysed, as well as to complement the findings obtained in the Statis method. As was stated in the previous chapter, it has three phases. We begin to analyse the results of the interstructure, followed by the intrastructure and decomposition of the squared distances.

Interstructure

Beginning by the analysis of the distances (Table 5.3) among data frames' representative objects, we can roughly identify the following groups of years: 2002-2008 and 2010-2011, as the most similar ones, because they have smaller distances. In contrast, 2009 with 2002 to 2007, 2009/2011 and 2010 with 2004 to 2006 seems to be the most different years.

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	0							
2004	**1.19**	0						
2006	**1.70**	**1.05**	0					
2007	**1.19**	**0.99**	**0.93**	0				
2008	**1.62**	**1.58**	**1.68**	**1.36**	0			
2009	3.41	3.59	3.52	3.23	2.52	0		
2010	2.94	3.05	3.06	2.78	2.50	2.26	0	
2011	2.90	2.78	2.68	2.54	2.59	3.06	**1.87**	0

Table 5.3 - Distances between representative objects.

Figure 5.6 represents the two dimensional Centred Interstructure Euclidean Image in the first and second axes, in which is explained 81% of the total variance. Hence, we can grossly group the years as 2002-2007, 2008, 2009 and 2010-2011. 2008 and 2009 are here the furthest consecutive years. As it was stated, this is not surprising because with the crisis in 2008, in 2009 European countries started to encourage several measures to try to contain crisis' effects as well as to promote economic welfare. But with public accounts already unbalanced in some countries, it had catastrophic effects in public debt so as in economic growth.

Notwithstanding, identical conclusions were obtained in the Statis method and they were already discussed.

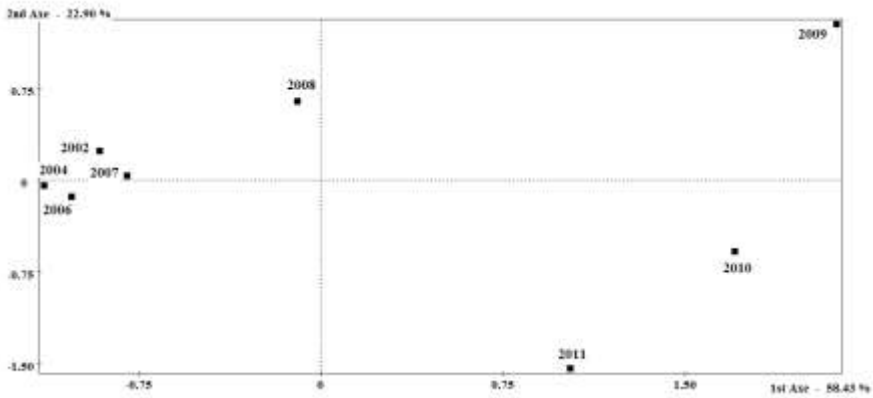

Figure 5.6- Centred Interstructure Euclidean Image in the plan [1, 2].

Intrastructure

Table 5.4 shows the scalar products and distances between the compromise object and the eight representative objects. Although, in general, the distances are low, 2007 and 2008 are the closest years to the compromise object, whilst 2009 and 2010 the furthest ones.

	2002	2004	2006	**2007**	**2008**	2009	2010	2011
Scalar products	16.982	18.300	18.435	18.329	17.088	14.996	14.179	14.893
Distances	1.341	1.263	1.304	**0.949**	**0.978**	2.513	2.002	1.950

Table 5.4 - Scalar products and distances among the compromise object and data tables' representative objects.

Towards eigenvalues, inertias and cumulative inertias of the compromise axes, we have decided to retain the four first axes in which approximately 87% of the total variance are explained.

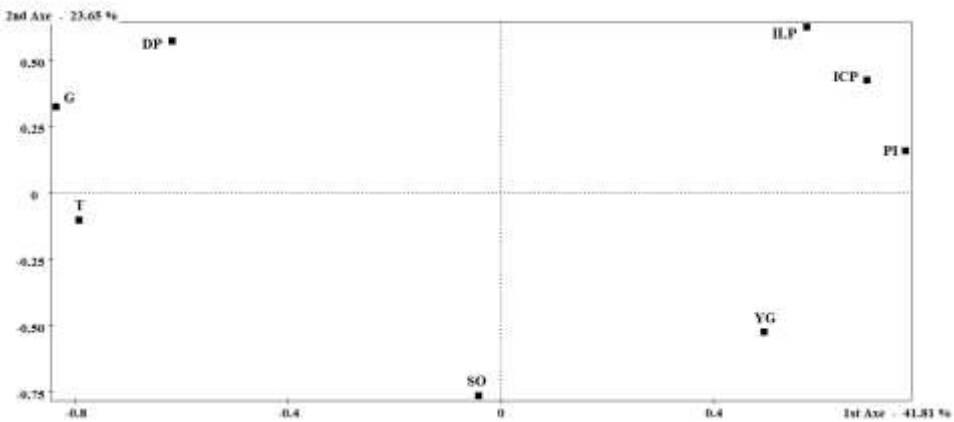

Figure 5.7 - Compromise's Euclidean Image in the plan [1, 2].

Hence, first axis (see Figure 5.7) opposes public expenses (G), public revenues (T) and public debt (DP) (negative coordinates) with inflation rate (PI) and short term interest rate (ICP) (positive coordinates). The first three variables can indicate public intervention or states' activeness in the countries' economy, whereas through the Fisher Equation the nominal rate is equal to real interest rate plus inflation rate. So, if this axis evidences countries with higher inflation rate and short term interest rate, it could mean that their real short term interest rate is lower than the average. So this axis opposes countries with higher indebtedness and real interest rate to countries whose debt is lower so as their real interest rate. **It is an indicator of the effects of public indebtedness in real short term interest rate.**

Second axis (see Figure 5.7) opposes government budget (SO) and GDP growth rate (YG) (negative coordinates) with long term interest rate (ILP) and public debt (DP) (positive coordinates). Thereby, **second axis indicates the negative effects of the public indebtedness in countries income and long term interest rate.**

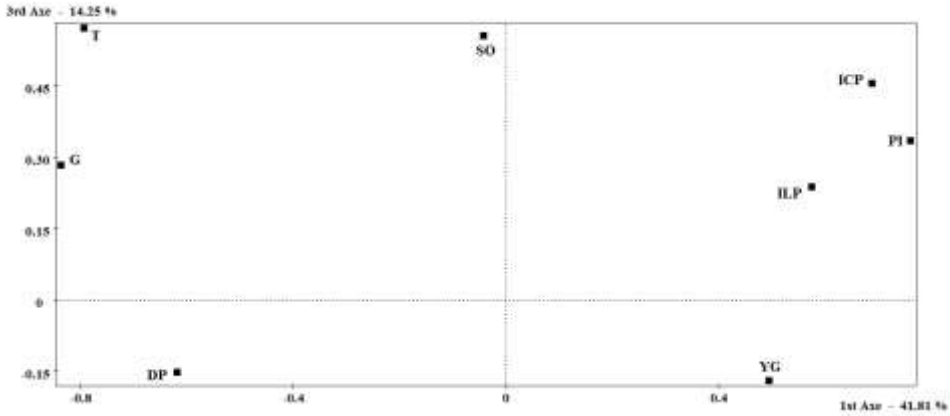

Figure 5.8 - Compromise's Euclidean Image in the plan [1, 3].

Third axis (Figure 5.8) highlights two variables: public revenues (T) and government budget (SO) (positive coordinates). **Thus, this axis is an indicator of the sustainability of public accounts, possibly financed by public revenues as taxes.**

Finally, fourth axis (see Figure 5.9) evidences GDP growth rate (YG) (negative coordinate). Thus, **this axis distinguishes countries that have higher economic growth.**

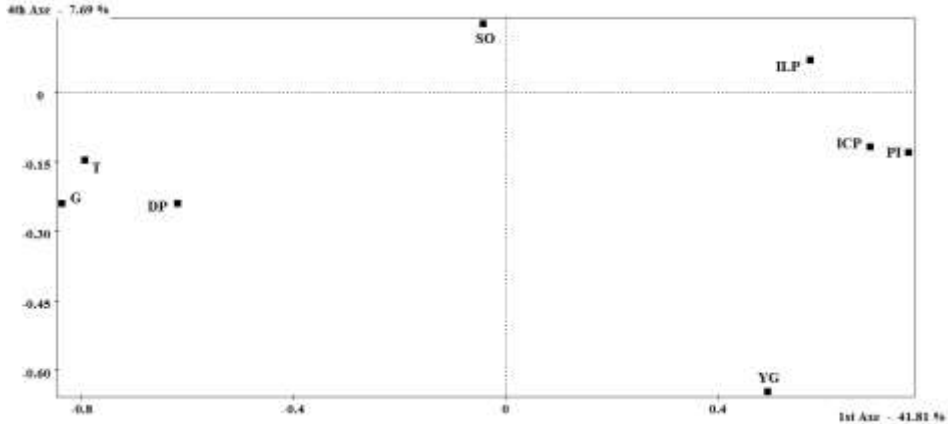

Figure 5.9 - Compromise's Euclidean Image in the plan [1, 4].

Contribution of the variables to the differences between years and their trajectories

The decomposition of the sum of squared distances between correlation matrices indicates that all variables have, in general, a high contribution to those differences among all years (between 6.5% and 31.3%). Although trajectories are only an approximate representation, the high contributions to the differences between years can be seen by the distances between each trajectory and the compromise object in all variables. Figure 5.10 shows the trajectories in the plan [1, 2], in which those axes explain 65.5% of the total variance. Nevertheless, GDP growth rate is the variable whose contribution to the structure's difference is higher and has a high contribution – 9.7% to 44.6% – to the differences between the pairs of years.

The remaining variables have some pairs of years whose contribution to the differences between them is lower. For instance, public debt's contributions in 2004/2010 and 2006/2007 are 2.5% and 3.1%, respectively, or long term interest rate's contribution in 2007/2008 is 2.4%. Short term interest rate and public revenues are variables with more "stable" pairs of years. Short term interest rate's contribution is among 3% and 3.8% in the years 2002/2010, 2006/2008, 2007/2008 and 2007/2010 and public revenues' contribution is between 0.9% and 3.9% in 2002 with 2006 and 2007, 2004/2006, 2008/2011, 2009 relatively to 2010 and 2011.

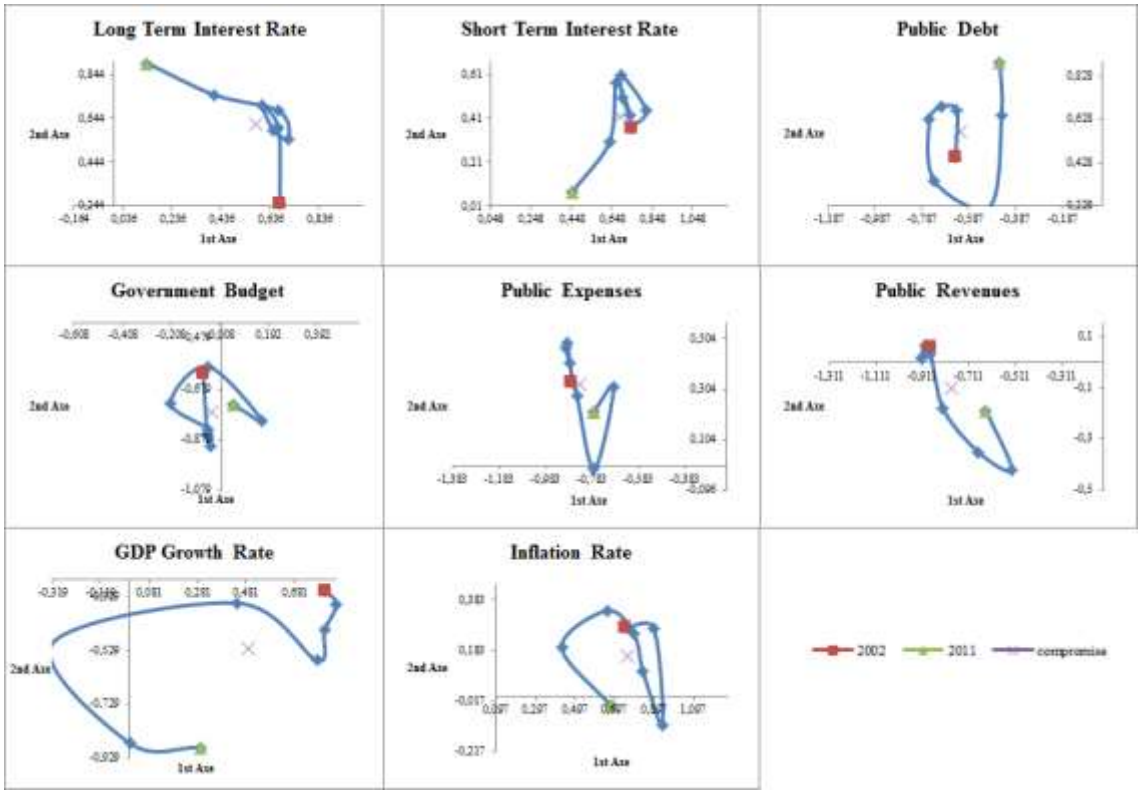

Figure 5.10 – Variables' trajectories in the plan [1, 2].

5.2 Private and Financial Sectors

Private and financial sectors have been pointed out in the economic literature as strong boosters of the Asian Crisis. It is also undoubted that those sectors are often subjected to speculation, being in almost constant volatility.

Following this, it is our aim to study here the similarities and differences of the financial and private sectors among European Countries. However, the group of variables chosen was very restricted by the lack of reliable and with quality microeconomic databases.

5.2.1 Conclusions of the Statis method

It is undisputed that some countries are more appealing for investors than others, attracting more investment. So, are European countries considered equal in level and quality of invest and save?

It is here our aim to find a common structure between private and financial sectors of European countries, discovering their similarities and differences.

Interstructure

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	1							
2004	**0.822**	1						
2006	0.768	**0.851**	1					
2007	0.708	0.774	**0.890**	1				
2008	0.607	0.650	0.688	0.701	1			
2009	0.597	0.641	0.669	0.726	0.623	1		
2010	0.609	0.671	0.644	0.620	0.644	0.750	1	
2011	0.620	0.668	0.661	0.651	0.721	0.755	**0.808**	1

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	0							
2004	**0.597**	0						
2006	0.681	**0.545**	0					
2007	0.764	0.672	**0.470**	0				
2008	0.887	0.837	0.790	0.773	0			
2009	0.898	0.847	0.814	0.741	0.868	0		
2010	0.884	0.811	0.843	0.872	0.844	0.707	0	
2011	0.872	0.815	0.823	0.835	0.746	0.699	**0.619**	0

Table 5.5 - Scalar products (above) and distances (below) among data tables' representative objects.

The RV coefficients and the distances (Table 5.5) show that 2002/2004, 2004/2006, 2006/2007 and 2010/2011 are the most similar years, while 2002/2009 and 2002/2010 the most different ones.

Identical conclusions are shown in the Centred Interstructure Euclidean Image (Figure 5.11), where it is possible to roughly consider the following groups of years: 2002-2004, 2006-2007, 2008 and 2009-2011.

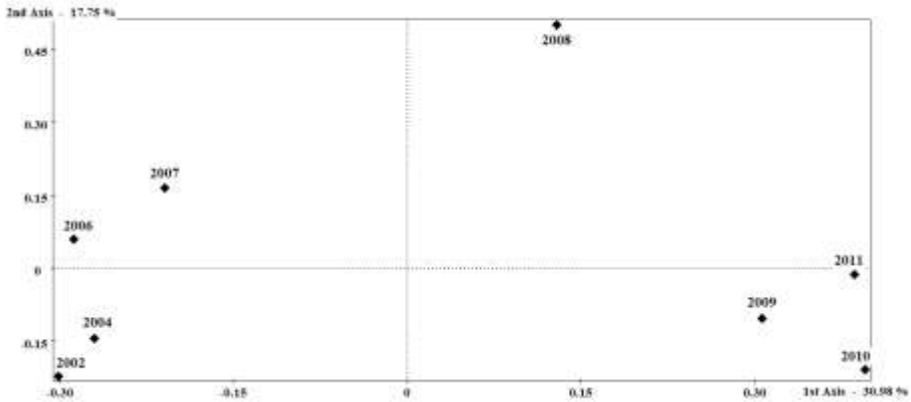

Figure 5.11 - Centred Interstructure Euclidean Image in the plan [1, 2].

We know, ex-post, that subprime crisis erupted in 2008, even that its effects got worst in 2009. Thus, the RV coefficients and the distances prove that the behaviour in the countries' private and financial sector was not only different before and after the crisis, but also different depending on the approach and the distance to the early years of the crisis. In other words, 2008 does not have a high proximity with any other year, while the RV coefficients and the distances highlighted the proximity among 2002-2004, 2004-2006 and 2006-2007 – the pre-crisis years – and 2010/2011 – the post crisis years. Additionally, 2002/2010 and 2002/2009 are the most different ones.

Intrastructure

Scalar products among the compromise object and representative objects are, in general, high and distances low, proving it is possible to find a common structure (Table 5.6). Nonetheless, 2004, 2006 and 2007 seem to be the closest years to the compromise object, and 2008 the furthest one.

	2002	**2004**	**2006**	**2007**	2008	2009	2010	2011
Scalar products	0.836	**0.888**	**0.903**	**0.887**	0.819	0.838	0.835	0.855
Distances	0.573	**0.473**	**0.441**	**0.475**	0.602	0.569	0.574	0.538

Table 5.6 - Scalar products and distances among compromise object and data frames' representative objects.

Bearing in mind eigenvalues, inertia and cumulative inertia of each compromise axis, we have decided to retain the first five axes, in which 79.22% of the total variance are explained. In order to find a meaning to the countries' position relatively to the compromise axes, the correlation coefficients between each axis and variables were calculated, and are shown in Table A.5, Appendix 3.

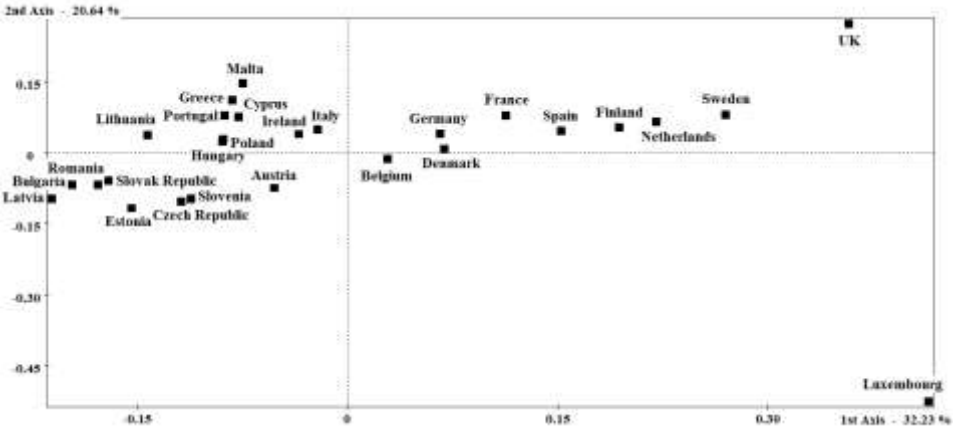

Figure 5.12 - Compromise's Euclidean Image in the plan [1, 2].

According to these, first axis (see Figure 5.12) opposes Latvia, Bulgaria, Romania and Slovak Republic (negative coordinates) with Luxembourg, UK, Sweden, Netherlands and Finland (positive coordinates). This axis is also positively correlated with shares traded (AT) and market capitalization (CM), wherefore, Luxembourg, UK, Sweden, Netherlands and Finland have had a market capitalization and shares traded higher than the average, contrarily to Latvia, Bulgaria, Romania and Slovak Republic whose shares traded and market capitalization have been lower than the average. Therefore, **this axis seems to be an indicator of financial market's activeness.**

In second axis (see Figure 5.12), Luxembourg (negative coordinate) is opposed to UK and Malta (positive coordinates). The second axis has a strong negative correlation, in almost all years, to private capital flows (FCP) which is the sum of net foreign direct investment and net foreign portfolio investment. Thus, **this axis indicates which countries have been more attractive to foreign investors.** Wherefore, Luxembourg

seems to be in this position, as their capital flows were higher than the average, in contrast to UK and Malta.

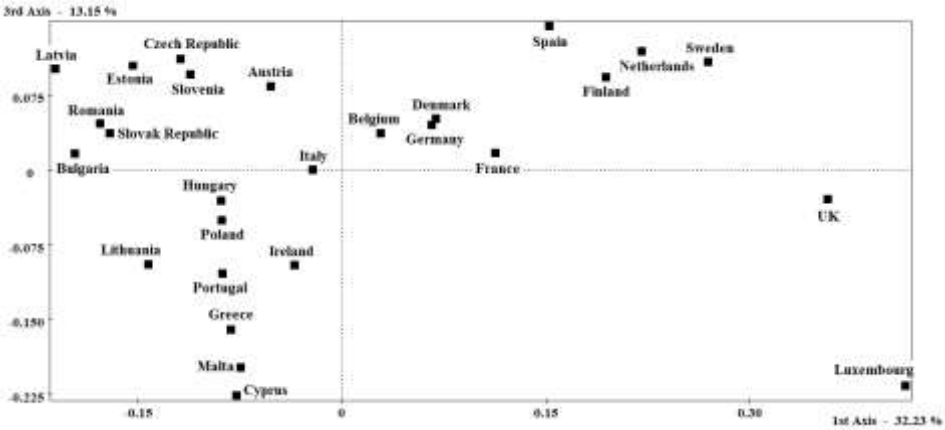

Figure 5.13 - Compromise's Euclidean Image in the plan [1, 3].

Cyprus, Luxembourg, Malta and Greece (negative coordinates) are opposed to Spain, Netherlands and Sweden (positive coordinates) in third axis (see Figure 5.13). **It only seems to have a strong positive correlation to savings (S) in 2008-2011.** Thus, Spain, Netherlands and Sweden had savings above the average, in 2008-2011, in contrast to Cyprus, Luxembourg, Malta and Greece that had small savings.

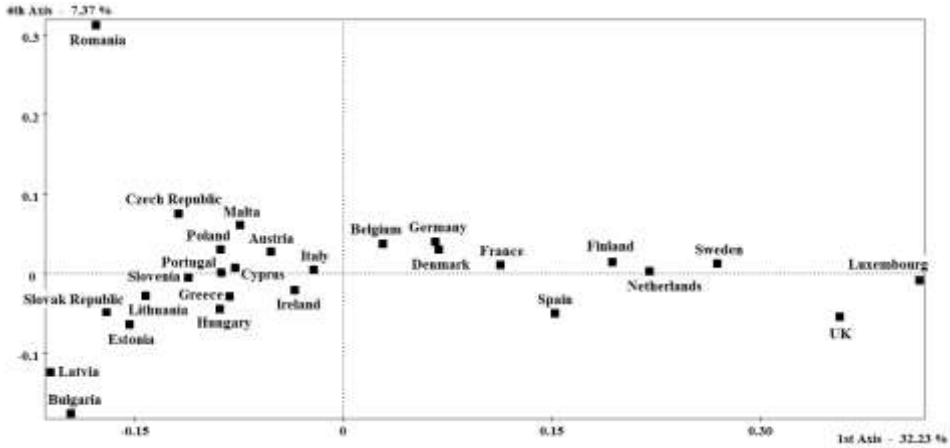

Figure 5.14 - Compromise's Euclidean Image in the plan [1, 4].

Fourth axis (see Figure 5.14) distinguishes Bulgaria and Latvia (negative coordinates) to Romania (positive coordinates). This axis has a strong negative correlation to the ratio of foreign portfolio to direct investment (PDI) in 2006 and a strong positive correlation with the same variable in 2007 and 2009. So it is interesting this evolution as it seems that Bulgaria and Latvia had a portfolio to direct investment above the average in 2006 and then it turns to Romania in 2007 and 2009. Thus, **this**

axis seems to indicate the evolution of the proportion between foreign portfolio and direct investment.

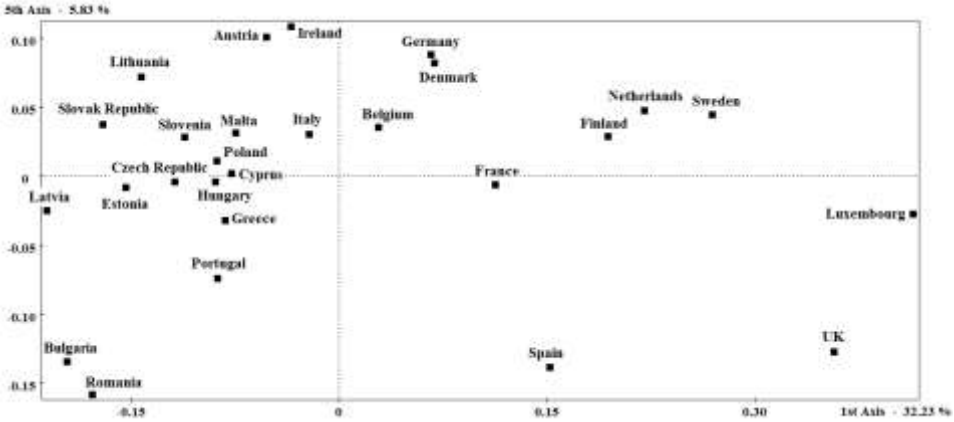

Figure 5.15 - Compromise's Euclidean Image in the plan [1, 5].

Finally, fifth axis (Figure 5.15) opposes Romania, Bulgaria, Spain and UK (negative coordinates) to Austria, Denmark and Lithuania (positive coordinates). This axis has a positive correlation with ratio of portfolio to direct investment (PDI) in 2004 and a negative correlation with investment (IN) in 2009. Thus, **this axis opposes countries with a ratio of portfolio to direct investment in 2004 higher than the average** – Austria, Denmark and Lithuania – **to countries with investment in 2009 higher than the average** – Romania, Bulgaria, Spain and UK.

Contributions of the countries to the differences between years and their trajectories

Through the decomposition of the sum of squared distances among normed objects, it is evidenced that, on the one hand, Romania (10.0%), Bulgaria (9.0%), Luxembourg (8.7%), Czech Republic (6.8%), Cyprus (6.5%), Ireland (5.5%), UK (5.4%), Latvia (5.4%), Lithuania (5.3%) and Malta (5.0%) are the countries whose contributions to those differences are higher.

That is also highlighted by the representation of their trajectories, which shows instability relatively to the compromise object. Figure 5.16 shows the trajectories in the plan [1, 2], in which those axes explain 52.9% of the total variance. The only country whose trajectory does not show instability, as it is slightly enlarged and defined around itself, is Czech Republic. However, it has a broad trajectory when defined in the plan [1,

4], albeit not presented here, which can reflect a change in the variable ratio of foreign portfolio to direct investment over the study's horizon that differs from the average trend.

On the other hand, Slovak Republic (2.7%), Slovenia (2.6%), Spain (2.0%), Portugal (1.7%), Austria (1.6%), Germany (1.1%), Denmark (0.9%), Belgium (0.8%), France (0.66%) and Italy (0.54%) are the countries whose contributions to the differences among pairs of years are, in general, lower. Their trajectories are, wherefore, closer to the compromise object.

Although the contributions of Estonia, Netherlands, Sweden, Finland, Greece, Hungary and Poland are not high (among 1.79% and 3.94%), their trajectories note some instability. This is also corroborated by the decomposition of squared distances among normed objects' analysis, which shows some pairs of years where their evolution were different from the average.

The pairs of years 2002/2009 and 2002/2010 were evidenced in the interstructure phase as the most distant ones. Through the decomposition of squared distances between objects, Finland, Lithuania and Luxembourg were the countries more responsible for those differences, jointly with Bulgaria and Romania in 2002/2009 and Hungary, Ireland, Slovenia and UK in 2002/2010.

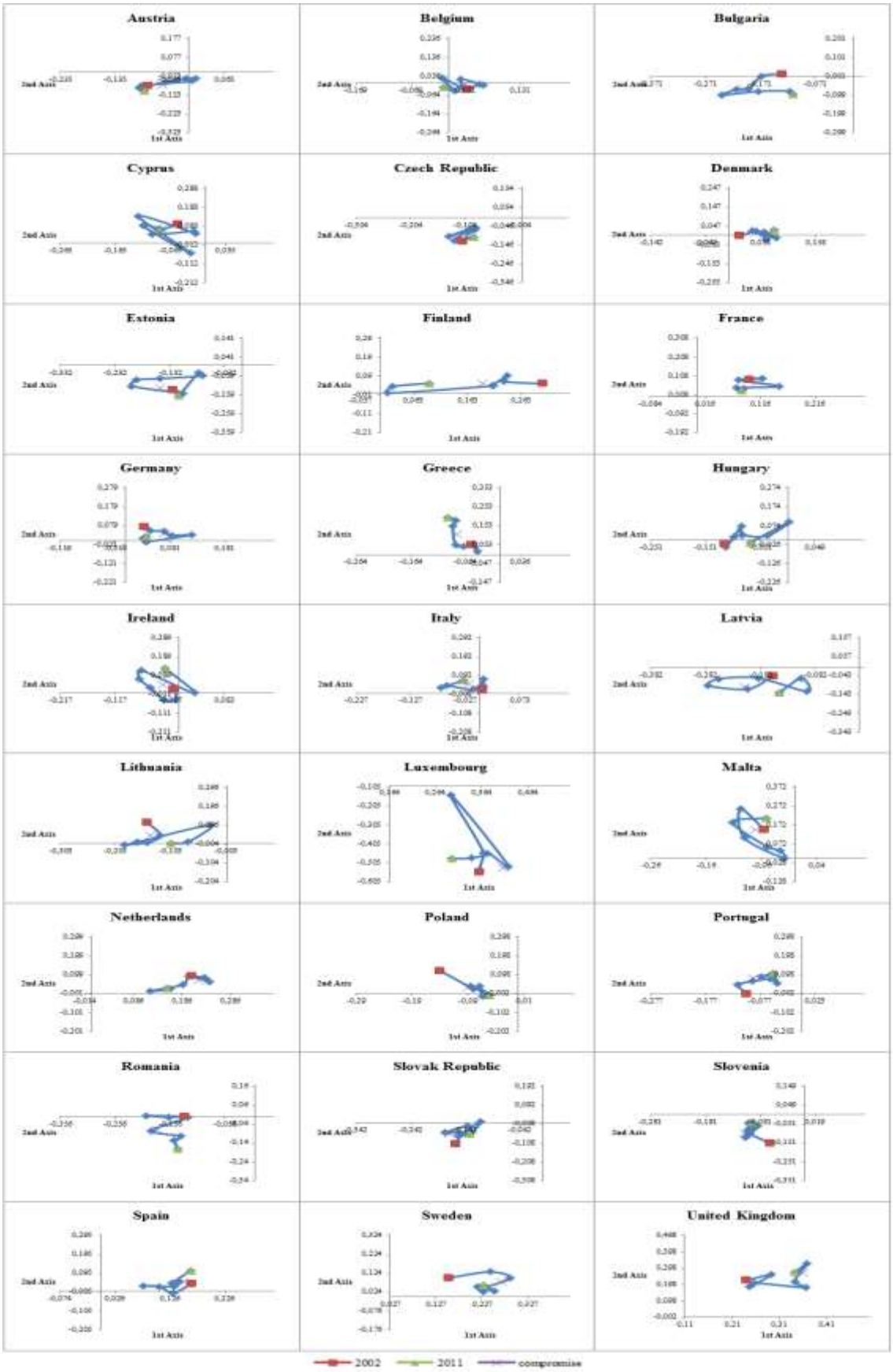

Figure 5.16 – Countries' trajectories defined in the plan [1, 2].

5.2.2 Results of the Dual Statis method

Throughout the previous subchapter, we have studied the similarities and differences among European countries' private and financial sectors and calculated the linear correlation coefficients between variables and compromise axis, in order to find a meaning to the countries' position. It is now high time to study further the variables and their evolution.

Interstructure

The pairs of years 2002/2004, 2002/2011, 2004/2006 and 2010/2011 are the most similar ones, in what concerns to the correlations between variables, taking into consideration the distances among correlation's matrices (Table 5.7). In contrast, 2006/2009, 2007/2009 and 2009/2010 are the most distant, or in other words, the most different ones.

	2002	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2002	0							
2004	**0.840**	0						
2006	1.007	**0.818**	0					
2007	1.377	1.124	1.016	0				
2008	1.052	1.007	1.003	1.112	0			
2009	1.770	1.774	1.915	2.130	1.399	0		
2010	1.099	1.152	1.110	1.419	1.520	1.837	0	
2011	**0.876**	1.097	1.343	1.627	1.396	1.653	**0.946**	0

Table 5.7 - Distances between data tables' representative objects.

The representation of the Centred Interstructure Euclidean Image (Figure 5.17) allows us to reach similar conclusions. Through it, we can roughly divide the years in four groups: 2002/2010/2011, 2004/2006/2007, 2008 and 2009.

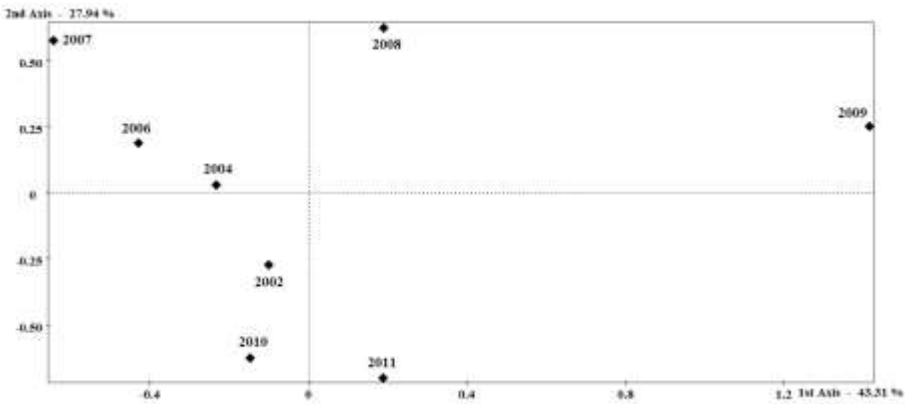

Figure 5.17 - Centred Interstructure Euclidean Image in the plan [1, 2].

This conclusion is different from the conclusions for the other groups of variables, even as of those obtained in the Statis method, where the closest years were, in general, pre and post years' crisis. Here, apparently, the behaviour of the financial and private sectors' variables was similar between the beginning of the period here considered – 2002 – and the post 2008/2009 crisis years – 2010 and 2011. Consequently, 2008/2009 are similar as well as the three pre-crisis years – 2004, 2006 and 2007.

The similarities evidenced above can be due, for example, to the behaviour of investors in the financial and real markets as well as their expectation and reaction to economic events. We know, ex-post, that before and during the subprime crisis some countries, as United States or UK, have had bubbles in their markets, evidencing an overinvestment and speculation. As the crisis erupted, this trend has turned to a bust in markets. Thus, if we consider this, Dual Statis highlighted those sequences of economic events.

In this subchapter we will be able to find which variables contribute more to these differences, understanding why these differences happened.

Intrastructure

Taking into consideration the distances among the compromise object and all the representative objects, it is concluded that, in general, they are low, so it is possible to find a common structure (see Table 5.8).

Notwithstanding, 2004 and 2006 are the closest years to the compromise object, while 2009 the furthest or the most different one.

	2002	**2004**	**2006**	2007	2008	2009	2010	2011
Scalar products	8.250	8.421	8.350	7.892	7.758	6.789	7.913	8.006
Distances	0.646	**0.593**	**0.694**	1.004	0.738	1.455	0.860	0.840

Table 5.8 - Scalar products and distances among the compromise object and correlation matrices.

Once the first four axes explain, 87.51% of the total variance, we have decided to retain them to do the analysis.

According to this, **the first axis** (Figure 5.18) **seems to be an indicator of the predominant type of investment - real or financial investment** - since it opposes the variable investment (IN) (negative coordinate) to market capitalization (CM) and shares traded (AT) (positive coordinates).

The second axis (Figure 5.18) distinguishes the variables savings (S), private capital flows (FCP) and investment (IN) (positive coordinates). Therefore, this axes discriminates countries with investment above the average, whose savings are also higher than the average as well as their capacity to attract foreign investment (measured by private capital flows). **This axis indicates countries which are investment attractors.**

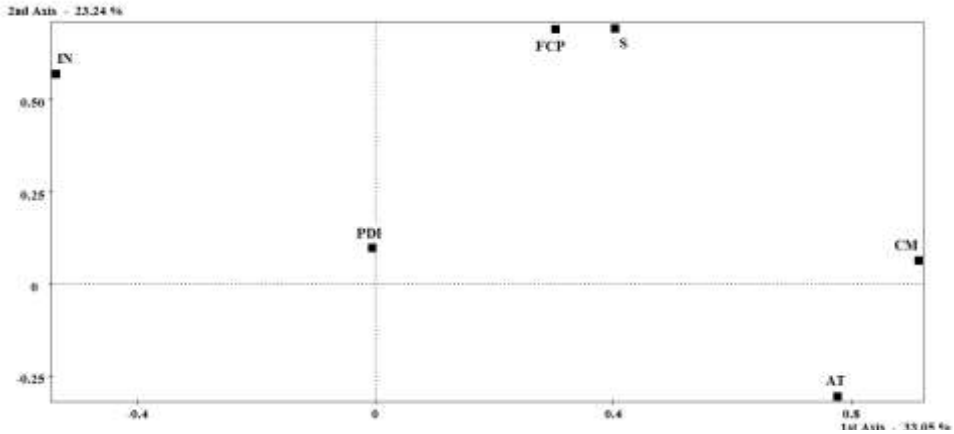

Figure 5.18 - Compromise's Euclidean Image in the plan [1, 2].

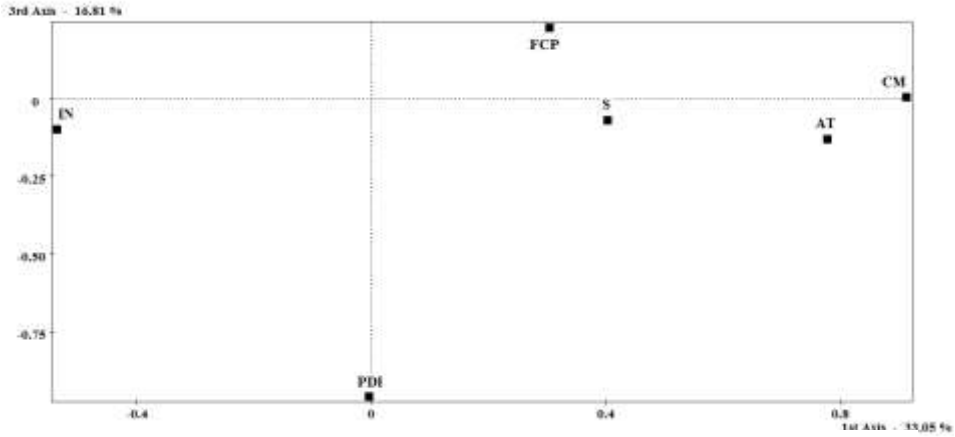

Figure 5.19 - Compromise's Euclidean Image in the plan [1, 3].

The ratio portfolio to direct investment (PDI) is distinguished in third axis (see Figure 5.19). Direct investment involves a more long-term relationship with the country, as it encompasses the purchase or investment in companies, for example. Portfolio investment is more volatile and also more liquid, it can therefore easily leaves the country in situations of adverse economic events or contrary to the perspectives of the investor. Thus, **this axis discriminates countries whose foreign portfolio investment is higher in proportion than foreign direct investment.**

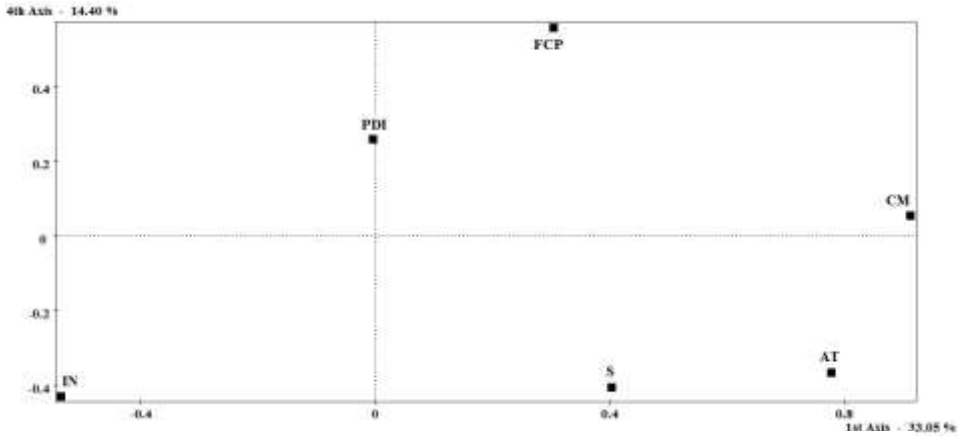

Figure 5.20 - Compromise's Euclidean Image in the plan [1, 4].

Finally, fourth axis (Figure 5.20) opposes private capital flows (FCP) (positive coordinate) to investment (IN) and savings (S) (negative coordinates). Therefore, **this axis seems to distinguish countries with higher foreign investment from countries whose domestic investors are more important to the economy.**

Contribution of the variables to the differences between years and their trajectories

Towards the decomposition of the sum of squared distances between pairs of objects, all six variables have a high contribution to the structure's differences in the period 2002-2011. Private capital flows (24.2%) and market capitalization (21.4%) are the variables with a higher contribution to the differences among pairs of years, followed by savings (17.2%), investment (16.4%), shares traded (10.6%) and foreign portfolio to direct investment (10.2%). This is also evidenced in their trajectories, which show irregularity in relation to the compromise object. Figure 5.21 shows the trajectories in the plan [1, 2], in which the first two axes explain 56.3% of the total variance.

In the interstructure phase three more distant pairs of years were highlighted: 2009/2006, 2009/2007 and 2009/2010. Thus, it is now possible to figure out which variables are more responsible for them. Accordingly, the differences between 2009/2006 and 2009/2007 are due, mainly, to the same variables: shares traded, market capitalization, private capital flows, investment and savings. Instead of it, in 2009/2010, the variables shares traded, market capitalization, portfolio to direct investment and private capital flows have a higher contribution to the differences among them. Thus, it

seems that the differences between 2009/2007 and 2009/2006 are due to the behaviour of the capital markets and the reaction of the national and foreign investors, whilst the ones between 2009/2010 are mainly due to the reaction of foreign investors.

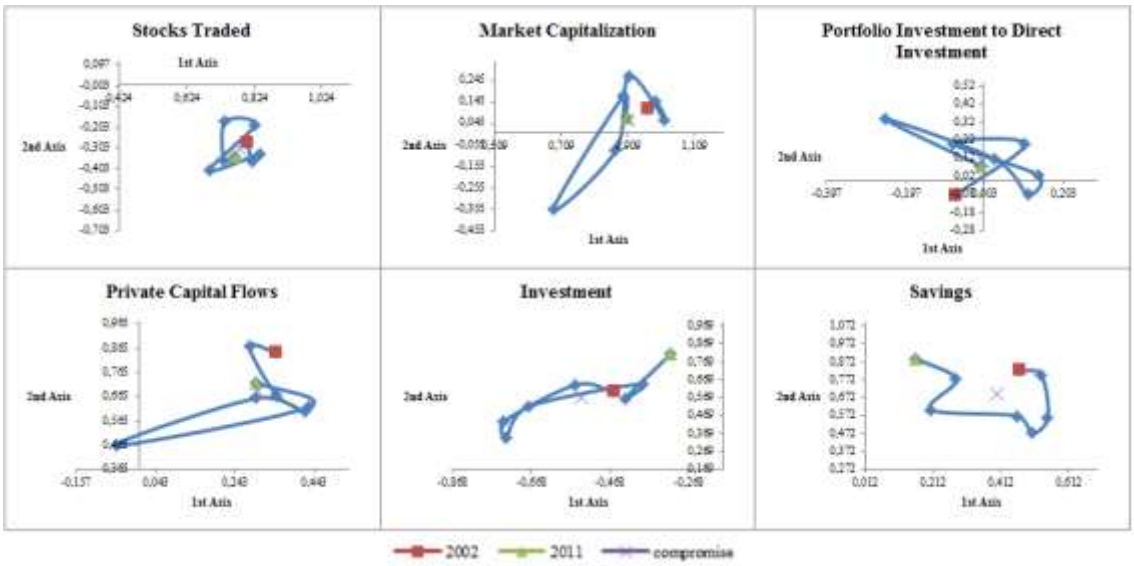

Figure 5.21 - Trajectories of the variables in the plan [1, 2].

CHAPTER 6

Concluding Remarks

This study has consisted in analysing, between 2002 and 2011, the similarities and differences between the twenty-seven European countries, identifying a common structure, and allowing analyzing vulnerabilities present in their economies.

Thus, variables that feature the public, private and financial sectors, macroeconomic, competitiveness and debt of these countries were collected. It is noteworthy that the choice of variables was widely influenced by the lack of accessible, reliable, with quality and comparable macroeconomic databases and, especially for the private and financial sectors, of microeconomic databases, which covered the twenty-seven European countries. The use of more macroeconomic variables, such as interest rates in the banking sector or long and short terms debt, and microeconomic variables, as ratio of private debt, credit granted by the banking sector or non-performing loans, could further enrich the study. Even so, the Statis methodology allowed us to obtain quite interesting and relatively surprising findings about European countries' common features and dissimilarities.

In general, this methodology opposed the years before and after the financial crisis of 2007/2008. Therefore, it can be concluded that the years 2002-2004, 2006-2007 and 2009-2011 are in general identified as being the most similar in what concerns to the similarities between countries but also the correlations between variables, but opposite when compared to others, seeming the year 2008, a "*turning point*" between these years. In this sense, the Statis methodology showed the economic developments in this period.

The conclusions obtained in the analysis of private and financial sectors' variables through the Dual Statis method were the most different ones. Here, the behaviour of the financial and private sectors' variables was similar between the beginning of the period here considered – 2002 – and the post crisis years – 2010 and 2011. Consequently,

2008/2009 are similar as well as the three pre-crisis years – 2004, 2006 and 2007. Notwithstanding, the similarities evidenced above can be due, for example, to the behaviour of investors in the financial and real markets as well as their expectation and reaction to economic events.

But, after all, what have the member countries of the European Union, one of the biggest economic and political union in the world, of similar and different? What binds twenty-seven different economies?

With the twenty-seven European countries being mentioned in the literature as having very different economies and, in general, being in divergence, the Statis methodology allowed to study them from a different perspective and to obtain interesting conclusions about what have anyway twenty-seven European countries in common and what differentiates them in relation to each other.

This methodology evidenced Hungary as a country with an income above the average. Notwithstanding, Hungary as well as Greece, Ireland, Latvia and Estonia were pointed out as countries with a GDP growth lower than average, in contrast with Malta, Romania and Slovakia. Relatively to trade's destination, Hungary and Luxembourg have external trade activeness above the average, when compared to Greece, UK and Portugal, whose domestic trade seems to have more importance.

Germany, Ireland and Luxembourg also seem to have a high competitiveness and activeness in external market, while Bulgaria, Latvia and Romania do not. Germany, jointly with UK, France, Italy and Romania seems to have been gaining external trade importance, as Statis evidenced a positive correlation with shares of exports in world trade, in contrast with Greece, Lithuania, Slovakia, Estonia and Luxembourg. The exports and imports of Estonia and Luxembourg were higher, but as well their effective exchange rate and labour costs' evolution.

Germany and Luxembourg, jointly with Netherlands, Sweden and Belgium were also evidenced as countries with higher foreign assets (measured by current account, trade balance and international investment position) accumulated by them, in contrast to Bulgaria, Estonia, Greece, Latvia and Portugal. Although, Luxembourg was pointed out, in average, as a country with lower current transfers, mainly in 2004-2011, and international reserves, as well as Hungary, and in opposition with Germany, Poland, Romania, UK and France. In this sequence, Germany and Poland seem to have higher

international reserves in 2006 and 2008-2011, as Denmark and Hungary, whilst Cyprus, Luxembourg and Malta seem to have higher current transfers (2004-2011). Cyprus and Portugal also seem to have lower capital account, in contrast with Estonia, Latvia, Lithuania, Luxembourg and Poland.

As far as investment and savings are concerned, European countries are different too. Austria, Czech Republic, Estonia, Latvia and Spain have, in average, higher investment and savings, which could indicate a higher activeness in these countries, while Cyprus, Greece, Lithuania, Malta and UK seems to be in the opposite situation. In countries as Finland, Luxembourg, Netherlands, Sweden and UK, the financial investment seems to be the predominant type of investment, whilst in Bulgaria, Latvia, Romania and Slovak Republic the real investment is the predominant one. If we make a comparison relatively to public intervention (measured by public expenses and public revenues), Bulgaria, Romania and Slovak Republic are countries with lower public intervention, jointly with Estonia, Latvia, Lithuania and Luxembourg, while Denmark, Finland, France, Hungary and Sweden are the countries whose states have more intervention in the economy. Luxembourg also seems to be an investment attractor (in average, it has higher investment, savings and private capital flows) and Malta and UK the opposite. Subsequently, investment and savings were, in average, higher in countries as Netherlands, Spain and Sweden, in contrast with Cyprus, Greece, Luxembourg and Malta, which had private capital flows above the average.

We have also concluded some interesting facts about the public states. Greece, Ireland and Spain, as was expected, were highlighted as the countries with the lowest sustainability of public accounts, as they have had a government budget lower than average; in contrast with Denmark, Finland, Hungary, Romania and Sweden, whose government budget were higher than the average, possibly financed with public revenues (which was also above the average). It was also found a negative effect of public indebtedness in countries' income and long-term interest rate in Greece, Hungary, Italy and Romania; the opposite in Estonia, Finland, Luxembourg and Sweden. Finally, it was also found that Austria, Belgium, Denmark, Finland, France, Italy and Sweden were countries with more public investment in the economy (measured by public debt, public expenses and public revenues), whilst Bulgaria,

Latvia, Lithuania, Romania and Estonia seems to have lower public investment, but higher inflation rate and short-term interest rate.

Following this, Bulgaria and Latvia were the most unstable in this period or in other words, they were pointed out as having higher contributions to the 2002-2011 period's within the different groups of variables. Ireland, Lithuania and Romania had also a high contribution to the structure differences, as well as Luxemburg, apart from the variables that feature the external debt or, concerning the last country, the public sector. Finland also had a high contribution to some years' differences, in exception to public sector's variables. Other countries were pointed out as having a high contribution in some groups of variables, as Cyprus (relatively to debt and, private and financial sector), Estonia (macroeconomic, debt and public sector), Greece and Hungary (public sector and debt), Malta (debt and, private and financial sector) and Poland (macroeconomic, competitiveness and debt).

Czech Republic and UK were, in contrast, countries with lower contribution to the structure differences, except in relation to the private and financial sectors which may evidence some instability in these sectors. The same is applicable to Portugal but in relation to the external debt and macroeconomic variables. Netherlands, Slovakia, Slovenia and Sweden also had been pointed out as having a high contribution to some years' differences in some groups of variables, but they are more stable in others.

In contrast, Austria, Belgium, Denmark, France, Germany, Italy and Spain were countries whose contributions were lower and their trajectories plainly more regular.

In respect to the variables, only GDP, GDP per capita, consumption, imports and exports had a lower contribution to the structure's difference. Thus, the remaining variables' correlations with the others were unstable, evidencing a period of great changes and instability.

The Statis methodology allowed us to obtain interesting conclusions. Although, it may also be used to compare the European countries with other countries as China or the United States of America as well as to study further other characteristics of these countries, allowing other overviews of the similarities and differences of them. For example, the inclusion of more variables, particularly microeconomic, could enrich the study, as well as the use of a higher level of economic disaggregation, for example, in terms of sectors of activity or industries.

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APPENDICES

Appendix 1 – Variables under study and source's data

	Variable	Source
GDP	Gross domestic product, constant prices	International Monetary Fund – World Economic Outlook Database
YPC	Gross domestic product *per capita*, constant prices	International Monetary Fund – World Economic Outlook Database
U	Unemployment rate	International Monetary Fund – International Financial Statistics (IFS)
PI	Inflation, consumer prices (annual %)	World Bank - International Monetary Fund (International Financial Statistics and data files), Catalogue Sources World Development Indicators
C	Final consumption aggregates, current prices, in per cent of GDP	Eurostat
G	General government total expenditure, in per cent of GDP	International Monetary Fund – World Economic Outlook Database
T	General government revenue, in per cent of GDP	International Monetary Fund – World Economic Outlook Database
IN	Total investment, in per cent of GDP	International Monetary Fund – World Economic Outlook Database
SO	General government net lending or borrowing, in per cent of GDP	International Monetary Fund – World Economic Outlook Database

Table A.1 - Variables: source and description.

X	Exports of goods and services, in per cent of GDP	Eurostat
M	Imports of goods and services, in per cent of GDP	Eurostat
ILP	Nominal long-term interest rates, government securities and government bonds	AMECO and International Monetary Fund – International Financial Statistics (IFS)
ICP	Nominal short-term interest rates	AMECO and Organization for Economic Cooperation and Development (OECD)
DP	General government gross debt, in per cent of GDP	International Monetary Fund – World Economic Outlook Database
YG	GDP growth (annual %)	World Bank - Catalogue Sources World Development Indicators
QE	Share of world exports	Eurostat
TB	External balance on goods and services, in per cent of GDP	Eurostat
RER	Real effective exchange rate index (2005=100)	Eurostat
CT	Nominal unit labour cost index (2005=100)	Eurostat
TT	Terms of trade goods and services	AMECO
P	Labour productivity per person employed index (EU-27=100)	Eurostat

Table A.1 - Variables: source and description (cont.).

CA	Current account balance, in per cent of GDP	International Monetary Fund – World Economic Outlook Database
TC	Net current transfers from the rest of the world	AMECO
BK	Net capital account, in per cent of GDP (current US dollars)	World Bank - International Monetary Fund, Balance of Payments Statistics Yearbook and data files, Catalogue Sources World Development Indicators
R	Total reserves excluding gold (US dollars)	International Monetary Fund – International Financial Statistics
IIP	Net international investment position, in per cent of GDP	Eurostat
AT	Stocks traded, total value, in per cent of GDP	World Bank - Standard & Poor's, Global Stock Markets Fact book and supplemental S&P data, Catalogue Sources World Development Indicators
CM	Market capitalization of listed companies, in per cent of GDP	World Bank - Standard & Poor's, Global Stock Markets Fact book and supplemental S&P data. Catalogue Sources World Development Indicators
PDI	Foreign direct investment, net (current US dollars) Portfolio investment, excluding LCFAR (current US dollars)	World Bank - International Monetary Fund, Balance of Payments Statistics Yearbook and data files, Catalogue Sources World Development Indicators Author's calculations.
FCP	Private capital flows, total, in per cent of GDP	World Bank, Catalogue Sources World Development Indicators
S	Gross national savings, in per cent of GDP	International Monetary Fund – World Economic Outlook Database

Table A.1 - Variables: source and description (cont.).

Appendix 2 – Boxplots of the variables

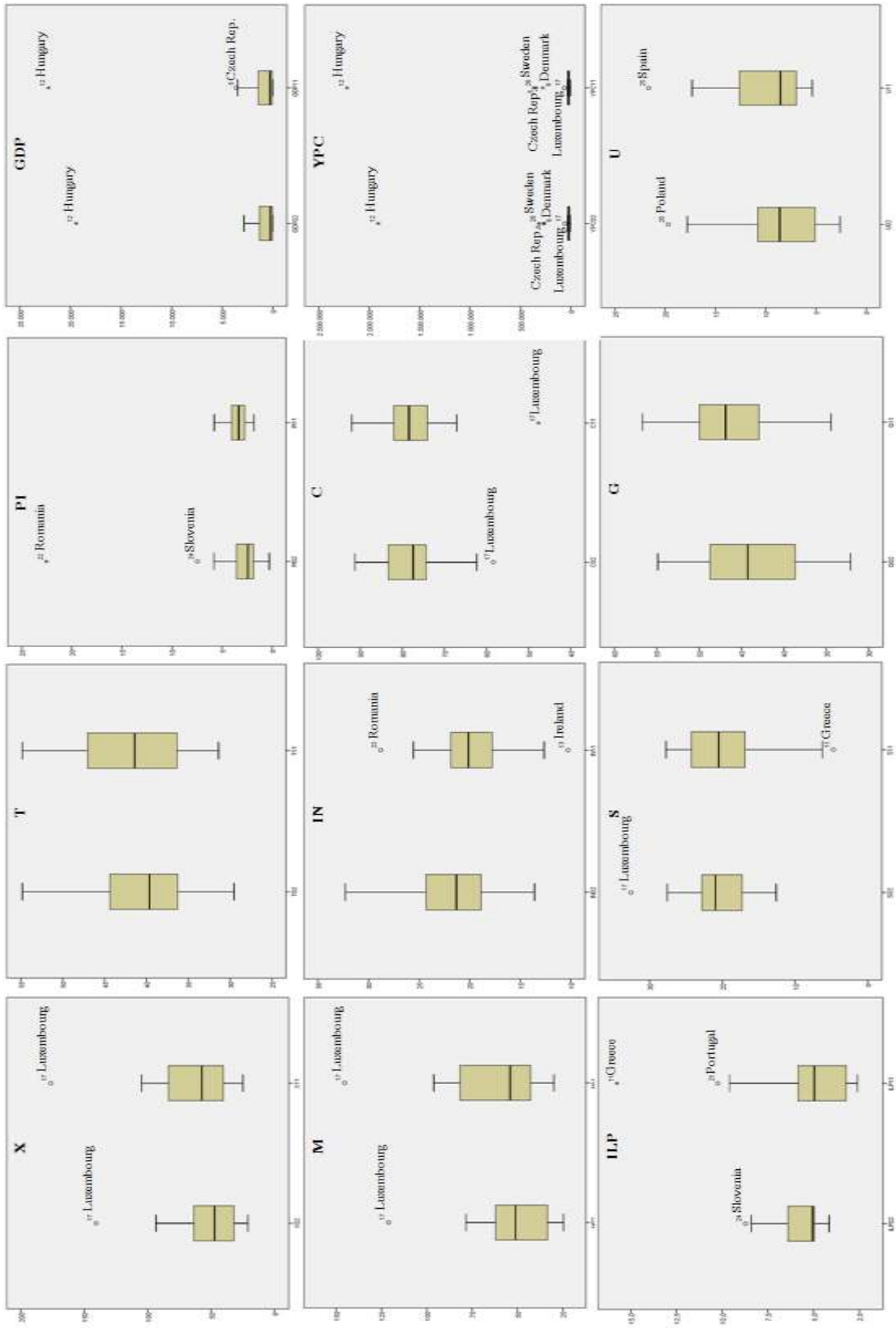

Figure A.1 - Boxplots of the variables in 2002 and 2011, respectively.

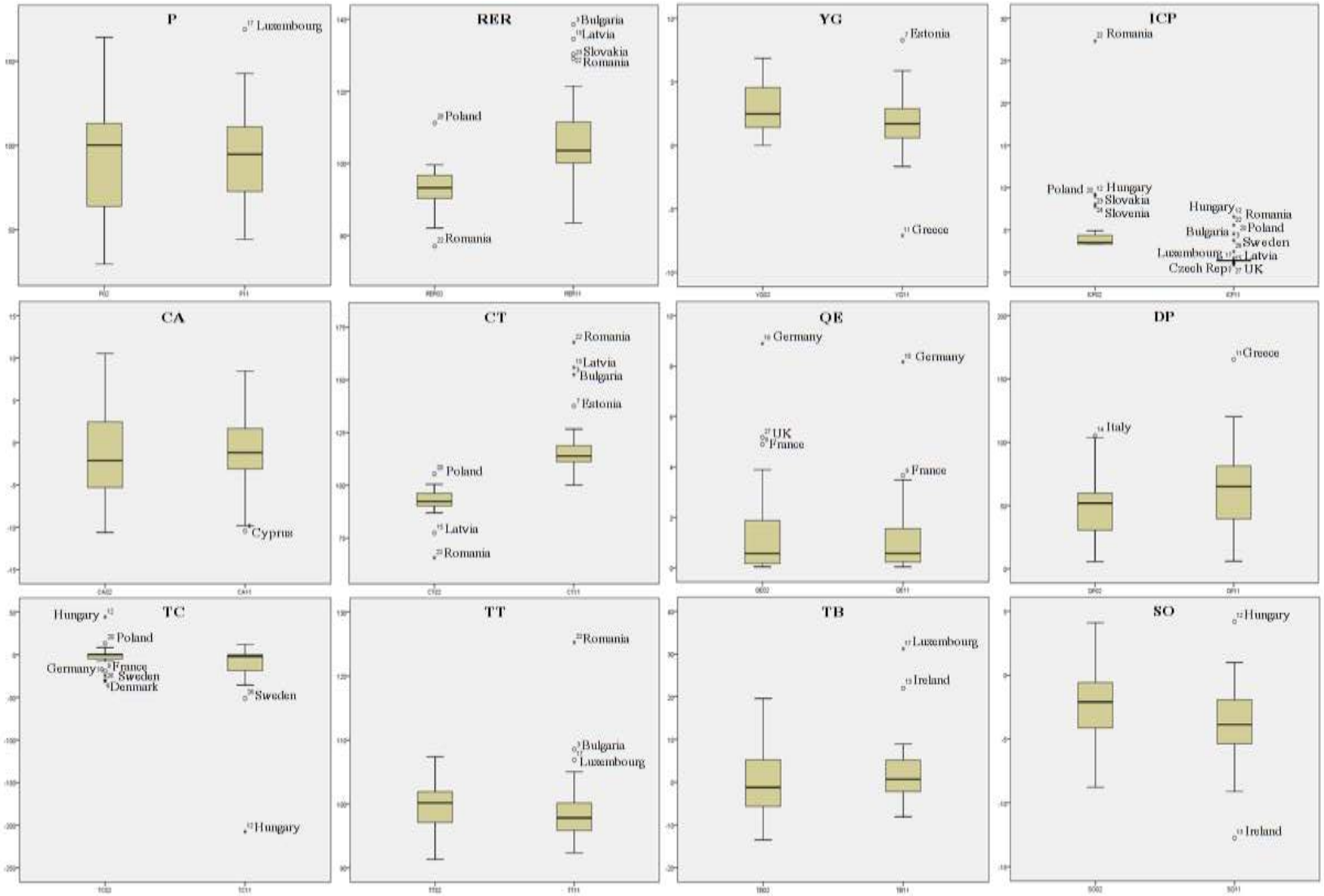

Figure A.1 - Boxplots of the variables in 2002 and 2011, respectively (cont.).

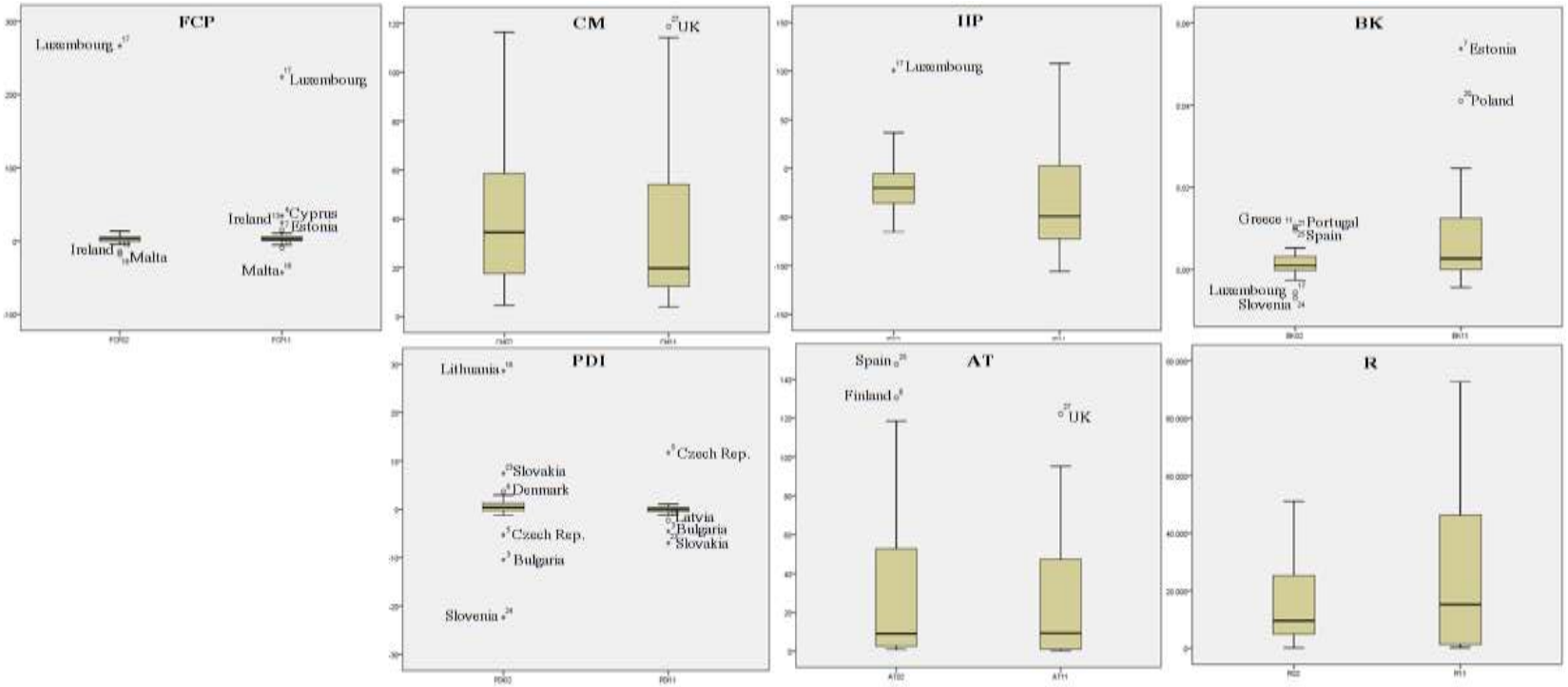

Figure A.1 - Boxplots of the variables in 2002 and 2011, respectively (cont.).

Appendix 3 – Correlation coefficients between variables and compromise axes

	GDP				YPC				U			
	1	2	3	4	1	2	3	4	1	2	3	4
2002	0.269	-0.420	**-0.856**	-0.013	0.337	-0.391	**-0.851**	0.004	-0.394	0.453	-0.152	-0.432
2004	0.269	-0.414	**-0.860**	-0.011	0.334	-0.386	**-0.855**	0.004	-0.335	0.221	-0.054	-0.485
2006	0.271	-0.411	**-0.861**	-0.013	0.334	-0.382	**-0.856**	0.003	-0.267	-0.066	-0.084	-0.365
2007	0.270	-0.412	**-0.860**	-0.015	0.336	-0.382	**-0.855**	0.002	-0.290	-0.154	-0.125	-0.286
2008	0.271	-0.410	**-0.861**	-0.016	0.335	-0.380	**-0.857**	0.002	-0.326	-0.010	-0.223	-0.274
2009	0.269	-0.412	**-0.860**	-0.018	0.335	-0.381	**-0.856**	0.001	-0.257	0.388	-0.229	-0.325
2010	0.270	-0.414	**-0.858**	-0.019	0.335	-0.382	**-0.856**	0.000	-0.290	0.474	-0.276	-0.277
2011	0.270	-0.415	**-0.857**	-0.020	0.335	-0.382	**-0.856**	0.000	-0.380	0.370	-0.250	-0.144
	PI				**C**				**G**			
	1	2	3	4	1	2	3	4	1	2	3	4
2002	-0.141	0.308	-0.258	-0.139	**-0.834**	0.079	-0.298	0.123	0.212	**-0.863**	0.063	-0.167
2004	-0.132	0.504	-0.551	-0.228	**-0.850**	0.014	-0.298	0.138	0.166	**-0.906**	0.158	-0.078
2006	-0.169	**0.726**	-0.434	-0.127	**-0.884**	-0.041	-0.277	0.151	0.085	**-0.952**	0.017	-0.044
2007	-0.042	0.491	-0.610	-0.235	**-0.890**	-0.078	-0.287	0.185	-0.003	**-0.961**	0.005	-0.016
2008	-0.157	0.634	-0.355	-0.259	**-0.898**	-0.045	-0.234	0.265	-0.060	**-0.897**	0.072	-0.036
2009	-0.237	0.222	-0.526	-0.067	**-0.868**	-0.150	-0.155	0.247	0.039	**-0.866**	0.189	-0.063
2010	-0.134	-0.092	-0.451	0.080	**-0.916**	-0.191	-0.115	0.167	0.104	-0.649	0.257	0.094
2011	-0.244	0.461	-0.362	-0.032	**-0.895**	-0.250	-0.085	0.189	0.082	**-0.879**	0.258	0.008
	T				**IN**				**S**			
	1	2	3	4	1	2	3	4	1	2	3	4
2002	0.295	**-0.818**	0.302	-0.257	0.106	0.393	-0.271	-0.497	**0.721**	-0.072	0.353	-0.422
2004	0.279	**-0.826**	0.298	-0.212	0.041	0.507	-0.326	-0.530	0.686	-0.143	0.367	-0.457
2006	0.196	**-0.858**	0.309	-0.180	-0.088	0.637	-0.247	-0.478	0.673	-0.195	0.403	-0.462
2007	0.170	**-0.887**	0.217	-0.153	-0.180	0.684	-0.203	-0.504	0.607	-0.223	0.446	-0.454
2008	0.203	**-0.882**	0.229	-0.155	-0.186	0.617	-0.268	**-0.547**	0.528	-0.217	0.312	**-0.627**
2009	0.333	**-0.802**	0.190	-0.213	-0.176	0.249	-0.118	**-0.572**	0.407	0.079	0.052	**-0.767**
2010	0.282	**-0.820**	0.239	-0.190	-0.105	0.250	-0.123	**-0.650**	0.572	0.021	0.077	**-0.655**
2011	0.295	**-0.871**	0.048	-0.150	-0.007	0.298	-0.134	**-0.782**	0.512	0.095	0.024	**-0.675**
	X				**M**							
	1	2	3	4	1	2	3	4				
2002	**0.880**	0.348	0.088	0.260	**0.778**	0.505	-0.044	0.255				
2004	**0.893**	0.370	0.085	0.188	**0.775**	0.540	-0.062	0.173				
2006	**0.905**	0.323	0.043	0.193	**0.769**	0.514	-0.094	0.180				
2007	**0.913**	0.283	0.046	0.197	**0.789**	0.480	-0.083	0.195				
2008	**0.917**	0.281	0.058	0.210	**0.806**	0.442	-0.051	0.242				
2009	**0.913**	0.305	0.022	0.235	**0.846**	0.380	-0.044	0.299				
2010	**0.892**	0.358	-0.007	0.233	**0.828**	0.426	-0.061	0.276				
2011	**0.872**	0.406	-0.025	0.213	**0.808**	0.474	-0.077	0.209				

Table A.2 – Linear correlation coefficients between macroeconomic variables and each compromise axis (1, 2, 3 and 4).

	QE			TB			X		
	1	2	3	1	2	3	1	2	3
2002	0.382	0.635	**-0.537**	**0.819**	-0.199	-0.239	0.523	**-0.832**	-0.020
2004	0.382	0.629	**-0.540**	**0.893**	-0.180	-0.202	0.509	**-0.847**	-0.035
2006	0.380	0.621	**-0.544**	**0.908**	-0.164	-0.170	0.529	**-0.825**	0.000
2007	0.382	0.615	**-0.544**	**0.916**	-0.190	-0.164	0.565	**-0.798**	0.010
2008	0.380	0.611	**-0.544**	**0.876**	-0.241	-0.216	0.571	**-0.801**	-0.016
2009	0.381	0.607	**-0.549**	**0.724**	-0.514	-0.253	0.559	**-0.813**	-0.043
2010	0.379	0.604	**-0.549**	**0.695**	-0.577	-0.252	0.504	**-0.840**	-0.023
2011	0.373	0.604	**-0.550**	**0.717**	-0.562	-0.207	0.456	**-0.859**	-0.010
	M			RER			CT		
	1	2	3	1	2	3	1	2	3
2002	0.324	**-0.906**	0.060	0.346	0.331	0.109	**0.677**	0.368	0.284
2004	0.269	**-0.931**	0.033	**0.655**	0.277	0.338	**0.737**	0.309	0.375
2006	0.265	**-0.917**	0.068	**-0.594**	-0.404	-0.094	**-0.544**	-0.412	-0.074
2007	0.312	**-0.903**	0.082	**-0.709**	-0.450	-0.217	**-0.659**	-0.409	-0.182
2008	0.365	**-0.886**	0.062	**-0.660**	-0.522	-0.138	**-0.695**	-0.445	-0.265
2009	0.455	**-0.857**	0.036	**-0.515**	-0.575	-0.017	**-0.719**	-0.487	-0.292
2010	0.410	**-0.872**	0.053	**-0.577**	-0.584	-0.084	**-0.729**	-0.461	-0.392
2011	0.344	**-0.890**	0.050	**-0.558**	-0.580	-0.110	**-0.703**	-0.464	-0.408
	TT			P					
	1	2	3	1	2	3			
2002	0.516	0.420	0.317	**0.878**	0.147	-0.148			
2004	0.333	0.466	0.330	**0.893**	0.100	-0.156			
2006	-0.386	-0.408	-0.448	**0.899**	0.042	-0.185			
2007	-0.633	-0.336	**-0.554**	**0.897**	0.021	-0.188			
2008	-0.619	-0.340	**-0.556**	**0.891**	0.059	-0.182			
2009	-0.527	-0.133	**-0.637**	**0.882**	0.079	-0.164			
2010	-0.525	-0.269	**-0.621**	**0.888**	0.035	-0.180			
2011	-0.521	-0.372	**-0.600**	**0.881**	0.007	-0.197			

Table A.3 – Linear correlation coefficients between competitiveness' variables and compromise axes (1, 2 and 3).

	CA				TB				TC			
	1	2	3	4	1	2	3	4	1	2	3	4
2002	**0.867**	-0.134	0.101	0.096	**0.897**	-0.067	-0.189	0.028	-0.420	0.125	**0.538**	0.011
2004	**0.926**	-0.011	0.079	0.112	**0.926**	-0.039	-0.162	-0.001	-0.063	**-0.810**	**0.533**	-0.117
2006	**0.897**	0.169	0.106	0.092	**0.921**	0.039	-0.171	0.000	0.029	**-0.771**	**0.598**	-0.128
2007	**0.885**	0.184	0.075	0.041	**0.917**	0.052	-0.208	-0.037	0.043	**-0.774**	**0.592**	-0.117
2008	**0.839**	0.255	0.095	-0.143	**0.902**	0.072	-0.236	-0.172	0.002	**-0.796**	**0.572**	-0.114
2009	**0.507**	0.203	-0.122	-0.582	**0.780**	-0.020	-0.393	-0.337	-0.058	**-0.849**	**0.477**	-0.128
2010	**0.641**	0.178	-0.227	-0.461	**0.743**	-0.040	-0.455	-0.329	-0.074	**-0.850**	**0.464**	-0.141
2011	**0.662**	0.210	-0.228	-0.393	**0.718**	-0.070	-0.468	-0.208	-0.031	**-0.826**	**0.520**	-0.139
	BK				R				IIP			
	1	2	3	4	1	2	3	4	1	2	3	4
2002	**-0.664**	0.025	-0.115	0.098	0.193	**0.586**	**0.587**	0.111	**0.742**	-0.348	0.094	0.024
2004	**-0.820**	-0.004	0.218	0.087	0.250	**0.696**	**0.620**	0.003	**0.817**	-0.359	0.120	0.059
2006	**-0.624**	-0.113	-0.086	-0.435	0.129	**0.723**	**0.622**	-0.044	**0.857**	-0.316	0.116	0.013
2007	**-0.510**	0.048	0.045	-0.449	0.069	**0.689**	**0.641**	-0.092	**0.888**	-0.234	0.171	-0.028
2008	**-0.818**	0.188	-0.005	-0.371	0.069	**0.776**	**0.543**	-0.094	**0.882**	-0.172	0.226	-0.072
2009	**-0.665**	0.008	0.140	**-0.650**	0.157	**0.793**	**0.525**	-0.087	**0.867**	-0.145	0.251	-0.100
2010	**-0.638**	0.071	-0.003	**-0.700**	0.141	**0.776**	**0.558**	-0.089	**0.883**	-0.145	0.208	-0.113
2011	**-0.609**	0.142	-0.081	**-0.705**	0.143	**0.776**	**0.546**	-0.075	**0.870**	-0.117	0.178	-0.190

Table A.4 – Linear correlation coefficients between debt's variables and compromise axes (1, 2, 3, and 4).

	AT					CM				
	1	2	3	4	5	1	2	3	4	5
2002	**0.701**	0.443	0.384	-0.079	-0,151	**0.931**	0.086	-0.085	-0.044	-0,089
2004	**0.752**	0.497	0.361	-0.074	-0,147	**0.954**	-0.028	-0.080	-0.042	-0,068
2006	**0.739**	0.502	0.367	-0.040	-0,060	**0.949**	0.007	-0.179	-0.002	-0,052
2007	**0.743**	0.537	0.301	-0.083	-0,168	**0.841**	-0.323	-0.318	-0.021	-0,103
2008	**0.753**	0.501	0.337	-0.061	-0,188	**0.901**	-0.220	-0.234	-0.008	-0,170
2009	**0.719**	0.510	0.306	-0.089	-0,254	**0.885**	-0.291	-0.134	-0.013	-0,227
2010	**0.738**	0.510	0.339	-0.072	-0,189	**0.928**	-0.178	-0.106	0.003	-0,178
2011	**0.745**	0.504	0.365	-0.052	-0,159	**0.957**	0.003	-0.011	-0.010	-0,179
	FCP					IN				
	1	2	3	4	5	1	2	3	4	5
2002	0.445	**-0.792**	-0.368	-0.038	-0,118	-0.401	-0.414	0.345	-0.194	-0,153
2004	0.324	**-0.827**	-0.342	-0.081	-0,188	-0.516	-0.426	0.356	-0.277	-0,198
2006	0.411	**-0.784**	-0.391	-0.079	-0,195	-0.599	-0.330	0.351	-0.366	-0,247
2007	0.344	**-0.728**	-0.463	-0.095	-0,221	-0.632	-0.337	0.363	-0.257	-0,284
2008	0.133	-0.193	0.289	-0.076	-0,306	-0.650	-0.367	0.368	-0.189	-0,411
2009	-0.357	0.610	0.563	-0.001	0,048	-0.384	-0.273	0.375	0.054	**-0,526**
2010	0.405	**-0.728**	-0.297	-0.073	-0,001	-0.366	-0.368	0.444	0.217	-0,398
2011	0.433	**-0.795**	-0.366	-0.055	-0,042	-0.299	-0.500	0.572	0.195	-0,340
	PDI					S				
	1	2	3	4	5	1	2	3	4	5
2002	-0.016	0.153	-0.215	0.106	0,196	0.446	-0.650	0.336	0.038	0,216
2004	0.135	0.016	0.056	-0.478	0,556	0.510	-0.597	0.365	-0.072	0,323
2006	0.001	-0.033	0.087	**-0.882**	0,127	0.491	-0.480	0.489	0.062	0,431
2007	0.135	0.043	0.022	**0.851**	-0,106	0.499	-0.412	0.480	0.218	0,472
2008	0.227	0.015	0.037	-0.405	0,085	0.382	-0.404	**0.664**	0.212	0,346
2009	-0.009	-0.059	0.074	**0.820**	-0,182	0.125	-0.550	**0.717**	-0.027	0,063
2010	-0.192	-0.293	0.057	0.357	0,286	0.211	-0.579	**0.640**	0.003	0,184
2011	0.045	-0.046	0.041	0.385	-0,005	0.144	-0.576	**0.643**	0.044	0,083

Table A.5 – Linear correlation coefficients between private and financial sectors' variables and compromise axes (1, 2, 3, 4 and 5).

	ILP				ICP				DP			
	1	2	3	4	1	2	3	4	1	2	3	4
2002	**-0.571**	0.027	-0.299	0.071	**-0.612**	0.372	-0.398	0.296	0.624	**0.559**	0.058	0.063
2004	**-0.490**	0.559	-0.478	0.096	**-0.626**	0.480	-0.467	0.192	0.678	**0.588**	0.058	0.075
2006	**-0.550**	0.613	-0.505	0.070	**-0.614**	0.525	-0.444	0.075	0.675	**0.646**	0.086	0.023
2007	**-0.670**	0.451	-0.489	-0.066	**-0.617**	0.324	-0.350	-0.423	0.652	**0.680**	0.112	0.016
2008	**-0.715**	0.270	-0.430	-0.291	**-0.737**	0.313	-0.500	-0.145	0.660	**0.688**	0.161	-0.072
2009	**-0.777**	0.082	-0.114	-0.419	**-0.778**	0.156	-0.387	-0.385	0.598	**0.714**	0.265	-0.132
2010	**-0.642**	0.441	0.107	-0.501	**-0.631**	0.412	-0.563	0.032	0.534	**0.713**	0.376	-0.173
2011	-0.198	0.628	0.427	-0.313	-0.443	0.475	-0.596	0.131	0.503	**0.708**	0.445	-0.165
	SO				G				T			
	1	2	3	4	1	2	3	4	1	2	3	4
2002	0.143	**-0.622**	-0.065	-0.286	**0.806**	0.125	-0.422	0.072	**0.840**	-0.143	-0.435	-0.051
2004	-0.049	**-0.795**	-0.081	-0.232	**0.865**	0.132	-0.412	0.023	**0.846**	-0.179	-0.444	-0.068
2006	0.038	**-0.809**	-0.029	-0.126	**0.825**	0.268	-0.432	-0.059	**0.843**	-0.148	-0.446	-0.123
2007	0.112	**-0.843**	-0.220	-0.032	**0.824**	0.358	-0.365	-0.146	**0.838**	-0.075	-0.455	-0.155
2008	0.321	**-0.610**	**-0.505**	0.314	**0.782**	0.311	-0.255	-0.413	**0.829**	-0.084	-0.495	-0.167
2009	0.125	**-0.503**	**-0.710**	0.199	**0.820**	0.123	-0.188	-0.432	**0.748**	-0.190	**-0.566**	-0.242
2010	0.126	-0.246	**-0.673**	0.206	**0.676**	0.076	0.102	-0.447	**0.782**	-0.147	**-0.509**	-0.254
2011	0.023	-0.181	**-0.814**	-0.042	**0.879**	0.115	-0.161	-0.289	0.023	-0.181	**-0.814**	-0.042
	YG				PI							
	1	2	3	4	1	2	3	4				
2002	**-0.812**	-0.152	0.124	-0.344	**-0.558**	0.327	-0.275	0.213				
2004	**-0.813**	-0.124	-0.136	-0.279	**-0.760**	0.370	-0.234	0.160				
2006	**-0.777**	-0.282	0.007	-0.281	**-0.845**	0.038	0.039	-0.184				
2007	**-0.685**	-0.460	0.245	0.035	**-0.732**	-0.026	-0.135	-0.526				
2008	-0.352	0.222	-0.172	**0.762**	**-0.761**	-0.207	-0.085	-0.405				
2009	**0.533**	0.337	0.094	**0.634**	**-0.571**	0.315	-0.446	0.138				
2010	0.168	-0.469	-0.449	0.397	-0.216	0.559	-0.429	0.226				
2011	-0.274	-0.600	-0.326	-0.145	**-0.701**	0.148	-0.249	-0.115				

Table A.6 – Linear correlation coefficients between public sector's variables and compromise axes (1, 2, 3 and 4).