

**MASTER OF SCIENCE IN
MONETARY AND FINANCIAL ECONOMICS**

**MASTERS FINAL WORK
DISSERTATION**

**FORECASTING UNEMPLOYMENT ERRORS BY THE TROIKA :
EVIDENCE FROM THE ADJUSTMENT PROGRAMMES FOR GREECE**

TIAGO PAIXÃO MOREIRA DOMINGUES

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Abstract

The aim of this dissertation is to study the unemployment errors present in the troika's economic adjustment programs for the Greek economy. I start by reviewing theoretical aspects of the fiscal and monetary interactions in the European Monetary Union (EMU) and the particular case of Greece. Then, I use two methodologies to test the performance of troika's economic adjustment programs: a Vector Error Correcting (VEC) model and the Leontief Input-Output (IO) model. I found evidence for the econometric model to underestimate unemployment, as troika's forecasts did, but with a slightly higher accuracy when compared to troika's programs. In contrast, the Input-Output application tends to overestimate the unemployment rate for the same period. However, after adjusting to the figures available from the Organization for Economic and Co-operation and Development (OECD), its performance is substantially improved. We conclude that such unemployment boom was relatively hard to predict, especially when using simple standard econometric techniques, but it could have been better assessed with an inter-sectoral analysis such as the one we apply in this work.

Keywords: Input-Output analysis, VECM, Greece, Fiscal Consolidation, Forecasting unemployment errors, Monetary and Fiscal Interactions, EMU adjustment programmes

JEL Classification Numbers: C67, C53, E24, E27, E63, E65

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All faults and mistakes should be addressed to me alone. This document has dynamic references for all objects such as equations, figures, tables and bibliography, for that digital reading is encouraged using Adobe reading or similar.

— Tiago Paixão Moreira Domingues

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1. Introduction

For many European Monetary Union (EMU) countries, especially for Greece and Portugal, the so-called great recession and the following years of depression have contributed to a change in our economic institutions and policy. As a matter of fact, the years prior to 2009 were marked by a significant increase on Greek imbalances alongside with an incomplete integration process that was misunderstood in the financial markets. Ten years later, it is evident that EMU institutions failed to provide a convergence and integrated union. The Greek crisis was in fact considered one of the major economic events of the past decades and it contributed to a series of political debates with implications for actual policy.

In 2010 Greece signed an agreement with the International Monetary Fund (IMF), European Central Bank (ECB) and European Commission (EC), later called Troika. This agreement conduct the Greek economy to a huge internal devaluation with enormous consequences in financial, economic and social terms, in exchange for financial provision. Two more programs were signed and implemented in 2012 and 2014, respectively.

Those programs were based on high fiscal discipline measures, by reduction of both external and government budget imbalances, and additionally by a set of structural reforms to guide the Greek economy on a more sustainable path. After some years, it is easy to identify a considerable number of miscalculations and bad predictions contained in those programs, especially related to unemployment. In fact, the highest unemployment rate ever registered in the EMU occurred in Greece in 2013, more precisely 2013Q3, with a record of 27.73 percent of the labor force being unemployed. For the same year, troika memorandums predicted 14.8 percent and 17.8 percent respectively. According to the OECD numbers, considering an active population of around 4.84 million persons, those flaws represent approximately an error of 580 thousand and 484 thousand workers, respectively.

My main research question consists of empirical assessing whether or not the unemployment forecasts contained in those documents could be more accurate, using two different approaches. In both approaches, the core analysis will be made through the so-called unemployment/external balance trade-off.

First, I chose to develop an econometric analysis by running a Vector Error Correcting (VEC) model that is intended also to produce an explicit stochastic forecast, allowing for dynamic solutions. Secondly, following recent publications from both my supervisors, I chose to replicate the work done for Portugal, to the Greek economy. We computed the trade-off

equation and by assuming the Troika scenarios for the external balance, we will be able to estimate explicit values for the unemployment rate in those years.

This dissertation is organized as follows: Section 2 intends to provide a theoretical background on the crisis in EMU, especially the case of Greece. Section 3 presents my main literature review, following the work by both professors João Carlos Lopes and João Ferreira do Amaral. Section 4 consists on the empirical assessment and it is divided into two subsections, first the econometric approach and second the inter-sectoral analysis. Finally, section 5 provides the main conclusions of the work and suggests future research.

2. The Great Recession, Great Depression and the Eurozone: Evidence from the last decade

2.1. Exploring the causes and policy implications of the recent financial crisis

The last 10 years have been marked by the global financial crisis that was seen as a relatively unexpected event, even to our national and international economic institutions. Such event contributed to a series of political debates and lead to new thoughts and theories govern all economic and financial sectors. The global financial crisis also produced valuable lessons with different policy implications. In fact, the so-called new-neoclassical synthesis¹, that is expected to incorporate both Classical and Keynesian features, failed in explaining those serious fluctuations on output and unemployment and negligence issues related to the financial stability, the role of money and inequality. At the light of the new-neoclassical synthesis one can conclude, as Minsky (1982) or more recently Arestis (2009) that (1) the theory offers little explanation of those phenomena, and (2) at the light of the theory, those same deviations should be seen as anomalies rather than causes of endogenous mechanisms. I discuss in this section the main contributory causes of the recent global financial crisis. I also intend to expose some changes to the policy framework, especially for the EMU, that has already taken place as a result of the crisis and to discuss it's consequent political debates.

The great depression of the 20th century, that started with the Wall Street crash of 1929 was followed by a turning point in what regulation of the financial sector concerns. In fact, the 1933 Glass-Steagall Act ² was developed to limit, contain and regulate the increasing tendency for the financial liberalization that took place, especially in the banking system. In

¹Goodfriend and King (1997) examines the foundations of the so-called new-neoclassical synthesis.

²The Glass-Steagall, or the Banking Act legislation describes four provisions of the U.S. Banking Act of 1933 separating commercial and investment banking.

that light, the Banking Act of 1933 was intended to separate the commercial bank's activities to the pure-speculative operations that started to emerge at that time. The objective was then to avoid the speculative leveraged activities of the past decade. In that sense, the repeal of the Act in 1999 contributed to a paradigm shift. Fostered by the removing of regulation Q³, during the 70s and the 80s, investment banks and commercial banks started to incorporate common activities and therefore to compete for profits in a way. That continuous process lead to a liberalization of the financial markets that went overseas and allowed for financial (in)stability to play an important role in modern economies.

Moreover, the continuous process of financial liberalization until the end of the 20th century lead to new innovations in the financial markets and opened the space for the financial engineering and the related activities. This made both commercial and investment banks to connect their activities with the effect of raising the share of the top largest American banks from 10 percent to 40 percent between 1990-2007 (Haldane et al., 2010). As a consequence of that banking sector mingle, the risk aversion fell sharply and therefore the (miss)perception of the risk lead to the credit crisis of 2007. As Phillip Arestis refer, "the underpricing of risk came about by low risk spreads whereby the differentials between risky assets and safe assets declined substantially"(Arestis, 2016, p. 5). This liberalization process in the banking sector produced a huge growth of credit, especially in the subprime mortgage market. However, when the long run interest rate becomes lower than the short-run ones, the subprime market collapsed. This collapse of the subprime mortgage market contributed also to the end of the real estate boom and to the consequent fall of the housing bubble which generated spillovers into the real economic system.

Other aspects that the standard mainstream economic theory ignored were inequality and the distributional effects. Beyond the evaluation about output and employment, and how far are we locate in terms of the potential output and full employment, it is important to stress the determinants of both profits and wages as well as identify how they co-move. For that, and bearing in mind that the marginal propensity to consume from those who receive the salaries is bigger than those who get the profits, one can state that during bust periods, when output fell below its potential and employment fell below full employment, there is a straight mechanism that pressure demand to have self-fulfilling recessionary dynamics. In fact, as a consequence of the recent financial liberalization that preceded the crisis, income distribution suffered dramatic changes in favor to the profit takers. For the US economy, Piketty (2014) suggests that 75 percent of the aggregate income growth has gone to the top

³Regulation Q was a Federal Reserve regulation which set capital requirements for banks in the U.S..

of the distribution. Similarly, the share of income going to the top 0.1 percent increased from 2.6 percent in 1976 to 12.3 percent in 2007 (Atkinson et al., 2011).

In a macroeconomic perspective, one can argue that the price stability became the main mandate for the central bank authorities implying the use of interest rates as a tool for the targeting control of inflation, which lead to an increase in the outstanding household debt and mortgage debt making short-term household expenditure relatively more sensitive to changes in the short-run interest rate. This shows the need for regulatory and prudential control mechanisms in order to deal with liquidity issues. In that sense, instead of having only a microprudential framework, concerning partial equilibrium, international authorities implemented a new macroprudential approach, that considers the financial system as a whole. This argument is summarized by Samuel Hanson, "In the aftermath of the crisis there seems to be agreement among both academics and policymakers that financial regulation needs to move in a macroprudential direction"(Hanson et al., 2011, p. 3). So, one can argue that a single price stability policy should not be seen as a guarantee for the economic and financial stability since different policy applications should be undertaken and more than that, they should be coordinated. In fact, alongside with monetary policy and macroprudential policies to control for the price stability and financial stability, respectively, one should argue that fiscal policy may have an important role in a sense that adjustments to fiscal stance are highly needed and there are strong arguments for them to be discretionary.

Finally, it is legitimate to state that within the financial innovations that happened in the last decades, one should rethink the role of credit rating agencies and their contribution to the financial markets stability. In fact, there is strong evidence for the need of those institutions to produce more transparent results in order to recover their credibility. Especially in the Eurozone, there is evidence for lack of rigor from those agencies when ranking European economies, especially the southern ones. In fact, Vernazza and Nielsen (2015) found that countries like Portugal, Ireland and Spain were underrated above their fundamental level during the period after the global financial crisis.

In sum, we have discussed what factors really determined and fostered the great recession of 2008, which began in the US and spread overseas to the European countries and stressed EMU institutions with consequences for policy design. Those factors rely on the financial liberalization and its distribution effects on the economy. The lack of macroprudential policies contributed to such a deep recession and the role of the credit rating agencies should be rethought. We are now able to produce broader conclusions about the consequences of the crisis in the EMU countries as well as contribute to a better understanding of both fiscal and

monetary interactions in the EMU, especially during fiscal consolidations episodes. Those topics will be explored in the next section.

2.2. Monetary and Fiscal Interactions in the EMU

After a brief explanation of the main contributory causes of the recent global financial crisis, it is now important to refocus our work in the EMU case. Before a more concrete examination of the causes and consequences of the crises in the Euro countries, and especially the Greek case, it is important to understand the theory behind such a monetary union. Starting with the work of Mundell (1961), one can delineate the conditions under which an economy should implement a common currency and obey to a centralized monetary policy as well as the benefits and costs of such an integration. As it is shown in the paper, the benefits of a common currency include the elimination of both exchange rate risk and transaction costs and the reduction of uncertainty produced by inflation distortion. On the other hand, the main disadvantages associated with a common currency rely on the inability to adjust exchange rate and to set the interest rate, meaning that each individual country is no longer capable to control and pursuit both monetary and exchange rate policies. As McKinnon (1963) argue, the "optimum" term is intended to describe the capacity of a single currency union to produce and maintain full employment, balanced international payments and also to pursuit a relative price stability regime.

The main idea is that a unified currency area with the objective of maintaining price stability, would not suffer from asymmetric shocks since those shocks will tend to be reduced by the maintenance of sound fiscal policies. Additionally, reduced ability to conduct demand-side countercyclical policies to deal with asymmetric shocks leads to an increased tendency of those countries to undertake structural reforms, both in product and labor markets. Finally, the elimination of exchange rate risk would lead to an increasing market discipline from the fiscal authorities. Having said that, it is reasonable to think about EMU as a positive externality.

Thus, it is important to underline that both monetary and fiscal policies should be coordinated to produce such "optimal" results. A necessary condition for the effectiveness of a monetary union is indeed that both policies be synchronized during the economic cycle and also to contribute to economic convergence and business cycle synchronization. Although the ECB mandate is to keep low and stable inflation in the present, if a countries' fiscal authority sets its budget independently, the result will force the ECB in the future to increase the supply of money which in turn will pressure inflation to rise. This argument is summarized by Thomas Sargent and Neil Wallace as a response to Friedman monetarists as-

sumptions. According to the unpleasant monetary arithmetic, "(...)Friedman's list of things that monetary policy cannot permanently control may have to be expanded to include inflation"(Sargent and Wallace, 1984, p.1). In fact, their main contribution relies on the relation and interconnection of both monetary and fiscal policies.

Again, if the fiscal authority sets its budget independently from the monetary policy, the latter's natural response is to contain money supply. However, it will end up having to choose between inflation in the future or inflation in the present, since a low level of the money supply in the present is able to maintain a low-price level but it will generate an increase in the real value of the stock of government debt. "So the current price level and inflation rate depend not only on how tight money is today, but also on how tight it is for all tomorrows"(Sargent and Wallace, 1984, p.5). In that sense, the main question is to know which authority have the (political) force to impose discipline on the other. Thereby, according to Leeper (1991), one can identify two different regimes based on interactions between fiscal and monetary policies: either the monetary policy dominates fiscal policy or the other way around. This discussion contributed to a deep understanding of direct effects of fiscal policy on the price level. In a Ricardian regime⁴, it is the price level that adjusts to ensure that the current value of outstanding government debt is equal to the actual real value of future primary budget balances. This terminology is linked to the idea of Ricardian equivalence, where budget deficits do not affect income and interest rates. On the other hand, a non-Ricardian regime is the one where primary budget balances can be determined by the government without looking at the actual level of government debt. In this case, to satisfy the government intertemporal budget constraint, money and prices would then need to adjust. In contrast, a regime characterized by an active monetary policy will fulfill the intertemporal government budget constraint for every price level. For both the US and EMU economies, Canzoneri et al. (1998) and Afonso (2008), respectively, found little evidence for the Fiscal Theory of the Price level⁵, and therefore the results give support to the Ricardian fiscal regime hypothesis.

The EMU is characterized by a single currency area where the monetary policy is centralized and run by an independent institution. In its foundation is implicit a certain level of active monetary policy, and despite the fact that all individual economies have main-

⁴Woodford (1995) refer to the active monetary policy as a Ricardian regime and consequently to the active fiscal policy as a non-Ricardian regime.

⁵The fiscal theory of the price level is based on the idea that government fiscal policy affects the price level. It is an unorthodox theory, which contrasts with the usual monetary theory of the price level, where the price level is exclusively determined by supply of money.

tained control to their fiscal policies, it turned out not to be completely independent of the centralized monetary policy. Although the budgetary autonomy is absolute, in formal terms, fiscal policies in the EMU are strongly subject to rules of budgetary discipline. The EMU intergovernmental fiscal framework is based on the consensus of the Stability and Growth Pact (SGP)⁶, where each member state agrees to pursue its fiscal policy within the guidelines presented in that agreement. Since the implementation of the SGP there were introduced new features and reforms that are intended to provide actual guidelines for fiscal governance. Those reforms are implemented and explained by the ECB (see Morris et al., 2006) and (see Schuknecht et al., 2011). Each government's performance in applying those principles is continuously monitored by the so-called preventive arm, that is essentially concerned with macroeconomic projections and fiscal policy plans, which defined the Medium-Term-Objective (MTO) in terms of fiscal sustainability. This fiscal sustainability is mainly assessed via the cyclical adjusted primary balance (CAPB) evaluation and also by measuring fiscal policy performance⁷. On the other hand, when an economy exceeds the set limits, the excessive deficit procedure contained in the corrective arm will operate. In this case, correcting measures, recommendations and continued monitoring forces the fiscal policy to retake a sustainable path. Despite the fact that those rules are not country-specific, especially in the coercive arm, it is true that they contain a considerable level of flexibility. Additionally, one can say that both structural reforms and fiscal soundness complement, rather than substitute, each other.

This fiscal framework is intended to provide mechanisms that ensure a Ricardian regime, meaning that all countries fiscal policies should be in line with the centralized action of the ECB. Moreover, these mechanisms and procedures evidence how ECB is concerned about fiscal sound behavior. Such fiscal policies should be conducted in a way that ensures that countries never surpass the threshold values for the main macroeconomic aggregates regarding fiscal sustainability. Macroeconomic imbalances are highly discouraged since they can produce spillover effects on other member states. In that sense, both external imbalances and public imbalances represent one of the main concerns of the central monetary authority.

The next section will describe in a more detailed way, the macroeconomic imbalance procedure and financing programs that came as a consequence of the recent financial cri-

⁶The Stability and Growth Pact (SGP) is an agreement, among the 28 Member states of the European Union, to facilitate and maintain the stability of the Economic and Monetary Union (EMU).

⁷Sustainability of public finances is commonly evaluate via cointegration analysis between government revenue and spending (see for example (Hakkio and Rush, 1991a) or (Hakkio and Rush, 1991b)). (Afonso, 2005) used a panel data analysis to assess about that cointegration relation in EMU.

sis. Several consolidation programs were designed and applied in the EMU and produced enormous consequences at both economic and political levels. Such programs can be seen, according to the standard theory, as expansionary fiscal consolidations, or by critics, as recessionary austerity measures. In the next chapter we assess the practical case of such adjustments and we discuss the reasonings behind those different terminologies, according to the economic literature.

2.3. Fiscal consolidation episodes and the Economic Adjustment Programmes

As mentioned above, EMU has developed a set of mechanisms to guarantee that all member states remain within the threshold values for the sustainability of their public finances and also to ensure that no spillovers will be produced for the other member states. In that sense, when countries surpass those values during severe external shocks such as the one caused by the financial crisis of 2008, at the light of the standard theory, they should reduce those imbalances at any cost. In contrast to what the Keynesian theory suggests, the EMU policy strongly advises countries to conduct a series of contractionary policies in order to deal with increasing public deficits or in cases of external imbalances. Contrary, standard Keynesian theory suggests more demand-side contracyclical policies to foster economic growth and to help the economy leave a recessionary-spiral.

In this section I intend to address one question: given the diversity in the economic literature about how to conduct policy in a case of a recession in a monetary union such as the EMU, what is the best response from our policymakers? The key point to a better understanding of this question relies on the expectations of economic agents. For a fiscal consolidation to be effective, it first should be seen as a serious and sustained attempt to decrease the twin imbalances. This idea of expansionary fiscal consolidations comes from the so-called German view that was created by the German council of economic experts (see Hellwig and Neumann, 1987) and assumes the possibility of non-Keynesian effects of fiscal policy. In other words, as an opposite of what Keynesian theory predicts, a reduction in the government spending, in theory, can produce positive economic effects. Since the agents are constantly producing expectations about the future, in recession times such policies can be seen as a positive contribution to a more sustainable path for the whole economy and especially to a reduction of those imbalances. This non-Keynesian idea was to some extent present in the fiscal convergence criteria of the Maastricht Treaty.⁸ Alongside with huge twin imbalances, southern EMU countries like Portugal or Greece suffered a boom in their

⁸The Maastricht Treaty or the Treaty on the European Union was the starting point to European integration by creating the three pillars structure of the European Union and led to the creation of the Euro.

public debt to GDP ratio, which was mainly driven by the financial stress that intoxicated the markets at that time. This can be seen as another constraint to both fiscal and monetary authorities and contributes to an increasing limitation in the use of standard Keynesian policies.

An expansionary fiscal consolidation relies on the idea of the so-called non-Keynesian effects which in turn may reverse the sign of the traditional Keynesian multipliers. It is intended to produce positive effects in the economy that can come either from private consumption or investment. Nevertheless, there is no consensus in the literature about the possible existence of such expansionary events. Afonso (2010) and Giavazzi and Pagano (1990) found some evidence of non-Keynesian effects, using OLS and panel data methods, respectively. A more illustrative empirical work was developed by Afonso and Jalles (2012), differentiating between 3 types of adjustments⁹ and identifying fiscal episodes either from decrease in spending or by an increase in revenue from taxes.

Those fiscal consolidation episodes were in some sense imposed in countries like Portugal and Greece with the objectives of eliminating the imbalances and promoting structural reforms, in order to approximate those countries to the remaining EMU members in terms of product and labor market regulation¹⁰ as well as to ensure a better use of public spending. Those programs forced a strong reduction in the government deficits and corrected the external dependency that was fostered by the crisis. However, through a simple ex-post analysis one can identify a significant amount of miscalculations and mistakes governing the elaboration and implementation of such consolidation policies. A more detailed analysis of those flaws is presented in section 4.

As we saw in this section, the diversity present in the literature mostly relies on the magnitude of the fiscal multipliers. The possibility of non-Keynesian dominant effects comes from the assumption of a representative Ricardian agent that is expected to be able to smooth their consumption mainly through savings and by the access to credit. Those assumptions were shown to be wrongly made and therefore those miscalculations contributed to some extent to a significant error in predicting the future short-run impact of such consolidation. In that sense, one crucial point when analyzing such programs relies on the fiscal multipliers.

⁹Adjustment type 1:(Giavazzi and Pagano, 1996); Adjustment type 2:(Alesina and Ardagna, 1998); Adjustment type 3:(Afonso, 2010)

¹⁰For the Portuguese economy, Monteiro et al. (2017) conclude that such structural reforms imposed in Portugal had positive impacts at a firm level, and especially for the most productive ones. It was also shown that the adoption of product market reforms leads to a more resilient economy that is expected to be better off to face future adverse shocks.

Instead of the typical constant fiscal multipliers present in the literature at that time, recent work has indicated that the multipliers are relatively higher in a crisis environment. (see Blanchard and Leigh, 2013) or (see Afonso et al., 2012).

We are now able to explore the case of the Greek crisis as well as the fiscal consolidation programs that were imposed to Greece by the IMF, ECB and European Commission. I analyze the Greek crisis and its adjustment programs in the next section.

2.4. The Greek crisis, financial stress and structural reforms

As mentioned earlier, the economic adjustment program imposed in Greece represented a fiscal consolidation episode that had two main objectives: First, it was intended to correct and reduce the imbalances accumulated in the previous years, both the government deficit and the external deficit. In addition, the economic adjustment programs intended to pursue a series of structural reforms in order to promote convergence in the EMU and, in light of the standard theory, to restore growth and reduce unemployment. In fact, when the EMU was created in 1999, the prevailing view was that external imbalances among EMU countries should not be a significant concern in a monetary union (Blanchard and Giavazzi, 2002).

¹¹ Those imbalances were interpreted as a natural cause of an integration process among economies in different stages of development. ¹²

The idea was that those countries with a relatively low per-capita income will attract capital inflows mostly because of the high productivity growth and therefore high rates of return on capital. Consequently, Greece external deficit increased from 11.5 percent of GDP in 2001 to 18 percent in 2008 (Provopoulos, 2013). Such experience shows the consequences of a fixed-exchange-rate regime that did not promote convergence and instead led economies like Greece to suffer from the integration process.

Despite the continuous increase in Greece imbalances, which was a sign of a competitiveness problem, capital inflows continued to occur until 2009, contributing to money and credit growth, which lead to a deterioration of Greece external competitiveness. At the same time, countries like Germany maintained an average external surplus of 4.4 percent during the same period of 2001-2009 (Matsaganis, 2011). The relative opposite flows of money and credit lead to a significant appreciation of Greece's real exchange rate when comparing to

¹¹However, after the crisis period it became evident that as current account balances reflect underlying domestic distortions, they should be reduced (Blanchard and Milesi-Ferretti, 2012).

¹²Afonso and Silva (2017) studied the determinants of the cyclical and noncyclical components of the external balance for Portugal during the crisis and conclude that especially the noncyclical component was negatively explained by the financial integration of the eurozone. Moreover, it was showed that external factors had more impact for the Portuguese external balance cyclical when compared with Germany.

Germany's. However, since Germany and Greece agreed to share the same currency, that appreciation was totally due to movements in relative prices. The consequent increase in Greece inflation contributed to a decrease in the real interest rate, which opened the space for more and more borrowing and to a loss of competitiveness, especially in the non-traded sector, as the government continued to increase their spending. The stock of government debt almost double between 2001 and 2009 and the share of Greek sovereign debt held by non-residents increased from 43.4 percent to 78.7 percent (Gibson et al., 2014). This process represents a deterioration in the fundamentals of the Greek economy that were not correctly expressed in the interest rates paid by the Greek government on sovereign debt.

In fact, during the period 2001-2009, investors did not draw a distinction between the sovereign debt of Greece and Germany. Contrary, investors pushed interest rates on Greece sovereigns down close to the Germany levels. This misperception of the risk was empirically assessed and shows the existence of contagion effects (Aït-Sahalia et al., 2014). Moreover, the aftermath of the crisis was, especially for the southern EMU economies, a period of high financial stress that contributed largely to the bailout episode in Greece. Such financial stress produced strong negative effects on output growth for the EMU economies (Afonso et al., 2011).

One of the major costs for Greece when entering in the eurozone was the significant lack of flexibility to deal with asymmetric shocks. In that sense, real effective exchange rate adjustment mechanisms are mainly due to price adjustments (prices and wages), that is through internal devaluations. As it was evidenced in Greece, such internal devaluations are highly costly and produce, as an external devaluation, huge consequences in economic and social terms. Moreover, that devaluation is more difficult to achieve in a price stability regime.

Additionally, a monetary union like the EMU is expected to increase the trade integration among the members of the eurozone. This idea comes essentially from the elimination of transaction costs and by the decrease in exchange-rate uncertainty, which was expected to contribute to a reduction in EMU countries asymmetries. However, this trade integration process led to an increase in the concentration of industrial activities. This contributed to a reduction in production costs in those countries that experienced a clustering of such industrial activities. These agglomeration effects led to an increase in the production concentration in favor of the north economies (Pisani-Ferry, 2013).

However, it is important to state that such internal price adjustment (devaluation) costs are expected to be a decreasing function of product and labor markets flexibility. As countries

can no longer pursue continuous and persistent changes in their currency valuation in order to surpass booms and busts, according to the standard theory, they should conduct a series of structural reforms in order to facilitate those internal adjustments when they are needed. In fact, one of the fundamentals that made the southern EMU countries adjustment so costly is due to the fact that those economies persist in having considerable rigid markets, both labor and financial markets, that contributed to a costlier adjustment when they were needed.

Especially in the Greek economy, such adjustment was so costly in terms of production lost, unemployment and social aspects, that it had no counterpart in modern history and therefore was characterized by Krugman as "the mother of all asymmetric shocks" (p.4 Krugman, 2013). Therefore, it is important to underline some characteristics of the Greek economy, that contributed to such a costly adjustment.

The Greek economy is characterized by a relatively low female participation rate in the labor market, and also by a low part-time work. The level of informal family companies is relatively high and therefore the Greek economy incorporates a substantial share of self-employed workers. The difference between the minimum wage and the median wage is relatively low when comparing with EMU countries, which can produce labor market inefficiency, especially when there is a poor social insurance system, as it is the case of Greece. Moreover, Greece also has a strict employment protection that produces low rates of worker reallocation (Meghir et al., 2017). The tax system is relatively complex leading to high levels of fiscal avoidance and also contributes to low productivity rates and persistent unemployment. The Greek labor market prior to the crisis was characterized by a strict employment protection, limit working time flexibility, multi-layer bargaining systems and also by a high tax wedge (Papageorgiou et al., 2015). Additionally, the public sector pays 20-35 percent more than the private sector, with no performance evaluation (Meghir et al., 2017). In that sense, labor market reforms intended to deal with the overregulation that can discourage job creation and increase labor costs. Those same regulations subsidize the informal sector, that is mainly focused on domestic low-quality services and tourism. Thus, the system encourages the formation of non-exporting low growth type of employment.

As for tax and welfare systems, recent structural reforms are intended to simplify and redesign the tax system as a whole, introducing different welfare programs and providing support for those workers who persist in not participate in the formal labor market. There was an evident need to introduce progressivity in the tax system as well as to correct some imperfections in the system. The Greek tax system suffers from compliance problems and from an enormous degree of complexity Litina et al. (2013). There is also a need to introduce

welfare system to address both in-work and out of work poverty.¹³

The Greek product market is composed of a very small size of firms in many sectors and high concentration in others, and it overall produces a low effective entry in the market that comes from a very complex tax system and a dysfunctional public administration (Meghir et al., 2017). Another interesting aspect of the Greek product market is the substantial low degree of openness of the economy. In fact, the sum of imports and exports as a percentage of GDP remains the smallest in the Eurozone, meaning that Greece remains a very closed economy. Additionally, Greek institutions display a weak performance in the global competitive rankings, which contribute to low efficiency in general terms.

In sum, in this section we exposed some of the most important characteristics of the Greek economy, especially related to, product market, tax and welfare system and also public administration. After more than 20 years from the Eurozone inception, Greek economy remains relatively stuck in the same structural issues that were supposed to be surpassed before the entrance in the eurozone. Those problems rely on the complexity of the tax system, the strong rigidities in the labor market and are also related to the efficiency of the public sector as well as from all general institutions. These concerns must be seen as main causes of such a costly and slow adjustment, that was somehow fostered by the economic adjustment programs imposed by the troika. One can also conclude that those same characteristics may be in the heart of a series of mistakes and miscalculations that are presented in those documents.

Especially in the case of unemployment, the Greece experience proved that the lack of real convergence within a monetary union like the EMU can produce enormous unemployment levels that were somehow impossible to predict by our economic institutions. In fact, the unemployment rate in Greece peaked up to 27.5 percent in 2013, which was clearly underpredicted in the fiscal consolidation programs.

A simple ex-post assessment of those errors is shown in table (2.1). The values for the Troika Unemployment forecast correspond to the first and second economic adjustment programs (see Comission, 2010) and (see Comission, 2012). The actual values for the unemployment rate were taken from OECD database.

These unemployment mispredictions are the core of my main empirical assessment. Be-

¹³Meghir et al. (2017) studied a possible reform of the tax system by comparing the results from three different types of system: VAT based system, Income tax based system and also by a Flat tax system. Their main conclusion is that a VAT based system while being the least redistributive has the potential to provide a simple alternative that will improve their strength as the formal sector of the economy grows.

	2010	2011	2012	2013	2014
Unemployment forecast Troika1	12	14.7	15.2	14.8	NA
Unemployment forecast Troika2	11.7	15.9	17.9	17.8	16.7
Actual Unemployment	12.7	17.9	24.4	27.5	26.5

Table 2.1. **Unemployment Forecast Troika vs Actuals**

fore that, section 4 provides a better understanding on how central banks and international economic institutions commonly display their forecasts.

3. Literature Review

To explore the unemployment errors by the Troika in the economic adjustment programs imposed in several euro area peripheral countries like Portugal and Greece, I take as my main reference, recent work published by both my supervisors. (see Lopes and do Amaral, 2017) and (see Amaral and Lopes, 2016). As mentioned before, those fiscal consolidation programs were to some extent based on the reduction of both public and external imbalances as well as to conduct a series of structural reforms. It is now evident that such an improvement in those countries imbalances leads to enormous increases in unemployment.

Therefore, one can stress the possibility of existing a considerable relationship between the value of those (im)balances and the unemployment rate. In that vein, the application of the so-called Leontief Input-Output model to the Portuguese economy raised the possibility of a better assessment of the real impact on the unemployment rate of such a shock in the external balance and on the public balance, respectively. Those empirical assessments are based on the link between the twin imbalances and the unemployment rate, assuming some crucial technological and final demand relationships that are provided by the Input-Output modeling of an economy. Assuming a relatively unchanged productive structure, one can evaluate through a static comparative exercise, how does imbalances co-move with the unemployment rate. In fact, this methodology is not able to produce explicit forecasts for those variables but instead, it is powerful in trace paths for the variables present in the trade-off equation by assuming different scenarios in the other variable(s). In that sense, assuming a relatively stable production structure, the relations present in this way of modeling an economy can be seen as appropriate instruments in evaluating short-term shocks like the ones produced in the economic adjustment programs, although they are not very useful for normal macroeconomic and financial forecasts.

The Input-Output model was initially used by Francois Quesnay, that had developed an

initial version of this methodology called *Tableau économique*. Afterwards, Léon Walras's work on general equilibrium theory generalized this concept to a complete tool for inter-sectoral analysis and it was the first to use a matrix representation of a national economy.

Amaral and Lopes (2016) conducted an inter-sectoral analysis for the Portuguese adjustment program, using the unemployment/external balance trade-off. Their results evidence that, if the (sectoral) structure of the economy and the predicted trade deficit had been taken into account, unemployment prediction would be more accurate. Additionally, it concludes that for each additional unit value in domestic final demand (exports) of the Portuguese economy, imports raise by 0.26 (0.35). By another hand, each 1 million euros increase in demand (exports) has the potential to create 19 (20) new jobs in the Portuguese economy. They also conclude that for a complete elimination of the external imbalances in one year, the Portuguese economy will tend to accumulate an unemployment rate of 23 percent.

Similarly, using the unemployment/budget balance trade-off, they conclude that a complete elimination of the budget deficit in one year will produce an unemployment of 17.2 percent. They also conclude that such policies were indeed self-defeating to the Portuguese economy and the main negative impacts are threefold: a significant increase in unemployment, a disproportionate reduction in social transfers and a huge neutral budget balance (Lopes and do Amaral, 2017). Additionally, it was concluded that too much consolidation in one year makes more difficult the next year's consolidation by a 21.6 percent increase in next year's budget deficit (Lopes and do Amaral, 2017).

In sum, the overall main results of their research evidence the usefulness of the Leontief Input-Output model application for assessing these types of adjustment programmes and it can be easily replicated for the other cases of Greece, Ireland and Cyprus (Amaral and Lopes, 2016). At that light, my main motivation is to replicate their work for the Greek economy.

4. Empirical Assessment

The art of predicting future outcomes is predominantly attributed to the economic and financial sectors. During the last decade, different fields of knowledge evolved to generate different ways to predict the future. Despite the continuous effort made by researchers and policymakers to search and conduct better policies and to increase the ability to predict the future, unexpected events like the 2008 crisis continue to occur. In fact, the recent financial crisis appeared as what Nassim Taleb called "Black Swan"¹ into financial markets,

¹Taleb (2007) suggests the theory of black swan events, which is a metaphor that describes an event that comes as a surprise, has a major effect and is often inappropriately rationalized. The term is based on an

because neither researchers or policymakers predicted the crisis and the financial markets did not show any sign of fearing a collapse. The continuous use of computation and machine learning increase the strength of the new computational models. Those methodologies differ in their nature and also in their purpose and one can differentiate them according to Domingos (2015).

In what can be attributed to the economic and financial sector, one should underline both the Dynamic Stochastic General Equilibrium (DSGE) and Vector Autoregression (VAR) models that represent two major families of macroeconomic models used for prediction in central banks. These families differ in the ways in which they attempt to use general equilibrium theory as a source of information in formulating the model and conducting statistical inference and forecast. The first type (DSGE) are typically specified with inputs directly drawn from economic theory and are widely used by many central banks to proceed forecasts and historical analysis. In contrast, Policy-oriented macroeconomic forecasting is often based on time series and panel data models that are more agnostic with respect to general equilibrium theory when compared with more structural approaches as the Input-Output Leontief model. Among these models, the most widely used are the Vector Autoregression (VAR) models introduced by (Sims, 1980) (see Brooks, 2014). It is reasonable to understand statistical and econometric models as powerful techniques in what forecast and inference concerns. As mentioned before, central banks and international policymaking institutions have not only the responsibility to produce good quality figures for the current state of the economies, but they are also expected to predict, in some way, all future short-term economic path for the main economic variables.

In that sense, forecasts of unemployment rate have been at the center of many recent policy discussions. Recent research evidences the need to improve existing methods as well as to find new tools to assess the unemployment rate behavior. Tasci et al. (2015) compared the forecast from four different methods (Federal Reserve Bank of Philadelphia's Survey of Professional forecasts; Federal Reserve Board's Greenbook; VAR approach and also a FLOW-UC model) and conclude that none of them performed satisfactorily during the great recession and the following years. Moreover, Dumičić et al. (2015) developed a similar exercise for the EMU countries using a time series approach based on smoothing methods. It found the Holt's method and Holt-Winters as the most accurate methods to explain unemployment rate behavior in Greece. Similarly, a joint work of ECB and the Federal Reserve

ancient saying which presumed black swans did not exist, but the saying was rewritten after black swans were discovered in the wild.

Bank of New York evidences that many opportunities to improve the forecast performance were missed during the economic adjustment programs, and it concludes that high-frequency financial data could have been used more efficiently (Alessi et al., 2014). Moreover, Cabanillas et al. (2012) conclude that despite lack of evidence of a bias in the European Commission forecasts, meaning that no systematic over or underestimation was detected, there were serial correlation issues, especially in unemployment and current account forecasts.

Here, our objective is to assess whether the unemployment errors present in the economic adjustment programs for Greece could have been more accurate. For that, I chose to apply two different methodologies. First, within the econometric framework, I chose to run a VAR model, more specifically a VEC model, to study the relationship between a group of variables in a way that it could produce explicit forecasts. It is important to underline that this work consists in a pure out-of-sample time series approach and so both robustness and statistical inference were done and the common econometric test was performed. However, the main objective is to forecast the short-run trajectory for the unemployment rate during the first fiscal consolidation program.

Secondly, following the work by Amaral and Lopes (2016), I decided to build an inter-sectoral analysis, through the so-called Leontief Input-Output model. The Input-Output model comes from the Walras theory and it was formalized by Miller and Blair (2009). This model has been applied in inter-sectoral and regional studies, environmental economics, and it is a very powerful tool to a more detailed and structural analysis of an economy. In this case, we used the most recent dataset available for the Greek economy with the objective of studying the trade-off relationship between unemployment rate and the external balance, and then trace scenarios for the economic adjustment programs period.

4.1. Econometric Analysis

With both the Greek crisis and the EMU fiscal consolidation programs exposed, and after a brief exhibition of some methodologies used mainly in Central Banks to forecast macroeconomic variables, this chapter discusses the first methodology used, that consists in an econometric regression for which the empirical results will be exposed afterward. To conclude about the effectiveness of the economic adjustment programs designed by the ECB, IMF and by the European Commission for Greece, the first methodology used requires the estimation of an econometric regression with some relevant macroeconomic variables. The assessment is based on the macroeconomic relationship used by Amaral and Lopes (2016), in a sense that our analysis starts from the same unemployment/external balance trade-off rela-

tionship. In a first step we should conclude about the validation of that trade-off in statistical terms, and then we move to the model construction oriented to the empirical predictions.

Having in mind the objective to forecast the unemployment rate for Greece, there were introduced to the estimation three more variables in order to capture more information directly linked from the economy. So, the main objective is to conduct a model with the variables chosen in the regression and then forecast the path of those variables for the economic adjustment program period of time, especially unemployment. Although the model is expected to produce a reasonable prediction for all the endogenous variables, the focus is on the external balance and the unemployment rate. When modeling for macroeconomic variables, researchers and analysts used either time-series or panel data, and their main purpose is to forecast its future behavior vis-à-vis from what was observed. It is also possible to predict and infer about the short/long run dynamics of the variables when facing an exogenous shock. In this work, I look to apply standard econometric methods for time-series modeling, from a multivariate point of view. In that sense, it was chosen to run a Vector Autoregression (VAR) model, more specifically a Vector Error Correcting (VEC) model, since there was expectedly found cointegrations between the variables.

4.1.1. Data description

The core database at hand comprehends data containing several economic variables for Greece, especially the two variables present in the trade-off mentioned before, namely the unemployment rate (U) and the external balance (EXB). In order to study that relationship, there were introduced to the model three more variables to capture different economic dynamics. Alongside with U and EXB, it was decided to add the real gross domestic product (RGDP), the real effective exchange rate (REER) and the price deflator (P). We have considered quarterly data, starting from 1995Q1 until 2010Q2, the time when the economic adjustment program was signed. Since it is intended to replicate the results presented in the economic adjustment programs, we decided to plot the complete series for Greece to compare our result not only with the Troika's results but also with actuals.

The data was gathered at ISEG institution facilities, using both DataStream and Bloomberg terminals. RGDP, REER and P were transformed by the base of the first observation date. All series were previously seasonally adjusted in the source, in this case by the OECD. The first step of a pertinent analysis is computing the basic descriptive statistics and graphical representations for all series. In that sense, the common descriptive statistics of the data are presented in table (A.1) in the Appendix. Additional details and information about the series are presented below in table (4.1).

Variable	Description	Seasonal Adj.	Unit	Source
U	Unemployment, % labour force	Yes	Percentage	OECD
EXB	Net Trade of Goods and Services, Current Prices, % GDP	Yes	Percentage	OECD
RGDP	Real Gross Domestic Product, Millions of Euros	Yes	1995Q1=100	OECD
REER	Real Effective Exchange rate, (Constant Trade Weights)	Yes	1995Q1=100	OECD
P	Implicit Price Deflator	Yes	1995Q1=100	OECD

Table 4.1. Data Details

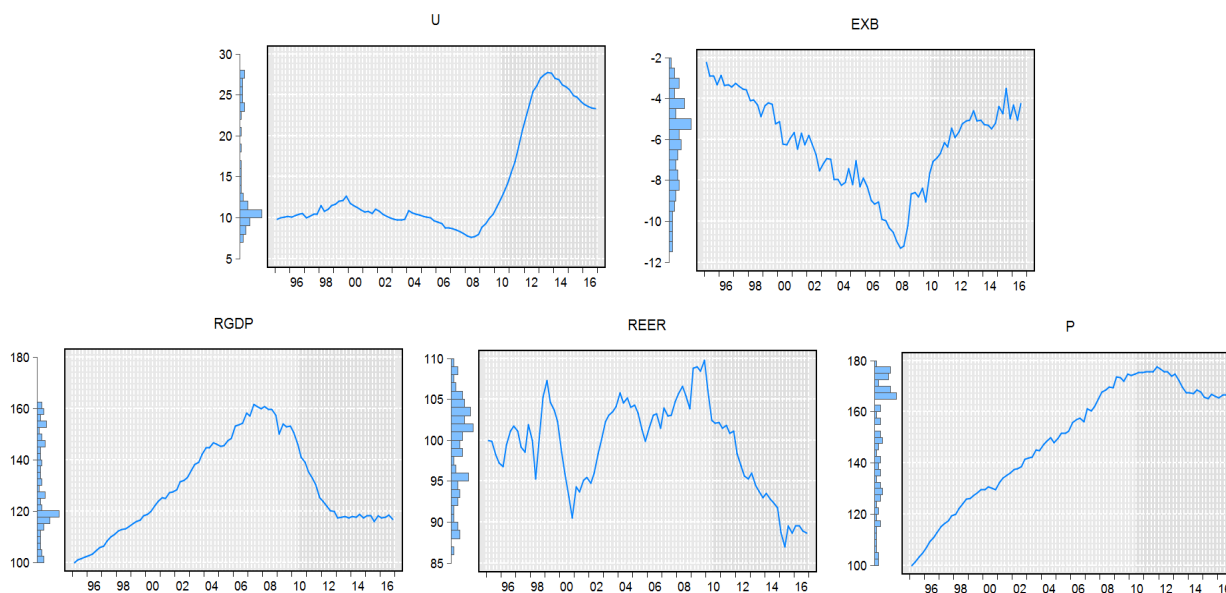


Figure 4.1: Graphical Representations of the Series

By looking at figure (4.1) one can draw 5 ideas: The unemployment rate in Greece show a clear structural break in 2008, that was mainly caused by the financial frictions in the markets at that time, as a result of the global financial crisis that started overseas. Until that period, unemployment in Greece experienced a relatively flat behavior, with small deviations over the trend during more than 13 years. However, it is also legitim to say that the unemployment rate was still considered high when compared with the other Eurozone members. From that point in 2008/2009, unemployment explodes to unsustainable levels, never faced in the Eurozone, that reach to a peak of 27.5 percent of the working population in 2013. Afterwards, the unemployment rate declined and face a downward tendency, mainly driven by external factors like mass emigration, informal economy, discourage workers and others. When looking at that figure, one may forget about the typical NAIU² models,

²NAIU models or non-accelerating inflation rate of unemployment refers to the interconnection between the inflation rate and the unemployment rate. It basically refers to a level of unemployment below which inflation tends to rise. It is based on the Milton Friedman's concept of natural rate of unemployment.

and start to address conclusions about a possible maximum level of unemployment that an economy can support.

On the other hand, the external balance path for the Greek economy clearly shows a strong deterioration during the same first 13 years, meaning that from 1995 to 2008, the Greek economy increased its external dependency at a macroeconomic level. The external balance reached a negative value of 13.5 percent of current GDP, which is again a sign of lack of convergence when looking at the other Eurozone members. After the crisis point in time, Greece started to improve their commercial and payments balances, at the same time that government bond yields started to increase dramatically. If, by one hand, Greece was forced to reduce its external deficit, the increase in interest payments caused a bailout in the public sector that led to the international intervention from IMF, ECB and EC, forcing both public and external deficits down to more reasonable levels, as we can see in the figure.

The RGDP path shows clearly a time-varying behavior. First, until 2007 it faced an enormous boom, mainly driven by unsustainable measures that led to the Great Recession period. After 2012, there was a dramatic decrease in RGDP, that amount for almost 1/3 of the productive capacity that was lost. Afterwards, Greece as the other Eurozone countries faced the period called Great Depression, with relatively no fluctuations in the GDP levels.

REER is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator. An increase in REER implies that exports become more expensive and imports become cheaper. Therefore, an increase indicates a loss in trade competitiveness. In that sense, the REER can be used to measure the equilibrium value of a country's currency.³ By looking at that figure (4.1), one can grossly measure the immediate impact in Greek trade competitiveness of that policy. Since the entry in the Eurozone, that happened in 2001, the Greek economy faced an increase in their trade terms, indicating that the Euro contributed to a loss in competitiveness and trade position for Greece, either through the imports channel and also by the exports. The Euro fostered the level of Greek imports by making them cheaper in relative terms. Since Greek exports are based on services and low-valued goods, such an appreciation in the REER hampers the level of exports. This idea is summarized in the EXB chart. After the crisis, EXB and REER jumped in opposite directions. The significant improvement of Greek trade competitiveness measures the huge internal adjustment in the post-crisis period.

Finally, the price deflator confirms the existence of a continuous relatively low inflation

³The change from Dracma to Euro and the previous short-term adjustment is clear in the REER chart.

each year, that is in the heart of the EMU and it is considered the principal mandate of the ECB. However, by looking at the graphical representations, one can evidence the successive increase in inflation in the pre-crisis period, as mentioned before in this work.

At this point, there were shed some light into the fluctuations of the variables and their behavior as well as it was possible to conclude and identify some intuition for the data. To solidify these graphical intuitions, next step consists in conducting the standard stationarity tests, to conclude about the existence or not of stationarity within the data.

Engle and Granger (1987) raised the possibility that two or more integrated, nonstationary time series might be cointegrated so that some linear combination of these series could be stationary even though each series is not. If two series are both integrated of order 1 $I(1)$, we could model their relationship by taking first differences of each series and including the differences in a VAR or a structural model. Moreover, Stock and Watson (1988) also refer to the cointegration process and conclude that cointegrated variables share the same stochastic trends, which provides a valid option to study cointegration relationships. If two or more $I(1)$ variables are shown to be cointegrated, then they must follow an equilibrium long-run relationship, although they may diverge in the short-run.

Thus, for testing the degree of integration it was performed three different unit root tests to conclude about stationarity or not in the series and the respective degree of integration. The tests chosen were the Augmented Dickey-Fuller (ADF)⁴, Phillips Peron (PP)⁵ and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS)⁶. The ADF, PP and KPSS tests for non-stationarity, i.e. it tests if the series contains a unit root, and this hypothesis is only rejected if there is strong evidence against it.

Both tests in levels and first differences were performed and the results are presented in table (A.2) in the Appendix. The tests evidence that all variables tend not to be stationary in levels. However, when taking the first differences the results are significantly different and almost all indicate the presence of stationarity, and consequently, the series follows an $I(1)$ process. It is important to state that these unit root stationarity tests are very sensitive to shocks in data, what lead many authors to introduce some kind of structural break in the series, mainly adding one or more dummy variables. That procedure is done in order to

⁴The augmented Dickey-Fuller test (ADF) tests the null hypothesis that a unit root is present in a time series sample.

⁵The Phillips–Perron test is a unit root test and it is used in time series analysis to test the null hypothesis that a time series is integrated of order 1. It builds on the Dickey-Fuller test of the null hypothesis.

⁶Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests are used for testing a null hypothesis that an observable time series is stationary around a deterministic trend against the alternative of a unit root.

introduce a discretionary information such as the crisis event in 2008. Another important aspect that is important to highlight is the need for a relatively high number of observations in order to accurately evaluate about stationarity in the series. However, since we are using the longest figures for macroeconomic variables in OECD for Greece, which starts in 1995Q1, we decided not to transform it in a higher frequency data and therefore use them as they appear in the OECD database, mainly for transparency purposes.

4.1.2. The multivariate VEC specification

Vector autoregression (VAR) was first introduced by Sims (1980) and it has been mostly used as a tool for researchers to characterize the joint dynamic behavior of a collection of variables without having to stress into the structural dynamics of an economy. The vector autoregression (VAR) is most commonly used for forecasting systems of multivariate time series and for analyzing the dynamic impact of shocks on the endogenous variables. The VAR approach sidesteps the need for structural modeling by using every endogenous variable in the system as a function of the lagged values of all the endogenous variables. So, the simple mathematical representation of a VAR is:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-p} + Bx_t + e_t \quad (4.1)$$

Where y_t is a k vector of endogenous variables, x_t is a vector of exogenous variables, and A_1, A_2, \dots, A_p and B are matrices of coefficients to be estimated. e_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

A vector error correction (VEC) model is a restricted VAR designed for use with non-stationary series that are known to be cointegrated. The VEC has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. In other words, the main difference between the VAR and the VECM models relies on the error correction term since any deviations from the long-run equilibrium are corrected gradually through a series of partial short-run adjustments. Granger and Engel in their celebrated work (see Engle and Granger, 1987) raised the possibility that two or more integrated, nonstationary time series might be cointegrated so that some linear combination of these series could be stationary even though each series is not. If two series are both integrated of order 1, $I(1)$, we could model their relationship by taking first differences of each series and including the differences in a VAR or a structural model. However, this approach

would be suboptimal if it was determined that these series are indeed cointegrated. In that sense, the VAR would only express the short run responses to these series to innovations in each series. This implies that the simple regression in first differences is misspecified. If the series are cointegrated, they move together in the long run. The idea behind the concept of cointegration is that although multivariate time series is integrated, certain linear transformations of the time series may be stationary.

A VAR in first differences, although properly specified in terms of covariance-stationary series, will not capture those long-run tendencies. Accordingly, the VAR concept may be extended to the Vector Error Correction model, or VECM, when there is evidence of cointegration among two or more series. Equivalently, any VAR model can be rewritten as a VEC model. Using some algebra, it is possible to rewrite (4.1) as:

$$y_t = v + A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-p} + e_t \quad (4.2)$$

Where y_t is a $k \times 1$ vector of variables, v is a $k \times 1$ vector of parameters, A_1, \dots, A_p are $k \times k$ matrices of parameters, and e_t is a $k \times 1$ vector of disturbances. e_t has mean zero, covariance matrix σ , and is independent and identically distributed over time.

Additionally, when looking at differences, any VAR(p) can also be rewritten as a VEC model. Using some algebra, it is then possible to rewrite (4.2) as:

$$\Delta y_t = v + \prod y_{t-1} + \sum_{t=1}^{p-1} \Gamma_t \Delta y_{t-1} + e_t \quad (4.3)$$

Where $\prod = \sum_{j=1}^{j=p} A_j - I_k$ and $\Gamma_i = -\sum_{j=i+1}^{j=p} A_j$. The v and the e_t are identical in both (4.1) and (4.2). Additionally, if the variables y_t are integrated of order 1, then the matrix \prod in (4.1) has rank $\leq \gamma < 0$, where γ is the number of linearly independent cointegrating vectors. If the cointegrating tests evidence for cointegration among the variables, one should not run a VAR because $0 < \gamma < 0$ according to (4.2) it is possible to show that a VAR in first differences is misspecified because it omits $\prod y_{t-1}$, the lagged level term.

4.1.3. Model construction

This subsection intends to describe the construction and estimation of the final VEC model, according to Toda and Yamamoto (1995) procedure. After the previous data evaluation, it was concluded that all five variables are not stationary when looking in levels, but there is strong evidence for those variables to follow an I(1) process, meaning that all variables

are stationary in first differences. This conclusion lead, in the end to the use of the VEC specification.

The next step evolves a creation of a VAR model for the variables in levels. After that, the information criteria (AIC⁷, SIC⁸, HQ⁹) states that 2 lags are the optimal lag number for the variables. The lag length criteria test performed are shown in figure (A.1) in Appendix. Thus, caution tells us to analyze careful the residuals and to check for the presence of problems related to serial correlation between the residuals, normality and heteroskedasticity. After stressing the residuals issue, it was found that the model is well specified only when the lag interval is increased to 4. At this stage knowing that the variables are I(1) and that the model is well specified with 4 lags, one should analyze and conclude about the presence of cointegration in the series using Johansen's methodology based on the VAR(4) in levels to obtain a reliable result. The results are present in figure (A.2a) and (A.2b) in the Appendix and lead to the conclusion of the presence of 1 cointegration equation, considering both AIC information and SIC information. The conclusion about the cointegration was expected in a sense that all series represent different generic macroeconomic variables that are expected to co-move in the long-run. Additionally, the use of the external balance/unemployment trade-off as the main core of our analysis was again another indicator for a possible existence of cointegration.

After that, one should cross-check this result asymptotically using Granger non-causality test. The results are presented in figure (A.3a) and (A.3b) in the Appendix and as one can see, both the unemployment rate and the external balance do not reject the hypothesis of causality. However, the remaining three variables do not evidence to grange cause mutually. It is important to state that this result is very sensitive to data changes and could be outdated with the transformation of our data into a higher frequency dataset. For a more independent and transparent work, it was chosen to use the series as they appear in the OECD database.

Since the series follow an I(1) process and have at least one cointegration vector that was checked by Johansen test, Toda and Yamamoto (1995) procedure tell us that the final model should be a VECM with the variables in levels. Our final model is then a VEC model with 4 lags and 1 cointegration equation, using no trend intercept.

⁷The Akaike information criterion (AIC) is an estimator of the relative quality of statistical models for a given set of data. AIC does not provide a test of a model in the sense of testing a null hypothesis and it tells nothing about the absolute quality of a model, only the quality relative to other models.

⁸The Schwarz criterion (SIC) or Bayesian information criterion is a criterion for model selection among a finite set of models. It is based on the likelihood function and it is closely related to the AIC criteria.

⁹The Hannan–Quinn information criterion (HQC) is a criterion for model selection. It is an alternative to Akaike information criterion (AIC) and Bayesian information criterion (BIC).

The serial correlations, normality and heteroskedasticity test performed to the final VECM are available to check in figures (A.4a), (A.4b) and (A.5a) and as one can see the model does not reject the null hypothesis for the tests, which lead to the conclusion that the model is well-specified and stable, as (A.4b) suggests. The final estimation is presented in figures (A.7a) and (A.7b) in the Appendix.

With the final VEC model correctly build, next we will describe the empirical assessment made for Greece during the first economic adjustment program period of time. For that purpose, the estimation is intended to replicate the European Commission information at the time the first program was signed in May 2010. The analysis will then use all information from the five variables choose from 1995Q1 to 2010Q2. As it was mentioned before, this was the way founded to approximate this work with the exercise made by the European Commission at that time. The main objective of this econometric approach is to evaluate the capacity of a relatively simple out of sample model to produce reasonable results, and therefore to test the ability of the model to capture such an exogenous shock as the one brought by the crisis in 2008 and consequently during the fiscal consolidation years. In that sense, first I will analyze the cointegration equation in order to infer about the validation or not of the external balance/unemployment trade-off. After that, a more practical exercise was developed using both impulse response functions (IRF) and variance decomposition techniques to study how variables co-move in the short-run. In the end, it is expected for the model to produce a path for all the endogenous variables for the economic adjustment program period of time.

4.1.4. Cointegration equation and VEC coefficients

As mentioned before in this work, the presence of cointegration represents an equilibrium phenomenon among different variables in the model. In other words, it means that the variables tend to co-move in the long-run although it may exist some short-run adjustment dynamics. Following the Johansen cointegration test, this cointegration relationship can be express as follows:

$$U = 0.480499EXB - 0.136006RGDP + 0.191983REER + 0.105537P \quad (4.4)$$

As (Brooks, 2014) suggests, the cointegration equation was estimated through the Johansen test and it's graphical representation is shown below in figure (4.2).

As one can see there is strong evidence for the existence of cointegration, especially between the unemployment rate (U) and the external balance (EXB). By other hands, it is also possible to identify a clear positive relationship between those two variables, which

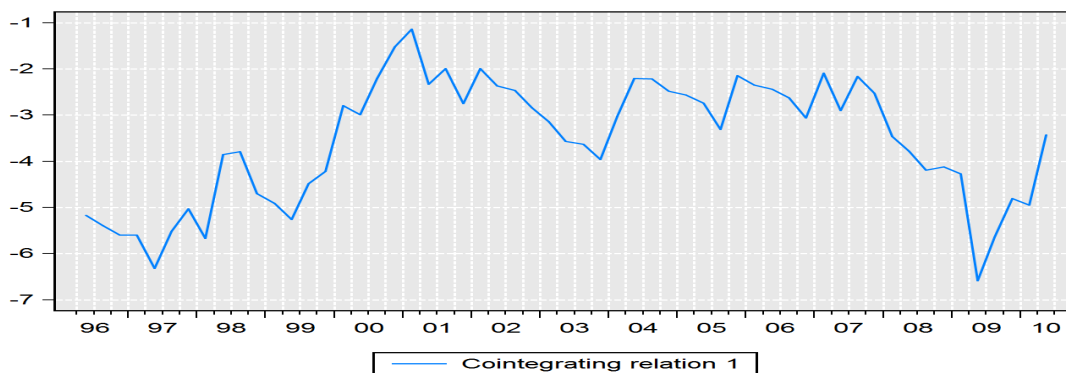


Figure 4.2: **Johansen Cointegration Graph**

validates statistically, the existence of the so-called unemployment/external balance trade-off. As Amaral and Lopes (2016) suggests, that relationship is positive, meaning that in the long-run the two variables co-move in the same direction. In fact, according to our cointegration equation, *ceteris paribus*, an increase of 1 p.p. in EXB will generate an average increase in the unemployment rate of about 0.480499 p.p.. Additionally, it is possible to identify a change in that cointegration condition with time.

After analyzing figure (4.2), it is easy to identify a few shocks in the figure. The first one is in 2001 and clearly represents the entering in the Eurozone that happened for Greece in 2001. The convergence period to the Euro represented a reduction in the magnitude of that trade-off relationship and can be interpreted as a result of a relatively flat unemployment rate and a continuous increase in the external dependence. Secondly, and after a period of relatively constant cointegration relation, the Greek economy faced the international financial crisis of 2008, with a huge boom in unemployment rate while it started to be pressured to reduce its external accounts. This event is clearly identifiable in the figure above with a dramatic increase in the magnitude of the relationship until the Great Recession and then followed by a strong adjustment in the following years, that was mainly driven by the international institutions that conduct the fiscal consolidation programs.

Afterwards, it is also possible to analyze and conclude about the remaining variables. As one can see, an increase of 1 p.p. in the Real GDP will produce a decrease in the actual unemployment by 0.136006 p.p., which goes in line with the economic theory and can be easily considered a stylized fact about modern economies. Additionally, both REER and P evidence a positive relationship alongside with the unemployment rate. An increase of 1 p.p. in REER and P will produce an increase of 0.19983 p.p. and 0.105537 in the unemployment rate, respectively.

4.1.5. Variance Decomposition

An interesting way of analyzing the results from a VEC model is to compute the variance decomposition. It is a simple way of making inference about the results, and more than identifying the space, it helps us to stress the behavior of our endogenous variables. It was used a variance decomposition of our two main economic variables: unemployment and external balance, and under the Cholesky decomposition, it was chosen to order the variables according to their degree of endogeneity presented in the Granger test. The forecast error variance decomposition measures the relative importance of each variable in explaining the variance of another variable, in this case unemployment and external balance.

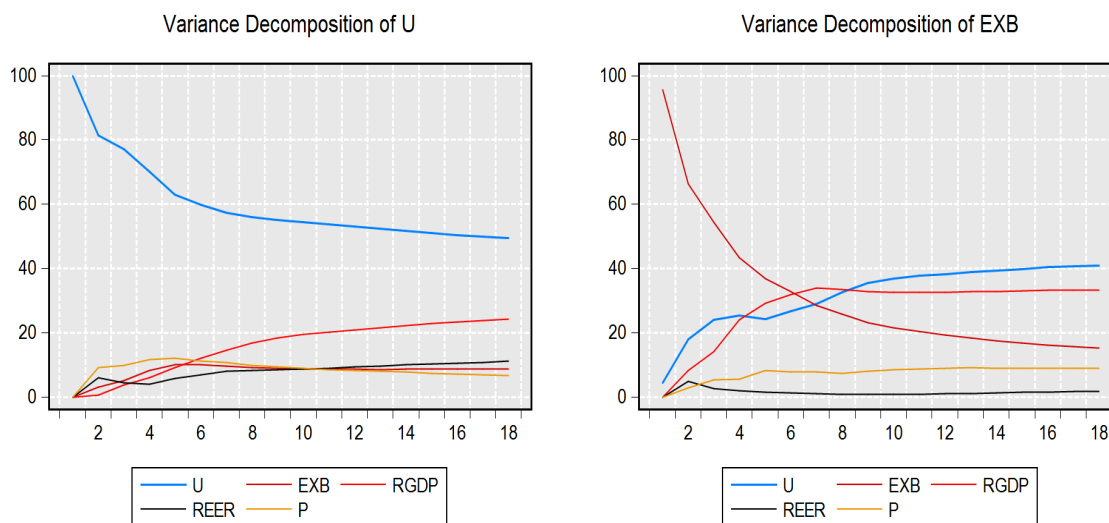


Figure 4.3: **Variance Decomposition Graph**

Through the analysis of figure (4.3) it is possible to extract some conclusions. After 18 iterations, unemployment is the variable that explains the most of the external balance variation, converging to a value of around 40 percent, which is explained by the high positive relationship and also by the causality we have explained before. Likewise, the external balance also figures to have a relatively important impact, since it converges to an explanatory factor of around 15 percent, again after 18 iterations. Additionally, there is evidence for the RGDP to be a considerable explanation of both unemployment and external balance variations. Especially in what the external balance concerns, RGDP explains around 1/3 of the external balance variation, mostly because the RGDP itself is not independent of the value of external balance.

4.1.6. Impulse Response function

At this point, we are now finally set to apply this model to our main purpose: impulse response analysis and forecasting. Starting with the impulse response behavior of variables, we are interested in understanding how the model predicts unemployment and external balance fluctuations when facing each other shocks. For a complete result, responses for RGDP, REER and P were also computed. Generalized impulses were applied, mostly because it does not interfere with the order of the variables. Considering a 18-period time-frame, a one-unit impulse in each unemployment and external balance yields the following output shown below in figure (4.4). The results produced seems to be theoretically consistent and economically interpretable in the line with what was expected.

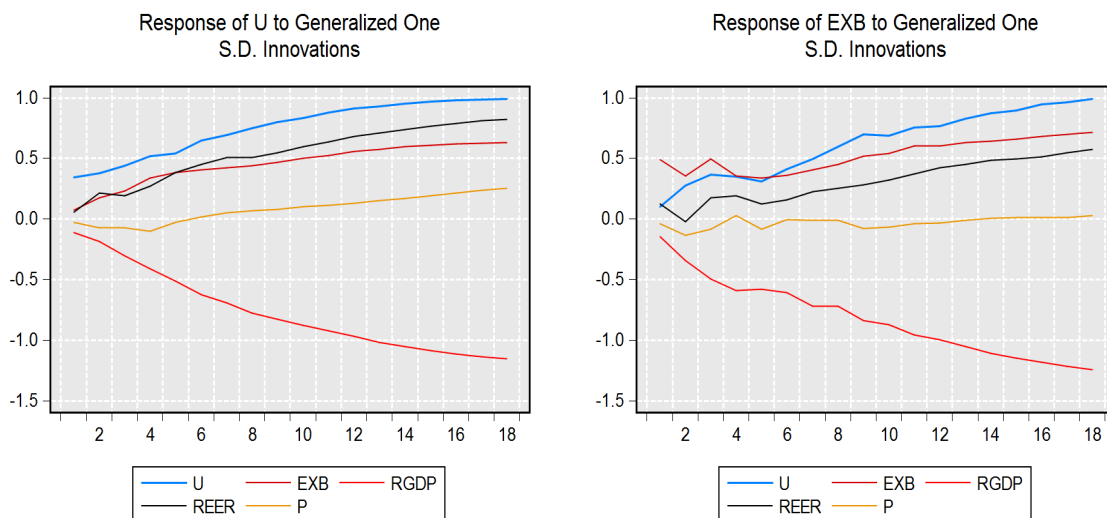


Figure 4.4: **Impulse Response Function**

For a shock in the unemployment rate, that is, considering a scenario in which the unemployment rate increases, its effect span across the other macroeconomic variables, and particularly to our other main variable, the external balance. As one can see, facing this shock, the external balance has a positive response and it converges to a long-run persistent positive equilibrium, which proves the positive relation present in the trade-off equation. On the other hand, it is also possible to conclude that an increase in unemployment will generate more unemployment in the future. For the remain variables, unemployment evidence to produce a negative impact, especially in RGDP, that is in line with economic theory. Another interesting conclusion comes from the fact that as our cointegration equation show, all variables tend to have a positive impact on unemployment, except the RGDP.

The impulse on external balance also gives quite interesting conclusions. For a positive shock, unemployment rate evidences an increasing trajectory that once again validates the existence of our trade-off. Moreover, an increase in the external balance will produce a slight increasing path for the external balance itself, that once again is in line with economic theory. Another valid result that can be taken from the IRF's analysis is that an increase in external balance, *ceteris paribus*, lead to an increase in the country's RGDP. Once again that result was expected and contribute to the model robustness and validation. Finally, both REER and DEFL seem to react negatively, to innovations on the external balance.

4.1.7. Forecasting

After estimating both the impulse responses and the variance decomposition, we are now concern about forecasting the trajectory of all endogenous variables, especially for the unemployment rate. I started by creating a model featuring the 5 equations that the VEC output yielded. Afterwards, to assess the quality of predicting actual values of our model, we computed a deterministic static in-sample forecast for the sample period, both for the unemployment and for the external balance. The results are presented in figure (A.6b) in the Appendix.

From figure (A.6b), it is possible to check that our model displays a very encouraging explanation of both unemployment and external balance, although it evidences a small lag - it tends to capture cycles after they happen. Nevertheless, it seems pertinent in explaining all endogenous variables. Facing this daunting results in the in-sample forecast, we computed dynamic out-of-sample forecasts until the last quarter of 2014, to check how well could our model predict the behavior of the variables during the adjustment programs. Using stochastic simulations with dynamic solutions, our results are presented in figure (4.5).

Our model's predictions are quite bold and reflect the concerns that the European Commission was facing in 2010 which remain to this day - the possibility of a recessionary fiscal consolidation process, in a defaulting scenario like the one that Greece faced at that time. The stochastic simulations for our dynamic forecasting suggest that such a boom in unemployment were very difficult to predict, especially through statistic methods.

The stochastic simulations for our dynamic forecasting proved that all results are within the confident boundaries suggested by the model, with one exception: the unemployment rate. In fact, our model actually gives a reasonable short-term forecast for those variables. Moreover, in the case of REER, RGDP and P, the model was able to predict a downward path in the short run, that is valid when we compare with the actual data for those variables

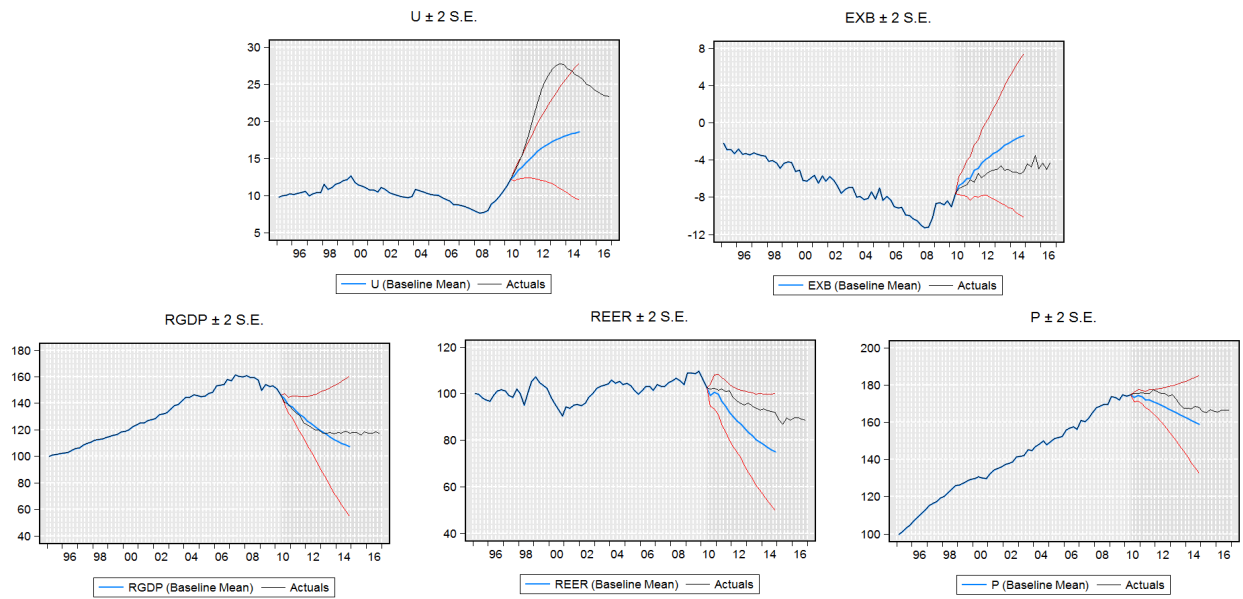


Figure 4.5: Dynamic Stochastic Forecast

during the forecast period of time. In the case of the EXB, the model was able to capture its actual increase, that was mainly forced by the successive consolidation programs. In the other hand, our model failed in predicting the short-run behavior of unemployment during the fiscal consolidation years. The results are even out of the confident boundaries which means that it was relatively hard to predict it and that short-term unemployment behavior should be a consequence of an unexpected event. Despite the huge underestimation of our model for unemployment, it is legitim to state that it captures the dynamics present in the actual data, meaning that it predicts a relatively high positive variation in the series. However, as it was said before, the results are still far away from the reality.

4.1.8. Assessment of the Troika's economic policy

After explaining the choice of methodology and the consequent results of the empirical assessment for Greece, this section intends to draw some conclusions about the results produced during our analysis as well as to leave some considerations about the fiscal consolidation programs that were imposed to Greece. We intend to assess in a more complete and robust way the predictions contained in those programs. The goal of our analysis was to conduct an empirical assessment of troika's programs. We were particularly interested in determining if it had been possible to produce more accurate predictions for the Greek economy in respect to the unemployment rate. The main motivation of this assessment relies on the considerable errors contained in both economic adjustment programs for Greece, especially

in the first one. In fact, the European Commission’s unemployment forecast present in that document lacks rigor and contains a considerable number of mistakes that can be easily seen when confronted with what happened afterwards.

The European Commission’s forecasts for the unemployment rate, both in the first and the second economic adjustment programs are shown below alongside with our model predictions in table (4.2).

	2010	2011	2012	2013	2014
Unemployment forecast Troika1	12	14.7	15.2	14.8	NA
Unemployment forecast Troika2	11.7	15.9	17.9	17.8	16.7
Unemployment forecast VEC model	12.4	14.6	16.5	17.8	18.4
Actual Unemployment	12.7	17.9	24.4	27.5	26.5

Table 4.2. **Unemployment Forecast Troika vs VECM vs actuals**

It is clear that unemployment rates predicted for 2011, 2012, 2013 and 2014 were completely blind in a sense that more than an error in the magnitude of the unemployment boom, it’s dynamics was not reasonable captured. The Troika predictions evidence a slight boom for the unemployment rate until 15.2 percent in 2012 and then a recovery in 2013 to 14.8 percent. When we look at the actual data for the unemployment rate in Greece, we see a continuous and enormous boom that reached its peak in 2013Q3 for a value of 27.73 percent, followed by a slight recovery that is still going on at this time. (the unemployment rate registered in 2017Q3 was 22.5 percent).

Based on our model predictions, we can draw 2 main conclusions: First, we found evidence for the existence of the so-called unemployment/external balance trade-off in a sense that our policymakers should bear in mind that an improvement of a country’s external balance will produce, *ceteris paribus*, an increase in the unemployment rate. This result was confirmed through the cointegration equation, variance decomposition and impulse response functions that were analyzed in this section. Secondly, when we compare our model prediction with the ones present in the adjustment programs one may conclude that they are very similar. In fact, they both underestimate unemployment rate in a considerable magnitude. However, our model evidences a slightly more accurate forecast for the unemployment rate when compared with the European Commission’s results. Another interesting result is that until the end of our forecast sample, the model predicts a continuing straightforward increase in the unemployment rate, which contrasts with the troika’s predictions. Finally, we conclude that standard econometric methods like the one we built here are incapable of capturing such an

exogenous shock as the one brought by the economic financial crisis of 2008. Therefore, we conclude that applying such methodologies in contexts like the one faced by Greece in the last decade is unreasonable.

4.2. Inter-Sectoral Analysis

This section presents the second methodology used for this empirical assessment on the Greek economy. As it was mentioned above in the Literature Review, I chose to extend the work developed by Amaral and Lopes (2016) on the Portuguese economy, for the Greek adjustment programs period of time. In that sense, this empirical exercise is based on their approach and construction of the so-called Inter-sectoral analysis represented by the Input-Output model. In order to do this empirical assessment and analyze the results, first it was decided to describe the methodology and the model construction, and after a brief explanation of some basic assumptions about the Leontief Input-Output relationships, we present our database and basic assumptions for the empirical assessment. Finally, I will explain the results that are mainly from the computation of the unemployment/external balance trade-off equation. After that, one should be able to trace different scenarios for the Greek economy and also conclude about the policy that was pursued.

4.2.1. Basic assumptions and Input-Output IO relationships

The empirical assessment is based on the tradeoff relationship between unemployment and the external balance of goods and services, according to the structural relationships in the multi-sectoral economy, formalized through the Leontief Input-Output model. This methodology allows us to compare between the policy that was adopted in the economic adjustment programs for Greece and its unemployment forecasts mainly with the results that could be reached if it was used the structural IO relationships expressed in the trade-off equation mentioned before, and using only data for 2011.

In that sense, this assessment does not intend to compare the unemployment forecasts made by the European Commission and expressed in the adjustment program with what actually happened. Our objective is then to compare those unemployment predictions with what could be predicted if it was chosen to run an inter-sectorial analysis like the one present in this section.

This formula of modelling the economy through those Input-Output relations is not *á priori*, a reasonable way to produce accurate short-term forecasts for economic or financial data, but one should consider that those relationships are relatively immune to short-term macro and sectoral shocks like the one produced by the fiscal consolidation program, even tho

it is a linear version of the model that is not able to consider short-term structural dynamics. Assuming some short-run rigidities in the economy, and in the context of a deep economic recession, this methodology provides a useful way for assessing macroeconomic forecasts using a comparative analysis structure. It is then a methodology that is relatively robust vis-à-vis other methods that rely on (econometric) relations that are erroneously supposed to be stable in the unstable context of a crisis (Lopes and do Amaral, 2017).

For a detailed analysis of the IO model, (see Miller and Blair, 2009). For an empirical application to the Portuguese economy (see Amaral et al., 2010), (see Reis and Rua, 2009) and also (see Lopes, 2012).

To modeling an economy according to the Leontief Input-Output relations, the basic equation is:

$$x = Ax + y \quad (4.5)$$

Where x is the column vector of gross output values of the n sectors of the economy, y is the final demand vector and A is the technical coefficients matrix. The final solution of this system is:

$$x = (I - A)^{-1}y \quad (4.6)$$

Where $(I - A)^{-1}$ is the so-called Leontief inverse matrix of output multipliers (afterwards represented by B), whose generic element, b_{ij} gives the increase of sector j 's production caused by an additional unitary final demand directed to sector i . The vector of (total) final demand can be divided in two vectors: the domestic final demand d (public and private consumption plus investment), and the external final demand e , representing the sectoral exports:

$$y = d + e \quad (4.7)$$

The solution of the Leontief system is given by:

$$x = B(d + e) \quad (4.8)$$

After that, one should calculate the primary factor income (salaries and profits, including also, for simplicity, the net indirect taxes) and values of imports, necessary for production, x , and for domestic demand, D :

$$VA = a^v B a^d D + a^v B a^e E + a^t D \quad (4.9)$$

$$M = a^m Ba^d D + a^m Ba^e E + a^m D \quad (4.10)$$

Where VA is the total gross value added of salaries and profits (plus net indirect taxes), a^v is the vector of value-added coefficients of n sectors ($a^v = VA/X$), a^d and a^e are the vertical coefficients of final demand (domestic and external) directed to the productive sectors. D is the total value of domestic final demand, E is the value of exports and M correspond to the imports. Additionally, a^m corresponds to the vector of imported input coefficients, a_d^m and a_d^t are the vertical coefficient of imports and net indirect taxes in the domestic final demand, respectively. From equation (4.9), the value-added content of domestic and external final demand can be expressed as:

$$va_D = a^v Ba^d D + a_d^t \quad (4.11)$$

$$va_E = a^v Ba^e D + a_e^t \quad (4.12)$$

Similarly, from equation (4.10) the import content of domestic and external final demand are:

$$m_D = a^m Ba^d + a_d^m \quad (4.13)$$

$$m_E = a^m Ba^e + a_e^m \quad (4.14)$$

An equilibrium condition from the IO tables is that $VA + M = D + E$, leading to the following conclusion:

$$m_D = 1 - va_d \quad (4.15)$$

$$m_E = 1 - va_e \quad (4.16)$$

The total value of imports made by the economy can be computed as:

$$M = (1 - va_D)D + (1 - va_E)E \quad (4.17)$$

This result is used as our starting point to formulate the unemployment/external balance trade-off equation. In order to determine the employment contents of domestic final demand and exports, we should consider the employment coefficients of the productive sectors, given by the (row) vector a^l . As it was done above, to get the generic element of this vector we divide

the employment (number of employees) of sector j by its gross output value $a_j^l = L_j/X_j$. Then, assuming that the vertical structure of sectorial domestic final demand, given by the (column) vector a^d , do not change, the employment content of one unit of domestic final demand value is given by:

$$l_D = a^l B a^d \quad (4.18)$$

Then, the employment content of one unit of external demand(exports) value is:

$$l_E = a^l B a^e \quad (4.19)$$

In fact, l_D can be computed by difference, since both net direct taxes and imports do not generate employment. After computing the employment associated with exports $L_E = l_E E$, one can determine $L_D = L - L_E$, and then dividing by D one get:

$$l_D = L_D/D \quad (4.20)$$

4.2.2. Data description

The data used in this assessment was all gathered from the World Input-Output Database (WIOD), corresponding to the structural matrix from Greece during the year of 2011. For the labor market, it was used the social-economic accounts tables from the WIOD(Social Economic Accounts). The WIOD database used for Greece in 2011 is expressed in millions of U.S. dollars and on the other hand, the tables for the labor market are expressed in thousands of persons.

In this assessment, our data corresponds only to information about 2011 but it is expressed in such a structural way that is known as a robustness element for this Keynesian analysis. Within this assessment, it is also possible to calibrate the model according to different data published by different institutions. In this case, after computing the essential values for the trade-off equation assessment, one can calibrate it using different figures from another economic institution such the OECD data. Indeed, it is possible to identify relatively high differences in the actual figures presented in the WIOD matrix for Greece vis-a-vis with OECD figures for the same period of time. Those same differences are expressed in table (A.3) in the Appendix. In fact, the major differences rely on both the labor market and in the value of the exports. First, despite both sources gave the exact same unemployment rate, the WIOD(SEA) give us higher values for the labor force and also for the employment when compared to the OECD data. This major difference may come essentially from the over-

regulating labor market issues and also from different methodologies in collecting the data. Second, the value of exports is higher in the OECD data when comparing with the WIOD information by almost 50 percent. This relatively low valuation of the Greek exports from the WIOD may come from the fact that most of the exporting services sectors like tourism and related activities such hotels and restaurants (present in the WIOD as the sector number 22)¹⁰ are highly informal and for that they are very sensitive and different methodologies can differ on their results. For those reasons, we decided to calibrate our model, in the end, to the actual figures from OECD in order to produce more accurate results.

4.2.3. Unemployment/External Balance trade-off

With the objective of computing the trade-off between an austerity policy for the reduction of the external imbalance with the value of unemployment, according to the previous calculations, we can write:

$$E + H = (1 - va_D)D + (1 - va_E)E \quad (4.21)$$

Where E and H are the exports and external balance, respectively. Additionally, va_D is the value-added content of domestic demand and va_E is the value-added content of exports. The right side of equation (4.21) represents the level of imports, when the economy is treated as an IO system as the one described previously. Starting from equation (4.21), we can obtain:

$$D = (H + va_E E)/(1 - va_D) \quad (4.22)$$

Considering, respectively, l_D and l_E as the employment content of final demand and exports, and L the value of total employment, and assuming our previous computations in the last section, we have:

$$L = l_D D + l_E E = l_D (H + va_E E)/(1 - va_D) + l_E E \quad (4.23)$$

Assuming N as the labor force and $u = 1 - (L/N)$ the unemployment rate, then we have:

$$u = [1 - l_D va_E E/(1 - va_D)N - l_E E/N] - [l_D/(1 - va_D)N]H \quad (4.24)$$

Making H our independent variable, and after fixing the values for the exogenous variables, this expression is a straight line with a negative slope. The negative slope of this line,

¹⁰Sector c22, H, Hotels and Restaurants.

$-[l_D/(1 - va_D)N]$, gives us the trade-off between external deficit (symmetric of the external balance) and the unemployment rate. Additionally, instead of using the external balance in millions of U.S. dollars, we consider it as a proportion of GDP, $h = H/Y$, one can write as:

$$E + hY = (1 - va_D)D + (1 - va_E)E \quad (4.25)$$

Since $Y = (va_D)D + (va_E)E$, after eliminating Y , we get:

$$D = [va_E(1 + h)/[1 - (1 + h)va_D]]E \quad (4.26)$$

The expression analogous to equation (4.23) is now:

$$L = l_D D + l_E E = [l_D va_E(1 + h)/[1 - (1 + h)va_D] + l_E]E \quad (4.27)$$

And considering N and u , equation (4.24) can be rewritten as:

$$u = 1 - l_E E/N - [l_D va_E(1 + h)/[1 - (1 + h)va_D]]E/N \quad (4.28)$$

As E and N are assumed constant (exogenous) variables, the trade-off can be studied by analyzing the term $l_D va_E(1 + h)/[1 - (1 + h)va_D]$. Looking at equation (4.28), we can see that $1 - (1 + h)va_D < 0$, which implies, as expected, that u is an increasing function of h . Furthermore, it can be shown that $h > (1 - va_D)/va_D$.

4.2.4. Results for the Unemployment/External Balance trade-off for 2011

After the explanation of the model and its basic assumptions, it is now possible to apply it to the Greek economy. In order to formalize it, it is necessary to identify A , the domestic technical coefficients matrix and also the correspondent Leontief inverse matrix $B = (I - A)^{-1}$. From that, we get the vectors of sectorial value-added coefficient a^v and imported intermediate input coefficient a^m . We also get the coefficients of indirect taxes on domestic final demand and of direct imports for domestic final demand, a_d^t and a_d^m . Upon that, the value added contents of final demand and exports were calculated as:

$$va_D = a^v B a^d + a_d^t = 0,772298 \quad (4.29)$$

$$va_E = a^v B a^e = 0,751618 \quad (4.30)$$

Accordingly, the imports content of final demand and exports can be written as:

$$m_D = (1 - va_D) = a^m Ba^d + a_d^m = 0,227702 \quad (4.31)$$

$$m_E = (1 - va_E) = a^m Ba^e = 0,248382 \quad (4.32)$$

From the previous values one can make our first conclusions in terms of the Leontief model. In that sense, by looking at m_D one can conclude that for each one-unit increase in the domestic final demand of the Greek economy, the value of imports increases by 0.23. By other hand, an additional increase in the value of exports will lead to a 0.25 increase in imports.

Using the values of sectoral outputs given by the WIOT and the number of employees per sector, from the social accounts, it is possible to calculate the vector of employment coefficients, a^l . In that sense one can write, l_E , as:

$$l_E = a^l Ba^e = 0,011029 \quad (4.33)$$

As employment is measured in thousands of persons and exports in millions of dollars, from that value one can conclude that a 1 million dollar increase in the level of exports will generate approximately 11 new jobs. To compute the employment content of domestic final demand, l_D , one can do it by difference, as it was mentioned above and its value is:

$$l_D = 0.014015 \quad (4.34)$$

To determine the value of the parameters of the linear unemployment rate/external balance trade-off, we first considered the WIOD and WIOD(SEA) figures, that is, our endogenous variables.

With $u = 1 - (L/N)$ being the unemployment rate and H the trade deficit (the symmetric of external balance), the tradeoff equation can be deriving from equation (4.23) as:

$$u = 0,60187058 - 0,00000949H \quad (4.35)$$

Since there are considerable differences in the data between WIOD and OECD data, as one can see in table (A.3) in the Appendix, we also decide to calibrate our model for the OECD values. In that case, considering the previous calculations and plotting in the end the OECD

values, we get the following tradeoff equation:

$$u = 0,37349967 - 0,00000962H \quad (4.36)$$

In that sense, table (4.3) show different values for the external balance (as it is our independent variable) and the correspondents estimated unemployment levels. The values for the external balance plotted in the table correspond to the forecast values present in the economic adjustment programs and therefore allow us to make an assessment of the policy chosen by the troika. As one can notice, the Input-Output Leontief model is more accurate when compared with the actual data, if adjusted to the OECD data. This conclusion may evidence the lack of harmonization among different data sources. The structural data present in the WIOD tables is more sensitive to changes in accountability measures. Despite that, in a general way, there is clear evidence for the Input-Output model application to overestimate the real unemployment rate when changing the values for the external balance according to troika forecasts, both in the first and in the second economic adjustment program. A more detailed description of the results will be present in the next section.

4.2.5. Assessment of the Troika's Economic Policy

After a brief introduction to the Leontief Input-Output model and its application to the Greek economy, our trade-off equation results can serve now as a tool to assess the fiscal episode of the two major economic adjustment programs for Greece signed in May 2010 and March 2012, respectively. Our main objective was to compute an explicit trade-off equation that relates both the unemployment rate and the external balance. Modeling the Greek economy in an Input-Output model we can reach that explicit relation, and therefore conclude about how those two variables co-move. By assuming a relatively unchanged productive structure in the Greek economy during (2011-2014), we can assess the effectiveness of the Troika programs in terms of unemployment predictions mainly by introducing into our trade-off equation the forecast values for the external balance, (see Comission, 2010) and (see Comission, 2012), and then compare the unemployment forecasts present in those documents with the one our model traces. Those results can be seen below in table 4.3.

In fact, a simple linear version of the Leontief Input-Output model is not able to produce explicit forecasts. Instead, this model construction allows us to trace scenarios, in this case for unemployment and external balance. Assuming the two forecasts present in those programs, we can compare one of the two with the other our model trace as a scenario, in our case we trace into our model the external balance scenario from the troika and therefore estimate

	2010	2011	2012	2013	2014
Unemployment forecast Troika1	12	14.7	15.2	14.8	NA
Unemployment forecast IO model (Troika1 Scenario)	40.4	47.8	52.2	55.9	NA
Unemployment forecast IO model adjusted (Troika1 scenario)	16.7	24	28.2	32	NA
Unemployment forecast Troika2	11.7	15.9	17.9	17.8	16.7
Unemployment forecast IO model (Troika2 scenario)	35.8	41.8	47.8	51	53.3
Unemployment forecast IO model adjusted (Troika2 scenario)	12.1	18	24	27.1	29.4
Actual Unemployment	12.7	17.9	24.4	27.5	26.5

Table 4.3. **Unemployment Forecast Troika vs IO Model vs Actuals**

explicit values for the unemployment rate.

When comparing our two estimations with the unemployment forecasts present in the two economic adjustment programs we can conclude that contrary to the results obtained in the previous econometric section, the Input-Output application tends to overestimate the unemployment rate. In contrast to the troika predictions, which underestimated the unemployment trajectory, the initial model largely overestimates the unemployment rate. However, when adjusted with OECD data for 2011, it tends to perform significantly better than the results present in troika's programs. The initial model gave very high values for unemployment (almost 56 percent in 2013). However, those results can be substantially biased by differences in the data. In fact, according to the World Input-Output Database (WIOD), Greece external balance as a percentage of GDP for 2011 was 13.5 percent, contrary to the 5.5 percent present in OECD data. When we adjusted our model to OECD figures, we saw that it gave very encouraging results when compared with what was concluded in those programs. The relatively unexpected boom in the unemployment rate is then better captured in this sectorial analysis.

Additionally, some of the theoretical considerations exposed in section 2.4 about the structural behavior of the Greek economy can be empirically assessed by using the Input-Output results. First, equation (4.31) and (4.32) underlines the tendency for the Greek economy to concentrate its production activity in self-employed low skill activities. The value for m^e is considered high when compared with the empirical assessment made for Portugal (see Amaral and Lopes, 2016)) and evidence the (weak) structure of Greek exports (more details see (Amaral et al., 2010)). We reach the same conclusion after observing equations (4.33) and (4.34). In fact, both values indicate a very weak performance of the Greek economy in terms of the labor market. Additionally, we see that for each one-million dollar increase in exports, the Greek economy has half the potential to create jobs than the Portuguese economy does. These results show a considerable low value-added oriented activity and also

that Greek exports are considerable anchored in the imports values.

5. Conclusions/Future Research

The aim of this thesis was to assess the miscalculations present in the economic adjustment programs imposed to Greece by the Troika, especially concerning unemployment. In that line, I chose to run two different methodologies: an econometric analysis and an inter-sectoral analysis. To forecast the unemployment rate for Greece during the economic adjustment programs period, I decided to use the trade-off unemployment/external balance as the main core of the analysis.

The econometric exercise showed statistical evidence for the existence of the unemployment/external balance trade-off, as it was expected. In fact, I found a significant positive cointegration between those two variables. Moreover, I found evidence for a positive shock in the external balance, like the one imposed by Troika, directly contributed to an increase in the unemployment rate. The stochastic forecast with dynamic solutions analysis showed that, while our model displays a reasonable explaining for all variables, it still largely underestimates the unemployment rate, as Troika forecasts also suggest. However, our model still displays better results when compared with the ones present in those programs.

Contrary to the econometric predictions, the Input-Output model was able to capture such an unemployment boom but it tends to overestimate it in a significant manner. However, after adjusting the WIOD data to the OECD figures, I found very encouraging results. Assuming the same scenario for the external balance made by Troika, our model was able to almost predict the unemployment rate vis-a-vis with what really happened. Moreover, I also found that a one million US dollars increase in Greek exports produces, *ceteris paribus*, a creation of 11 new jobs, which is significantly low. In fact, Greek exports have half the potential to generate jobs when compared with Portugal. This highlights the importance of low value-added sectors in Greek exports, mainly those represented in sector c22 from the WIOD tables. By another hand, each one-unit increase in Greek exports increases the imports by 0.25, which is a substantial high value, even when compared to Portugal.

To sum up, this thesis concludes that an unemployment boom such as the one the Greek economy faced in recent years was very difficult to predict, especially using standard econometric methods. During the years that preceded the crisis, rather than converge within the guidelines provided by the EMU framework, Greece's policy fostered weakness and dependency and failed to provide a more stable environment for economic activity to evolve. This deterioration in the Greek sustainability fundamentals was indeed not captured by the

financial markets. In that sense, the use of the Input-Output model application in fiscal consolidation episodes is encouraged and we expect that it will become increasingly useful as more data becomes available. A complete exercise on the Leontief Input-Output application for Greece can be done, mainly by using a more structural adjustment of the WIOD data to the Hellenic Statistical Authority (ELSTAT/ΕΛ.ΣΤΑΤ) figures, and it is expected to produce even better results for the Greek economy.

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A. Appendix

	U	EXB	RGDP	REER	P
Mean	10.15468	-6.622177	132.4889	101.4864	140.3085
Median	10.20000	-6.842500	132.5803	102.1156	139.9651
Maximum	12.64000	-2.234000	161.5551	109.8039	174.6946
Minimum	7.650000	-11.30900	100.0000	90.50568	100.0000
Std. Dev.	1.143047	2.482877	19.98104	4.255686	21.38392
Skewness	-0.322963	-0.023268	-0.113995	-0.375304	-0.058451
Kurtosis	2.864933	1.926569	1.594386	2.684591	2.016574
Jarque-Bera	1.124950	2.982250	5.238305	1.712483	2.533713
Probability	0.569797	0.225119	0.072865	0.424756	0.281716
Sum	629.5900	-410.5750	8214.309	6292.157	8699.127
Sum Sq. Dev.	79.69994	376.0455	24353.75	1104.763	27893.60
Observations	62	62	62	62	62

Table A.1. Descriptive Statistics

Unit Root tests in Levels	U	EXB	RGDP	REER	P	C.VAL
ADF(C)	0.4064	0.3622	0.2522	0.2647	0.3270	0.05
ADF(TREND+C)	0.9836	0.9504	1.0000	0.3734	0.1228	0.05
ADF(NONE)	0.8554	0.7767	0.9894	0.6937	1.0000	0.05
PP(C)	0.7381	0.3608	0.3884	0.1969	0.5064	0.05
PP(TREND+C)	0.9863	0.9792	1.0000	0.2536	0.1823	0.05
PP(NONE)	0.8621	0.8023	0.9547	0.6887	1.0000	0.05
KPSS(C)	0.233371	0.900679	0.936542	0.469275	1.016862	0.463
KPSS(TREND+C)	0.107793	0.141120	0.183879	0.092158	0.099081	0.146
VEREDICT	NON	NON	NON	NON	NON	

Unit Root tests in First Differences	U	EXB	RGDP	REER	P	C.VAL
ADF(C)	0.1543	0.0000	0.0320	0.0000	0.0000	0.05
ADF(TREND+C)	0.2721	0.0000	0.0000	0.0000	0.0000	0.05
ADF(NONE)	0.0223	0.0000	0.0036	0.0000	0.1324	0.05
PP(C)	0.0000	0.0000	0.0000	0.0000	0.0000	0.05
PP(TREND+C)	0.0001	0.0000	0.0000	0.0000	0.0000	0.05
PP(NONE)	0.0000	0.0000	0.0000	0.0000	0.0000	0.05
KPSS(C)	0.255428	0.328186	0.500665	0.046672	0.290517	0.463
KPSS(TREND+C)	0.179835	0.116988	0.119000	0.047373	0.052511	0.146
VEREDICT	STAT	STAT	STAT	STAT	STAT	

Table A.2. Unit Root Tests

VAR Lag Order Selection Criteria
 Endogenous variables: U EXB RGDP REER P
 Exogenous variables:
 Sample: 1995Q1 2010Q2
 Included observations: 56

Lag	LogL	LR	FPE	AIC	SC	HQ
1	-365.8499	NA	0.796065	13.95893	14.86310*	14.30947*
2	-338.1802	45.45750*	0.736051*	13.86358*	15.67193	14.56467
3	-325.7458	18.20751	1.209166	14.31235	17.02487	15.36399
4	-310.3655	19.77459	1.879809	14.65591	18.27261	16.05810
5	-283.4706	29.77655	2.089394	14.58824	19.10911	16.34097
6	-256.3106	25.22000	2.574918	14.51109	19.93614	16.61437

* indicates lag order selected by the criterion
 LR: sequential modified LR test statistic (each test at 5% level)
 FPE: Final prediction error
 AIC: Akaike information criterion
 SC: Schwarz information criterion
 HQ: Hannan-Quinn information criterion

Figure A.1: Lag Length Criteria

<p>Sample: 1995Q1 2010Q2 Included observations: 58 Series: U EXB RGDP REER P Lags interval: 1 to 3</p> <p>Selected (0.05 level) Number of Cointegrating Relations by Model</p> <table border="1"> <thead> <tr> <th>Data Trend</th> <th>None</th> <th>None</th> <th>Linear</th> <th>Linear</th> <th>Quadratic</th> </tr> <tr> <th>Test Type</th> <th>No Intercept</th> <th>Intercept</th> <th>No Trend</th> <th>Intercept</th> <th>Intercept</th> </tr> <tr> <th>Trace</th> <td>1</td> <td>1</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <th>Max-Eigen</th> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> </thead> </table> <p>*Critical values based on MacKinnon-Haug-Michelis (1999)</p> <p>Information Criteria by Rank and Model</p> <table border="1"> <thead> <tr> <th>Rank or No. of CEs</th> <th>None</th> <th>None</th> <th>Linear</th> <th>Linear</th> <th>Quadratic</th> </tr> <tr> <th></th> <th>No Intercept</th> <th>Intercept</th> <th>No Trend</th> <th>Intercept</th> <th>Intercept</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Log Likelihood by Rank (rows) and Model (columns)</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>0</td> <td>-358.9026</td> <td>-358.9026</td> <td>-347.3063</td> <td>-347.3063</td> <td>-341.6447</td> </tr> <tr> <td>1</td> <td>-336.7089</td> <td>-332.9163</td> <td>-330.4508</td> <td>-330.4282</td> <td>-326.1257</td> </tr> <tr> <td>2</td> <td>-327.0215</td> <td>-320.4878</td> <td>-319.0538</td> <td>-319.0384</td> <td>-314.7364</td> </tr> <tr> <td>3</td> <td>-322.7705</td> <td>-313.3840</td> <td>-312.0083</td> <td>-311.2630</td> <td>-307.0200</td> </tr> <tr> <td>4</td> <td>-319.1208</td> <td>-309.3449</td> <td>-309.0755</td> <td>-304.7029</td> <td>-302.8192</td> </tr> <tr> <td>5</td> <td>-319.1208</td> <td>-306.8288</td> <td>-306.8288</td> <td>-302.3190</td> <td>-302.3190</td> </tr> </tbody> </table> <p>Akaike Information Criteria by Rank (rows) and Model (columns)</p> <table border="1"> <thead> <tr> <th>Rank or No. of CEs</th> <th>None</th> <th>None</th> <th>Linear</th> <th>Linear</th> <th>Quadratic</th> </tr> <tr> <th></th> <th>No Intercept</th> <th>Intercept</th> <th>No Trend</th> <th>Intercept</th> <th>Intercept</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>14.89319</td> <td>14.89319</td> <td>14.73470</td> <td>14.73470</td> <td>14.71189</td> </tr> <tr> <td>1</td> <td>14.54169</td> <td>14.44539</td> <td>14.49830</td> <td>14.53201</td> <td>14.52157</td> </tr> <tr> <td>2</td> <td>14.55246</td> <td>14.39648*</td> <td>14.45047</td> <td>14.51850</td> <td>14.47367</td> </tr> <tr> <td>3</td> <td>14.75071</td> <td>14.53048</td> <td>14.55201</td> <td>14.62976</td> <td>14.55241</td> </tr> <tr> <td>4</td> <td>14.96968</td> <td>14.77052</td> <td>14.79571</td> <td>14.78286</td> <td>14.75239</td> </tr> <tr> <td>5</td> <td>15.31451</td> <td>15.06306</td> <td>15.06306</td> <td>15.07997</td> <td>15.07997</td> </tr> </tbody> </table> <p>Schwarz Criteria by Rank (rows) and Model (columns)</p> <table border="1"> <thead> 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Type	No Intercept	Intercept	No Trend	Intercept	Intercept	Trace	1	1	1	1	1	Max-Eigen	1	1	0	1	0	Rank or No. of CEs	None	None	Linear	Linear	Quadratic		No Intercept	Intercept	No Trend	Intercept	Intercept	0	Log Likelihood by Rank (rows) and Model (columns)					0	-358.9026	-358.9026	-347.3063	-347.3063	-341.6447	1	-336.7089	-332.9163	-330.4508	-330.4282	-326.1257	2	-327.0215	-320.4878	-319.0538	-319.0384	-314.7364	3	-322.7705	-313.3840	-312.0083	-311.2630	-307.0200	4	-319.1208	-309.3449	-309.0755	-304.7029	-302.8192	5	-319.1208	-306.8288	-306.8288	-302.3190	-302.3190	Rank or No. of CEs	None	None	Linear	Linear	Quadratic		No Intercept	Intercept	No Trend	Intercept	Intercept	0	14.89319	14.89319	14.73470	14.73470	14.71189	1	14.54169	14.44539	14.49830	14.53201	14.52157	2	14.55246	14.39648*	14.45047	14.51850	14.47367	3	14.75071	14.53048	14.55201	14.62976	14.55241	4	14.96968	14.77052	14.79571	14.78286	14.75239	5	15.31451	15.06306	15.06306	15.07997	15.07997	Rank or No. of CEs	None	None	Linear	Linear	Quadratic		No Intercept	Intercept	No Trend	Intercept	Intercept	0	17.55756	17.55756	17.57659	17.57659	17.73150	1	17.55130	17.50053*	17.60554	17.76477	17.89644	2	17.92733	17.84239	18.00296	18.14203	18.20378	3	18.48082	18.36717	18.45975	18.54407	18.53778	4	19.05504	18.99798	19.05869	19.18794	19.19300	5	19.75512	19.68130	19.68130	19.87583	19.87583	<p>Sample (adjusted): 1996Q1 2010Q2 Included observations: 58 after adjustments Trend assumption: No deterministic trend (restricted constant) Series: U EXB RGDP REER P Lags interval (in first differences): 1 to 3</p> <p>Unrestricted Cointegration Rank Test (Trace)</p> <table border="1"> <thead> <tr> <th>Hypothesized No. of CE(s)</th> <th>Eigenvalue</th> <th>Trace Statistic</th> <th>Trace Critical Value</th> <th>Prob.**</th> </tr> </thead> <tbody> <tr> <td>None *</td> <td>0.562691</td> <td>100.1476</td> <td>76.97277</td> <td>0.0003</td> </tr> <tr> <td>At most 1</td> <td>0.348333</td> <td>52.17498</td> <td>54.07904</td> <td>0.0732</td> </tr> <tr> <td>At most 2</td> <td>0.217535</td> <td>27.33816</td> <td>35.19275</td> <td>0.2721</td> </tr> <tr> <td>At most 3</td> <td>0.130013</td> <td>13.11039</td> <td>20.26184</td> <td>0.3551</td> </tr> <tr> <td>At most 4</td> <td>0.083107</td> <td>5.032325</td> <td>9.164546</td> <td>0.2799</td> </tr> </tbody> </table> <p>Trace test indicates 1 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values</p> <p>Unrestricted Cointegration Rank Test (Maximum Eigenvalue)</p> <table border="1"> <thead> <tr> <th>Hypothesized No. of CE(s)</th> <th>Eigenvalue</th> <th>Max-Eigen Statistic</th> <th>Trace Critical Value</th> <th>Prob.**</th> </tr> </thead> <tbody> <tr> <td>None *</td> <td>0.562691</td> <td>47.97266</td> <td>34.80587</td> <td>0.0008</td> </tr> <tr> <td>At most 1</td> <td>0.348333</td> <td>24.83683</td> <td>28.58808</td> <td>0.1402</td> </tr> <tr> <td>At most 2</td> <td>0.217535</td> <td>14.22776</td> <td>22.29962</td> <td>0.4414</td> </tr> <tr> <td>At most 3</td> <td>0.130013</td> <td>9.078068</td> <td>15.89210</td> <td>0.5385</td> </tr> <tr> <td>At most 4</td> <td>0.083107</td> <td>5.032325</td> <td>9.164546</td> <td>0.2799</td> </tr> </tbody> </table> <p>Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values</p>	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Trace Critical Value	Prob.**	None *	0.562691	100.1476	76.97277	0.0003	At most 1	0.348333	52.17498	54.07904	0.0732	At most 2	0.217535	27.33816	35.19275	0.2721	At most 3	0.130013	13.11039	20.26184	0.3551	At most 4	0.083107	5.032325	9.164546	0.2799	Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Trace Critical Value	Prob.**	None *	0.562691	47.97266	34.80587	0.0008	At most 1	0.348333	24.83683	28.58808	0.1402	At most 2	0.217535	14.22776	22.29962	0.4414	At most 3	0.130013	9.078068	15.89210	0.5385	At most 4	0.083107	5.032325	9.164546	0.2799
Data Trend	None	None	Linear	Linear	Quadratic																																																																																																																																																																																																																																						
Test Type	No Intercept	Intercept	No Trend	Intercept	Intercept																																																																																																																																																																																																																																						
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Rank or No. of CEs	None	None	Linear	Linear	Quadratic																																																																																																																																																																																																																																						
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0	Log Likelihood by Rank (rows) and Model (columns)																																																																																																																																																																																																																																										
0	-358.9026	-358.9026	-347.3063	-347.3063	-341.6447																																																																																																																																																																																																																																						
1	-336.7089	-332.9163	-330.4508	-330.4282	-326.1257																																																																																																																																																																																																																																						
2	-327.0215	-320.4878	-319.0538	-319.0384	-314.7364																																																																																																																																																																																																																																						
3	-322.7705	-313.3840	-312.0083	-311.2630	-307.0200																																																																																																																																																																																																																																						
4	-319.1208	-309.3449	-309.0755	-304.7029	-302.8192																																																																																																																																																																																																																																						
5	-319.1208	-306.8288	-306.8288	-302.3190	-302.3190																																																																																																																																																																																																																																						
Rank or No. of CEs	None	None	Linear	Linear	Quadratic																																																																																																																																																																																																																																						
	No Intercept	Intercept	No Trend	Intercept	Intercept																																																																																																																																																																																																																																						
0	14.89319	14.89319	14.73470	14.73470	14.71189																																																																																																																																																																																																																																						
1	14.54169	14.44539	14.49830	14.53201	14.52157																																																																																																																																																																																																																																						
2	14.55246	14.39648*	14.45047	14.51850	14.47367																																																																																																																																																																																																																																						
3	14.75071	14.53048	14.55201	14.62976	14.55241																																																																																																																																																																																																																																						
4	14.96968	14.77052	14.79571	14.78286	14.75239																																																																																																																																																																																																																																						
5	15.31451	15.06306	15.06306	15.07997	15.07997																																																																																																																																																																																																																																						
Rank or No. of CEs	None	None	Linear	Linear	Quadratic																																																																																																																																																																																																																																						
	No Intercept	Intercept	No Trend	Intercept	Intercept																																																																																																																																																																																																																																						
0	17.55756	17.55756	17.57659	17.57659	17.73150																																																																																																																																																																																																																																						
1	17.55130	17.50053*	17.60554	17.76477	17.89644																																																																																																																																																																																																																																						
2	17.92733	17.84239	18.00296	18.14203	18.20378																																																																																																																																																																																																																																						
3	18.48082	18.36717	18.45975	18.54407	18.53778																																																																																																																																																																																																																																						
4	19.05504	18.99798	19.05869	19.18794	19.19300																																																																																																																																																																																																																																						
5	19.75512	19.68130	19.68130	19.87583	19.87583																																																																																																																																																																																																																																						
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- (a) Summarize all 5 Sets of Assumptions
- (b) Linear Deterministic Trend in Data

Figure A.2: Johansen Cointegration Test

VEC Granger Causality/Block Exogeneity Wald Tests
 Sample: 1995Q1 2010Q2
 Included observations: 57

Dependent variable: D(U)				
Excluded	Chi-sq	df	Prob.	
D(EXB)	1.746181	4	0.7823	
D(RGDP)	4.311094	4	0.3655	
D(REER)	13.03668	4	0.0111	
D(P)	14.22904	4	0.0066	
All	31.24877	16	0.0125	

Dependent variable: D(EXB)				
Excluded	Chi-sq	df	Prob.	
D(U)	7.977768	4	0.0924	
D(RGDP)	15.81766	4	0.0033	
D(REER)	1.708440	4	0.7892	
D(P)	4.564632	4	0.3350	
All	37.73915	16	0.0016	

(a) endogenous variables

Dependent variable: D(RGDP)				
Excluded	Chi-sq	df	Prob.	
D(U)	4.131266	4	0.3885	
D(EXB)	4.696965	4	0.3198	
D(REER)	0.439968	4	0.9791	
D(P)	2.175634	4	0.7035	
All	13.52438	16	0.6341	

Dependent variable: D(REER)				
Excluded	Chi-sq	df	Prob.	
D(U)	4.300652	4	0.3668	
D(EXB)	1.316392	4	0.8586	
D(RGDP)	3.514208	4	0.4757	
D(P)	2.420161	4	0.6590	
All	12.40994	16	0.7153	

Dependent variable: D(P)				
Excluded	Chi-sq	df	Prob.	
D(U)	2.101499	4	0.7171	
D(EXB)	0.315973	4	0.9888	
D(RGDP)	9.895891	4	0.0422	
D(REER)	1.241775	4	0.8712	
All	17.74084	16	0.3393	

(b) exogenous variables

Figure A.3: Granger Causality Test

VEC Residual Serial Correlation LM Tests
 Null Hypothesis: no serial correlation at lag order h
 Sample: 1995Q1 2010Q2
 Included observations: 57

Lags	LM-Stat	Prob
1	24.48414	0.4916
2	21.12632	0.6855
3	31.64215	0.1686
4	22.29207	0.6188
5	27.65135	0.3242
6	24.91041	0.4674
7	14.68823	0.9484
8	20.17570	0.7375
9	23.85657	0.5277
10	23.25453	0.5627

Probs from chi-square with 25 df.

(a) Serial Correlation LM Test

VEC Residual Normality Tests
 Orthogonalization: Cholesky (Lutkepohl)
 Null Hypothesis: residuals are multivariate normal
 Sample: 1995Q1 2010Q2
 Included observations: 57

Component	Skewness	Chi-sq	df	Prob.
1	-0.421905	1.691033	1	0.1935
2	0.564516	3.027463	1	0.0819
3	-0.453698	1.955498	1	0.1620
4	0.336593	1.076298	1	0.2995
5	-0.226634	0.487947	1	0.4848
Joint		8.239239	5	0.1436

Component	Kurtosis	Chi-sq	df	Prob.
1	3.591903	0.832079	1	0.3617
2	3.180746	0.077599	1	0.7906
3	3.025336	0.001525	1	0.9689
4	2.652620	0.296599	1	0.5924
5	3.645112	0.988402	1	0.3201
Joint		2.186192	5	0.6228

Component	Jarque-Bera	df	Prob.
1	2.523112	2	0.2832
2	3.105052	2	0.2117
3	1.362895	2	0.5059
4	1.476349	2	0.4790
Joint	10.42443	10	0.4041

(b) Normality Test (Lutkepohl)

Figure A.4: Residuals Tests

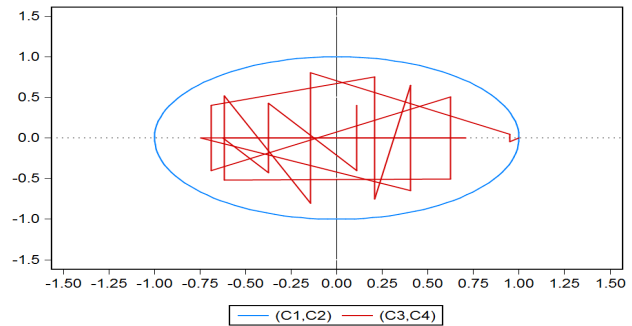
VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
 Sample: 1995Q1 2010Q2
 Included observations: 57

Joint test:					
Chi-sq	df	Prob.			
627.7594	630	0.5177			

Individual components:					
Dependent	R-squared	F(42,14)	Prob.	Chi-sq(42)	Prob.
res1*res1	0.861010	2.064926	0.0711	49.07759	0.2105
res2*res2	0.587533	0.733446	0.7863	39.18938	0.5950
res3*res3	0.729359	0.898311	0.6260	41.57347	0.4896
res4*res4	0.787084	1.232228	0.3475	44.86378	0.3627
res5*res5	0.752504	1.013487	0.5171	42.89270	0.4327
res2*res1	0.681248	0.712412	0.8059	38.83113	0.6109
res3*res1	0.879084	2.423405	0.0376	50.10780	0.1827
res3*res2	0.744145	0.969488	0.5571	42.41627	0.4530
res4*res1	0.697002	0.766783	0.7544	39.72910	0.5711
res4*res2	0.697588	0.766915	0.7523	39.76251	0.5696
res4*res3	0.594355	0.488403	0.9629	33.87822	0.8097
res5*res1	0.674195	0.689772	0.8265	38.42909	0.6285
res5*res2	0.734198	0.920688	0.6033	41.84874	0.4775
res5*res3	0.620847	0.545818	0.9344	35.38826	0.7547
res5*res4	0.564569	0.432192	0.9818	32.18043	0.8631

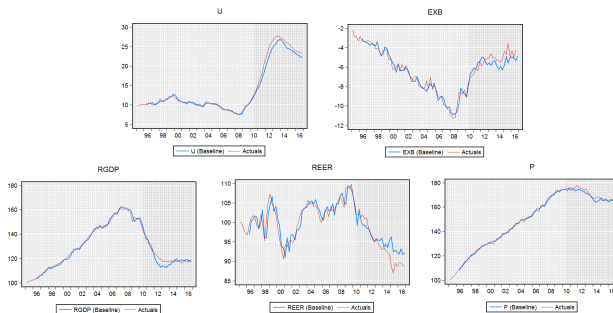
(a) White Heteroskedasticity Test

Inverse Roots of AR Characteristic Polynomial

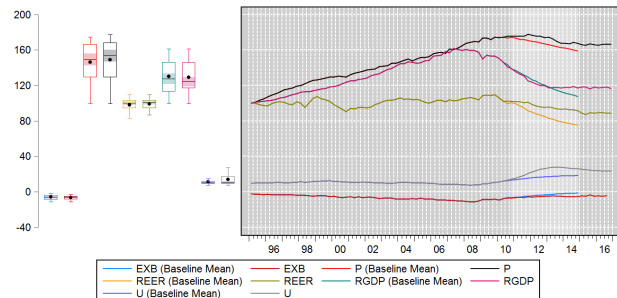


(b) AR Roots

Figure A.5: Residuals Tests



(a) Static Deterministic Forecast



(b) Dynamic Stochastic Forecast

Figure A.6: VEC Model Forecasts

Vector Error Correction Estimates											
Sample (adjusted): 1996Q2 2010Q2											
Included observations: 57 after adjustments											
Standard errors in () & t-statistics in []											
Cointegrating Eq:		CointEq1									
U(-1)	1.000000					D(RGDP(-1))	-0.039055 (0.03093) [-1.26270]	-0.133264 (0.04411) [-3.02084]	0.007295 (0.17916) [0.04072]	0.036035 (0.20921) [0.17225]	0.031451 (0.11749) [0.26768]
EXB(-1)	-0.480499 (0.71290) [-0.67401]					D(RGDP(-2))	-0.055994 (0.03410) [-1.64201]	-0.102822 (0.04864) [-2.11404]	0.312483 (0.19753) [1.58194]	0.107543 (0.23066) [0.46625]	0.304016 (0.12954) [2.34688]
RGDP(-1)	0.136006 (0.09170) [1.48321]					D(RGDP(-3))	0.019592 (0.03825) [0.51216]	0.000595 (0.05456) [0.01091]	0.265626 (0.22158) [1.19876]	-0.248323 (0.25874) [-0.95974]	-0.077686 (0.14531) [-0.53462]
REER(-1)	-0.191983 (0.08186) [-2.34529]					D(RGDP(-4))	0.034999 (0.03642) [0.96090]	-0.031786 (0.05195) [-0.61186]	-0.050694 (0.21099) [-0.24027]	0.277582 (0.24637) [1.12671]	0.150637 (0.13836) [1.08871]
P(-1)	-0.105537 (0.07197) [-1.46636]					D(REER(-1))	0.086215 (0.02812) [3.06591]	-0.044593 (0.04011) [-1.11184]	0.032585 (0.16289) [0.20004]	0.331881 (0.20121) [1.74486]	-0.019803 (0.10682) [-0.18538]
C	-0.739891 (8.62548) [-0.08578]					D(REER(-2))	-0.061674 (0.03294) [-1.87251]	0.034219 (0.04698) [0.72842]	0.039504 (0.19079) [0.20706]	-0.283907 (0.22278) [-1.27438]	-0.094903 (0.12512) [-0.75852]
						D(REER(-3))	0.045750 (0.03415) [1.33978]	0.003477 (0.04870) [0.07140]	-0.105475 (0.19780) [-0.53324]	-0.066269 (0.23097) [-0.28692]	-0.026903 (0.12972) [-0.20740]
						D(REER(-4))	0.027674 (0.03129) [0.88439]	-0.013748 (0.04463) [-0.30805]	0.092835 (0.18126) [0.51217]	0.079412 (0.21165) [0.37520]	-0.052340 (0.11887) [-0.44032]
						D(P(-1))	-0.195273 (0.05623) [-3.47283]	-0.129046 (0.08020) [-1.60910]	0.322194 (0.32571) [0.98921]	0.013010 (0.38033) [0.03421]	-0.302247 (0.21360) [-1.41503]
						D(P(-2))	-0.079360 (0.06458) [-1.22877]	-0.064235 (0.09212) [-0.69732]	-0.019498 (0.37411) [-0.05212]	0.414717 (0.43685) [0.94934]	0.020069 (0.24534) [0.08180]
						D(P(-3))	-0.114704 (0.05661) [-2.02605]	0.045396 (0.08075) [0.56219]	0.113498 (0.32794) [0.34609]	0.428282 (0.38294) [1.11841]	0.094329 (0.21506) [0.43861]
						D(P(-4))	-0.049743 (0.05688) [-0.87452]	-0.080158 (0.08113) [-0.98806]	-0.206439 (0.32948) [-0.62657]	0.451453 (0.38473) [1.17343]	0.466488 (0.21607) [2.15898]
						R-squared	0.566077	0.562164	0.372380	0.303862	0.390680
						Adj. R-squared	0.325008	0.318921	0.023702	-0.082881	0.052169
						Sum sq. resids	4.214278	8.572951	141.4044	192.8057	60.81297
						S.E. equation	0.342145	0.487993	1.981893	2.314242	1.299711
						F-statistic	2.348197	2.311124	1.067978	0.785696	1.154114
						Log likelihood	-6.649166	-26.88798	-106.7738	-115.6105	-82.72492
						Akaike AIC	0.970146	1.680280	4.483292	4.793351	3.639471
						Schwarz SC	1.722849	2.432983	5.235995	5.546054	4.392174
						Mean dependent	0.036842	-0.084105	0.760591	0.099578	1.187961
						S.D. dependent	0.416448	0.591310	2.005807	2.223916	1.335001
						Determinant resid covariance (dof adj.)	0.398159				
						Determinant resid covariance	0.040012				
						Log likelihood	-312.6684				
						Akaike information criterion	14.86556				
						Schwarz criterion	18.84413				

(a) 1/2

(b) 2/2

Figure A.7: VECM Output Representations

	Employment	Labour force	Unemployment	Unemployment rate	Exports	Imports	External Balance	(% GDP)	Demand = (C+G+I)	Final Output
WIOD/SEA	5183.3**	6313.4**	1130.1**	17.9%	42560.7*	83517.6*	-40956.9*	-13.9%	336356.6*	295399.7*
OECD	4054.3**	4936.1**	881.8**	17.9%	66183.5*	83293.1*	-17109.6*	-5.9%	307406.3*	290296.7*

*Values expressed in Millions of U.S. dollars

**Values expressed in thousands of persons

Table A.3. WIOD/SEA vs OECD : Macroeconomic Data for Greece, 2011