Inflation Differentials in European Monetary Union: A Theoretical and Empirical Approach

Thomai Filippeli

Supervisor: Prof. Ioannis A. Mourmouras

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Thomai Filippeli

University of Macedonia, Greece [1]

[1]Address: 156 Egnatia Street, Thessaloniki, Greece

E-mail: thomai.filippeli@gmail.com

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Abstract

This PhD thesis studies and contributes to the literature regarding the causes and the consequences of inflation differentials in the European Monetary Union. In the first chapter of the thesis it is provided evidence about the phenomenon of inflation differentials in the euro area since 1999 and also there is an extensive review about the structure of the currency union, the strategies of the monetary authority and its objectives. In the second chapter, the causes of inflation differentials are empirically estimated. In the third chapter, I discuss whether the inflation process in Portugal, Ireland, Greece and Spain - countries that after the launch of the euro experienced national inflation rates above the weighted average of the union - has different time series properties from the EMU average and the possible implications of inflation differentials for the EMU and the national governments of member-countries are explained. The next chapter is dealing with the issue of one monetary policy but many different fiscal policies in EMU and the free - riding incentives that appear in the context of a monetary union and what are the implications for the inflation rates in the union. It is discussed with detail the implications of the Fiscal Theory of Price Level and the empirical plausibility of this theory in EMU. In chapter five, I use a Dynamic Stochastic General Equilibrium Model (DSGE) with fiscal authority to examine the implications of fiscal policy shocks, among others, on inflation differentials of a small open

economy in a monetary union. The last chapter reviews the results of the thesis and concludes.

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1. THE EURO AND INFLATION DIFFERENTIALS IN EUROPEAN MONETARY UNION

1.1 Introduction

Since 1999 eleven member - countries of the European Union - twelve since 2001 and seventeen since 2008 - have been members of the European Monetary Union (EMU) and abandoned their national currencies and their national monetary policies in order to adopt one single currency, the euro. The EMU will provide a good benchmark and point of reference for future research in academia and policymaking. The experience so far, has showed that a lot of have to be learnt for successful monetary arrangements among countries that decide to practise a monetary union.

Open economies under flexible exchange rate system restore the adjustment towards equilibrium in relative prices after an idiosyncratic shock through movements in nominal prices and nominal exchange rate. Apparently, movements in nominal exchange rate are no possible in a currency union, so the only route for equilibrium in relative prices is changes in nominal prices.

Moreover, monetary policy cannot react and change its policy for country - specific shocks. Someone can easily conclude that the adjustment through nominal prices shows the asymmetry of the shocks and the degree of integration among different regions. The less integrated the countries are or/and the more asymmetric the shock that hits the union the more intense the adjustment through nominal prices will be. In other words, inflation divergence can be considered as the result of asymmetries in a union.

In this chapter, I try to provide some evidence about the phenomenon of inflation differentials in EMU. Data supports the existence of different inflation rates. After a noticeable convergence in inflation rates a few years before the launch of the euro, inflation rates started to divert again once the euro was adopted.

1.2 The road to European Monetary Union

Economic and Monetary Union was a constant ambition for the European Union since the late 1960s' as there was strong belief that it could guarantee the route to sustainable growth and increasing employment among its members because of the stability it could provide. Yet, a sequence of obstacles prevented this to happen earlier - weak political commitment, division over economic priorities and turmoils in international markets- and it only came true after the second half of the 20th century.

The road towards the Economic and Monetary Union and the launch of the common currency can be divided into four distinct phases:

Phase I: From the Treaty of Rome towards the Werner Report (1957 - 1970) After the end of WWII the international currency stability did not last for long and turbulence on international currency markets was a great threat for the common price system of the Common Agricultural Policy of the European Economic Community. As a response, European leaders set up a group at the highest level led by Pierre Werner - the Prime Minister of Luxembourg that time - to elaborate on how an economic and monetary union could be achieved.

Phase II: From the Werner Report to the European Monetary System (1970 - 1979) The Werner report was a three - stage process to achieve EMU in a period of 10 years. However, a new period of currency instability launched again and the hopes of a new monetary union began to disappear again. Finally, the European Monetary System came true in 1979.

Phase III: From the start of EMS to Maastricht (1979 - 1991) The EMS was built on exchange rates defined with reference to the newly created European Currency Unit (ECU) which was a weighted average of the currencies of the EMS. The EMS presented an unprecedented coordination of the monetary policies of the member - countries and its operation was considered to be successful for more than a decade.

Phase IV: From the Maastricht to the euro and the euro area (1991 - 2002) Following the success of the previous years the European Commission President Jacques Delors and the governors of the Central Banks of the member - countries produced the "Delors Report". This report divided the process to the euro to a three distinct stages:

Stage 1: Completion of the free market i.e. free movement of the capital//

Stage 2: Preparation of the European Central Bank (ECB) and the European System of Central Banks (ESCB)

Stage 3: Fixed exchange rates and launch of the euro (from 1999)

1.3 The Monetary Policy of European Central Bank

1.3.1 The structure of the European System of Central Banks

In January 1999 the European Central Bank (ECB) undertook the responsibility for the formulation and conduct of monetary policy in the euro area - the second largest economic zone in the world after the United States. The transfer of responsibility for monetary policy from the 11 national central banks - which later became 12 with the participation of Greece on January 1, 2001 and 17 since 2008 – to a new supranational institution, was a landmark in the long and complex process towards European Integration.

The European System of Central Banks (ESCB) comprises of the ECB and the national central banks of member countries of the European Monetary

Union. Its primary objective is to maintain price stability and act in accordance with the principle of open market economy with free competition, supporting an efficient allocation of resources. In this context, Article 2 of the Treaty states that objectives of the European Union is the high level of employment, stable non-inflationary growth, a high level of competitiveness and economic convergence. The Treaty clearly shows that price stability is the most important contribution of the monetary policy in order to achieve a constructive and positive economic environment and a high level of employment. The main tasks of the ESCB are as follows:

a. To define and implement monetary policy in the union.

b. To conduct the foreign exchange policy.

c. To hold and manage the official foreign reserves of the Member States - without canceling the role of the national governments of the members - and the balances in foreign currency.

d. To promote the smooth operation of the payment systems.

Moreover, the ESCB contributes to the smooth conduct of policies relating to the prudential supervision of credit institutions and financial stability. The ECB and the national central banks of member states which have adopted the euro are often referred to as the Eurosystem. If all member states adopt the euro then the Eurosystem and the ESCB will be identical - the national central banks of member states of the EU which have not adopted the euro, namely Denmark, Sweden and the United Kingdom are members of the ESCB, but do not participate in the formulation of monetary policy for the

euro area. The ESCB is governed by the decision-making bodies of the ECB: the Governing Council, the Executive Committee and General Council.

- The Governing Council

The Governing Council consists of 6 members of the Executive Board and the governors of national central banks of countries - members of the eurozone. Both, the Governing Council and the Executive Committee are chaired by the President of the ECB or in his absence the Vice President. The responsibilities of the Council are as follows:

i. To adopt the guidelines and make decisions necessary to ensure the smooth conduct of the Eurosystem's tasks.

ii. To configure the policy in the eurozone.

Moreover, where it is necessary for the intermediate monetary objectives, the Council takes decisions about the key interest rates and the liquidity in the ESCB and it also establishes the necessary guidelines for their implementation.

- The Executive Board

The Executive Board comprises of the President, the Vice-President and 4 other members and is responsible for current issues of the ECB. It also conducts the monetary policy, in accordance with the guidelines and decisions

adopted by the Governing Council. To achieve this, the Executive Board gives the necessary instructions to national central banks. Also, the Board decides whether to delegate or not certain powers to the Executive Committee.

- The General Council

The General Council, the decision-making body of the ECB, comprises of the Chairman and the Vice-President of the ECB and the Governors of central banks. During the negotiations for the drafting of the Maastricht Treaty, it was clear that it was not possible for all member countries of EU to participate in EMU from its beginning. The two-speed economy in the context of EMU was seemed to be inevitable i.e. countries that would meet the criteria at the beginning of EMU and those countries that they were expected to adjust their macroeconomic indices according to the Maastricht Treaty. Countries which belonged to the second group demanded that all national central banks should participate in the Governing Council even if some governors would not be able to vote. Some other member - states wanted to completely exclude the countries not participating in EMU from any official role. So a compromise was reached which took the form of the General Council.

The General Council contributes to the activities of the ESCB like the collection of statistical information, the activities of the ECB on the reports, the establishment of conditions of employment of ECB staff e.t.c. Also, it takes

part to the necessary preparations for fixing the exchange rates of currencies of the countries - members who are not yet members of EMU and the single currency of the member states which are already members of EMU.

1.3.2 Monetary Policy

In the last ten years there has been a growing interest in the possibility of promoting price stability through the establishment of independent central banks. Since the end of 1980, countries all over the world such as Chile, Venezuela, Mexico, Argentina, New Zealand, South Africa, as well as former Communist countries like Poland, have implemented or are intending to make changes to the legislation, giving the central bank constitutional independence from the government. In the European Union, the Maastricht Treaty enforced the national central banks of the member countries who intended to enter the monetary union to become independent before the third phase of Economic and Monetary Union. In this spirit, France and Spain in 1994 gave independence to the Bank of France and the Bank of Spain, respectively. An additional requirement of the Maastricht Treaty was that the European Central Bank would also be independent.

Central bank independence relates to three areas in which the influence of government should be excluded:

a. Independence in personnel matters

b. Financial autonomy

c. Political independence

About (a), in practice it is not possible to exclude the government influence when it comes to appointments to an important public institution such as the central bank. Thus, independence in personnel matters referred to the influence exercised by the government on the appointment process and several criteria play role, such as government representation on the governing body of the bank, appointment procedure and working conditions. Concerning (b) if the government is able to finance its expenditure directly or indirectly through loans granted by the central bank, then we talk about financial dependence and monetary policy is subordinated to fiscal policy. In such cases, some restrictions are necessary, which would prevent government interference in monetary policy. Political independence has to do with the planning and implementation of monetary policy. At this point, we should differentiate between independence of goals and independence of means. A central bank is independent if it is able to decide on the formulation of its objectives. More specifically, most central banks have more than one objective, which can also be conflicting with each other, namely the existence of one invalidates the existence of the other such as achieving low inflation and low unemployment. In this case, the independence of goals is of crucial importance if the central bank is free to decide the final objectives of monetary policy. Regarding the second, the central bank is independent in choosing

the instruments for achieving the objectives for the monetary policy.

The two Pillars strategy

As already mentioned, the primary objective of the Eurosystem is to maintain price stability in accordance with Article 105 of the Treaty. The implementation of the monetary policy of the ESCB requires the Governing Council to define precisely the term price stability, and to formulate a strategic policy. The press release titled "A Stability-oriented monetary policy strategy for the ESCB " in October 1998 provided important information to the public on how this objective could be achieved. According to this, the policy strategy should have the following three components:

1. Quantitative definition of the primary objective of monetary policy in the euro area, namely price stability. Price stability is defined as an annual increase in the Harmonised of Consumer Price Index (HCPI) for the euro area below 2% in the medium-run.

In order to maintain price stability the ECB's Governing Council agreed to adopt a monetary policy strategy, which consists of two basic elements:

2. It was assigned a prominent role to money. This role will be marked by a notice of the quantitative reference value for the growth of a broad monetary aggregate M3 (first pillar of the strategy).

3. The broad-based assessment of the prospects of price developments and risks to price stability in the euro area. This assessment is based on a wide

range of economic and financial variables as indicators of future price (second pillar of the strategy). Regarding the first, the definition of price stability with a purely quantitative manner is extremely difficult. Any measure currently used to measure inflation is problematic. There are various distortions that have to do with quality changes, introduction of new goods, changes in consumption patterns e.t.c. Despite this, the HCPI is the most appropriate price index for the definition of price stability that the ESCB. Moreover, focusing on the HCPI for the euro area, it is clear that decisions will be based on monetary, economic and financial developments across the euro area. The single monetary policy will adopt a perspective on the euro area as a whole and will not respond to individual developments at a regional or national level.

Considering the strategy of a central bank to achieve price stability, the time horizon is usually a hot topic of controversy. The notion that price stability should be maintained in the medium-run indicates that monetary policy should be oriented at medium-run, although the fact that the prices have short-term volatility - which cannot be controlled by monetary policy.

According to the ECB, the quantitative definition of price stability is based on sound economic criteria. Allowing only for low growth rates of the price level, the cost of inflation is minimized. Moreover, the quantitative definition helps to control inflation expectations and therefore the uncertainty created by the existence of inflation is reduced. Finally, ECB has the chance to

further strengthen its credibility and effectiveness of the monetary policy conducted.

Regarding the two pillars as the strategy of the ECB, they form part of a broader strategic framework and their role is to provide an outline for organizing, analyzing, and verify the large amount of economic information that are available to the architects of monetary policy. The distinction between the two pillars of the strategy is a separate approach for analyzing the inflationary process.

More specifically, the first pillar provides an analysis which gives a prominent role to money - which is marked by the reference value for the increase in M3. The ECB chose to do this because the causes of inflation are monetary in nature in the medium - term, i.e. there is a long-term relationship between the price level and money. In macroeconomics, the relation between the price level and the quantity of money shows a remarkable empirical regularity and unlike other economies where this monetary development lacks this regularity, in the euro area the data indicate the existence of this relationship. Many academics and policy makers have misinterpreted the ECB's strategy, arguing that it has multiple purposes and that the two pillars represent competing and conflicting objectives. At that point it must underlined that the only objective of the ESCB is the price stability, in other words, the first pillar is not a monetary goal and the second is not an inflation target. To be more specific, as the first pillar states, the reference value of M3 is an intermediate

monetary target, i.e. the ECB tries to control monetary expansion so that it cannot exceed this reference value at a given time. The reference value is simply a mean of analyzing and assessing risks for price stability. Also, the strategy under the first pillar provides a deeper analysis of the behavior of M3 compared with the reference value and thus it is an estimation of the size of the monetary effects on the economy and a more realistic picture of the liquidity situation.

The ECB evaluates a wide range of other economic and financial indicators in the assessment of risks to price stability in the euro area. The analysis of the second pillar focuses on identifying those factors which affect any changes in prices in the short term but they may be consolidated and have negative effects on the stability of the price index in the medium-term. Also, under the second pillar, indicators which may affect the stability in the medium-term in a more direct way are analyzed, such as shocks in the supply and demand side, interactions among supply and demand and cost pressures. Other indicators that are examined under the second pillar are these of financial market and asset prices. The asset prices affect the evolution of prices -through the influence on income and wealth- and expectations for future price developments which reflect the expectations prevailing in financial markets.

I mentioned above that the ECB's strategy was misinterpreted by some economists who argue that the two pillars strategy represents competing and potentially conflicting objectives. There are cases where there may be

conflicting signals from the two pillars for the policy makers, but this should not be regarded as an argument in favor of putting limits on this strategy. If the strategy is based solely on one or the other pillar there is great possibility that problems may arise. Concerning the analysis under the first pillar, two main disadvantages may arise. First, it is possible that the M3 as a monetary indicator will give misleading information due to special factors such as the volatility of the velocity of money which makes difficult the interpretation of monetary developments in the short term. Second, monetary policy based solely on analysis of the first pillar may not give the appropriate attention to other factors that threaten price stability over the medium - term than money. For example, excess demand for labour is likely to create upward pressure on labour costs, which in turn can put pressure on consumer prices.

However, the approach and the strategy of the ECB in terms only of the second pillar, is also not recommended. As already mentioned, the orientation of the ECB is medium-term, and as far as the second pillar focuses on indicators that explain the short-term price developments, there is a danger to channel a short bias on monetary policy – despite that it contains forecasts beyond the year.

In conclusion, we would say that the reliance on a single index or a framework of analysis poses a high risk. The variety of indicators and a versatile analysis significantly reduces the risk of errors. The ECB's strategy is oriented to this diverse analytical framework that not only takes into account

the monetary nature of inflation but also incorporates the interplay of supply and demand pressures and cost in setting monetary policy. The two pillars strategy ensures that the information and analysis produced by a methodological perspective (first pillar) always intersect with the information and analysis of another perspective (second pillar). Besides, it is well known that monetary policy is complex and the environment in which central banks act is characterized by extreme uncertainty for relying only on a single analytical approach. For that reason, the ECB's strategy when presented to the public seems more complicated than other alternative strategies that are followed by other central banks, but reflects the complexity of the environment in which the ECB takes policy decisions - even more after the introduction of the euro.

A new strategy for the ECB?

Many economists criticized the strategy that the ECB follows (Svensson, 2000, 2005). The questions that arise is whether the Eurosystem is able to improve its strategy and how it could achieve something more efficient in terms of monetary policy. Regarding the first pillar, the Eurosystem's definition of price stability is an inflation rate below 2% annually. This definition is problematic, since it is ambiguous and asymmetric, and hence is less effective in controlling inflationary expectations. It is ambiguous because it is not clear on the lower bound of inflation and is asymmetrical because

the upper and lower bounds have been announced with different accuracy each, i.e. the upper bound is precisely defined but the lower bound not. A clear definition and symmetric definition could be a particular target point or a specific range of upper and lower limit (an alternative target range with x = 1% and y = 2%). Also, the range between 1% - 2% is very limited that it is clear that inflation will sometimes exceed these limits due to incomplete control by monetary authorities or unforeseen difficulties. The interval 1% - 2% is a clear span within which the ECB will be able to put the point target of 1.5% - which seems to follow anyway, but with the difference that now it will be clearly defined.

Another option would be to increase the limit to 1.5% -2.5%, putting the target at 2%, thereby reducing the probability of zero inflation or even deflation (Svensson, 2000). This reduces the risk to interest rates which are close to zero but also favors those countries that suffer from very low inflation (such as Germany). It could also raise the target further of 2.5%, as the Bank of England, Denmark, Iceland and Australia. The main issue is not the rate of inflation, but if it is defined clearly and precisely.

Regarding the strategy of the two pillars, the criticism for the ECB is that there should be only one pillar in which all the relevant information (monetary and credit aggregates) can be incorporated in order to get precise predictions about the evolution of inflation and output, provisions that are necessary for the design and conduct of monetary policy. The first pillar of the

Eurosystem is an unreliable indicator of future inflation, so it isn't worth maintaining it separately. The belief that the increase in the quantity of money is an important indicator for inflation, results from the already known high correlation that exists between them. Nevertheless, this relationship is often misunderstood. Since there is a correlation between two endogenous variables this cannot tell us anything about the direction of causality between them (money and inflation). The increase in the amount of money and inflation may be caused by other variables as well. The direction of causality is determined by the type of monetary policy that is followed every time. For example, under restrictive monetary expansion, the increase in the amount of money is constant, and therefore exogenous to inflation. So, one can say that endogenous inflation is caused by exogenous monetary growth. Similarly we can claim the opposite, i.e. under strict inflation targeting any increase in the amount of money is caused by exogenous inflation. Another example is when the target is the exchange rate, and the endogenous home inflation is determined by the foreign inflation. The domestic interest rate will be equal to the foreign interest rate and the endogenous growth of the amount of money should be determined by the demand for money which will be formed for a given domestic interest rate, level of product and price. Thus, we see that under fixed exchange rate, money growth and inflation are affected by other variables although in the long run they have high degree of correlation.

In fact, the high correlation between money growth and inflation in the long

run are largely irrelevant to the conduct of monetary policy in practice. The reason is that the key issue for the monetary policy is the relationship of these two at shorter intervals rather than those listed as long-run, about 1 -3 years. A number of studies have shown, using valid arguments that the correlation between money growth and inflation is much smaller at shorter intervals. This becomes more clear when we recall that a nominal increase of money equals the real growth of money plus inflation. Assuming that real money growth is relatively stable, the nominal money growth and inflation are highly related. Nevertheless in the short run the real money growth is quite volatile so that we have little correlation between inflation and money growth. The high correlation between money growth and inflation in the long term means that the long-term inflation rate can occur if the central bank suffers from long-term growth of money as also that a modest growth rate of money leads to a modest average rate of inflation. But even this can't prevent the high volatility of inflation around its long run mean. Indeed, Rudebusch and Svensson (2002) showed with data used for the U.S. economy that the money growth targeting, in order to stabilize the supply of money, is not the best policy that a monetary authority could follow as this would create great volatility of inflation and output gap compared with the results of inflation targeting. Interestingly, the work of Fats and Mihov (2003) questions the relationship between money growth and inflation even in the long run. For countries with inflation below 5% during the period 1970-1999 average growth of money and the average inflation rate was found

to be uncorrelated. From this, we can conclude that the increase of money is a less reliable tool for forecasting future inflation, at least for the periods to which monetary authorities are concerned (Stock and Watson, 2003).

This means that there should be a flexible strategy of inflation targeting - just as it is done by major central banks in other countries. For the central bank this means to communicate a symmetrical inflation target and use all available information so that forecasts are consistent with actual inflation (and interest rates). The adoption of such a flexible strategy should be accompanied by improved transparency procedures and communications to the public. The Monthly Reports must be improved and there should be a record of the meeting of the Board of ECB, as it happens with the Bank of England and the Riksbank. This will enable the public to monitor the quality of the discussions for setting monetary policy.

1.4 Inflation Differentials in Currency Unions

While the countries in a monetary union share the same currency and the same monetary policy, the price level of each member - country may differ. It is not surprising to see different price levels and different inflation rates across the members of a monetary union. The best example for this fact is provided by the experience of the United States, one of the longest established currency unions. Several studies tried to explain the causes and the behavior of these divergences in the U.S. Cecchetti et al. (2002) in their study find

that inflation differentials across U.S. cities are large and they can persist foe quite a long. Parsley and Wei (1996) examined if the law of one price holds for the U.S. and they found that the deviations from it are persistent in both traded and non - traded sector goods.

Tradeable goods and non-tradeable goods can be a source of divergence in the price level across the regions of a monetary union. More specifically, deviations from the Law of One Price for the traded sector and deviations in the relative prices of the non-traded sector can lead to different price levels among the members of a monetary union.

Following Duarte (2003) we can consider a currency union with only two countries 1 and 2. If we assume that the price level is given by a geometric weighted average of the prices of traded and non-traded goods, we have:

$$\begin{aligned} p_{i,t} &= ap^N_{i,t} + (1-a)p^T_{i,t} \qquad (1.4.1) \\ \text{where } i &= 1,2 \end{aligned}$$

$p_{i,t}$ is the log of the price index, $p^N_{i,t}$ and $p^T_{i,t}$ are the log of the trade and non-traded goods price index respectively and a is the share of the non - traded goods in the overall price index. In the case of an asymmetric shock that affects either the price index of traded or the non - traded sector across the countries, it will create inflation differentials. An example would be the

faster productivity growth in one member - country in the traded sector relative to the non - traded sector. This will create higher inflation rates for the country with the higher growth. How this can happen? A positive shock to the productivity of the traded sector will lead to higher real wages in the country assuming that there is perfect labour mobility across the different sectors. At the same time, if the productivity on the non - traded sector has not risen the relative price of non-traded goods in this country rises too and assuming that the Law of One price holds this means that the price level of this country rises in comparison to the one of the other country. Inflation differentials that are generated from productivity shocks is an equilibrium phenomenon and it will persist as long as productivity differentials are apparent between the members of the union. This is also known as the Balassa - Samuelson effect. Moreover, if initial price levels differ across countries at the beginning of the union, then the adoption of a common currency will lead to price convergence which is also a source of inflation differentials.

1.5 The adoption of the euro and behavior of the inflation

1.5.1 The path of inflation in EMU years

Focusing on the period before the third stage of EMU in 1997 and afterwards, in 1.1 we observe that the indices of dispersion of inflation in the eurozone

Tab. 1.1: EMU inflation rates

GEO/TIME	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium	1.1	2.7	2.4	1.6	1.5	1.9	2.5	2.3	1.8	4.5	0.0	2.3	3.5
Germany	0.6	1.4	1.9	1.4	1.0	1.8	1.9	1.8	2.3	2.8	0.2	1.2	2.5
Ireland	2.5	5.3	4.0	4.7	4.0	2.3	2.2	2.7	2.9	3.1	-1.7	-1.6	-1.5
Greece	2.1	2.9	3.7	3.9	3.4	3.0	3.5	3.3	3.0	4.2	1.3	4.7	3.1
Spain	2.2	3.5	2.8	3.6	3.1	3.1	3.4	3.6	2.8	4.1	-0.2	2.0	3.1
France	0.6	1.8	1.8	1.9	2.2	2.3	1.9	1.9	1.6	3.2	0.1	1.7	2.3
Italy	1.7	2.6	2.3	2.6	2.8	2.3	2.2	2.2	2.0	3.5	0.8	1.6	2.9
Luxembourg	1.0	3.8	2.4	2.1	2.5	3.2	3.8	3.0	2.7	4.1	0.0	2.8	3.7
Netherlands	2.0	2.3	5.1	3.9	2.2	1.4	1.5	1.7	1.6	2.2	1.0	0.9	2.5
Austria	0.5	2.0	2.3	1.7	1.3	2.0	2.1	1.7	2.2	3.2	0.4	1.7	3.6
Portugal	2.2	2.8	4.4	3.7	3.3	2.5	2.1	3.0	2.4	2.7	-0.9	1.4	3.6
Finland	1.3	2.9	2.7	2.0	1.3	0.1	0.8	1.3	1.6	3.9	1.6	1.7	3.3
Euro area 12	1.1	2.1	2.4	2.3	2.1	2.1	2.2	2.2	2.1	3.3	0.3	1.6	2.7
Min	0.5	1.4	1.8	1.4	1.0	0.1	0.8	1.3	1.6	2.2	-1.7	-1.6	-1.5
Max	2.5	5.3	5.1	4.7	4.0	3.2	3.8	3.6	3.0	4.5	1.6	4.7	3.7
Range	2.0	3.9	3.3	3.3	3.0	3.1	3.0	2.3	1.4	2.3	3.3	6.3	5.2
St. Dev	0.75	1.14	1.06	1.18	0.96	0.60	0.79	0.69	0.54	0.72	0.82	1.58	1.51

have reached their lowest levels during the second half of that year, increased slightly during 2000 and remained stable until the early 2001. In particular, the dispersion of inflation (in terms of standard deviation) decreased over time, especially during the second half of the decade of 1990. The non-weighted standard deviation was reduced by about 4 percentage points at the beginning of nineties to 1 percentage point in the season opening of the third stage of EMU in January 1999. Nevertheless, the lowest values of the dispersion of inflation occurred shortly after the middle of the same year (1999). Then, the dispersion of inflation rose again in 2000 without incurring major changes until the beginning of 2002.

In Table 1.1 there are the inflation rates for each member - country from the beginning of the union until 2011 and some basic statistics for each one of them.

Fig. 1.1: Deviation of Inflation in EMU

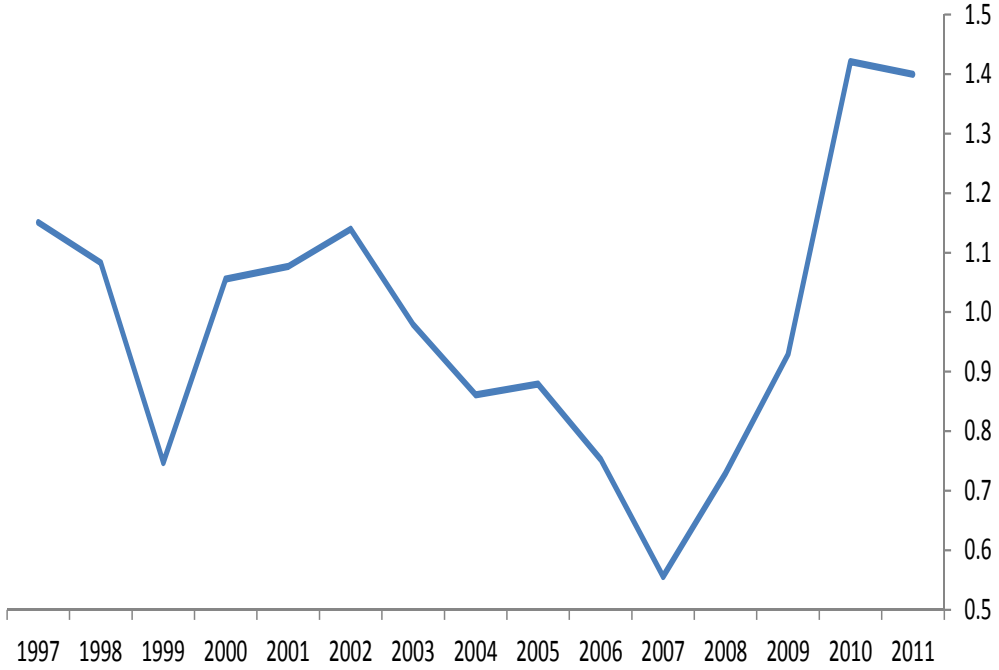


Figure 1.2 depicts the inflation rates for a subset of euro area countries. We can clearly see that inflation differentials were apparent from the beginning of the monetary union with Ireland and Greece having the highest rates and the larger differentials with Germany. Of course, there is a similar behavior of the inflations among all the countries during the period of the financial crisis where the decline of the inflations in all countries is very obvious. We can also see that except for France and Germany where their inflations were around the target of 2% in all other countries of the subset the inflation is above for most of the time under consideration.

Turning now to the behavior of inflation dispersion in the euro area for the same period (1998 - 2010) Figure 1.3 plots two summary statistics: the absolute difference between the highest and lowest inflation rates and the unweighed standard deviation of inflation rates. The absolute spread decreased sharply before the launch of the monetary union, as a result of the Maastricht criteria that had to be met before 2001 and then increased up to levels of 4% during the mid - 2000s. It decreased after 2006 to 2% and after the financial crisis rose again to even higher levels. The standard deviation has also a similar behavior.

Figure 1.4 plots the average inflation rates for the period 2000 - 2010 against the price level in 1999 for the 12 countries that initially participated in the eurozone. The relationship is clearly a negative one, with a correlation coefficient equal to -0.68, and this evidence is a strong argument that price level

Fig. 1.2: Inflation Rates 1998 - 2010

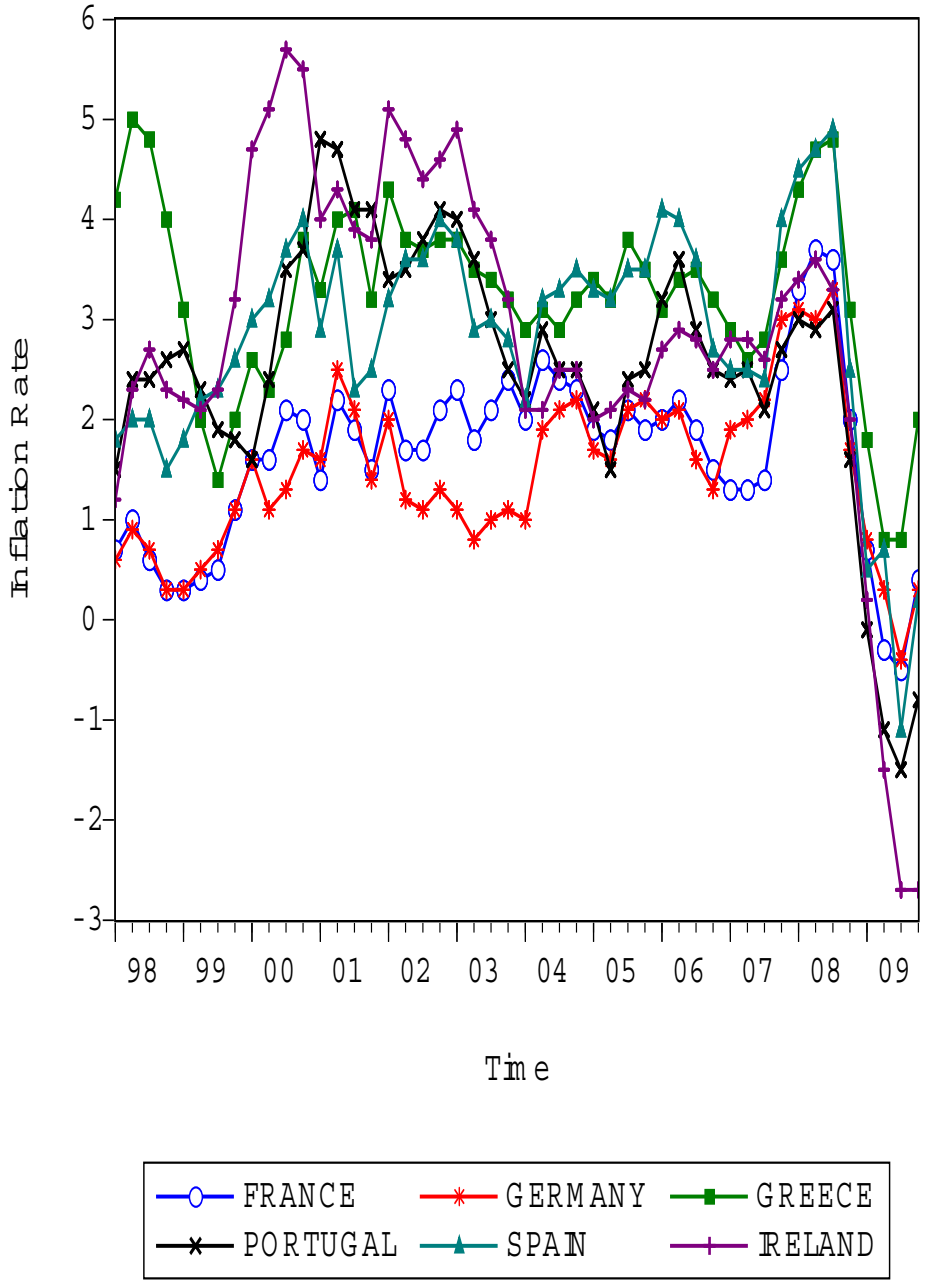
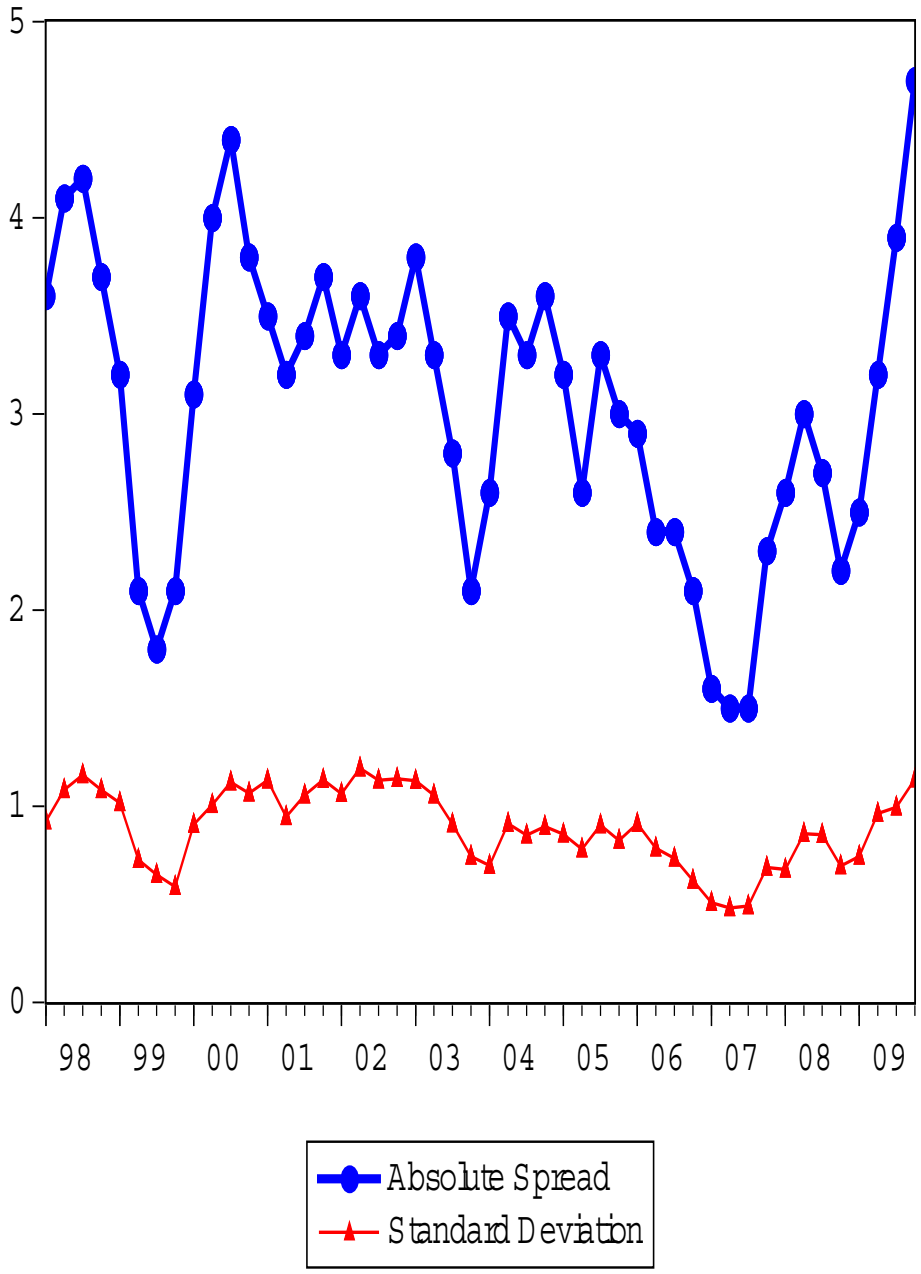


Fig. 1.3: Inflation Dispersion in the Eurozone



convergence is a partial explanation of inflation differentials at least during the first years of EMU.

Finally, in Figure 1.5 I plot the average inflation rate for the period 1998 - 2010 against the average growth rate of GDP for the same period of time for the same set of countries as previously. In this figure we can clearly see a positive relationship between these two variables after the adoption of the euro. According to the Balassa - Samuelson effect, this figure suggests that inflation differentials could be indicative of a process of convergence of productivity levels across member - countries of the eurozone as well as of the asymmetric shocks and desynchronized business cycles among countries (Duarte, 2003).

Fig. 1.4: Initial Price Level and Average Inflation Rates

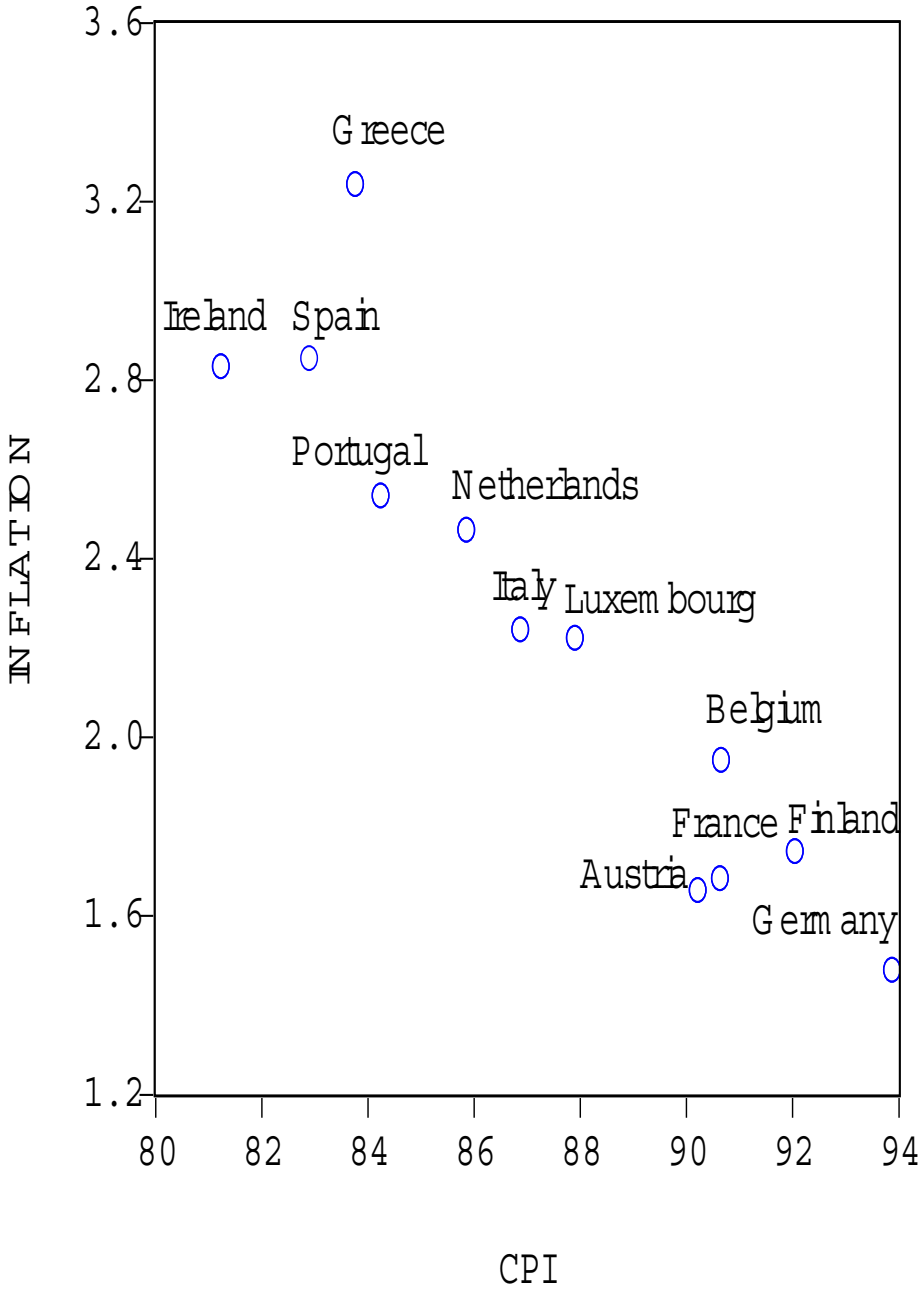
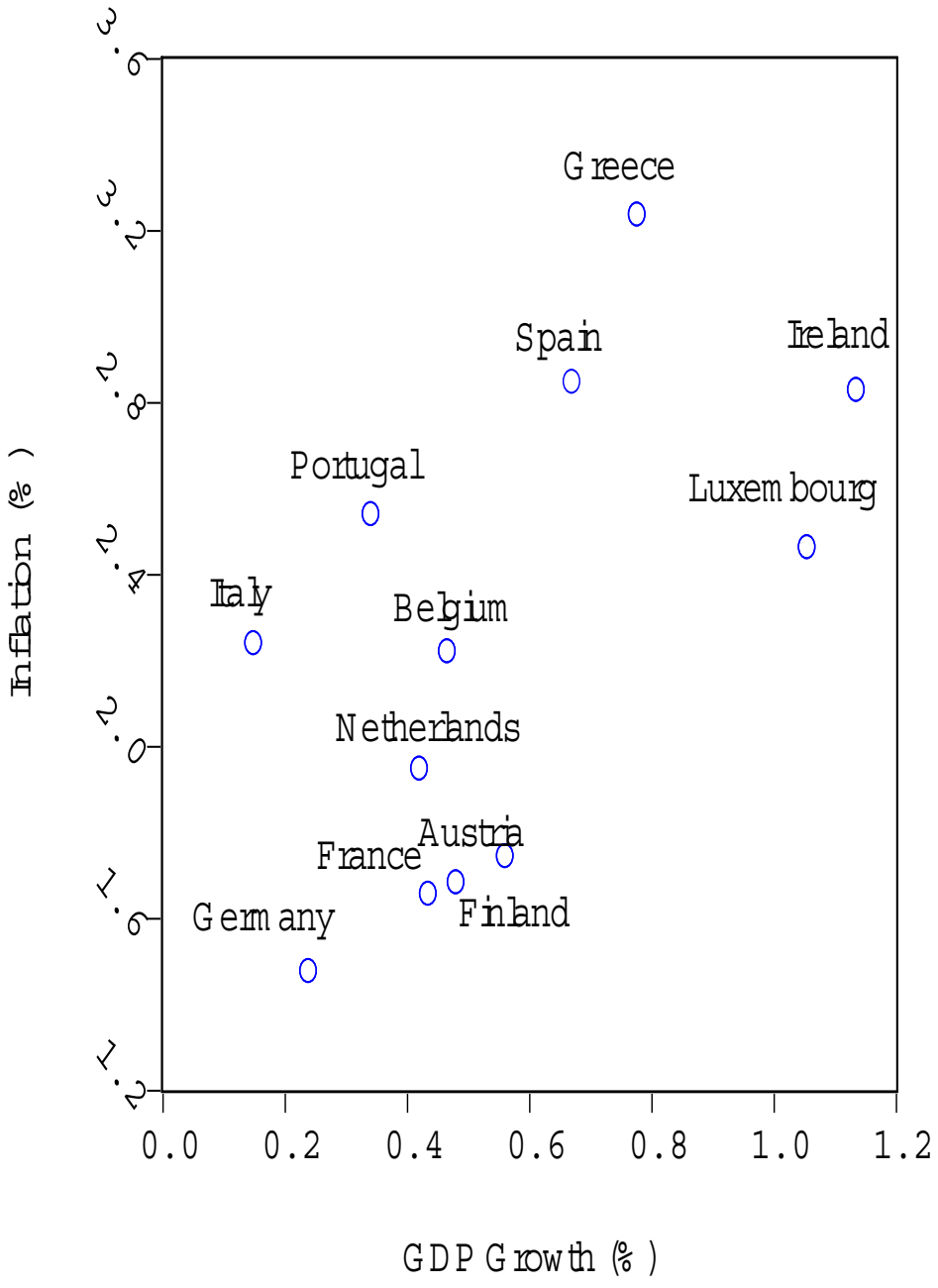


Fig. 1.5: Euro area Average Inflation Rates and GDP Growth Rates 1998 - 2010



1.5.2 Inflation persistence

Inflation in the eurozone is often described as "persistent". This was particularly noticeable in 2003 where, despite the weak demand, inflation has only a slight decline from 2.3% in 2002 to 2.1% in 2003. A large degree of inflation persistence is due to rigidities in labor and product market, which makes the adjustment process of the economy after several quarters more harmful. Economists make a common assumption that there is a temporary wage and price rigidity in the economy. These rigidities arise due to institutional factors (such as labor contracts, the structure of the social security system, the wage-setting process, etc.) and because of the existence of so-called cost price list (menu - cost). In any case, the persistent inflation may form an obstacle to the monetary authority (on the policy mix that will follow) in cases of low economic growth. From 1960 and onwards, inflationary expectations play a key role as an important source of persistent inflation. For example, the persistence of inflation may be due to the fact that people in order to formulate their inflation expectations use data from the recent past. In a different case, people may form expectations about high inflation in an environment with low inflation due to the lack of credibility of the monetary policy.

In order to assess whether inflation is persistent or not, we can distinguish between univariate and multivariate models. In the first case, the researcher attempts to examine the time course of inflation by relying on the information

it gets from past prices, while in the second case he takes into account the interactions between inflation and other macroeconomic variables according to economic theory. Although there is a variety of approaches to assess the persistence of inflation, there is still no consensus in the literature about which method is most appropriate. Below we will consider the two approaches.

Univariate time series models

The first approach involves univariate time series models, namely the inflation rate is determined by past prices. More specifically, persistence of inflation is the time required after a disturbance in order to return inflation to the level it was before this disorder. Although it is simple to understand, it is not as simple to evaluate it. One of the most direct ways to assess the degree of inflation persistence is to examine the relationship of inflation in the quarter of a year with that of other previous quarters (quarterly data are used so as to avoid any transient changes that may be present in monthly data). If inflation shows persistence of a high degree then someone would expect that inflation will be associated with the one in previous periods and that these correlations will decrease slowly. In other words, when a shock perturbates the inflationary process may affect inflation for a long time.

Inflation path over the economic cycle

Alternatively, we can assess the behavior of inflation from a different perspective and study how it responds to downturns in economic activity (cyclical downturn). This is another way to interpret the meaning of persistence of inflation and it shows the time needed for inflation to respond to changes in economic activity. This alternative interpretation is a multivariate econometric approach where inflation depends not only on past prices and other variables that affect the dynamic path, such as changes in supply and demand conditions but also in other disorders that may affect the economy (data contained in the New Phillips curve).

A first assessment of the extent of inflation persistence is the time needed for the inflation to respond to a critical point of growth of GDP. Stock and Watson (2001) in their study included the business cycle properties of 71 macroeconomic time series in the U.S., and they find that inflation is procyclical. Similar behavior is observed in the euro area and the only difference with the case of U.S. is that it seems to be less persistent.

2. CAUSES FOR INFLATION DIFFERENTIALS IN EMU

2.1 Introduction

The comparison between the size of inflation differentials in EMU and the U.S. is not sufficient to properly assess a relationship of inflation differentials with the conduct of monetary policy. The causes of this phenomenon should also be investigated and analyzed properly in more detail trying to investigate the main sources for this. In the remainder of this chapter I try to present some of the main causes for inflation differentials in eurozone using descriptive statistics and econometric evidence.

2.2 Structural reasons

Below I will examine the influence of structural effects (externalities, convergence of market, non-tradable goods sector and market rigidities) in shaping inflation differentials.

External reasons

The divergence of inflation rates may have an outer dimension of a structural nature, which is linked to disturbances in oil prices and changes in exchange rates. If economies are more dependent on each other than on oil or have different transmission mechanisms of the effects of changes in exchange rates the contribution to the deviation of inflation will be very weak. The different country's dependence on oil is measured as the share of net oil imports as a percentage of GDP and appears to differ from country to country (Eurostat). At that point, we must note that the relationship between the country's dependence on oil and the inflation differential does not seem to be so strong if we take into account the impacts of a price change of the former in an economy. This means that the change in oil price will enable governments to react which is likely to differ from country to country. For example, the large increase in oil prices in 1999-2000 was accompanied by additional control measures by the governments and as a result the price index was affected in different ways in each country.

Tradable goods price convergence

The literature often assumes that the true Purchasing Power Parity (PPP) for tradable goods (prices of homogeneous goods denominated in the same currency differ from country to country) is valid. Despite this, there are still differences in the prices of tradable goods even within the eurozone. Although

these differences are small compared to those of non-tradable goods, it seems to correlate with the latter. The differences in prices for traded goods are likely to be affected by the level of national and international competition, which in turn depends on factors such as the effectiveness of national competition policy in each country and a country's exposure to international trade. We can observe a sharp decrease of the dispersion of prices of traded goods in the first half of 1990's due to the implementation of the Single Market. But the pace of price convergence has decreased in recent years (Rogers, 2007). The single currency contributed positively to reducing these differences. The reason of their existence is that there are still differences in indirect taxation, the structure of distribution networks, the existence of monopoly power and inefficient service sectors (European Commission, 2002a). For example, the car market shows a wide divergence in prices between countries. The decomposition of the Single Market might have played an important role in the fact that prices of traded goods vary from country to country, and policies that will reduce this divergence will increase competition in the tradable goods and services could help reduce the spread of inflation, such as the exclusion of national regulations that prevent free trade, improvements in national and European competition policies, etc. (though it remains still difficult to assess the impact of one of these measures to variations in commodity prices and inflation). It is important to mention that there is no connection between the dispersion of price levels and dispersion of price changes between the member - countries of the tradable goods sector. The convergence of price

levels of tradable sector could accompany both, convergence and divergence of changes in prices of traded goods, each time depending on the nature of changes in national competitiveness. However, we should always take into account that even after the completion of the Single Market there are differences in price levels to the extent that each national market has nominal rigidities together with price discrimination practices.

Non - Tradable goods price convergence

The Model of Balassa-Samuelson (BS) which explains the differences in prices of non-traded goods between countries has been much discussed recently in relation to inflation differentials occurring in countries of a monetary union. The main reasons for the deviations of inflation is the productivity differential that exists between tradable and non-tradable goods. The tradable sector is mainly the industrial sector which is predominantly capital intensive and more competitive than the second, which consists mainly of the service industry and is labor intensive and less competitive. When productivity in the tradable goods increases then wages increase without leading to higher prices. Because of the mobility of labor, wages in the non-tradable goods will also increase until they will be equal to those of the first sector, but it will lead to higher prices of non-traded goods, since the factor productivity has not increased accordingly. The higher factor productivity in tradable goods but also the biggest inflationary pressures in the non-tradable goods is verified

from 1960 and onwards in all euro area countries. The greater the productivity differential of both sectors, the higher the inflation differentials. Because of the differences in productivity among member - countries, there are also differences in the rates of inflation, which may be regarded as "equilibrium" deviations (steady-state inflation). Also, it should be noted that as increases in wages in the tradable sector reflect gains in terms of productivity, the issue of competitiveness arises too. The BS model assumes that the true PPP for the tradable sector holds. But although it has been rejected by many studies, at least in the short run, the results given by the model are consistent with historical data for longer periods. But there are some disadvantages which make it difficult to quantify the potential effects of the BS model. These are mainly related to the assumptions made and the difficulties that arise in order to isolate the effects of the BS model by other influences that influence inflation in the past, mainly differences in monetary and exchange rate policies among countries. These disadvantages have led to a wide range of studies made for the BS effect and led to mixed results for each one. But it should be noted, that these studies are not directly comparable because of the different methodology used each time and the different samples. Some of these studies however, clearly show that Germany and France were below the eurozone average while Greece and Ireland above.

Market rigidities, structural reforms and inflation differentials

As mentioned above the level of inflation differentials and their persistence can be affected by nominal and real rigidities that affect the productivity. Reducing these rigidities through structural changes may improve conditions and may facilitate the absorption of shocks and therefore reduce the persistence of the effect on inflation. However, structural reforms in each country individually may have a temporary negative impact on wage and price formation and of course on inflation differentials. For example, short-run effects on demand followed by a reduction in income tax could lead to increased inflation. This effect depends on a number of factors including the nature of these reforms, the time horizon etc.

We can distinguish between two main types of structural reforms: First, structural reforms in specific sectors (such as network industries) are likely to have a temporary effect on inflation until the price level in both, in the sector and the economy reaches a new stable equilibrium point (steady-state). Second, measures of "horizontal" structural reforms, including reforms designed to increase supply and demand in the labor market is likely to enhance the overall level of economic activity. This in turn will result in higher inflation, assuming some constraints (capacity constraints).

Now regarding the timing of the above, it is difficult to predict the effect of structural changes in inflation in a particular country during the adjustment period following the policy changes. This adjustment period can last up to

several years and is always dependent on the nature of reform. In the long term, however, well-planned structural changes should reduce nominal and real rigidities. The greater the degree of price and wage flexibility, the easier and faster the economy adjusts to shocks and therefore reduces the likelihood of persistent inflation differentials in a monetary union.

The effect of structural reforms on inflation depends on the symmetry with which these reforms take place in the eurozone. On one hand, reforms aimed at reducing the level of prices in countries with asymmetric inflation rates above the average and it is likely to contribute to a temporary reduction in inflation differentials. On the other hand, the asymmetric implementation of reforms aimed at stimulating demand in rapidly developing economies may temporarily increase inflation differentials among euro area countries.

2.3 Cyclical reasons

Three mechanisms are significant for inflation differentials in a monetary union. First, since all countries have the same nominal interest rates, a country with high inflation rate will have lower real interest rate compared to the one in the union as a whole, assuming that the underlying inflationary expectations are specific to each individual country. Under these conditions the deviations of inflation will be enhanced through demand (disequilibrating mechanism). Second, a country with inflation above the average of the currency area tends to have a loss in competitiveness due to higher

prices, reducing demand (dampen) the product domestically (re-equilibrating mechanism). Third, the toughness of the dynamic evolution of inflation and output is possible to reproduce and expand the deviations.

2.3.1 Economic cycle and inflation

The differential inflation in the eurozone countries can be caused (at least part of) due to their different positions during the economic cycle. To the extent that inflation in each country is affected by the output gap, inflation differentials in the member states might reflect differences in the size of the output gap between them.

Several studies (Sinn and Reutter, 2001; Alberola and Tyrvinen, 1998; Tsintzos and Dergiades, 2011) showed a positive correlation between the measures of the cyclical positions of countries in the euro area and the relevant rate of inflation rates. Since the start of Stage Three of EMU in 1999, countries with inflation above the average had a higher overall growth of their output compared to the eurozone average and vice versa. Moreover, inflationary pressures are greatest in those countries with relatively large (positive) output gap (Eurostat, ECB).

Focusing on the demand side of the economy, it is evident that a number of factors related to the economic cycle could have resulted in differences in the output gap and hence to differences in inflation in the eurozone countries. Wages and unemployment may also have a role. Inflation in countries that

are above average are in line with high increases in wages and significant reductions in unemployment for some eurozone countries. In some countries however, such as Ireland and the Netherlands lower unemployment is likely to reflect not only changes in the economic cycle but also some improvement due to structural changes in the labor market.

2.4 Econometric Evidence

With the purpose of establishing the relative contributions of some of the causes of driving inflation divergence in EMU, I ran multivariate regressions using quarterly data for the period from 1q1999 to 4q2010. A general specification for explaining inflation differentials can be written as :

$$\pi_{it} - \pi_t^{EMU} = \alpha_i + \beta(P_{i,t-1} - P_{t-1}^{EMU}) + \gamma(\chi_{i,t} - \chi_t^{EMU}) + \varepsilon_{i,t} \qquad (2.4.1)$$

where $\pi_{i,t}$ is the inflation rate of country i for period t, π_t^{EMU} is the average inflation rate for the euro area, α_i is the unobserved country - specific effect, $P_{i,t-1}$ and $P_{t-1}^{EMU}$the national and euro area price levels respectively and $\chi_{i,t}$ and χ_t^{EMU} are the vectors of national and eurozone variables which play a key role in determining inflation differentials in the short run. In order to get a more simple version of the above equation we can follow Honohan and Lane (2003) and linearly combine into a time variable the euro area variables and obtain the following equation:

$$\pi_{it} = \alpha_i + \beta P_{i,t-1} + \gamma \chi_{i,t} + \phi_t + \varepsilon_{i,t} \tag{2.4.2}$$

where

$$\phi_t = \pi_t^{EMU} - \beta P_{t-1}^{EMU} - \gamma \chi_t^{EMU} \tag{2.4.3}$$

The explanatory variables that are included in the $\chi_{i,t}$ vector, are chosen on the rationale of the analysis in the previous section of this chapter. These variables are a measure of Balassa - Samuelson effect, output gap, a measure of fiscal stance and the growth rate of the nominal effective exchange rate. At that point we must note that the time dummies in the regression capture the euro - area common movements in inflation and in the regressors (Honohan and Lane, 2003). This leaves the regression to explain inflation differentials coming from idiosyncratic national movements in the determinants. So, our empirical specification is as follows:

$$\pi_{it} = \alpha_i + \beta P_{i,t-1} + \gamma_1 BS_{i,t} + \gamma_2 GAP_{i,t} + \gamma_3 FISC_{i,t} + \gamma_4 NEER_{i,t} + \phi_t + \varepsilon_{i,t} \tag{2.4.4}$$

where $\pi_{i,t}$ is the quarterly inflation rate in country i, $BS_{i,t}$ captures the Balassa - Samuelson effect through the difference between the CPI and PPI,

$GAP_{i,t}$ is the output gap, $FISC_{i,t}$ is the fiscal stance, where I included the deficit and the public debt as a measure for that, and $NEER_{i,t}$ is the growth rate of the nominal effective exchange rate. All the data are taken from Eurostat and are in quarterly frequency. Tables 2.1 and 2.2 show the results for the panel estimation using four different measures of inflation, namely Harmonized Index of Consumer Prices (HICP), HICP excluding energy, GDP deflator and private consumption deflator. Table 2.1 displays the pooled OLS estimates and Table 2.2 displays GMM estimates where I instrument for the fiscal variables and the output gap using lagged values of these variables.

When we estimate the causes of inflation differentials using OLS we see that the exchange rate has a significant impact on this phenomenon in euro area. The explanation is simple and very straightforward: when a member country experiences a nominal exchange rate depreciation will also experience higher inflation relatively to the rest of the currency area. In the HICP equation (first row) we see that the estimator is 0.22 meaning that a relative depreciation of 3 percent will result in almost 1 percent higher inflation in comparison to the rest of the union. The output gap is mainly important for HICP. The fiscal measures affect the GDP deflator rather than the HICP. However, the public debt has the opposite sign than what the one someone would expect. Moreover, the estimators are very small that someone would argue that its impact is almost negligible. Finally, the results show that differences in productivity growth (Balassa - Samuelson effect) is an important factor for producing inflation differentials in EMU countries.

Tab. 2.1: Euro Area inflation differentials: Pooled Least Square estimates

	(1)	(2)	(3)	(4)
Productivity Growth	-2.11	-1.38	-5.5	-0.56
	(-3.92)***	(-2.88)***	(-6.16)***	(-4.00)***
Public Debt	-0.005	-0.01	-0.02	-0.002
	(-0.78)	(-1.66)**	(-2.35)**	(-1.45)
Budget Deficit	0.09	0.04	0.14	0.002
	(2.17)**	(1.21)	(2.13)**	(0.20)
Output Gap	0.29	0.22	0.18	-0.03
	(3.9)***	(3.37)***	(1.42)	(-1.67)*
Log of Exchange Rate	-0.22	-0.1	-0.14	-0.39
	(-3.2)***	(-3.3)***	(2.17)***	(-4.94)***
SE of regression	0.63	0.54	0.55	0.88
Adjusted R^2	0.72	0.73	0.57	0.32

*The dependent variables in columns (1) - (4) are the inflation differentials based on: (1) HICP; (2) HICP excluding energy; (3) GDP deflator; (4) private consumption deflator Time - fixed effects included; The t-statistics are based on White - corrected standard errors. *, **, *** denote significance at the* 10%, 5% *and* 1% *levels respectively.*

Tab. 2.2: Euro Area inflation differentials: Pooled GMM estimates

	(1)	(2)	(3)	(4)
Productivity Growth	-1.41	-1.08	-2.5	-1.64
	(-1.25)	(-3.75)***	(-5.56)***	(-2.00)*
Public Debt	-0.01	-0.08	-0.005	-0.004
	(-0.78)	(-1.08)*	(-2.42)**	(-1.45)
Budget Deficit	0.15	0.06	0.51	0.01
	(2.54)**	(1.98)*	(2.35)**	(0.25)
Output Gap	0.54	0.15	0.38	0.001
	(2.8)**	(2.27)**	(2.42)*	(-1.05)
Log of Exchange Rate	-0.22	-0.15	0.04	-2.29
	(-2.5)***	(-3.8)***	(1.76)***	(-3.74)***
SE of regression	0.50	0.53	0.42	0.78
Adjusted R^2	0.48	0.65	0.57	0.42

*The dependent variables in columns (1) - (4) are the inflation differentials based on: (1) HICP; (2) HICP excluding energy; (3) GDP deflator; (4) private consumption deflator Time - fixed effects included; The t-statistics are based on White - corrected standard errors. *, **, *** denote significance at the* 10%, 5% *and* 1% *levels respectively.*

In addition, I conduct GMM estimation in order to defend for the case of a probable opposite causation between inflation and fiscal policy and output levels. The results are not very different if we compare them with the OLS estimation above. We can only say at this point that the significance levels change in the case of the exchange rate and the Balassa - Samuelson effect (productivity growth). Overall, the conclusion is the same as previously i.e. that the exchange rate, the output gap and the BS effect play a significant role for the inflation differentials in eurozone.

2.4.1 Robustness Checks

Table 2.3 displays the results of GMM estimation using alternative measures of fiscal stance. Instead of budget deficit and debt in the same regression I exclude one each time (column 1 contains only budget deficit and column contains only public debt). In column 3 I use the fiscal surplus in first differences as an indicator of fiscal stance for this period. The results are almost unaffected from this change in the data. In Table 2.4 I excluded countries from the sample which are considered to be outliers (Ireland and Greece because of the high inflation differentials especially at the beginning of the period and Luxembourg because of the very different economic performance especially in fiscal numbers). The results are not very different from the previous exercise.

Tab. 2.3: Euro Area inflation differentials (Alternative specification for fiscal stance): Pooled GMM estimates

	(1)	(2)	(3)
Productivity Growth	-2.05	-1.28	-2.5
	(-2.45)**	(-2.68)***	(-5.28)***
Public Debt		-0.04	
		(-1.32)*	
Budget Deficit	0.12		
	(2.00)**		
Fiscal 1st Diff			-0.05
			(-1.16)*
Output Gap	0.32	0.17	0.09
	(2.9)**	(1.97)**	(1.42)*
Log of Exchange Rate	-0.25	-0.51	0.24
	(-2.2)**	(-3.7)***	(2.02)**
SE of regression	0.54	0.62	0.45
Adjusted R^2	0.76	0.42	0.69

*The dependent variable in columns (1) - (3) is the inflation differentials based on HICP; Time - fixed effects included; The t-statistics are based on White - corrected standard errors. *, **, *** denote significance at the* 10%, 5% *and* 1% *levels respectively.*

Tab. 2.4: Euro Area inflation differentials (excluding Ireland, Greece and Luxembourg): Pooled GMM estimates

	(1)	(2)	(3)	(4)
Productivity Growth	-2.42	-2.58	-3.5	-0.56
	(-1.97)*	(-2.08)**	(-5.26)***	(-3.45)***
Public Debt	-0.009	-0.06	-0.13	-0.001
	(-0.78)	(-1.07)	(-2.05)**	(-2.65)**
Budget Deficit	0.11	0.09	0.26	0.007
	(2.45)**	(1.05)	(2.25)**	(0.02)
Output Gap	0.34	1.22	0.31	0.06
	(2.5)**	(3.98)***	(1.87)*	(1.00)
Log of Exchange Rate	-0.22	-0.32	0.25	-1.28
	(-3.77)***	(-2.54)***	(2.52)***	(-3.94)***
SE of regression	0.67	0.45	0.68	0.84
Adjusted R^2	0.72	0.76	0.69	0.35

*The dependent variables in columns (1) - (4) are the inflation differentials based on: (1) HICP; (2) HICP excluding energy; (3) GDP deflator; (4) private consumption deflator Time - fixed effects included; The t-statistics are based on White - corrected standard errors. *, **, *** denote significance at the* 10%, 5% *and* 1% *levels respectively.*

2.5 Conclusions

In this chapter I try to expose the main causes of inflation differentials in eurozone for the period 1999 - 2010. The results based on a panel data model estimated using OLS and GMM suggest that one major factor of this divergences among member - countries is the Balassa - Samuelson effect (defined as productivity growth in the estimations) and the nominal effective exchange rates deviations. Inflation differentials seem to be the result of different position of the countries in the economic cycle (the output gap in the estimations). The empirical evidence shows that 1 percent increase in output gap will result to 30 basis points increase in the inflation rate of the countries in euro area. However, and even surprisingly, fiscal stance doesn't seem to affect strongly the inflation differentials, only slightly.

3. INFLATION DIFFERENTIALS IN EMU: WHAT CAN WE LEARN FROM THE TIME SERIES EVIDENCE?

3.1 Introduction

It has been eleven years since the beginning of European Monetary Union (EMU) and the introduction of the euro. After a sharp convergence of the inflation rates of the countries initially participating in the monetary union during the nineties national inflation rates started diverging again. Although the European Central Bank (ECB) has done relatively well in relation to price stability in the monetary union as a whole, national inflation rates in some member-countries are well above the 2% objective of the monetary authority (Honohan and Lane, 2003).

In currency areas the phenomenon of inflation divergences among regions is not unusual. When the possibility of the exchange rate adjustment is not possible and labor mobility is low, inflation differentials play a key role to the absorption of idiosyncratic shocks. So, inflation divergence is a common characteristic of monetary unions even for the case of US where the hetero-

geneity among states is much less compared to that of the EMU. Moreover, it is easy to understand that inflation differentials can persist for some time and this can be due to various reasons. This can be due to (i) Balassa-Samuelson effect (ii) differences in business cycles (iii) idiosyncratic shocks and asymmetric adjustment mechanisms to euro area wide shocks (iv) structural differences in labor and product market and (v) different degree of rigidities in prices and wages (DeHaan, 2010).

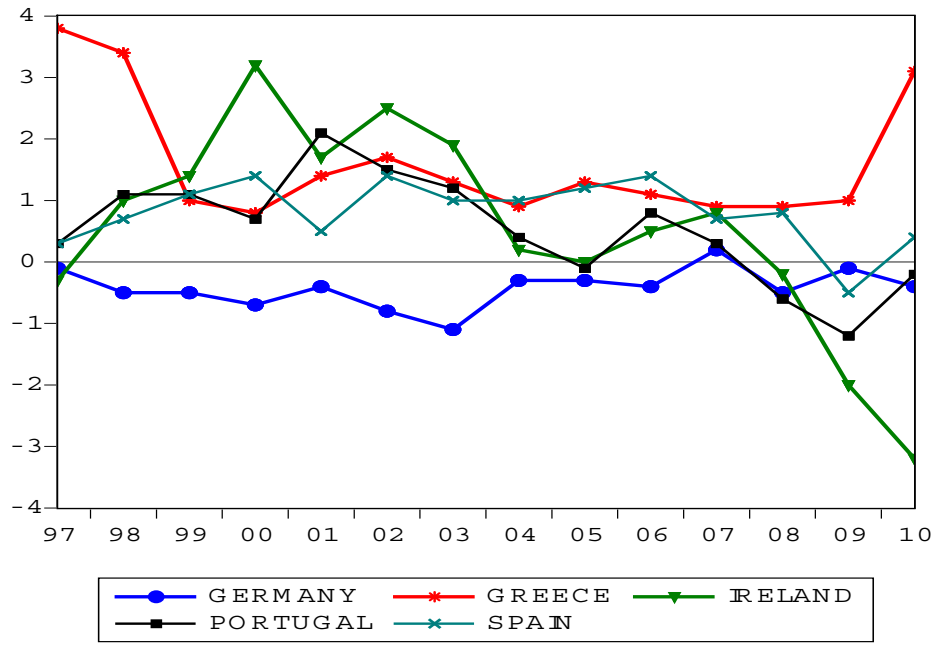
In this chapter I discuss whether the inflation process in Portugal, Ireland, Greece and Spain - countries that after the launch of the euro experienced national inflation rates above the weighted average of the union - has different time series properties from the EMU average and explains the possible implications of inflation differentials for the EMU and the national governments of member-countries. For this reason, it is important to obtain some support from the data. To this extent, we present those stylized facts that justify the claim that the inflation characteristics in these countries differ from those in the other countries of the euro area. The existence of long-run inflation differentials questions the effectiveness of the common monetary policy instrument to stabilize inflation expectations. Higher inflation expectations imply lower real – short and long-run – interest rates and deterioration of the terms of trade through reduced competitiveness, characteristics that should not persist over long periods of time since they create imbalances among the EMU members and could possibly lead to the destabilization of the union.

3.2 Time Series Evidence

Turning to the behavior of inflation in recent years, from the beginning of the euro and after, Figure 3.1 depicts the annual inflation differentials vis-a-vis the euro area for a subset of euro area countries. We can observe that positive inflation differentials were apparent from the very beginning of the EMU for Greece, Ireland, Spain and Portugal while at the same time Germany appeared to have inflation rates lower than the average of the currency as a whole. It can be clearly seen that inflation divergence was apparent from the very first years of the union. While it was declining during mid 2000s it started rising again into unprecedented levels.

A crucial issue for inflation divergence in a monetary union that must concern policy makers is whether these differentials constitute a part of the natural process of convergence between the member countries - a "catch-up" mechanism from different initial conditions at price levels - or are a permanent phenomenon which may manifest a clear separation between countries that have persistently inflation rates above the average of the monetary union and countries that are near or below this average. If this is the case, then the first cluster of countries may develop serious problems of deterioration in their balance of payments, loss of competitiveness and large external debt; problems that cannot be allowed to persist for too long. Countries that exhibit such characteristics would normally resort to the solution of devaluating their currency. However, in the case of a monetary union things are different

Fig. 3.1: Inflation Differentials



as the devaluation of the currency is not possible anymore.

A univariate autoregressive of order one model is used to examine whether the inflation differentials in these countries is a zero mean process or not:

$$\pi_t^i - \pi_t^{EMU} = c + \gamma(\pi_{t-1}^i - \pi_{t-1}^{EMU}) + \sigma\omega_t \tag{3.2.1}$$

where π_t^i and π_t^{EMU} are the national inflation rate and the average inflation rate of EMU respectively and ω_t is white noise normally distributed with zero mean and one standard deviation. Time series evidences seem to suggest

that inflation differentials in Greece, Portugal and Spain are permanently different from zero, explaining partly why these countries are currently facing a debt crisis. In the case of Ireland the hypothesis that inflation differentials dissipate over long periods of time seems to get marginal support from the data. The hypothesis of no long-run inflation differentials is summarized by

$$E\left(\pi_t^i - \pi_t^{EMU}\right) = \frac{c}{1-\gamma} = 0 \tag{3.2.2}$$

meaning that

$$c = 0 \tag{3.2.3}$$

This model has been estimated using Bayesian inference and the first prior moments regarding c and γ are motivated by the hypothesis that $(\pi_t^i - \pi_t^{EMU})$ is a white noise process, meaning that $c = 0$ and $\gamma = 0$. The model can be reexpressed in the following format

$$\pi_t^i - \pi_t^{EMU} = \beta x_t + \sigma \omega_t \tag{3.2.4}$$

where $\beta = \begin{bmatrix} c & \gamma \end{bmatrix}$ and $x_t = \begin{bmatrix} 1 \\ \pi_t^i - \pi_t^{EMU} \end{bmatrix}$. I assume independent normal and inverse gamma prior distributions for β and σ, respectively, and their posterior distribution is estimated using the Gibbs sampler (see Koop, 2003, for a detailed discussion). The data are taken from EUROSTAT database and the measure used here for inflation rate is the HCPI in a quarterly frequency.

The sample-period for this estimation is between 1998Q2 and 2010Q3.

3.3 Time Series Evidence

Figure 3.2 illustrates the posterior distribution of $\frac{c}{1-\gamma}$ for Greece, Portugal, Ireland, Spain and Germany, while the mode of this distribution is given by Table I. Both quantities have been calculated using a non-parametric kernel density estimator (see Canova, 2005, for a detailed discussion).

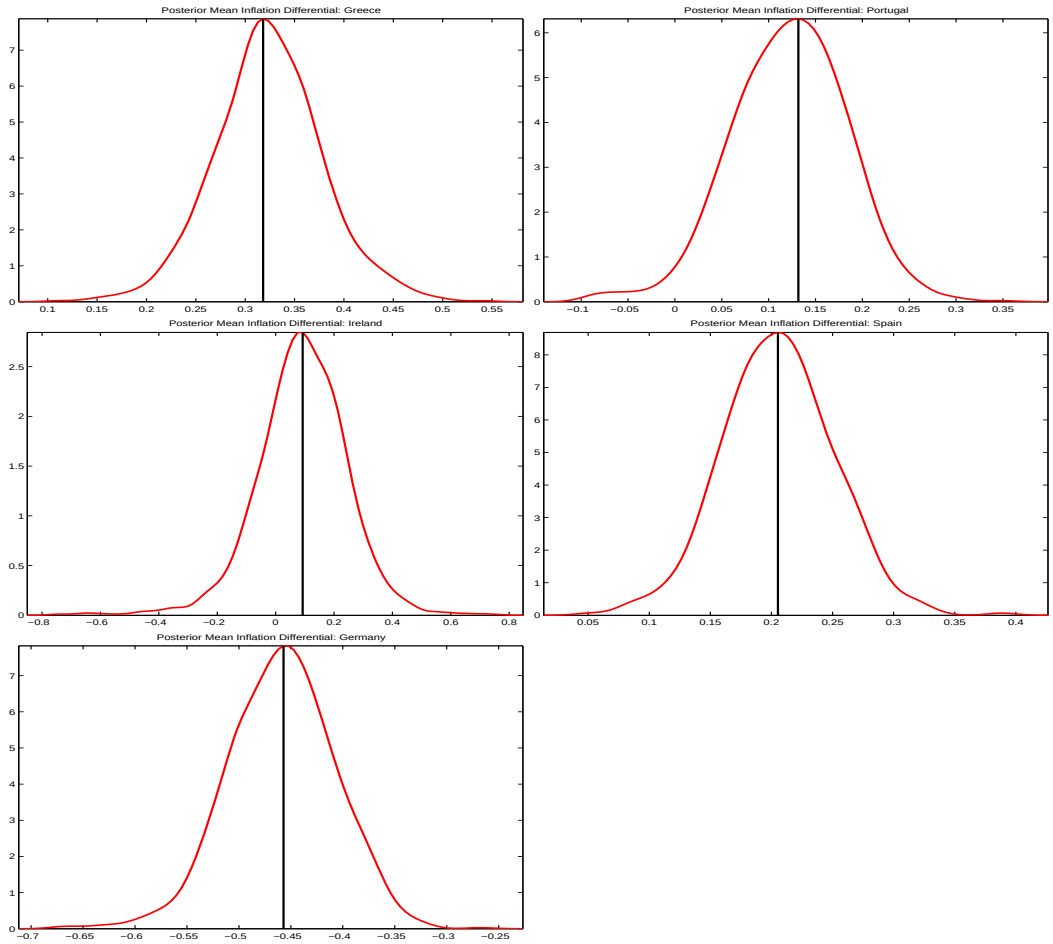
The results are quite revealing, as it can be seen – both from Figure 3.2 and Table I – inflation differentials are not only non-zero in the long-run but also the hypothesis that $E(\pi_t^i - \pi_t^{EMU}) = 0$ gets almost zero support in all countries– with an exception of Ireland.

Tab. 3.1: Long-Run Quarterly Inflation Differentials

Countries	*Greece*	*Portugal*	*Ireland*	*Spain*	*Germany*
Posterior Mode	1.330%	0.510%	0.615%	0.873%	-0.457%

Table 3.1 illustrates that the nominal trend heterogeneity among EMU members is vast. For instance, in Greece inflation is on average 1.3% higher than the EMU one, while in Germany the CPI index grows by 0.5% less than the average EMU one. In order to fully appreciate the implications of having different nominal trends in a common currency area let us consider the following Uncovered Real Interest Rate Parity (URIRP) condition (see Gali

Fig. 3.2: Posterior Unconditional Mean Distribution



and Monacelli, 2005, how URIRP can be derived from a DSGE model)

$$r_t^i - E_t\pi_{t+1}^i = r_t^{EMU} - E_t\pi_{t+1}^{EMU} - E_t q_{t+1} + q_t \tag{3.3.1}$$

where r_t^i and π_t^i are the nominal interest rate and the inflation rate in country i, r_t^{EMU} and π_t^{EMU} are the respective variables for the currency as a whole and q_t is the real exchange rate for country i. The nominal interest rate in

a monetary union is common for all the countries – unique monetary policy instrument, $r_t^i = r_t^{EMU}$ –, meaning that

$$E_t \Delta q_{t+1} = E_t \pi_{t+1}^i - E_t \pi_{t+1}^{EMU} \tag{3.3.2}$$

The steady-state version of this equation implies

$$\Delta q = \pi^i - \pi^{EMU} = \frac{c}{1-\gamma} \tag{3.3.3}$$

that the real exchange rate – level – is non stationary.

From equation (7) we can clearly see that a simple but valid way of measuring the competitiveness in a member country relatively to the rest of the monetary union is the inflation differential. It is well known that one of the most serious problems for the member-countries of the south Europe after the introduction of the euro is the continuous loss of competitiveness. This is clear from the assessments on their competitiveness by international organizations i.e. according to the World Economic Forum rankings of the EU27 in the global competitiveness index 2010-2011 , Greece is 27th while Spain and Portugal although ranking higher also seem to loose competitiveness every year.

3.4 Policy Implications

The previous section illustrates that long-term inflation differentials lead to a continuous real exchange rate appreciation. If labor productivity does not rise significantly to offset the loss in competitiveness caused by the exchange rate appreciation, then large imbalances – excess borrowing – are built up and they have to be confronted by adopting austerity measures and rescue packages.

The question that immediately arises is why these inflation differentials actually exist in the first place. The significant degree of heterogeneity – both in labor and financial markets – among EMU members reduces substantially the effectiveness of the common monetary policy instrument (Angeloni and Ehrmann, 2007) when EMU countries do not commit to the Stability and Growth Pact (SGP) (Uhlig, 2002).

Let us summarise the ECB's reaction function with the following "Taylor Rule"

$$r_t = \gamma_r r_{t-1} + (1-\gamma_r)\left[\gamma_\pi\left(\pi_t^{EMU} - \pi^{EMU}\right) + \gamma_y y_t^{EMU}\right] + \sigma_r \varepsilon_t^r \qquad (3.4.1)$$

where the policy maker adjusts the nominal interest rate to bring the aggregate inflation measure – π_t^{EMU} – back to its target – π^{EMU} – and to close the aggregate output gap y_t^{EMU} (see for instance Smets and Wouters, 2007). As we can see from the above equation the policy maker reacts to aggregate

and not to individual country's measures. This implies that if, say, inflation in Greece is well above the target and inflation in the rest sixteen members is below π^{EMU} then the ECB must decrease the interest rate to bring π_t^{EMU} back to the target, meaning even higher inflation in Greece. The mechanism is as follows: higher inflation implies lower real interest rate and this further means that long-term interest rate is also lower. This boosts consumption and investment – approximately 80% of the demand – and higher demand puts further pressures on inflation. It should be highlighted that the high real exchange rate lowers import inflation and, consequently, CPI inflation. However, this is a small component of the later index and this decrease is not strong enough to offset the rise in the domestic inflation.

This higher demand, which is accommodated by the absence of the monetary authority's reaction, is usually financed by debt – either private or public. This, clearly, cannot be sustainable and the recent debt crisis in the EMU revealed exactly this problem. Someone can argue that the recent downgrades of the Greek, Irish and Portuguese government bonds reveals exactly the above effect of inflation differentials. To be more specific, the replacement of the national currencies by the euro is only a currency change that cannot eliminate the systemic risk caused by persistent and chronic structural problems which are mainly reflected on the "twin deficits" i.e. the public and current account deficits, and this systemic risk is now embedded in nominal bond yield. The introduction of the euro expunged not only the exchange risk uncertainty but also the possibility of correction of macroeconomic im-

balances such as loss of competitiveness, through a de facto devaluation of the exchange rate. Before the creation of the EMU, when a country faced a deterioration in the deficit of the current account the devaluation of the national currency seemed to be the best and less controversial solution. Moreover, the euro appeared to provide a shield of protection for those countries that had experienced not only many but also severe devaluations in the past. But, there ain't no such thing as a free lunch,and this is the case with the common currency which means that the markets are now focusing on the budget deficit and government debt and require higher costs of borrowing in the country by increasing spreads, an aspect which often follows the deterioration of credit capacity. In other words, the risk of a currency devaluation in the past, is now the risk of a downgrade of government bonds.

The crucial question is what has to be done in the near future to avoid similar situations of fiscal crises in the euro area. There is a consensus among academics and policy makers that there is an imperative need for improvement in SGP (Schalck, 2006, 2011). According to some proposals a combination of the re-enforcement of SGP – being part of each country's constitution – and the implementation of structural reforms seems to be indispensable. These reforms should be aimed at the creation of more flexible markets and the improvement of the production factors, with the objective of increasing the growth rate of productivity and the potential output of the economy. These would be adequate and sufficient conditions for putting all member-countries in the same trajectory of growth and phenomena of asymmetries between

them would be only temporary.The structural reforms, with an emphasis on micro-reforms will make the economies who suffer from low competitiveness more flexible in dealing with negative shocks i.e. less vulnerable to various shocks that can come from either the demand or the supply side. Such reforms are of particular importance especially for countries like Greece, where persistent inflation differentials led to a continued weakening of competitiveness, which has been a root cause of macroeconomic instability since 2009. With respect to the re-enforcement of SGP, fiscal discipline in a monetary union is of primary concern for eliminating inflation differentials. This has to do with the role of expectations about further increase of inflation differentials within the eurozone. Through the mechanism of inflation expectations, persistent large fiscal deficits give a signal to the markets that relative production costs will increase in the future and the markets discount this by forming higher inflation expectations today which decreases prices for government bonds. On the other hand, there are those who argue that policy makers should take into account the heterogeneity among member countries and increasing the flexibility of SGP would be a change towards the right direction for the future of EMU. Fiscal coordination is compatible with the SGP and moreover by increasing the flexibility of policies EMU can avoid situations where strict policies can harm further the growth of the countries that are in bad fiscal position.

3.5 Conclusions

At this section, I tried to provide some explanation to the debt crisis in euro area. From the beginning of the common monetary policy inflation differentials were apparent among member-countries in EMU and according to the time series evidence we have so far, this divergence seems to be a long-run phenomenon for Greece, Portugal and Spain. The continuous real exchange rate appreciation of the countries of south Europe has led to a significant loss of competitiveness and the creation of persistent current account deficits. The evidence does not show that inflation differentials will be eliminated in the near future, something that poses numerous doubts about the future of the euro area without major changes in the current framework especially in terms of fiscal rules. The creation of a new framework for national fiscal policies seems to be more urgent than ever before.

4. DECENTRALIZED FISCAL POLICIES IN A CURRENCY UNION: THE CASE OF EMU

4.1 Introduction

Before the launch of the euro in 1999, many academics and policy makers had raised issues about the viability and the future of the European Monetary Union. The main concern was that the new monetary union was characterized by great heterogeneity among its member-countries and in case of idiosyncratic shocks the member-countries can only use the fiscal instruments to absorb the side effects. The crucial questions are to what extent the governments can make use of the pro-cyclical effects of fiscal policy, to what extent these policies may harm the stability of the monetary union as a whole and how much flexibility should the national governments have in order to get the economy back to its steady-state? Many economists have criticized the arbitrariness of the Stability and Growth Pact's rules i.e.budget deficits should not exceed 3% of GDP and public debt should be below 60% of GDP or the pace of declining should be sufficiently rapid. The Stability and

Growth Pact (SGP) is the current framework that had replaced Maastricht Treaty and have added new challenges in the conduct of the fiscal policy in EMU. Governments of the countries that have adopted the euro should adjust their policy in order to be in line with the requirements of the union.

In this chapter, I try to cite some of the literature that dealt with the issue of one monetary policy but many different fiscal policies in EMU and the free - riding incentives that appear in a context like that and what are the implications for the inflation rates in the union. One possible explanation of the different inflation performance of the countries in the eurozone could be the Fiscal Theory of Price Level which states that the inflation rate is not only a monetary phenomenon but could also be a fiscal one. I discuss with detail the implications of this theory and at the last part I try to investigate the empirical plausibility of this theory in EMU.

4.2 One monetary authority but several fiscal policies: What are the consequences?

Although the monetary authority is the sole responsible authority for maintaining the price stability, the founders of the euro were very concerned about the impact that the national fiscal policies may have on the inflation rate of the union. For this reason, fiscal rules were introduced in order to ensure a minimum degree of fiscal policy coordination among member-countries. Fis-

cal policies may be one major source of inflation and output differentials in the euro are. One major cause of inflation dispersion in the short to medium term is the indirect taxation and the administered prices which count for almost 6 % of the HICP (Hofmann and Remsperger, 2005). Moreover, inappropriate use of fiscal instruments can also reinforce the existence and the persistence of inflation divergence (Duarte and Wolman, 2008). It is straightforward for someone to consider that the cyclical differences among member-countries is due to the pro-cyclical effects of fiscal policies.

The Stability and Growth Pact (SGP) is based on the explicit assumption that "excessive deficits" are a potential source of inflation. For this reason, national fiscal policies must be restricted to the rules of the SGP and only in exceptional circumstances they are allowed to deviate from the targets of public deficit and debt. During the early years of EMU, the total framework of the union aroused assurance or putting it in a different way "a European Central Bank with a sound reputation of keeping inflation around the target and 12 member countries with cautious fiscal authorities that conduct their policies according to the requirements of the Pact". But that didn't mean that all the task had been done in the most efficient and best way: a particularly puzzling issue remained on the table concerning the interaction between the decentralized fiscal policies of EMU and the centralized monetary policy. The issue of the free-riding arises in the interplay between many fiscal policies and one central bank in a monetary union, as Chari et al. (2004) have pointed out.

4.2.1 Optimal monetary and fiscal policy

In a monetary union, someone can define the benchmark scenario where the monetary authority, ECB in our case, is committed to keep inflation close to its target and the policy undertaken targets to that objective, no matter what policies are conducted by the national fiscal policies. On the other hand, the fiscal authorities choose policies that are optimal for the economies in national level, meaning that the governments take into account the macroeconomic imbalances in regional level and the idiosyncratic shocks that may occur. In the case where a member country tracks an unsustainable fiscal policy, this will not interfere the conduct of the optimal monetary policy which is devoted to the stability of the medium term inflation expectations in the union as a whole. For example, if a member country has very high level of public debt to unsustainable proportions as a percentage of GDP, this member may have the only solution to default, but this outcome will leave the common monetary policy unaffected. Assuming that this is the case, then there are no side effects from the national fiscal policies to the macroeconomic performance of the union as a whole. The trade offs for fiscal policy remain the same, and someone can conclude that there are no new issues arisen from the creation of the union.

The above benchmark scenario does not seem to be an extreme case and in order to describe the difficulties that arise from the interaction between many national fiscal policies and one monetary authority, it is useful to define first

what is called optimal policy when this is chosen by a single and benevolent social planner. This is also known as the *Ramsey problem* of jointly and optimally choosing monetary and fiscal policies subject to the restrictions of the respective rules of a market economy (Uhlig, 2002).

New insights to the solution to the above mentioned problem have been yielded through new advances in the literature. Schmitt-Grohe and Uribe (2004) in their study try to solve the Ramsey problem of the optimal fiscal and monetary policy in the framework of a stochastic production economy without capital under Calvo sticky product prices. They assume exogenous government spending that is financed through printing money, distortionary income taxes and the issuance of one-period nominally risk free bonds. They show that even with low price stickiness the optimal volatility of inflation is near zero and the public debt and tax rates are almost random walks.

Correia et al. (2008) use a dynamic general equilibrium model and try to analyze optimal monetary and fiscal policy in an environment where the prices are fixed for one period in advance. They show that the fiscal policy can act as if prices are flexible and leave to the monetary authority to fix the distortions caused by sticky prices.

The above policy recommendations are only valid for the case of the European Monetary Union, only if the fiscal policies are coordinated and the central monetary authority is supplemented by them in an adequate way. In other words, if someone wants to apply the Ramsey solution in a monetary union,

he must coordinate the common fiscal policy with the common monetary policy.

4.2.2 The free-riding and coordination failures issues

The complexities of the interplay between a common monetary policy and several fiscal policies have been pointed out by several researchers during the past ten years. Dixit and Lambertini (2003) in their work show that unconstrained fiscal policies are capable of undermining the commitment of the monetary authority, giving a rationale for the existence of fiscal rules like the ones imposed by the Stability and Growth Pact. In another work Dixit (2001) shows that even when the voting is made under national interest the outcome is a moderate and rather stable inflation rate.

The issue of free-riding becomes very relevant in the framework of the EMU where there are 17 independent fiscal authorities and one monetary authority. If we use the assumption that the fiscal policy affects monetary policy and decisions, then each fiscal authority will considerate itself *as a small player* of the whole union and its impact on the integrated monetary policy will be only of minor importance. As a consequence, the free-riding issue on its fiscal policy choices becomes a reality as in equilibrium every government ends up by doing so, and the total outcome will be worse than the one if all member countries would have decided to coordinate their policies. A number of papers have pointed out this issue. Uhlig (2002) using a simple model tries

to highlight this phenomenon and the mechanism behind this rationale. This model is explained below. Also, Beetsma and Uhlig (1999) consider a two-period game between a single monetary authority and several - shortsighted - fiscal authorities. The governments fail to internalize the costs of their debt policies for the common inflation rate. In another work Chari et al. (2004) study the issues of strategic interaction and free-riding in a more general framework.

Sapir and Buti (2002) analyze a number of policy issues in EMU. Eichengreen and Ghironi (1998) give a detailed empirical analysis of many of these issues. Fats and Mihov (2003) deliver an empirical analysis of fiscal policy in Europe for the period from 1990 to 2000 whereas Beetsma and Bovenberg (2000) argue against a fiscal union in EMU.

4.2.3 A simple model of monetary and fiscal policies interaction within a monetary union

In order to study the consequences of deficit increase at a country level in a monetary union, Uhlig (2002) develops a model that is heavily relied on Clarida et al. (1999) previous work called the *New Keynesian Synthesis*. Uhlig's version of the model is static in nature and everything happens simultaneously, which means that there are no forward - looking terms. The main drawback of this model is the lack of an explicit incorporation of debt dynamics. This could be a serious omission since the creation of deficits means

future debt and repayments, an issue that cannot be addressed by a static model. Moreover, this model lacks of microfoundations which is one of the main features of the basic framework of Clarida et al. (1999). The redeeming however of this model is its simplicity. With few assumptions someone can easily understand the free-riding issue in a monetary union and also how fiscal and monetary authorities may play out in this particular framework of the monetary union.

We assume an economy that consists out of several countries with as many fiscal policies as the number of the countries, one Central Bank and the private sector. The nominal interest rate of the union is controlled by the Central Bank, $\bar{i}$, while the fiscal authority of each country controls the country-specific government deficit, g, which is the difference between government revenues (taxes) and government spending. This means that a higher g means an increase in spending, a cut in taxes or both. In the model, Uhlig does not distinguish between these two sources of deficit, but of course the implications of each are different. In Mountford and Uhlig (2009) someone can find evidence that the stimulation to the economy is higher when the increase in deficit comes from a tax-cut rather than when it comes from an increase in government spending. A country in this model is every region which has its own fiscal authority.

The private sector forms its expectations about inflation, π^e. For a country j the output gap χ_j is assumed to be given by the following IS-curve:

$$\chi_j = -\phi(\bar{i} - \pi_j^e) + g_j \tag{4.2.1}$$

where the output gap is inversely related to the real interest rate i.e. the difference between the nominal interest rate and the expected inflation. g_j is a demand shock interpreted as government spending or tax cuts.

The bar above the variables denotes European averages or variables that refer to the whole European area whereas all the other are country specific.

The inflation rate is positively related to the output gap and a cost - push shock with a zero mean. To be more precise:

$$\pi_j = \lambda\chi_j + u_t \tag{4.2.2}$$

The above equation is a version of the Phillips curve used by Clarida et al. (1999).

The Central Bank has its own objective which can be summarized as:

$$\max_i -\frac{1}{2}(a\bar{x}^2 + \bar{\pi}^2) \tag{4.2.3}$$

where $\bar{\chi}$ and $\bar{\pi}$ are the European average of the output gap and the European average of the inflation rate. From equations 4.2.1 and 4.2.2 someone can easily see that these averages are affected by the Central Bank's nominal

interest rate. Moreover, if we assume that member - countries are of different size, the weight in the European average for country j is equal to $1 - \psi_j$ - this means that the weight of all the other countries together is equal to ψ_j - where ψ_j is a parameter. If we assume symmetry between countries then the weight of each one will be equal to $1 - \psi_j = \frac{1}{n}$,where n is the number of countries in the union.

For the fiscal authority of each country, we assume an objective function equal to:

$$\max_{g_j} - \frac{1}{2}(\chi_j^2 + \theta(g_j - \varepsilon_j)^2) \tag{4.2.4}$$

where ε_j is a fiscal shock to the government's budget constraint with zero mean. From the above equation we can see that the fiscal authority wishes to minimize the deviations from output gap and from g_j and can tolerate only random deviations equal to the shock $\varepsilon_{j.}$ In other words, the government tries to stabilize the economy around its steady state level and also to run a fiscal balanced budget. The parameter θ reflects the weight that the government puts on the balanced budget relative to a stabilized economy with an output gap around its steady state level. On a no regular base, it can accept deviations from the target of the budget that may arise because of the needs of additional spending or further tax cuts than initially scheduled (the assumption here is that $\varepsilon_j > 0$).

The game between the agents, the Central Bank and the government is as follows:

1. The private sector formulates its expectations about inflation (π_j^e).
2. The shocks are becoming evident (u_j and ε_j).
3. Each government j makes decisions about the level of its deficit (g_j).
4. Finally, the Central Bank sets its interest rate for the whole union ($\bar{i}$)

The equilibrium in this game is a subgame perfect equilibrium except for the case of the formation of inflation expectations which are assummed to be formed not strategically but rationally i.e.$\pi_j^e = E[\pi_j]$.[1]

4.2.4 Analysis of the model

In order to solve for the equilibrium someone must proceeds backwards. The Central Bank solves its optimization problem subject to equations 4.2.1 and 4.2.2 in their European averaged version taken as given the inflation expectations and the fiscal deficits levels. Equations 4.2.1 and 4.2.2 are now as follows:

$$\bar{\chi} = -\phi(\bar{i} - \bar{\pi}^e) + \bar{g}$$

[1] A strategy profile is a subgame perfect equilibrium if it represents a Nash equilibrium of every subgame of the original game.

$$\bar{\pi} = \lambda\bar{\chi} + \bar{u}$$

and after some algebra the solution for the output gap and the inflation rate is:

$$\begin{aligned} \bar{\chi} &= -\lambda q\bar{u} \\ \bar{\pi} &= aq\bar{u} \end{aligned}$$

where

$$q = \frac{1}{\lambda^2 + a}$$

The nominal interest rate will be:

$$\bar{i} = \frac{\lambda q}{\varphi}\bar{u} + \frac{1}{\varphi}\bar{g} \tag{4.2.5}$$

Because of the linearity, the average of the inflation expectations is equal to the expectations of the inflation average:

$$\pi^e = \bar{E}[aq\bar{u}] = 0 \tag{4.2.6}$$

The country specific inflation rate varies from the union average by a mean zero component and as a result inflation expectations for members states will be zero as well.

$$\pi_j^e = 0 \tag{4.2.7}$$

The government knows the nominal interest rate rule, equation 4.2.4 which can be rewritten as:

$$\bar{i} = \frac{\lambda q}{\phi}\bar{u} + \frac{1-\psi_j}{\phi}g_j + \frac{\psi_j}{\varphi}\tilde{g}_j \tag{4.2.8}$$

The last component of the above equation $\tilde{g}_j$ is the weighted average of the fiscal choices in all other countries of the union. The optimization problem for the fiscal authority has the following constraint:

$$\chi_j = -\lambda q\bar{u} + \psi_j(g_j - \tilde{g}_j) \tag{4.2.9}$$

The solution is therefore:

$$g_j = \frac{\theta}{\psi_j^2+\theta}\varepsilon_j + \frac{\psi_j}{\psi_j^2+\theta}\lambda q\bar{u} + \frac{\psi_j^2}{\psi_j^2+\theta}\tilde{g}_j \tag{4.2.10}$$

By assuming n symmetric countries, $1-\psi_j \approxeq \frac{1}{n}$ and taking the average of equation 4.2.5 we have:

$$\bar{g} = \bar{\varepsilon} + \frac{n-1}{n\theta}\lambda q\bar{u} \tag{4.2.11}$$

$$\bar{i} = \frac{1}{\varphi}\bar{\varepsilon} + (1 + \frac{n-1}{n\theta})\frac{\lambda q}{\varphi}\bar{u} \tag{4.2.12}$$

The government spending g_j for a specific country is calculated if instead of $\tilde{g}_j$we put $\frac{n\bar{g}-g_j}{n-1}$ in equation (3.1.10). If we solve for g_j and substitute for $\bar{g}$ we get:

$$\begin{aligned} g_j &= \frac{n\theta}{n\theta+n-1}\varepsilon_j + \frac{n-1}{n\theta+n-1}\bar{\varepsilon} + \frac{n-1}{n\theta}\lambda q\bar{u} \\ &= \frac{n\theta}{n\theta+n-1}\varepsilon_j + \frac{n-1}{n\theta+n-1}\varphi\bar{i} \end{aligned} \tag{4.2.13}$$

We can easily conclude, that the government spending in each country is a weighted average of the country specific fiscal shock (ε_j) and nominal interest rate ($\bar{i}$) which is also rescaled for its effect on output gap (φ). Moreover, the country specific output gap is equal to:

$$\chi_j = -\lambda q\bar{u} + \frac{(n-1)\theta}{n\theta+n-1}(\varepsilon_j - \tilde{\varepsilon}_j) \tag{4.2.14}$$

The above results show that when a positive cost push shock takes place the government knows that the nominal interest rate will increase and as a result

they decide to spend more in order to ease the effects of a higher interest rate domestically. This means that the Central Bank will increase further the interest rates in order to maintain price stability.

4.2.5 Discussion on the results

According to the above analysis of the model a number of results emerges:

Result 1: Higher government debts will result in higher nominal interest rates but with average union inflation rate and output gap unchanged.

Result 2: If there is only one fiscal authority - no union - then the optimal fiscal choice would be to adjust fiscal deficits only in response to a fiscal shock (ε_j) and keep them unchanged in case of cost - push costs u_j or fluctuations of the output gap. In that case, inflation rate, nominal interest rate and the output gap cannot be affected by the government's preferences.

Result 3: In the case where there are more one fiscal authorities in hand with one central bank, the optimal choice for the government is to respond to European cost-push shocks $\bar{u}$ apart from the response to positive fiscal shocks ε_j. The result will be higher nominal interest rate in comparison to the case with only one fiscal authority and inflation rate and output gap unchanged.

Result 4: If we assume symmetric countries i.e. $1-\psi_j = \frac{1}{n}$ and that all $\varepsilon_j = 0$ then the optimal solution for all countries is the cooperative equilibrium

which in other words means agreement to a common fiscal policy of zero deficits.

Result 5: If we assume symmetric countries i.e. $1 - \psi_j = \frac{1}{n}$ and that all $\varepsilon_j = 0$, then the higher the number of members of the union the worse the noncooperative outcome. Moreover, as the number of members increase the more each country will react to a cost-push shock $\bar{u}$.

Result 6: If we assume symmetric countries i.e. $1 - \psi_j = \frac{1}{n}$ and that all $\varepsilon_j = 0$, the output gap χ_j and the inflation rate π_j for country j will increase because of a fiscal shock ε_j but they will decrease because of a fiscal shock of the others, $\bar{\varepsilon}$.

4.2.6 Interpretation and consequences

According to the above analysis, what should be "ideal" for a monetary union where there exist several fiscal policies, is the response of the fiscal authorities only to country - specific demand shocks and let the Central Bank to respond to the average country - specific "cost - push" shocks. Yet, each fiscal authority finds very tempting to respond to the increase of the interest rate from the side of Central Bank - as a reaction to a supply shock - by increasing the government spending. If all member - countries are reacting like that, the result will be a Central Bank that tries to absorb through the increase of the interest rate not only the shocks from the supply side of the economy but also the additional demand shocks that come from the fiscal

policy.

One theoretical foundation can be found in the Fiscal Theory of Price Level. In standard monetary theories the price level is indeterminate if the Central Bank follows an interest rate peg. The proponents of the Fiscal Theory of the Price Level argues that this theory closes the system of equations by demonstrating that the net present value of government repayments in real terms can be used to calculate the real value of the outstanding nominal government liabilities and therefore the initial price level. Sims (1999) explicitly applies the Fiscal Theory of Price Level to the European Monetary Union. Bergin (2000) uses a theoretical model to show the validation of the theory for a monetary union of two countries. The results of his theory are also applicable for an arbitrary number of countries but for simplicity reasons he uses only two. He provides the conditions under which fiscal solvency is not a necessary condition for the governments of the members of the union.

4.3 The Fiscal Theory of Price Level

4.3.1 Introduction to the Fiscal Theory of Price Level

Price stability is an important objective of economic policy. Two key questions must be addressed by a policy institution in order to meet its goal of price stability:

- How can price stability be achieved?

- How much price stability is desirable?

Concerning the first question, the standard monetarist doctrine offers a simple answer: Central Bank must have a firm commitment to price stability. Some economists, though recently, begun to dispute about the robustness of the foundations of this doctrine, giving rise to an alternative view in which a tough and fully committed monetary authority is not a sufficient condition to guarantee price stability. From that point of view, in order to achieve price stability in an economy, not only monetary policy needs to move towards that goal but also an appropriate fiscal policy is required. Because this new view of price determination fiscal policy receives so much attention, Michael Woodford has called it the *Fiscal Theory of Price Level*. Among those who advocate this theory someone can find Benhabib et al. (2002) Cochrane (2001, 1999), Leeper (1991) Sims (1994, 1999) Woodford (1994, 1995) while several critical discussions of the theory and of its assumptions are offered by Buiter (1999, 1998), Bassetto (2002), Kocherlakota and Phelan (1999), Carlstrom and Fuerst (2000) and McCallum (2001). Concerning the empirical testing of the theory the literature is rather limited. Canzoneri et al. (2001), Cochrane (1999), Woodford (2001), Mlitz (1997), Creel and Sterdyniak (2000) and Afonso (2008) are papers that try to find the empirical plausibility of the Fiscal Theory of Price Level. Throughout this chapter, I refer to it as the *FTPL*.

Motivating by the work developed by Leeper (1991), Sims (1994) and Woodford (1994, 1995) the FTPL is the innovative idea that there are some combinations of fiscal and monetary policy where the price level is determined by the ratio between government nominal liabilities and the real present value of future government assets i.e. budget surpluses. This is an important issue as the use of monetary rules is usually considered to be an attempt to capture the visible historical relationship between the money and prices.

Using general equilibrium models Woodford (1994) comes to doubt the broad perception that the monetary authority is the solely nominal anchor for the economy. The emphasis that is given to monetary policy to achieve price stability in the economy, is based on two principles. First, fiscal policy does not have important consequences on inflation and second, monetary policy can hardly influence the fiscal position of an economy. Concerning the latter, it is true that -at least- at developed economies inflation tax constitutes only a small fraction of total governments revenues. In combination with the prohibition of monetary financing of budgetary deficits, it gives the impression that the second principle is correct. This however does not take into consideration the repercussions of monetary policy in the real value of public debt, and more specifically when the debt is found in high levels as in Greece. Thus e.g. a contractive monetary policy through the effect on price level, will increase public debt in real terms while at the same time it increases also the obligations of government for its debt amortization. In other words, the budgetary consequences of monetary policy cannot be ignored. This means

that it is desirable from a policy point of view the coordination between the two arms of economic policy, monetary and fiscal policy.

With regard to the second principle, this is the result of the theorem of Ricardian Equivalence that claims that the budgetary policy does not have any effect on aggregate demand provided that a reduction of taxes today will increase savings for the payment of higher taxes tomorrow. According to the FTPL, however, fiscal policy is possible to influence the inflation rate immediately. It is remarkable that the above conclusion results from the same assumptions that we find also in the Theorem of Ricardian Equivalence (i.e. lump sum taxes, rational expectations, market clearing e.t.c.). The basic mechanism is that the budgetary policy has repercussions not only on agents' budget constraint but also on private consumption. Namely, the expectation of a reduction in taxes suffices to provoke an increase in demand. The resulting imbalance in output will cause the increase of price level. This increase leads to the reduction of the real value of agents' financial wealth which in turn will cause a reduction in excess demand restoring the equilibrium. The increase of price level will cause an increase in money demand and a passive increase from the Central Bank will restore equilibrium in money market. It is important to mention however, that the causality comes from the budget balance to the price level. So, someone cannot claim that the change in price level is a result of a change in money supply. The fundamental question is why Ricardian Equivalence does not hold at the above theoretical framework. At this point someone can find the substance of the FTPL: the budget con-

straint of households is different from the government's budget constraint. Households want to satisfy their lifetime budget constraint for all price levels regardless from the fact if markets balance or not with that particular price level.

In the monetarist doctrine there is the recognition that both monetary and fiscal policy must be selected appropriately if the goal of economic policy is price stability. However, this doctrine states that if the Central Bank is tough, the fiscal authority will be constrained to adopt an appropriate fiscal policy. According to the FTPL this cannot be the case. On the other hand, the theory states, that unless appropriate measures are taken to ensure that fiscal policy will be a suitable one, the objective of price stability may remain indefinable no matter how tough and independent the Central Bank may be.

The FTPL has important implications about the way the Central Bank conducts its monetary policy. The conventional view suggests that monetary authority should stay away from the government to minimize the likelihood to be pressured to take poor monetary policy decisions. In other words, the FTPL implies that central bankers must make sure that the fiscal authority conducts appropriate fiscal policies that support the objective of the monetary authority and not to be confined only in their policies.

The FTPL also draws attention to the second question - how much price stability is desirable?- which is not only important but also difficult to be answered. Sims (1999) and Woodford (1998) pointed out that if the price

level is allowed to fluctuate with unexpected shocks to the government budget constraint then public finances benefits will be produced. A good example of that is when a war or a natural disaster causes a negative fiscal shock then the price level will go up. This is equivalent to taxing the holders of the government debt. At that point, someone could argue that in terms of efficiency this is preferable as the government can keep the labour taxes smooth (Christiano and Fitzgerald, 2000). Of course, in practise the benefits from keeping labour taxes smooth in case of a negative fiscal shock can be mitigated by the distortionary effects that price instability will cause. About how much price stability is desirable Sims (1999) states that public finance benefits may overcome the cost caused by volatile prices and he infers that complete price stability is sub-optimal. Overall, a convincing answer to the second question would be a quantitative study that balances benefits and costs.

In the remainder of this section, I provide explanation according to the literature what differentiates FTPL from the conventional view about price stability and inflation. I summarize some of the key issues that this theory has to confront.

4.3.2 What distinguishes FTPL?

There are some authors who argue that the the difference between the conventional view and FTPL lies in an error of logic (Buiter, 1999). The difference

between the two approaches is that they differ in the view about the government's intertemporal budget constraint. This equation shows that the value of government debt is equal to the present discounted value of future government tax revenues net of expenditures i.e. surpluses, where both debt and surpluses are denominated in units of goods. This equation can be expressed as:

$$\frac{B}{P} = \text{present value of future surpluses} \tag{4.3.1}$$

where B is the outstanding nominal debt of the government and P is the price level. According to the conventional view this equation is a constraint on the government's tax and spending policy and this policy must be set so the right hand side of the equation equals the left hand side no matter what the value of the price level may be. According to this view, when the above is not satisfied the fiscal authority must change its taxes or spending so that the equilibrium will be restored again. On the other hand, those who advocate the FTPL argue that the government has no inherent requirement that it will consider this equation as a constraint on policy. Moreover, they support that the intertemporal budget equation is an equilibrium condition. In simpler words, when something threatens to disturb the equation the market - clearing mechanism will move the price level, in order to restore equality.

According to Michael Woodford's terminology, this assumption - that the government is not standardized to satisfy the intertemporal budget equation for all values of P - is called the *Non - Ricardian assumption*. According to Woodford (1995) the FTPL may be well comprehended on the basis of the distinction between two types of fiscal regimes: Ricardian versus non - Ricardian regime. To be more precise, this distinction between fiscal policies was first mentioned in Rao Aiyagari and Gertler (1985) who supported the idea that in a non - Ricardian regime the government has no commitment for future tax increase in case of creation of new public debt today. In a Ricardian regime the opposite would be true. In Canzoneri and Diba (1996) someone can find a different terminology about the two different fiscal policies. The first one is characterized as *regime of monetary predominance* where money demand and supply determine the price level, whereas the case where prices are endogenously determined from the government's budget constraint is called a *regime of fiscal predominance*.

When the monetary policy is characterized as active i.e. Ricardian regime, it determines the money stock and the price level through a money demand equation based on the quantitative theory of money. The government must manage its primary budget surpluses in order to have consistent budget constraint with the price level that is the outcome of the money demand equation. Using Leeper (1991) terminology, at that case we say that fiscal policy is *passive* trying to achieve fiscal solvency for any price level and monetary policy is *active* setting its control variable without facing any constraint. On

the other hand, when the government decides arbitrarily the values of the budget deficit and the public debt, then the price level can be determined independently from the actions of the monetary authority. The Central Bank is said to be *passive* if money supply is endogenous and the fiscal policy is *active* and determines the price level.

4.3.3 A simple model of FTPL

All the above, will be more clear if they will be shown in a simple model of numerous infinitely lived households that maximize their utility function. For this purpose it is introduced a utility function á la Sidrauski (1969) and Brock (1975) or in other words a money-in-the-utility-function type (MIIUF) model where the consumers' utility function is assumed to be additive and it can be written as:

$$U(c_t, m_t) = (1-\sigma)^{-1} A_1 c_t^{1-\sigma} + (1-\eta)^{-1} A_2 m_t^{1-\eta} \tag{4.3.2}$$

where $\sigma \succ 0$ and $\eta \succ 0$ and c_t is consumption in real terms in period t , $m_t = \frac{M_t}{P_t}$ and M_t is the nominal stock of money. The utility function used here was used by McCallum (1999) and is a parametric version of the general formulations used by Leeper (1991) and Woodford (1995).

The budget constraint for the households in nominal terms is as follows:

$$P_t(y - tx_t) = P_t c_t + M_{t+1} - M_t + \frac{B_{t+1}}{1+i_t} - B_t \tag{4.3.3}$$

where y is the output and is assumed to be constant, tx_t are the lump-sum taxes in period t, B_t is the government debt securities for period t and i is the nominal interest rate. In real terms the budget constraint can be written as:

$$y - tx_t = c_t + \frac{M_{t+1}}{P_{t+1}}\frac{P_{t+1}}{P_t} - \frac{M_t}{P_t} + \frac{B_{t+1}}{P_{t+1}}\frac{1}{1+i_t} - \frac{B_t}{P_t} \tag{4.3.4}$$

If we define $b_t = \frac{B_t}{P_t}$ and multiply the previous equation by $\frac{P_t}{P_{t+1}}$, we can express the consumer's optimization problem as follows:

$$\begin{gathered} \max U(c_t, m_t) = (1-\sigma)^{-1} A_t c_t^{1-\sigma} + (1-\eta)^{-1} A_2 m_t^{1-\eta} \\ \text{subject to} \\ (y - tx_t)\tfrac{P_t}{P_{t+1}} = \tfrac{P_t}{P_{t+1}} c_t + m_{t+1} - \tfrac{P_t}{P_{t+1}} m_t + \tfrac{1}{1+i_t} b_{t+1} - \tfrac{P_t}{P_{t+1}} b_t \end{gathered} \tag{4.3.5}$$

Using the assumption that $P^e_{t+1} = P_{t+1}$, if we solve for the optimal solution we get:

$$U_c(c_t, m_t) = \frac{P_t}{P_{t+1}} \frac{1+i_{t+1}}{1+r} U_c(c_{t+1}, m_{t+1}) \tag{4.3.6}$$

The government's budget constraint in per capita terms is as follows:

$$P_t(g_t - tx_t) = M_{t+1} - M_t + \frac{B_{t+1}}{1+i_t} - B_t \tag{4.3.7}$$

We assume that the budget deficit is financed by the issuance of money or the issuance of public debt. B_{t+1} is the quantity of one-period government bonds purchased in period t at price $\frac{1}{1+i_t}$ and they must be reimbursed at period $t+1$ for one monetary unit. g_t is the government expenditure and tx_t is lump-sum taxes both in real terms in period t. Rewriting the above government's budget constraint in real terms we have the following equation:

$$g_t - tx_t = m_{t+1}\frac{P_{t+1}}{P_t} - m_t + b_{t+1}\frac{P_{t+1}}{P_t}\frac{1}{1+i_t} - b_t \tag{4.3.8}$$

with the following transversality condition:

$$\lim_{j\to\infty} E_t\beta^j \frac{(M_{t+j} + B_{t+j})}{P_{t+j}} = 0 \tag{4.3.9}$$

where β is a typical agent's discount factor and it is equal to $\beta = \frac{1}{(1+\rho)}$ with $\rho \succ 0$ and $0 \prec \beta \prec 1$.

The interest rate is given by the Fisher equation:

$$1 + i_t = (1 + r_t)(1 + \pi^e_{t+1}) \tag{4.3.10}$$

If we assume perfect forecast for the price level for next period then the

inflation rate will be equal to:

$$\pi^e_{t+1} = \pi_{t+1} = \frac{P_{t+1} - P_t}{P_t} \tag{4.3.11}$$

and we can rewrite Fisher equation as:

$$1 + i_t = (1 + r_t)\frac{P_{t+1}}{P_t} \tag{4.3.12}$$

Substituting equation (4.3.12) into (4.3.8) we get:

$$b_{t+1} = (1 + r_t)b_t + (1 + r_t)(g_t - tx_t) \tag{4.3.13}$$

using the assumption that the real interest rate is constant and that budget deficit is stable we get the following equation:

$$b_{t+1} = (1 + r)b_t + (1 + r)(g - tx) \tag{4.3.14}$$

Since $(1 + r) \succ 1$ and $(g - tx)$ is constant, the real debt will follow an explosive trajectory. Moreover, the government debt is given from the following difference equation:

$$\frac{b_{t+1}}{b_t} = (1 + r)(1 - \frac{s}{b_t}) \tag{4.3.15}$$

where $s = (tx - g)$ is the primary budget surplus and $\frac{b_{t+1}}{b_t}$ converges to $(1+r)$ as b increases.

4.3.4 Evaluation of the FTPL

In order to evaluate the FTPL, someone should focus on some normative and positive issues:

- Is the non - Ricardian assumption empirically plausible?
- Does the FTPL offer a convincing explanation for episodes of high inflation?
- Does the FTPL provide useful input into the design of socially efficient policies?

Someone can easily understand that the non - Ricardian assumption is not something desirable and good at all times and places. In many cases in the past, governments seemed ready to adjust their policy when the debt got to very high levels. A representative example is the case of U.S. economy during the 1980s and 1990s when the public debt began to increase and getting too high. The government adopted austerity measures, increased the taxes and cut government spending and tried to bring debt back to its previous levels. A similar case is the example of SGP in EMU where member - countries must adjust their fiscal policy in case their debt grows to levels above the limits set by the Pact. International Monetary Fund is also another example

where the organization uses a range of sanctions and rewards to encourage its members to keep their debt to sustainable levels by adjusting their fiscal policy if needed.

The FTPL in order to be an interesting positive theory does not need to hold in all situations. According to Woodford (1998), FTPL may provide a useful characterization of policies in some cases and in others no. A good example for that is the standard economic models that were used in 1960s and 1970s. The government budget constraint was absent from economic models that economists used in that period and it played little role in Keynesian policy analysis (Sargent, 1987). It seems reasonable to assume that the non - Ricardian assumption was valid that period. Loyo et al. (2000) supports that Brazilian economy during the late 1970s and early 1980s experienced non - Ricardian regime and FTPL looks a reasonable explanation for the country's high inflation during that period.

However, even in the case where the FTPL cannot be supported by any of the episodes of high inflation in the past it can still offer interesting aspects of normative analysis for two reasons: (i) first, optimal policies might be non - Ricardian (see Sims (1999); Woodford (1998)) (ii) the FTPL could serve as a useful input into policy design even if non - Ricardian regimes can be considered as *bad*. But, why someone could characterize the non - Ricardian regimes as bad? If we consider legislators allowing a regime like that, where the policy makers could increase government spending and promote

tax cuts without be obliged to raise future taxes, then they might be tempted to conduct policies that imply too much spending and too much debt. An effective way to deal with this problem would be to impose limits to government debt. Chari and Kehoe (2008) in their paper develop a model where countries that constitute a monetary union and there are no debt constraints will result with excessive debt. Moreover, Woodford (1996) argues that a monetary union without debt constraints will end up with excessive price volatility. His reasoning is based on the fact that if policy is non - Ricardian, then fiscal shocks must show up as shocks to the price level regardless of the monetary policy regime. He argues that price- level instability that comes from the above mentioned source is very likely to be excessive in a monetary union that adopts a non - Ricardian regime. According to Woodford (1994), non - Ricardian regime is a realistic possibility - a possibility that in this case he thinks is bad - and he supports the idea of explicit debt targets in monetary unions like the Stability and Growth Pact and its predecessor the Maastricht Treaty. A further discussion about the dangers that are lurking in non - Ricardian regimes someone can find a more detailed discussion in Woodford (1996). So, by establishing the logical possibility of the non - Ricardian regimes, the FTPL implies that such policies may occur and for this reason there must be introduced measures to rule them out. The FTPL can be used to articulate the rationale behind the limitations imposed by International Monetary Fund and by European Monetary Union.

4.3.5 What other issues are addressed by the FTPL?

Even if the main purpose of the FTPL is to give an explanation about how price level can be achieved and how much price stability is desirable, its implications are not only limited to these issues but it can also offer a well designed framework for understanding price-level determination when the traditional quantity - theoretic reasoning breaks down (Christiano and Fitzgerald, 2000).

The equilibrium price level is the level that makes the real value of nominally denominated government liabilities equal to the present value of expected future government budget surpluses (Woodford, 1995). In nominal terms, government must pay off its existing liabilities i.e. government debt by:

1. Refinancing
2. Amortizing
3. Defaulting

In real terms, a government can also *inflate* away the debt: if it causes or allows high inflation the real amount it must repay will be smaller. Thus the Fiscal Theory of Price Level states that if a government has an unsustainable fiscal policy, such that it will not be able to pay off its obligation in the future out of tax revenue - which means that it runs a structural deficit- then it will pay them off via inflating the debt away. Thus, fiscal discipline, meaning a balanced budget over the course of the economic cycle - running surpluses in expansions and deficits only in contractions- is necessary for the price level

to remain stable: unsustainable deficits will require inflation in the future.

4.3.6 A critical discussion of the FTPL

The above simple model shows that in a Ricardian regime where the monetary authority is the nominal anchor for the economy,the nominal government debt is the dynamic accumulation of budget deficits. According to the monetarist view, the price level is determined by the quantity of money circulated in the economy (quantitative theory of money) and as a result the government debt in real terms is determined endogenously and the present value of the future budget surpluses must adjust in order to satisfy the budget constraint. On the other hand, in a non-Ricardian regime where the nominal anchor is the fiscal policy, the real public debt is determined by the present value of the future budget surpluses and the price level must adjust in order to meet the government budget constraint. In other words, in the framework of the government budget constraint, several macroeconomic variables adjust under two different regimes. Cochrane (2001) states that Ricardian regimes where the real public debt is determined by the value of past public surpluses and the price level are backward-looking whereas non-Ricardian regime where the real value of public debt is set accordingly to the present value of future pubic surpluses which in turn will determine the price level are forward-looking.

But how can the price level be determined? This an issue directly related

to how the Central Bank conducts monetary policy. If Central Bank determines the nominal interest rate, equation (4.3.12) and the equation of the quantitative theory of money determine the money stock and the price level-as mentioned at the previous section we assume a constant real interest rate. The crucial point is that equation (4.3.12) determines the inflation rate and not the price level which remains undetermined. In other words, through the interest rate set by the monetary authority, the equation of the quantitative theory of money determines the money stock in a passive way but it is impossible to determine the price level. This problem of the undetermination of the price level is solved through the budget constraint. This is one of the main arguments of the supporters of the FTPL. Alternatively, if the monetary authority decides to determine the money supply and the regime followed is Ricardian then the equation of quantitative theory and equation (4.3.12) determine the price level and the nominal interest rate. Moreover, the government budget constraint is always satisfied but the difference now is that it is not used to determine the price level. However, when the government conducts active fiscal policy and the Central Bank sets an objective for the money supply i.e. a non-Ricardian regime, then the price level may be overdetermined.

In fact, using rules to determine the interest rate may end in an indeterminate price level and the monetary authority may loose the control of the inflation rate. Sargent and Wallace (1975) argues that the price level is indeterminate when an interest rate rule is used and prices are flexible. The reader can find

a more detailed exposition of the above argument in Blanchard and Fischer (1989).

4.3.7 Empirical validation of the FTPL

The empirical validation of the FTPL has accepted many criticisms. The main argument for that is that someone must make additional assumptions in order to assess empirically the suitability of a Ricardian or a non-Ricardian regime. According to Cochrane (2001) such empirical validation lacks of interest since the causal relations between several variables can never be rejected or accepted without additional assumptions. Moreover, Kocherlakota and Phelan (1999) raise also doubts about the feasibility of the empirical validation of the FTPL. In addition, Woodford (1995) argues that the price level can only be determined by the fiscal policy and he bases this idea on the fact that monetary regimes, monetary rules and money demand specifications cannot determine the price level.

A possible way to test empirical the FTPL is by using the budget constraint equation and the transversality condition in order to assess the adjustment process of the fiscal variables. The method is to try to conclude if the price level adjusts to the future fiscal surpluses or the trajectory of fiscal surpluses adjusts to the price level.

In a Ricardian regime, agents know that an increase in government debt will result in future taxes in the future, so they know that the government will

adjust its surpluses to be consistent with the transversality condition and a sustainable fiscal policy. It may also be possible, that the surpluses are not sufficient to keep under acceptable limits the debt - to - GDP ratio nevertheless, even under these circumstances the monetary policy is the nominal anchor. On the other hand, in non-Ricardian regimes, the public debt may be so high that the transversality condition cannot be met in the equilibrium. In that case, despite the fact that the debt - to - GDP ratio is relatively high and there is a wealth effect from the increase in debt, there may also be an increase in aggregate demand that will result in an increase of the price level. This means that the real value of the debt (liabilities) will decrease. This reduction of the real value of the real debt will create the further formation of favorable expectations that the transversality condition will be met at the equilibrium.

Canzoneri et al. (2001) use a bivariate Vector Autoregressive Model (VAR) to test the existence of Ricardian or non-Ricardian regimes for the US economy for the period 1951-1955. They examine if and how the future surpluses and liabilities respond to shocks in the surplus. They take the impulse response functions of liabilities and future surpluses both as ratios of GDP and try to explain why the regime followed is Ricardian or not. They find that a positive innovation in surplus decreases liabilities for many periods in the future and increases also the future surpluses. This could be a straightforward explanation in favor of a Ricardian regime. The surpluses pay back the debt in that type of regime. However, this could be the case in a non-Ricardian

regime as well, although they provide a more complex explanation. The positive correlation between today's surplus innovation and future surpluses may turn negative after some periods.

It is more difficult than one may think to develop testable restrictions on the data so that someone could distinguish between Ricardian or non-Ricardian regimes.

4.4 Can the Fiscal Theory of Price Level Explain EMU inflation differentials? A Bayesian VAR approach

Eleven years after the launch of euro, the member states of eurozone are still characterized by great heterogeneity in comparison with other monetary unions like the United States and Canada. Countries that participate in European Monetary Union (EMU) delegated one of the basic arms of economic policy, monetary policy, to a single authority, the European Central Bank (ECB). Although, so far ECB has done relatively well trying to achieve its primary goal which is the stability of price level in the euro-zone as a whole, inflation differentials among member states are still playing an important role in discussions among academics and policy makers. As long as the mandate of the eurosystem is to provide price stability to the euro zone as a whole, ECB bases its monetary decisions on developments on average inflation of the union and not on country specific inflation rates. This means that as

long as the average inflation rate is close to the ECB's implicit target of 2% the policy makers have no reason to change their policy.

The concern about price stability goes back to 1992 and the Maastricht Treaty, according to which the designers of the single currency imposed some convergence criteria for member countries in order to enter the third stage of EMU. One of these criteria concerned government finance i.e. public debt and deficit should not exceed the level of 60% and 3% respectively. The Stability and Growth Pact (SGP), which succeeded Maastricht Treaty, was adopted by the member countries participating in the union, so that the fiscal discipline would be maintained and be enforced in the EMU in order to avoid any free-rider incentives that may occur among the member-countries (Uhlig, 2002). The existence of different fiscal regimes in the context of a monetary union raises questions about how desirable and possible is to achieve coordination between a centralized monetary authority and several decentralized fiscal policies. The rules imposed by the SGP are criticized to be very restrictive and sometimes harmful for the economies that may be hit from idiosyncratic shocks. However, the fiscal limitations imposed by the Pact suggest that the fiscal policy can affect the price level of a member country and consequently the inflation rate of the whole union. Unlike to the traditional point of view which suggests that the price level is determined in a conventional way by the monetary authority a new approach which has emerged in the 1990s' allows fiscal policy to have an "active" role in the determination of the price level. More precisely, in the first case the

central bank sets its control variable without facing any constraint and the government must set its primary surpluses in such a way that the fiscal solvency must be assured. This is the so-called " Ricardian" regime which allows the central bank to act in an "active" way determining the price level. On the other hand fiscal authorities may follow a "Non-Ricardian" regime which means that the government acts in a "passive" way trying to achieve fiscal solvency for any price level.

This section adds to the literature by examining empirically the impact of different fiscal policies on the development of national inflation rates for the twelve countries that initially participate in EMU. In other words, I try to investigate if the FTPL can be a reasonable explanation for the differences in price levels of those countries the last eleven years.

4.4.1 Theoretical Foundation of the Model

According to The Fiscal Theory of the Price Level the way according to which the government's budget constraint is satisfied can influence directly the inflation rate. Following Canzoneri et al. (2001) the features that define a regime to be Ricardian or not can be found in the government's budget constraint. In nominal terms, the government's budget constraint can be written as:

$$B_t = (T_t - G_t) + \frac{B_{t+1}}{1 + i_t} \tag{4.4.1}$$

Where B_t is the stock of nominal debt at the beginning of the period t, $T_t - G_t$is the difference between nominal taxes and nominal government spending i.e. the primary surplus during the same period and i_t is the nominal interest rate for this period. Equation (4.4.1) states that the debt has to be paid off by running a surplus or refinanced by issuing new debt. Dividing the above fiscal variables by nominal GDP and after some algebra we get equation (4.4.2):

$$\frac{B_t}{P_t y_t} = \frac{(T_t - G_t)}{P_t y_t} + \frac{\frac{y_{t+1}}{y_t}}{(1+i_t)\frac{P_t}{P_{t+1}}} \frac{B_{t+1}}{P_{t+1} y_{t+1}} \tag{4.4.2}$$

The above equation states that the ratio of government debt to nominal GDP must be equal to the ratio of the primary surplus to nominal GDP plus the discounted value of next period's debt ratio to nominal GDP. The discount factor is equal to the ratio of real growth of GDP to the real interest rate (the denominator is the familiar Fisher equation). Simplifying this equation and define that $P_t y_t = Y_t$ and $\frac{\frac{y_{t+1}}{y_t}}{(1+i_t)\frac{P_t}{P_{t+1}}} = a_t$ we can rewrite equation (4.4.2) in a simpler way:

$$\frac{B_t}{Y_t} = \frac{S_t}{Y_t} + a_t \frac{B_{t+1}}{Y_{t+1}} \tag{4.4.3}$$

After forward iteration of equation (4.4.3) and recursive substitution of $\frac{B_{t+1}}{Y_{t+1}}$ we end up with the following equation which is the present value constraint of government debt.

$$\frac{B_t}{Y_t} = \frac{S_t}{Y_t} + E_t \sum_{j=t+1}^{+\infty} (\prod_{k=t}^{j=1} a_k) \frac{S_j}{Y_j} \tag{4.4.4}$$

Or, in an equivalent way,

$$\lim_{T \to +\infty} E_t(\prod_{k=t}^{T+t-1} a_k) \frac{B_{t+T}}{Y_{t+T}} = 0 \tag{4.4.5}$$

Equations (4.4.4) and (4.4.5) indicate that the present value of government debt must be equal to the value of the current and future surpluses discounted with the appropriate discount factor . The main difference between the pros and the cons of FTPL is that the former treat the above equation as an equilibrium condition that must be satisfied and not as a constraint that must be tested empirically in terms of fiscal solvency. So the main question posed at this stage is how does equation (4.4.4) get satisfied?

The budget constraint has to be satisfied at any point in time, which can be achieved in two ways: The first way is the case where the fiscal surpluses follow an endogenous process to satisfy equation (4.4.4) no matter what

values the discount factor and/or the debt to GDP ratio may take. The second way is that fiscal surpluses follow an arbitrary exogenous process. In this situation, the discount factor and/or the debt to GDP ratio have to move in order that the budget constraint is satisfied. A crucial assumption of the model is that the nominal debt is fixed at the beginning of each period and so the only way the ratio of nominal debt to nominal GDP can be changed is through the denominator . As Canzoneri et al. (2001) mention 'all the onus of the adjustment to equilibrium would be on the discount factor or the real income'.

In order to differentiate between Ricardian and Non - Ricardian regimes is not a straightforward process. Following Canzoneri et al. (2001) there is way to differentiate between the two regimes: if we consider an innovation in S_t/Y_t we must examine how it passes to the B_{t+1}/Y_{t+1}. In a Ricardian regime we would expect the B_{t+1}/Y_{t+1} to fall as the surplus pays-off some of the debt. On the other hand, in a Non Ricardian regime there are three different possibilities. First, under the assumption that the innovation in S_t/Y_t is not correlated with the surpluses and the discount factors that are on the right hand side of (4.4.4). If the regime followed by the government is a Non Ricardian, then we expect that the B_{t+1}/Y_{t+1} will not be affected. Second, under the assumption that an innovation in S_t/Y_t is positively correlated with future surpluses and the discount factor we expect that B_{t+1}/Y_{t+1} will rise. In either of the above cases we should be able to distinguish between a Ricardian and a Non Ricardian regime, according to the response of the

B_{t+1}/Y_{t+1}. But there is also a third case to consider for Non Ricardian regimes: Under the assumption that an innovation in S_t/Y_t is negatively correlated with the future surpluses and the discount factor. In this case, we expect B_{t+1}/Y_{t+1} to fall, and this makes it difficult to conclude if the regime is a Ricardian or not. In that case we have an identification problem. As Canzoneri et al. (2001) argue, in a Ricardian regime someone would expect the ordering in the VAR to be, B_t/Y_t comes first and S_t/Y_t comes second because it does not allow for a contemporaneous affect on B_t/Y_t and we can identify shocks to S_t/Y_t. If the ordering is the other way - S_t/Y_t comes first and B_t/Y_t comes second - this allows for a contemporaneous effect on B_t/Y_t and it is in line with the rationale of a Non Ricardian regime, as nominal GDP has to "jump" in order to make the value of the existing debt equal to the expected present value of surpluses.

To be more specific, our VAR is as follows:

$$\begin{bmatrix} S_t/Y_t \\ B_t/Y_t \\ a_t \end{bmatrix} = const + \sum_{s=1}^{p} \begin{bmatrix} B_{11}(s) & B_{12}(s) & B_{13} \\ B_{12}(s) & B_{22}(s) & B_{23} \\ B_{31}(s) & B_{32}(s) & B_{33} \end{bmatrix} \begin{bmatrix} S_{t-s}/Y_{t-s} \\ B_{t-s}/Y_{t-s} \\ a_{t-s} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix} \tag{4.4.6}$$

where the $B(s)$ is a set of $p(m \times m)$ coefficient matrices with m being the number of dependent variables included ($m = 3$). u_t is Gaussian with zero

mean and:

$$E[u_t u_t^{'} \mid (S_{t-s}/Y_{t-s}; B_{t-s}/Y_{t-s})] = \Omega \tag{4.4.7}$$

where Ω is a positive definite symmetric and time - invariant covariance matrix of size $(m \times m)$.

I have also included in the VAR the discount factor. So, according to the previous arguments of Canzoneri et al. (2001) someone can identify between Ricardian and non Ricardian regimes by observing the behavior of B_{t+1}/Y_{t+1} and also the discount factor a_t. To be more specific, if we assume that there is an increase in S_t/Y_t in period t and the fiscal policy is Ricardian then we should expect to see B_{t+1}/Y_{t+1} to respond negatively or remain unaffected if the reaction of B_{t+1}/Y_{t+1} will be sound enough so that the price level will remain unaffected. If the regime is Non-Ricardian, then we should look ahead for a positive reaction of the B_{t+1}/Y_{t+1} after a positive shock of S_t/Y_t or if the discount factor reacts positively to a significant shock in S_t/Y_t combined with a negative reaction in B_{t+1}/Y_{t+1}. [2] [3] I made 1000 draws from the reduced - form posterior density and for each reduced - form draw 50 draws of the a- vector. The lag length is chosen to be equal to 2.

[2] For the case differentiation between responses which are positive and negative in sign I have chosen the pure - sign restriction approach by Uhlig (2005) and I only consider those cases where the orthogonalized impulse responses head for the desired direction in the period the shock takes place. The sign restriction is binding only for one period and the orthogonalized impulse responses are obtained using Cholesky decomposition.

[3] The discount factor remains unrestricted .

4.4.2 Empirical Results

A BVAR Approach

Following Canzoneri et al. (2001), I try to investigate how public debt -to – GDP ratio reacts to positive shocks of the surplus - to- GDP ratio using a Bayesian VAR approach. The reason of using a Bayesian instead of a classical inference is that the former has the advantage that the data used for estimation do not need to be stationary, as the Bayes' theorem does not require stationarity. The Augmented Dickey Fuller test suggests that the majority of the series for the 12 countries is not stationary, and according to classical approach, the estimation should be done in first differences or should be relied on cointegration analysis for obtaining statistically reasonable results. But this procedure would be problematic too, from an economic point of view, as this would implicitly assume that the government debt is a non-stationary process, which means that the sample of the data is not mean reverting, i.e. the fiscal policy is unsustainable Thams (2007). The Bayesian approach does not require to impose any restrictions concerning the stationarity or not of the data. Another advantage of Bayesian techniques is that they do not rely on asymptotic theory , so they provide a more general way to test an existing theory.

Data

In order to assess the possibility of a Ricardian or a Non Ricardian regime, I use quarterly data from Eurostat for public debt B_t and budget surplus S_t for the time period from 2000q1 to 2009q4. The only exceptions are France and Belgium where the time span is from 1995q4 to 2009q4 and from 1992q1 to 2009q4 respectively. The reason that the analysis is not expanded to previous years is that for the most countries of the sample there weren't data available in a quarterly frequency for public debt and in order to avoid interpolation of the data the analysis refers to the last ten years. All data are in nominal terms and seasonally adjusted. We use data on budget surplus -net lending (+)/net borrowing (-) – for the S_t and general government consolidated gross debt for B_t, both as percentages of nominal GDP. For the discount factor a_t I use two different series of interest rates, a long term interest rate on government bonds and a short term, both taken from OECD Economic Outlook 87. In the specification of VAR the relationship between these three variables is not linear, so the choice of the interest rate can be considered as an approximation of the discount factor a_t.

Figure (4.1) suggests that the correlation between the ratio of primary surpluses to GDP and the inflation rate is for all 12 countries under consideration positive. The highest correlation can be found for Ireland (correlation = 0.75), Spain (correlation = 0.69), Portugal (correlation = 0.68) and Greece (correlation = 0.56) .

A second stylized fact is depicted in Figure 4.2. I plot the primary surpluses against the change in debt both as percentages of GDP. For all countries except for the case of Austria and Luxembourg the relationship is a negative one.

Fig. 4.1: Primary Surpluses and Inflation Rates

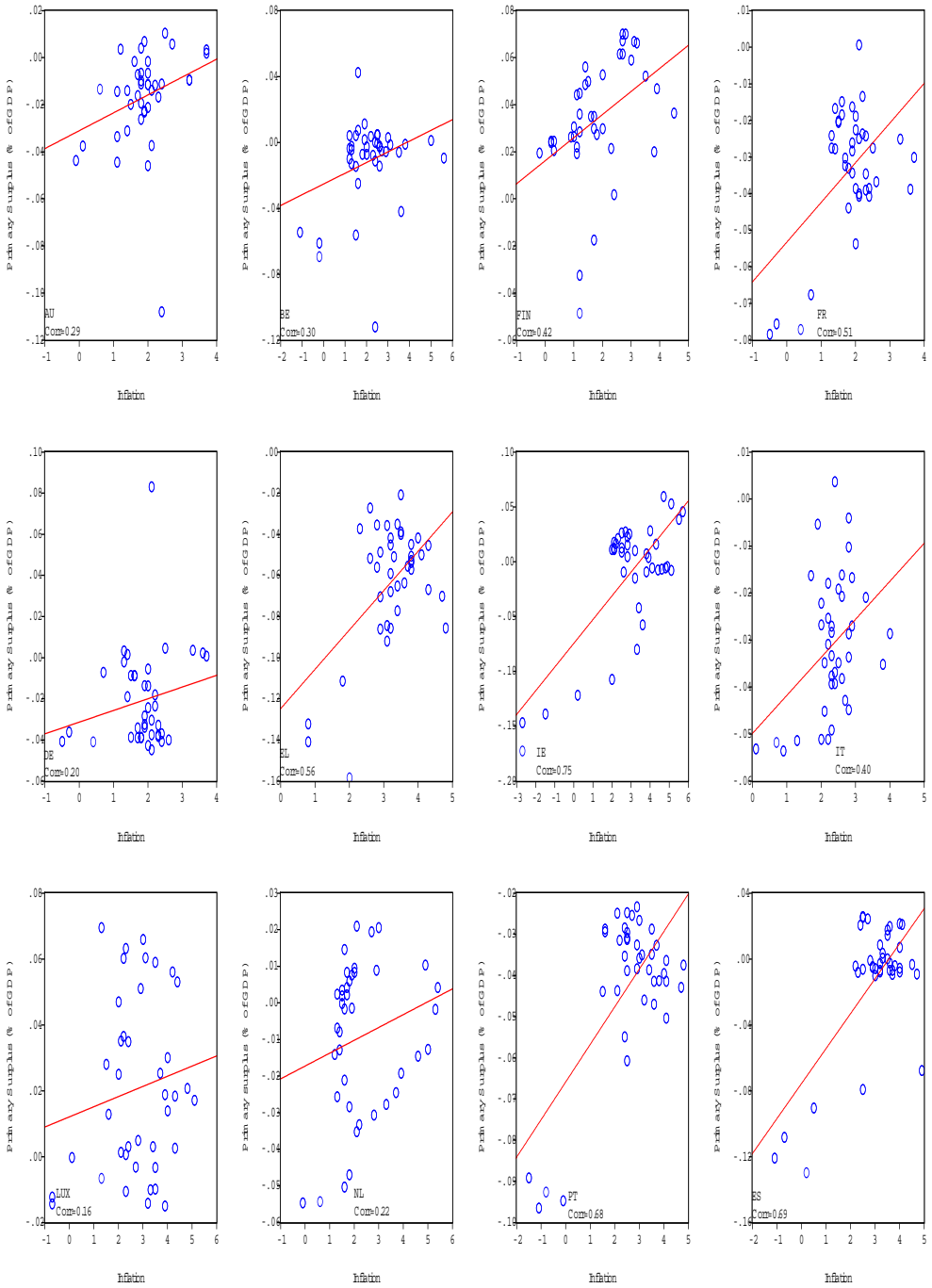


Fig. 4.2: Primary Surpluses and Change in Public Debt

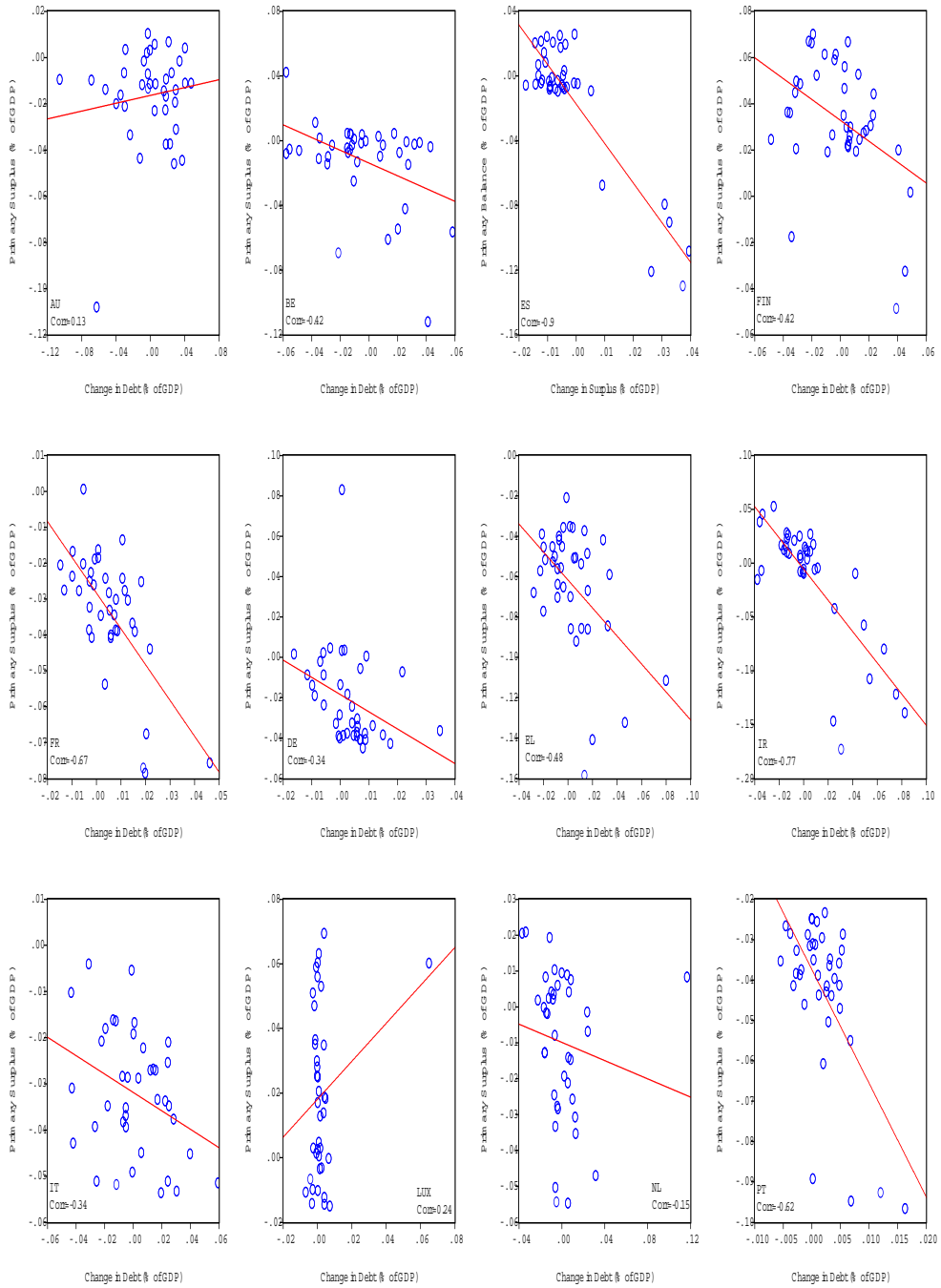


Figure 3.3: Primary balance ratio and and change in debt-to-GDP ratio (2000-2009)

Estimation Results

In the following I give the results for the twelve countries in form of impulse responses to a one standard deviation shock in S_t/Y_t and B_t/Y_t. For every country, I differentiate between two different orderings - S_t/Y_t comes first and B_t/Y_t which is likely to be found in a Non - Ricardian regime and for a Ricardian regime the first equation of the VAR can be considered as a reaction function in which B_t/Y_t influence the setting of the future surpluses comes first and S_t/Y_t. Additionally, for the discount factor I used both a short - term indicator and a long - term for both cases. This means that for every country I provide four different sets of impulse responses. In the figures below, we can clearly see that for most of the countries of EMU the regime is considered to be Ricardian. For all cases we can see that the reaction of the B_t/Y_t to a positive innovation of S_t/Y_t is negative. Of course, this does not cause any surprise as I used a sign restriction on the impulse responses to exclude all the cases in which a positive S_t/Y_t leads to a positive B_t/Y_t reaction. The variable that is of great importance is the discount factor. For almost all the countries the discount factor either remains unaffected or increase for a short period of time and then returns back to its initial levels. The only exception is Greece where the short - term and long - term interest rate increase significantly and remain at higher levels for the rest of the periods. For that country we observe a strong and positive response and this corresponds to negative response of the discount factor (by definition).

There are two different explanations about this reaction. The first is that the response of B_t/Y_t is not strong enough and the discount factor must also change in order to guarantee the fiscal solvency. The second explanation could be that the policy is indeed Ricardian during the period under consideration but agents expect this ti change in the near future and as a result they demand for higher interest rates as the expected inflation is higher because of the fiscal shock. Agents do not expect the fiscal regime to change to a Ricardian one in the near future and for that reason they demand for higher interest rates. [4] For all the other countries, we can clearly see that although the discount factor is affected in some cases it return back to its initial levels after a period of time, meaning that the agents expect the fiscal policy to be Ricardian and that the inflation rate is not going to be affected in order to maintain fiscal solvency.

4.4.3 Conclusions

In the above analysis I tried to provide a deeper insight in the relevance of the FTPL to EMU and if this theory can provide a reasonable explanation about inflation differentials among the members of the union. For the period under consideration, data about Greece show that the policies followed by the fiscal authorities were following a different fiscal regime in comparison to the ones followed by the governments of the other members. With the incorporation

[4] This is true through the Fisher equation.

of the short and long term interest rates into the analysis, there is evidence that not only current fiscal policy can affect the price level but also agents' beliefs about future actions taken by the authorities that are also closely associated with the determination of their inflation expectations.

Fig. 4.3: Germany

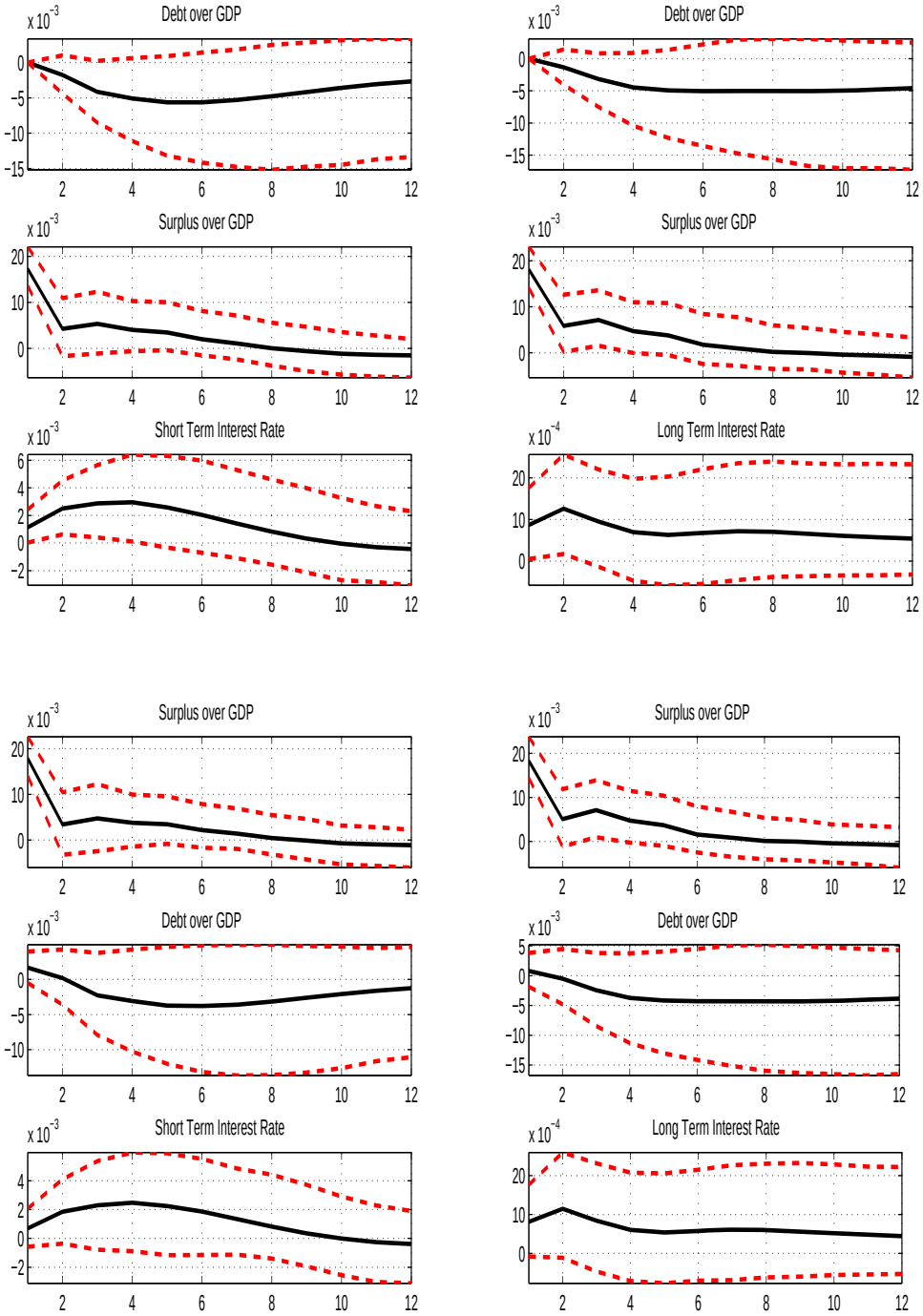


Fig. 4.4: France

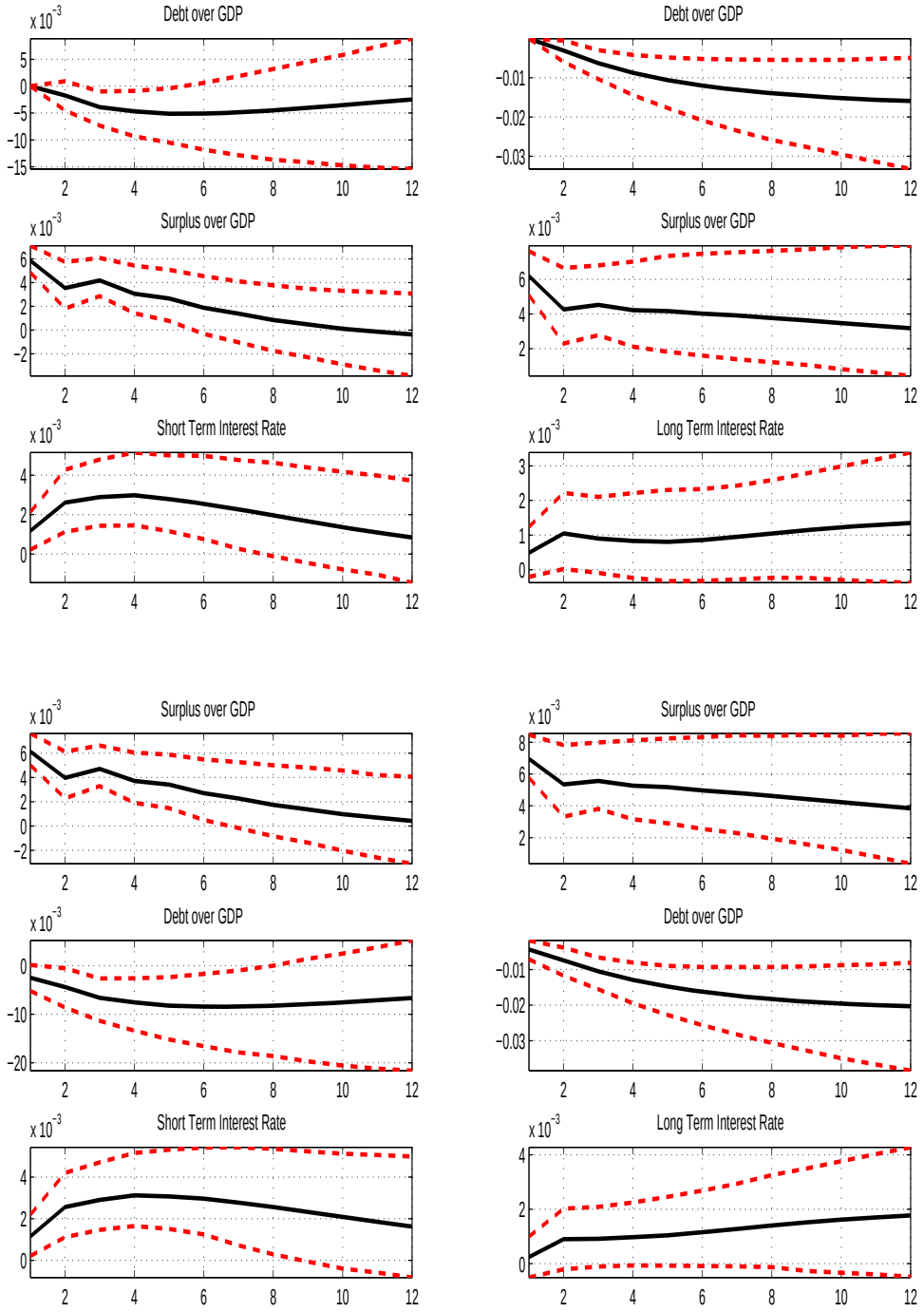


Fig. 4.5: Finland

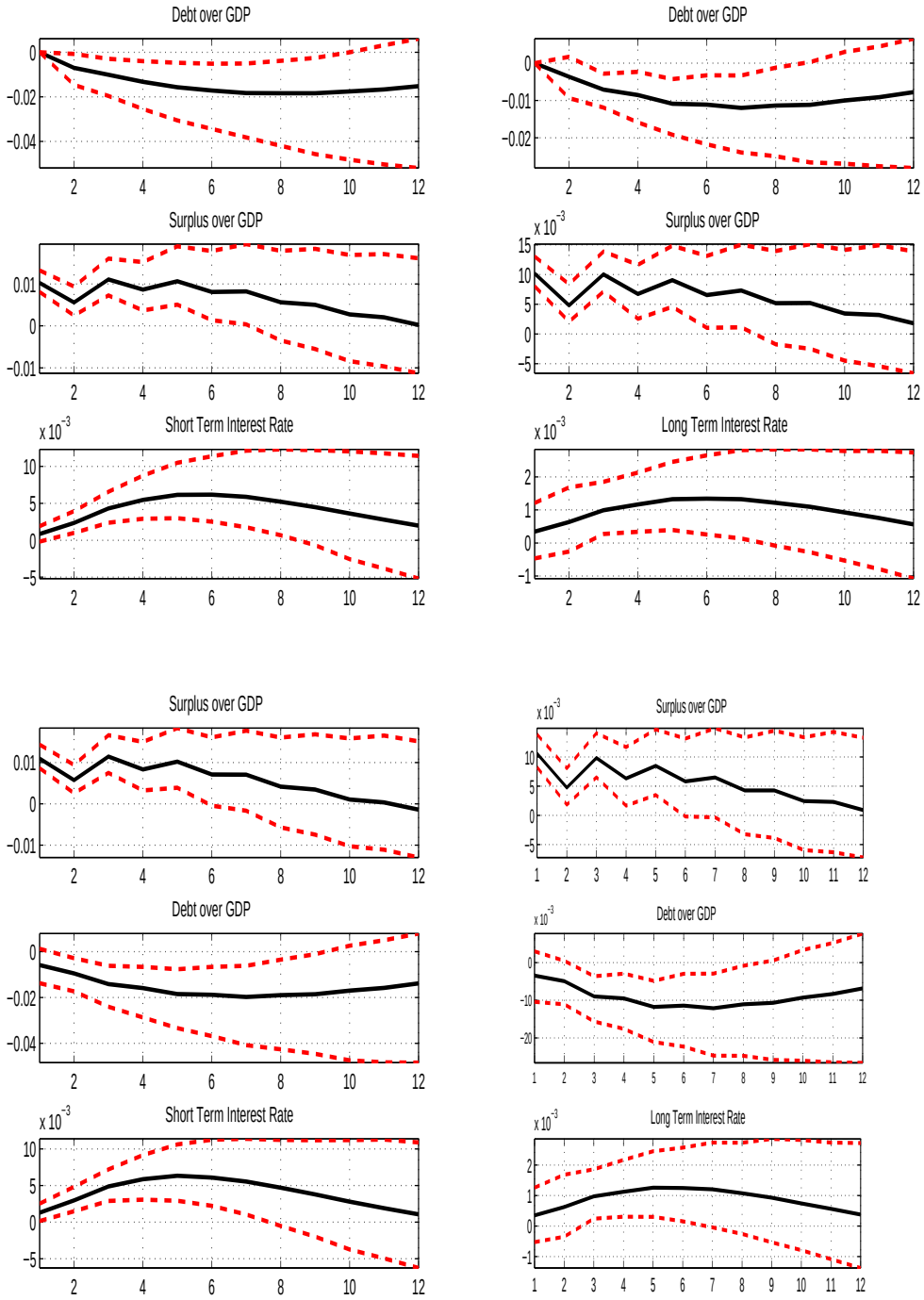


Fig. 4.6: Belgium

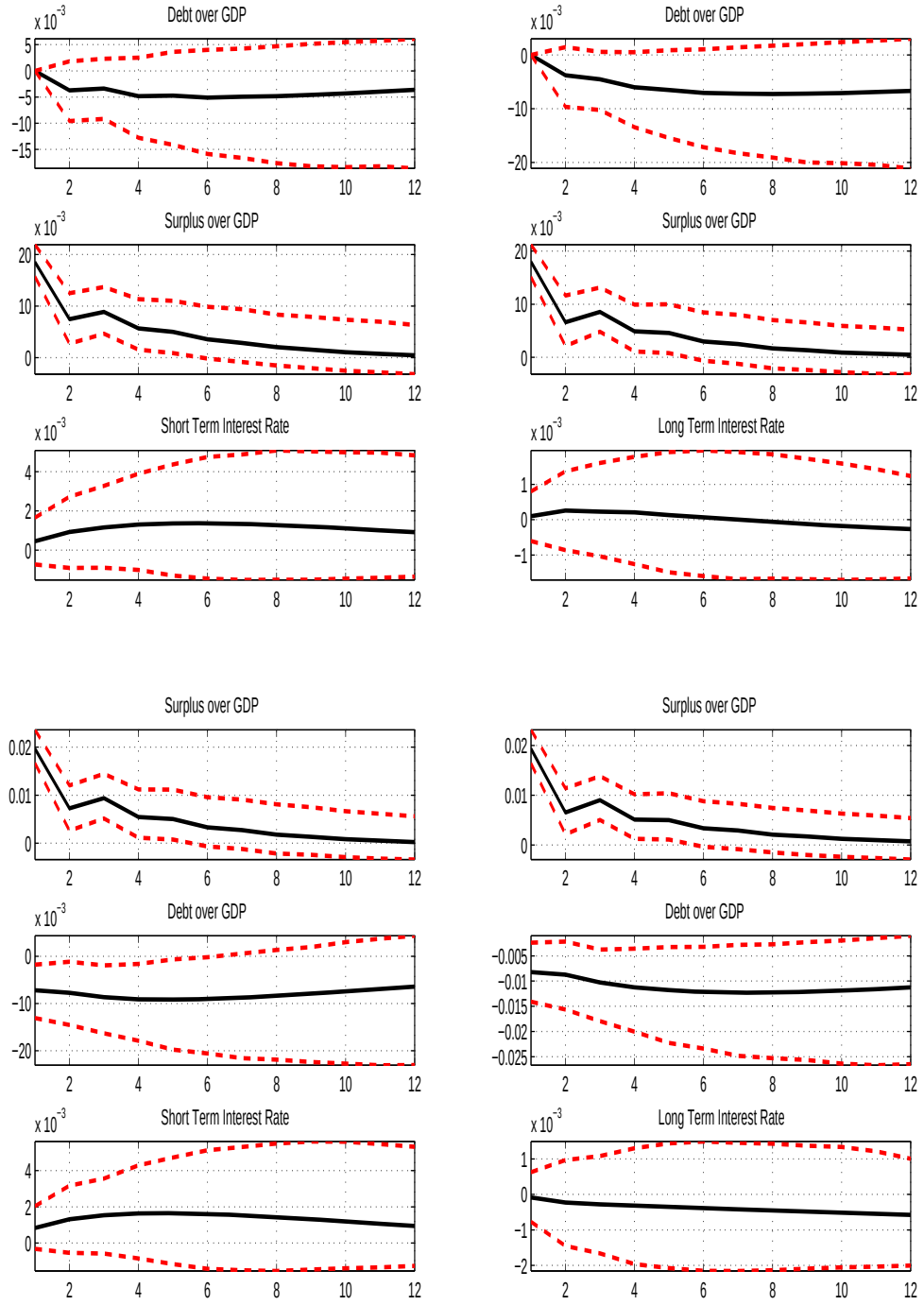


Fig. 4.7: Austria

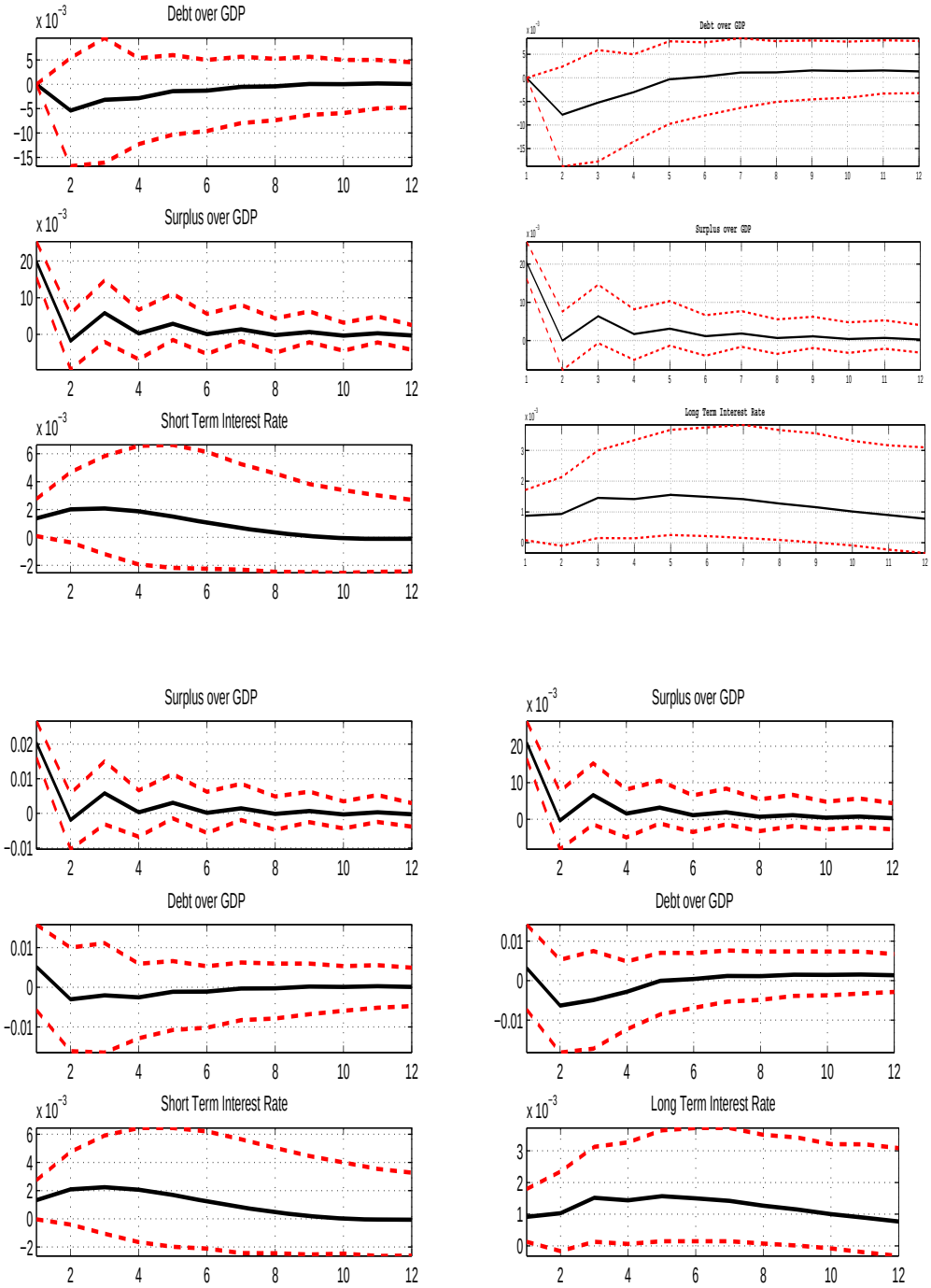


Fig. 4.8: Greece

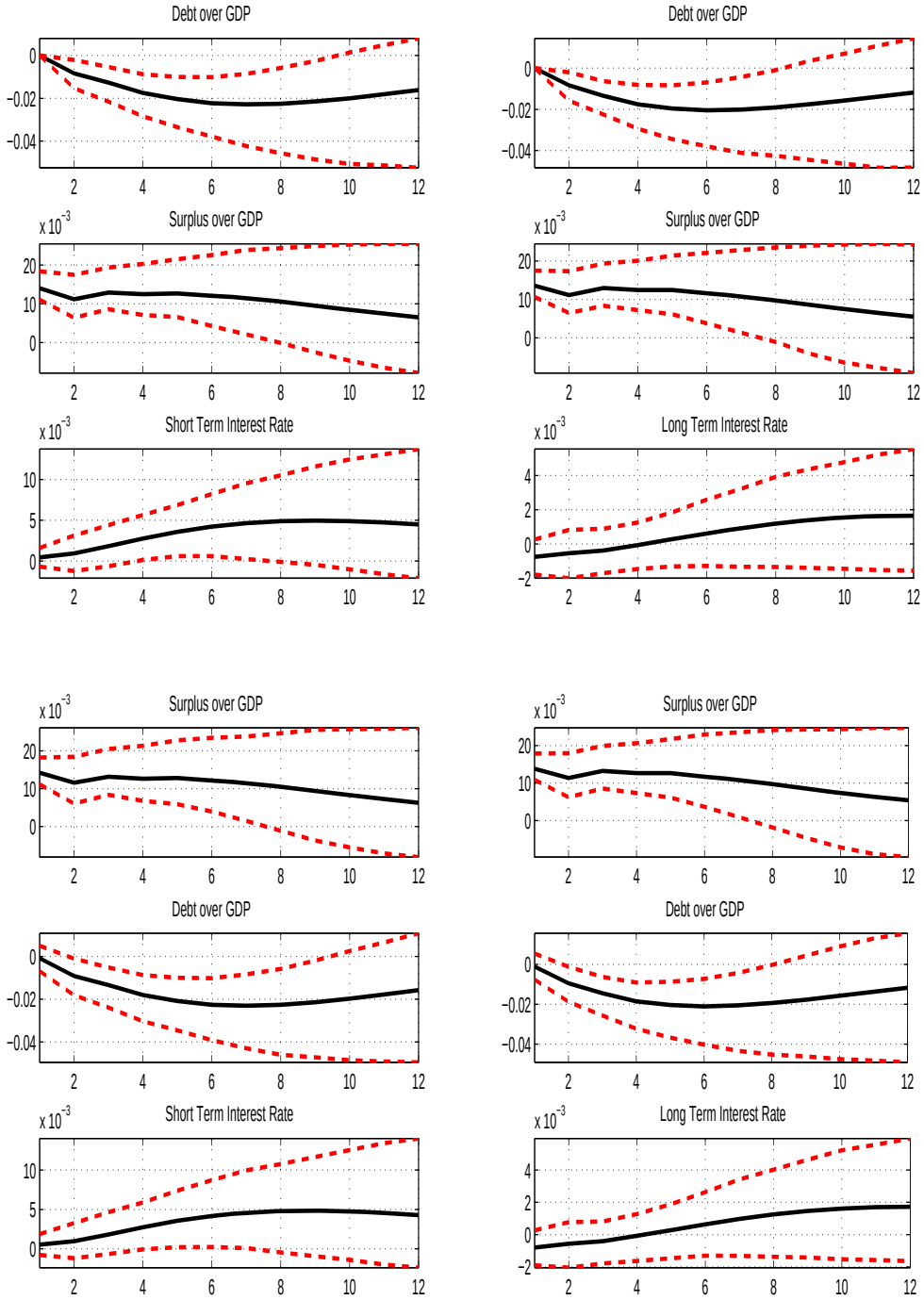


Fig. 4.9: Ireland

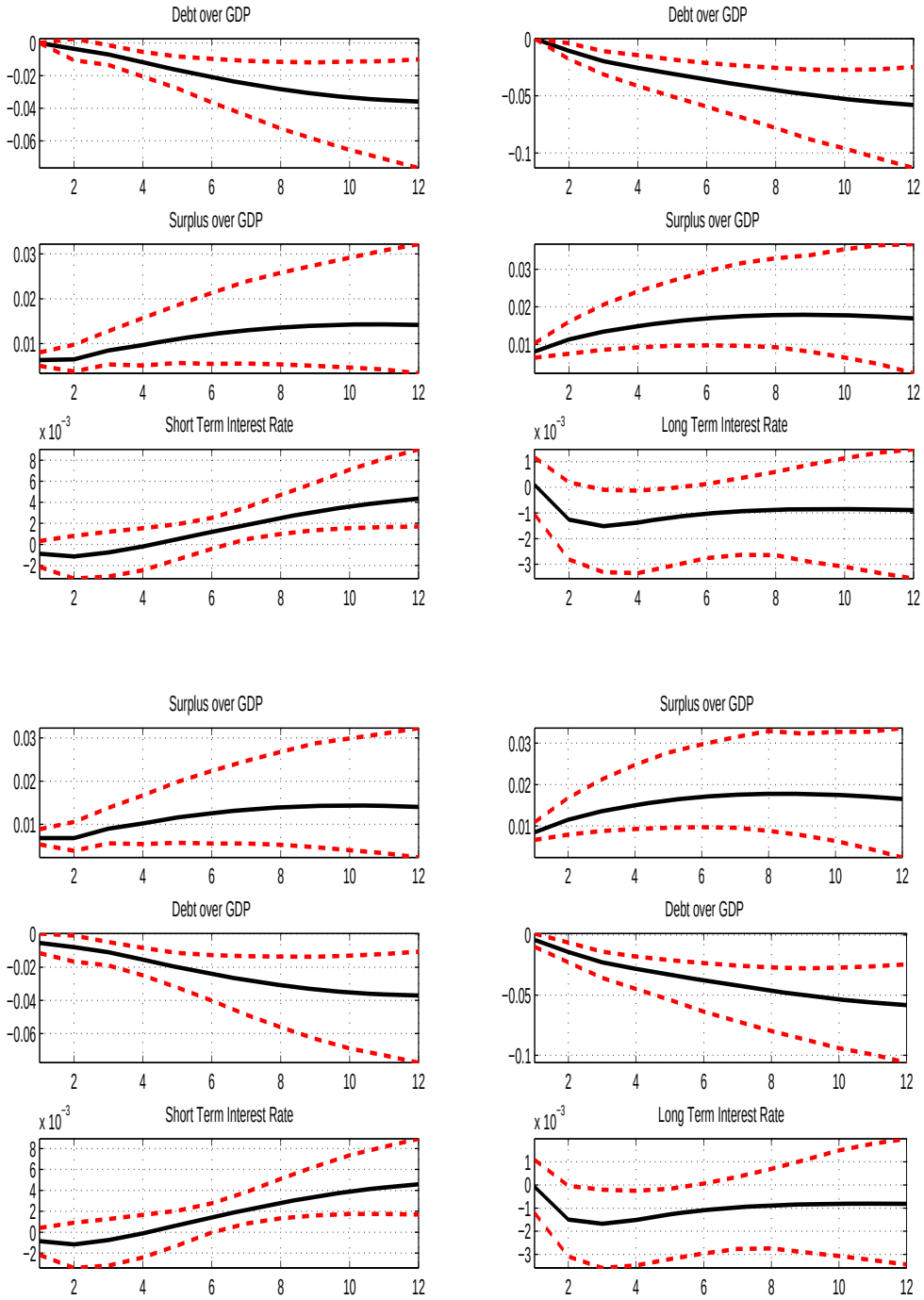


Fig. 4.10: Italy

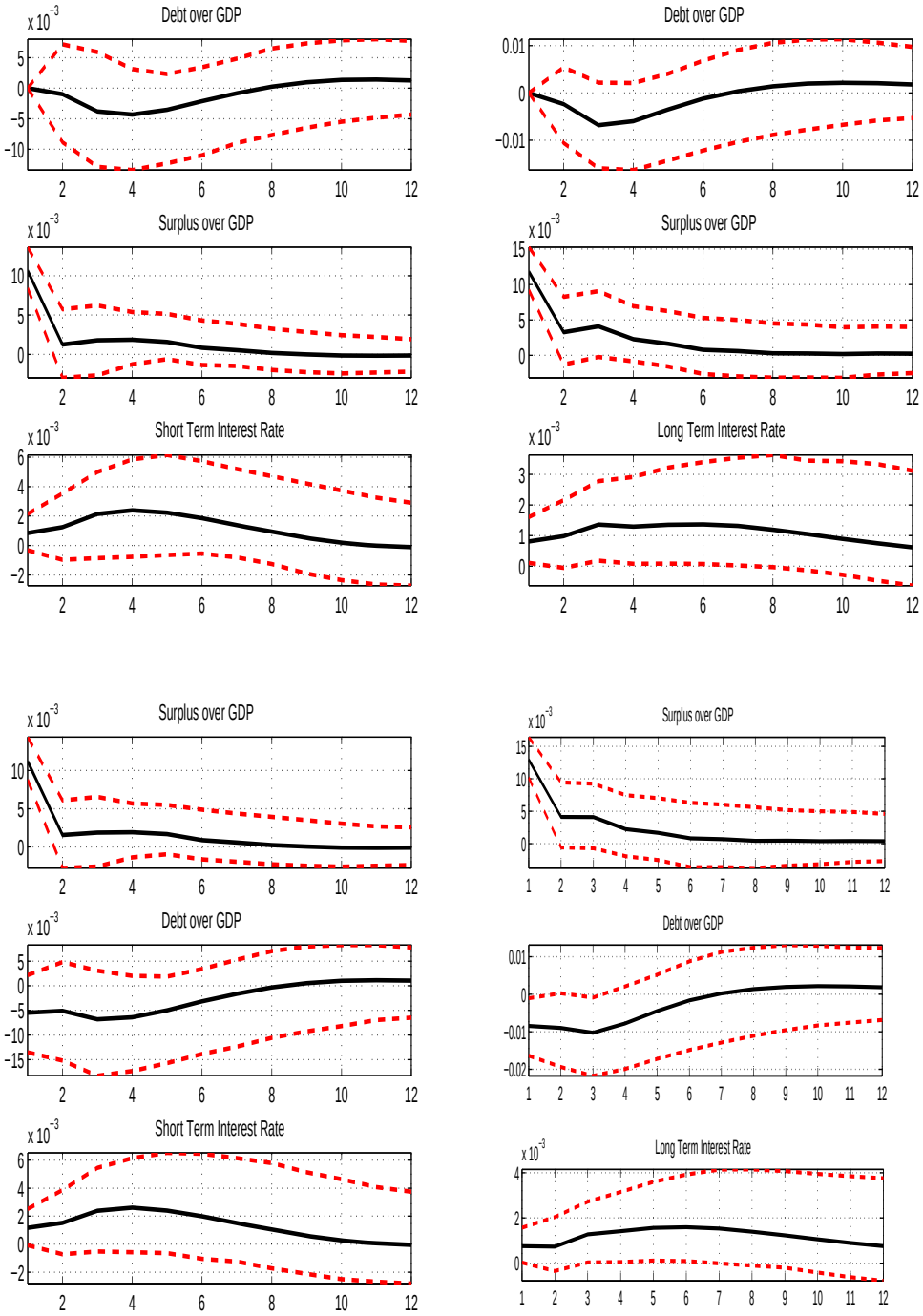


Fig. 4.11: Luxembourg

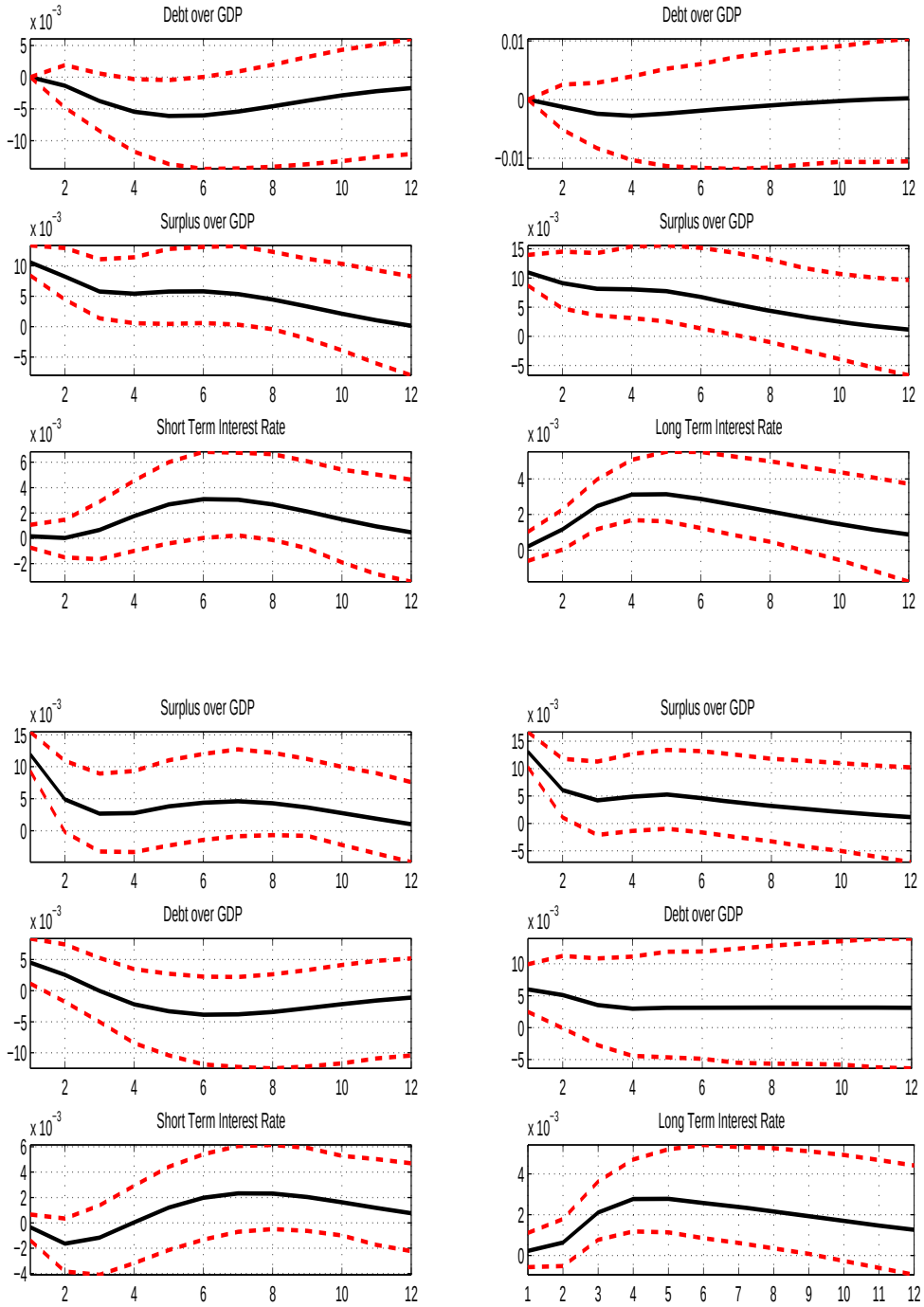


Fig. 4.12: Netherlands

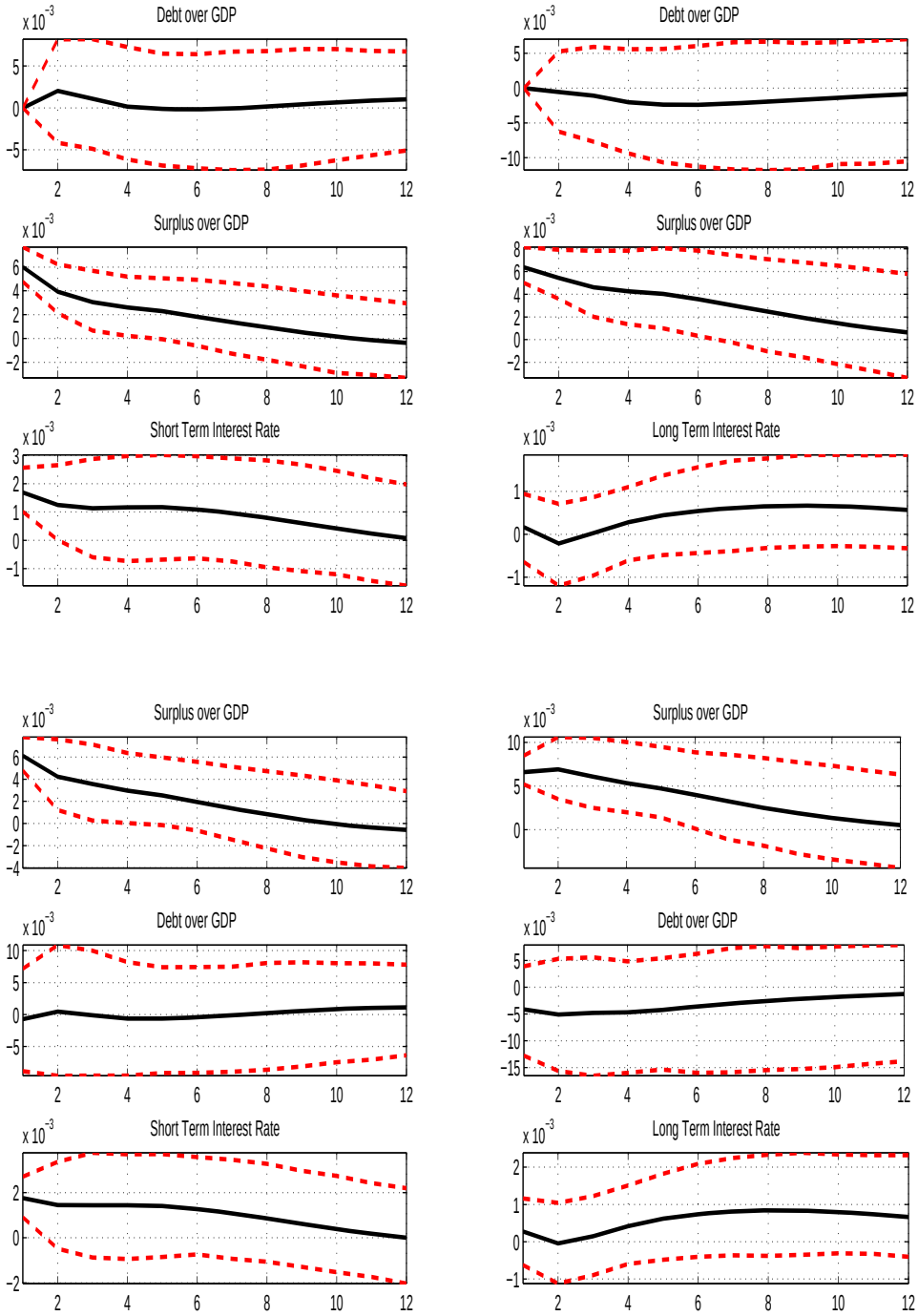


Fig. 4.13: Portugal

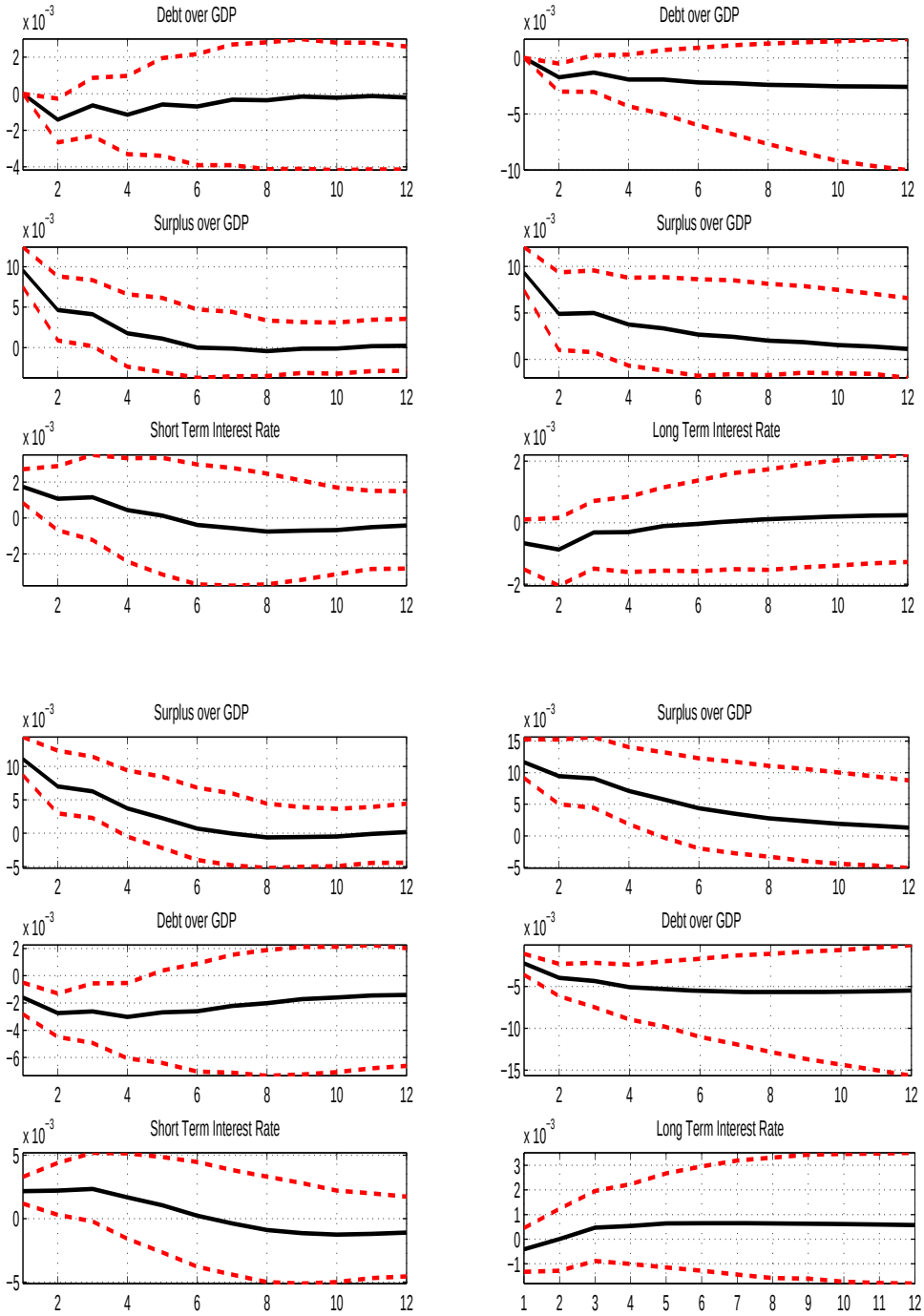
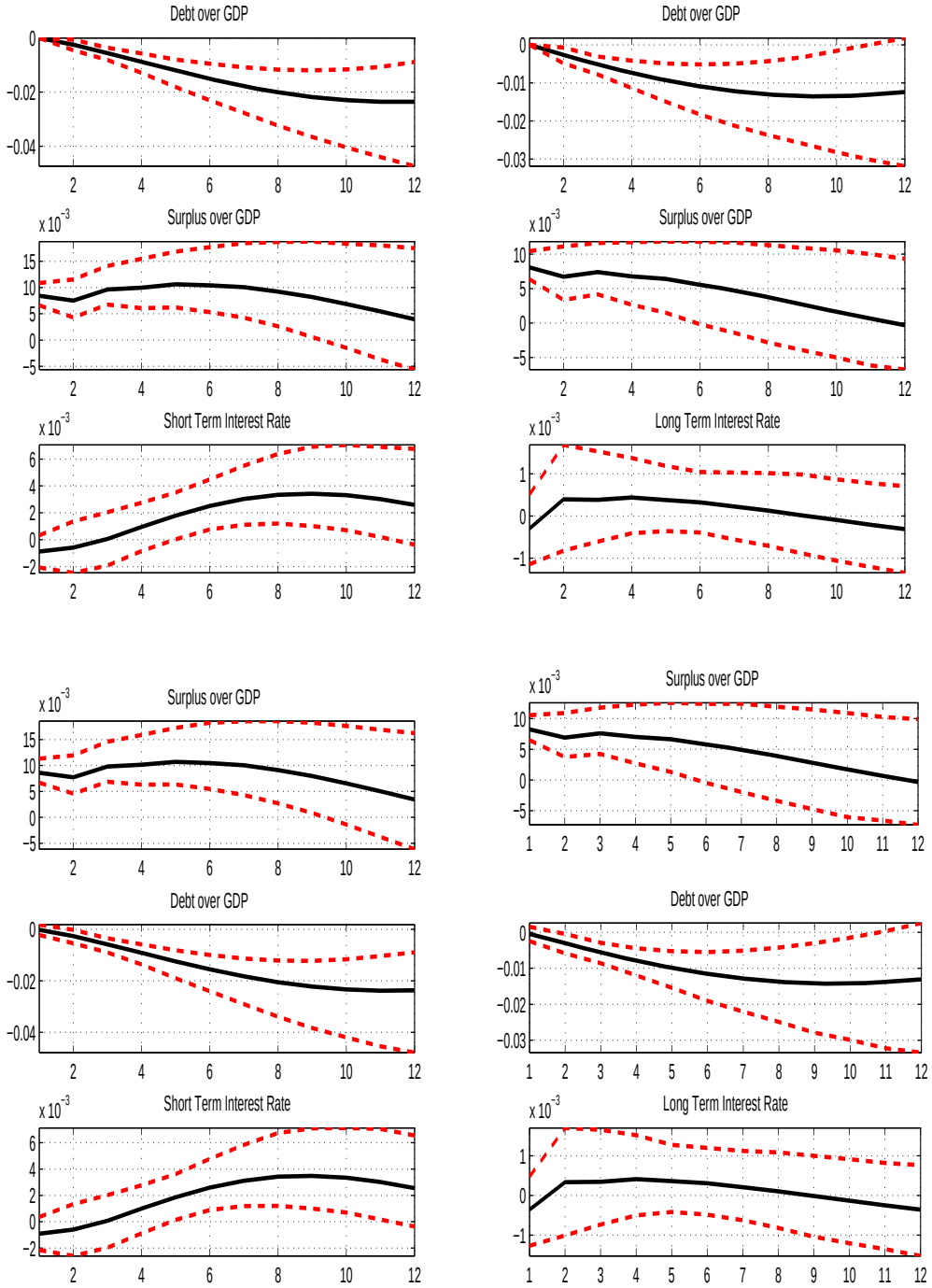


Fig. 4.14: Spain



5. INFLATION DIFFERENTIALS IN EMU: A DSGE APPROACH

Introduction

In this chapter, I try to explore the phenomenon of inflation differentials in EMU using a Dynamic Stochastic General Equilibrium (DSGE) approach. During the last ten years, economists try to build general equilibrium models trying to describe the behavior of the economy using microfoundations. I extend the model of Monacelli (2005) and Gali and Monacelli (2008) by incorporating a fiscal authority into my analysis. I calibrated and estimated the model for the case of Greece and the findings of the analysis reveal that the unconditional mean of the Greek inflation differential series over the studied period is definitely not zero. This seems quite important if someone considers also the recent developments in the eurozone concerning the debt crisis. In order for these series - inflation differentials - to sum to zero an equivalent period of negative inflation differentials is required. However, this sequence of negative inflation differentials can be produced either by

another sequence of positive productivity shocks – this seems unlikely – or by a severe recession – which sounds worrying if we take into account the present situation of Greek economy.

In relation to the previous chapter, this is a structural model where the fiscal policy is always passive and the monetary policy is always active (Leeper, 1991). This means that in this model the fiscal authorities will always adjust their instruments to stabilize the debt and the monetary authorities will bring inflation back to the target. This model excludes explosive public debt and monetary policy authorities to abandon the inflation target and switch to the debt stabilization. In other words long run inflation expectations are anchored to the target and debt always returns to its steady - state levels. In order to study the FTPL in a DSGE framework we need to allow for these mechanisms i.e.explosive public debt and stabilization from the Central Bank (Davig and Leeper, 2011).

5.1 The Model

The model builds extensively on previous work done in this area by Gali and Monacelli (2005) and Gali and Monacelli (2008). They develop a small open economy model in a currency union where the dynamics of the model are further enriched by incorporating habit formation on the demand side and price indexation on the supply side (Liu, 2006; Justiniano and Preston, 2010a). The model consists of two countries, a small open economy which

belongs to the monetary union and the rest of the world, which in this case is the rest of the union. The small open economy is considered to be the home country (domestic economy) and the actions taken by the households, firms and the government in that economy cannot influence the actions taken either by households/firms or policymakers in the monetary union. Moreover, because the size of the small open economy is negligible relative to the rest of the monetary union it takes the equilibrium of the union as given. Additionally, the exchange rate is fixed and the central bank takes into account the average inflation rate i.e. monetary policy is conducted at union's level. In the literature, someone can find similar models for small open economies Liu (2006); Lubik and Schorfheide (2005); Nimark (2009); Justiniano and Preston (2010b) and for a monetary union set up Herz et al. (????). This is definitely true for countries such as Greece, Portugal and Ireland, however, this assumption cannot be valid for bigger countries such as Germany and France. In the latter case a different modeling approach is required where agents' decisions in home economy affect those in the foreign economy (Lubik and Schorfheide, 2005).

I deviate from the existing work by augmenting the model with a "sophisticated" domestic fiscal authority. Using the terminology introduced by Leeper (1991) the fiscal policymaker is a "passive" one, meaning that he uses rules to bring the level of debt back to its steady-state during the business cycle. The monetary policy is conducted by the foreign authority and it is described by a "Taylor type" rule where the "Taylor principal" holds (Taylor, 1993).

As it is shown by Leeper (1991); **?** this set-up rules out pathologies, such as indeterminacy and the Fiscal Theory of Price Level (Sims, 1994; Woodford, 1996, 1998), that are outside the scope of this chapter.

Two policy instruments are available to the domestic authority to satisfy its budget constraint, government spending and lump-sum taxation. The former instrument is a negative function of the debt to GDP ratio, while the latter co-moves positively with the level of debt in the economy. Both rules allow for some smoothing and are subject to random perturbations. These structural shocks are going to be used later in the analysis to study counterfactual scenarios that will help us to understand the country implications – in GDP space – of the austerity measures that small EU countries are required to adopt in order to bring their national levels of debt back to sustainable levels.

However, the primary use of the model discussed in this chapter is to figure out whether inflation differentials in EMU countries are due to loss in competitiveness, or, due to domestic frictions – either in labour or product markets – or, finally, due to loose fiscal policy.

5.1.1 Households

Households in the domestic economy must decide on how much to consume and how much to work.

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{(C_t - H_t)^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \right\} \tag{5.1.1}$$

Data evidence for US and EU (Christiano et al., 2005; Smets and Wouters, 2003, 2005, 2007) seem to suggest that agents dislike consumption variations and this is reflected in their preferences, $H_t = hC_{t-1}$. Greece is another example that supports the latter statement. For instance, given country's difficult public financial position, the authorities of the union requested by Greece to decrease its deficits, the government responded by cutting down spending, however, this reduces the level of consumption substantially (significant austerity measures). Although this is a necessary austerity measure needed to be taken and agents do understand this, they do also protest against these severe cuts because this decreases the current level of consumption instantaneously and not smoothly.

The utility function of a representative household in this economy is given by (5.1.1), where σ is the inverse elasticity of intertemporal substitution and ϕ is the inverse elasticity of labour supply, also known as *Frisch elasticity*. This measures the elasticity of labour supply with respect to changes in current wage rate while keeping the marginal utility of consumption constant. We

can also interpret ϕ as the slope of the labour supply curve and $\beta \in [0, 1]$ is the time preference discount factor. Hours worked are represented by N_t, agents' consumption is denoted by C_t and $h \in [0, 1]$ is the external habit formation parameter.

The utility function (5.1.1) implies that agents preferences for consumption and labor are separable. This simplifies the calculations of agents' policy function below, however, it comes with a cost. This specification known as King et al. (1988) s' type preferences induce a strong wealth effect, meaning that the labour supply is a negative function of consumption. This implies that after a positive productivity shock, hours worked will fall (Gali, 1999). The intuition is obvious, agent feel rich enough, they reduce labour supply and increase their leisure activities. This type of behavior does not seem consistent with the data, where economic booms are usually positive correlated with hours. The studies of Greenwood et al. (1988) and Jaimovich and Rebelo (2009) have proposed alternative preference specification that reduce the importance of the wealth effect and, consequently, resolve the negative correlation between output and hours after a productivity shock.

[1]

Consumption C_t consists of a composite index of domestic and imported

[1] As it will be obvious later, my model has two fiscal rules that influence households' behavior mainly through the wealth effect. Preferences that eliminate the wealth effect reduces also the effectiveness of the fiscal authority to stabilise the debt. Having said that, I am working on a model with Jaimovich and Rebelo type preference that allows to estimate the importance of the wealth effect. I am doing this because I want to assess how the prediction of the model change under alternative utility function specifications.

goods, $C_{H,t}$ and $C_{F,t}$ respectively. I define it using a CES aggregation:

$$C_t = \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{5.1.2}$$

where $\eta > 0$ describes the elasticity of substitution between the home and foreign goods and $\alpha \in [0,1]$ is the share of imports in the total consumption bundle of the household. It is not hard to see that when the economy is closed – $\alpha = 0$ – then consumption index coincides with the domestic consumption – $C_t = C_{H,t}$. Moreover, the household allocates optimally its expenditure between domestic and imported goods according to equations 5.1.3 and 5.1.4:

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \tag{5.1.3}$$

$$C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t \tag{5.1.4}$$

with the Consumer Price Index (CPI) equal to $P_t = \left\{(1-\alpha)P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta}\right\}^{\frac{1}{1-\eta}}$. Loosely, speaking C_t is a weighted average between domestic and foreign produced consumption. These weights are time-varying and depend on the relative prices movements $\frac{P_{H,t}}{P_t}$ and $\frac{P_{F,t}}{P_t}$, respectively, η and a. The last parameter captures the preferences towards domestically produced good (home bias) and, consequently, indicates the degree of pass-through from exchange rate to domestic consumer price index (CPI).

Firms that produce final domestic and imported consumption goods are operated under perfect competition and use intermediate goods or type h and f, respectively, in the following technology

$$C_{H,t} = \left(\int_0^1 C_{h,t}^{\frac{\varepsilon-1}{\varepsilon}} dh \right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{5.1.5}$$

$$C_{F,t} = \left(\int_0^1 C_{f,t}^{\frac{\varepsilon}{\varepsilon-1}} df \right)^{\frac{\varepsilon-1}{\varepsilon}} \tag{5.1.6}$$

where ε is the elasticity of substitution of the different varieties in each bundle. We can think these firms as packagers that use intermediate produced goods – $C_{h,t}$ and $C_{f,t}$ – to deliver a single product.

We assume no transport costs and no price discrimination and because the model refers to a monetary union we also assume a single currency. These assumptions imply that $p_{F,t} = p_t^*$ where p_t^* is the union's price index. If we log-linearize the expression for the CPI we will get:

$$\begin{aligned} p_t &= (1-\alpha)p_{H,t} + \alpha p_t^* \\ &= p_{H,t} + \alpha s_t \end{aligned} \tag{5.1.7}$$

where the terms of trade are defined as $S_t = \frac{P_t^*}{P_{H,t}}$ or in a log-linear form $s_t = p_t^* - p_{H,t}$. Taking the first difference of equation 5.1.7 we can see that the gap between the domestic and the union wide inflation is proportional to the percentage change in the terms of trade - the openness indicator α

suggests the proportionality.

As it was mentioned earlier α captures the long run effect of foreign prices on the domestic CPI. This is an important equation since it illustrates the relationship between the domestic CPI and the union one. The degree of openness indicates how vulnerable is the domestic inflation to price movements in the EMU and the rest of the world more generally. An obvious example is the oil prices, these probably drive the European CPI and, consequently, the domestic one.

The household maximizes its utility subject to the following budget constraint

$$P_t C_t + E_t(Q_{t,t+1} B_{t+1}) = B_t + W_t N_t \tag{5.1.8}$$

where B_{t+1} is the payoff in nominal terms for period $t+1$ of the household's portfolio at the end of period t which consists of both domestic and foreign assets. W_t is the nominal wage and Q_{t+1} is the stochastic discount factor.

The solution to the household's optimization problem yields the following first order conditions

$$\frac{W_t}{P_t} = \frac{N_t^{\phi}}{\widetilde{C}_t^{-\sigma}} \tag{5.1.9}$$

$$\beta R_t^* E_t \left\{ \frac{P_t}{P_{t+1}} \left(\frac{\widetilde{C}_{t+1}}{\widetilde{C}_t} \right)^{-\sigma} \right\} = 1 \tag{5.1.10}$$

with equation 5.1.9 representing the intratemporal optimality condition where the marginal utility of consumption is equal to the hours worked to the real wage. Equation 5.1.10 is the well known Euler equation where $R_t^* = \frac{1}{E_t Q_{t,t+1}}$ is the gross nominal interest rate on a riskless one-period discount bond paying off one unit of the common currency in $t+1$ and I also assume that this is the common interest rate set by the central bank and $\widetilde{C}_t = (C_t - hC_{t-1})$. According to the Taylor Principle the nominal interest rate is adjusted more than one-to-one relative to the changes in inflation and this is a necessary condition for equilibrium determinacy (Gal, 2008). A small open economy when joins a monetary union will relinquish its ability to meet the Taylor Principle as the changes in home inflation will have only a minor effect on union-wide inflation. Below I will describe the monetary policy at a union level.

Log-linearizing the above first order conditions I get

$$\begin{aligned} w_t - p_t &= \phi n_t + \frac{\sigma}{1-h}(c_t - hc_{t-1}) \\ n_t &= \frac{1}{\phi}(w_t - p_t) - \frac{\sigma}{\phi(1-h)}(c_t - hc_{t-1}) \end{aligned} \tag{5.1.11}$$

where $\pi_t = p_t - p_{t-1}$ is the CPI inflation (lower case letters denote the logs of the respective variables). Expression (5.1.11) is the labour supply schedule that indicates that hours are negatively related to consumption, which is the wealth effect discussed above. In this economy I have made the assumption that wages are fully flexible, meaning that households have no monopoly

power over their labour. This does not seem to be supported by the data where wages appear to be sticky (Gertler et al., 2008; Christiano et al., 2005; Smets and Wouters, 2003). Labour market frictions – such as unions – imply that equation (5.1.11) cannot describe the behavior of wages in the real world. Wage rigidities are important to understand inflation dynamics in EU and I am working on a model with labour frictions. However, in the model used in this study these missing wage dynamics would be captured by the price markup shock and we must keep this in mind when we study the output of the estimation of this model.

The evolution of consumption in this model is given by

$$c_t = \frac{1}{1+h} E_t c_{t+1} + \frac{h}{1+h} c_{t-1} - \frac{1-h}{\sigma(1+h)} (r_t - E_t \pi_{t+1}) \tag{5.1.12}$$

The above equation shows that current consumption depends on previous and expected consumption and the real interest rate. In addition, the sensitivity of consumption to the real interest rate depends on the external habit formation and the inverse of the intertemporal elasticity of substitution which means that higher values of these two parameters lowers the elasticity of consumption with respect to the changes in interest rate. If $h = 0$ the above Euler equation becomes a forward-looking Euler equation (Gal, 2008). If we iterate this equation forwards and apply the Law of Iterated Expectations then we can see that domestic aggregated consumption is a function of long-term interest rate and the central bank can affect households' consumption

by influencing the yield curve.

Concerning the households of the rest of the world (monetary union) they face the same optimization problem but they get almost zero influence from the small open economy. For this reason consumption consists only from foreign goods i.e. $C_t = C_{F,t}$ and $P_t = P_{F,t}$. The optimality conditions are the same as in the case of the small open economy but now the variables are denoted with a superscript (*). Equation of the foreign and domestic optimality conditions yields:

$$\beta E_t \left\{ \frac{P_t}{P_{t+1}} \left(\frac{\widetilde{C}_{t+1}}{\widetilde{C}_t} \right)^{-\sigma} \right\} = \beta E_t \left\{ \frac{P_t^*}{P_{t+1}^*} \left(\frac{\widetilde{C}_{t+1}^*}{\widetilde{C}_t^*} \right)^{-\sigma} \right\} \tag{5.1.13}$$

Gali and Monacelli (2008) show that the following international risk sharing condition holds between the two countries in equilibrium:

$$C_t - hC_{t-1} = \vartheta(C_t^* - hC_{t-1}^*)Q_t^{-\frac{1}{\sigma}} \tag{5.1.14}$$

where $Q_t = \frac{P_t}{P_t^*}$ (in logs $q_t = p_t - p_t^*$) is the CPI differentials between home and foreign country. This is equation pins down the value of the of the real exchange rate and ensures that the value of assets (in consumption units) in the domestic economy grow in line with the foreign one. An increase of q_t means that the home country experiences real exchange appreciation, putting differently the prices in this economy grow faster than the rest of the union

and as a result the small open economy will lose competitiveness in terms of cost relative to the rest of the union. ϑ is a constant that depends on the initial asset position and under symmetric initial conditions ϑ is equal to 1. Log-linearization of the above equation around the steady-state yields equation 5.1.15:

$$c_t - hc_{t-1} = (c_t^* - hc_{t-1}^*) - \frac{1-h}{\sigma} q_t \tag{5.1.15}$$

Substituting equation 5.1.15 into the definition of q_t yields the well known relationship between inflation differentials and the terms of trade:

$$-q_t = (1-\alpha)s_t \tag{5.1.16}$$

A crucial assumption of the model is that the rest of the monetary union is a closed economy yielding that $c_t^* = y_t^*$. Putting equation 5.1.16 into 5.1.15 and substituting c_{t+1} from the Euler equation we get:

$$c_t = hc_{t-1} + y_t^* - hy_{t-1}^* + \frac{(1-h)(1-\alpha)}{\sigma} E_t s_{t+1} - \frac{1-h}{\sigma}(r_t - E_t \pi_{t+1}) \tag{5.1.17}$$

This open economy version of the consumption Euler equation that we show above illustrates that domestic consumption is positively related to the previ-

ous consumption, the external demand and the terms of trade and negatively to the real interest rate.

5.1.2 Firms

Production technology

Turning now to the supply side of the economy, domestic intermediate good producers are described by a continuum of identical monopolistically-competitive firms. Each intermediate firm produces a differentiated good Y_t with a linear production function and labour as the only input.

$$Y_t(j) = A_t N_t(j) \tag{5.1.18}$$

The production function can also be expressed in logs as $y_t = \alpha_t + n_t$ where α_t is a firm-specific productivity index following an AR(1) process, $\alpha_t = \rho_a \alpha_{t-1} + \epsilon_t^\alpha$ with $\epsilon_t^\alpha \sim i.i.d.N(0, \sigma_\alpha^2)$. Capital is in fixed supply in this world and this is made again for model simplicity. In this case this does not seem to harm the analysis since capital is a highly slow moving variable (you cannot change the quantity of capital in the economy very easily, build a new factory or destroy an existing one in few quarters). On the other hand, investment dynamics are very interesting (stock prices movements) and, perhaps, very interesting to understand GDP cycle variations. However, they are probably less important for inflation dynamics since the aggregated demand (and not

its individual components) is what it matters.

Final output is given by:

$$Y_t = \left[\int_0^1 Y_t(j)^{\frac{1}{1+\lambda_{p,t}}} dj \right]^{1+\lambda_{p,t}} \tag{5.1.19}$$

where $\lambda_{p,t} - \lambda_p = \rho_\lambda (\lambda_{p,t} - \lambda_p) + \sigma_\lambda \varepsilon_{\lambda,t}$ determines the time-varying mark-up in the goods market. The real total cost of production and the real marginal cost $TC_t(j) = \frac{W_t}{P_{H,t}} \frac{Y_{t(j)}}{A_t}$ and $MC_{t,(j)} = \frac{dMC_{t,(j)}}{dY_{t,(j)}} = \frac{W_t}{A_t P_{H,t}} \forall j$ respectively are the same for all firms since they are sharing the same technology. In logs the real marginal cost is expressed as:

$$mc_t = w_t - p_{H,t} - a_t \tag{5.1.20}$$

In other words the marginal cost reflects variation in wages and productivity.

Finally, the sector that imports differentiated goods from the rest of the union and sells them domestically takes foreign prices as given.

Price setting behavior

Firms in the small open economy operate in a monopolistic competitive market, they set prices and supply what ever quantity is demanded at this price level. The pricing scheme is as follows, in any period t a fraction $(1 - \vartheta_H)$ of firms receives a random signal and sets prices optimally (Calvo, 1983),

meaning that prices are selected in order to maximize the present value of the expected stream of profits taking into account domestic and foreign demand and the fact that in the future they may not be able to reset optimally their prices. The fraction of firms (ϑ_H) who loses the random signal to optimally adjust prices uses a backward-looking "rule of thumb" to set them

$$P_{H,t}(i) = P_{H,t-1}(i)\left(\frac{P_{H,t-1}}{P_{H,t-2}}\right)^{\delta_H} \tag{5.1.21}$$

where the degree of indexation to the past inflation rate is measured by the parameter $\delta_H \in [0,1]$. The combination of these two prices[2]

$$P_{H,t}^{-\frac{1}{\lambda_{p,t}}} = (1-\theta_H)\tilde{P}_{H,t}^{-\frac{1}{\lambda_{p,t}}} + \theta_H\left(P_{H,t-1}\left(\frac{P_{H,t-1}}{P_{H,t-2}}\right)^{\delta_H}\right)^{-\frac{1}{\lambda_{p,t}}} \tag{5.1.22}$$

where $\tilde{P}_{H,t}$ is the price that the $(1-\vartheta_H)$ fraction of firms can reset optimally during period t, leads to the New Keynesian Phillips (Gali and Gertler, 1999)

$$\pi_{H,t} = \frac{\delta_H}{1+\delta\beta}\pi_{H,t-1} + \frac{\beta}{1+\delta_H\beta}E_t\pi_{H,t+1} + \frac{(1-\theta_H)(1-\theta_H\beta)}{\theta_H(1+\delta_H\beta)}(mc_t + \lambda_{p,t}) \tag{5.1.23}$$

The above Phillips curve states that the inflation rate in domestic economy is determined by past and expected inflation and by real marginal costs. The

[2] I will only consider the symmetric equilibrium case, meaning that the index i can be dropped.

backward-looking inflation appears as a result of the price indexation rule described above. According to the literature this "hybrid" Phillips curve contains three key parameters: the measure of price stickiness which is given by the fraction of firms ϑ_H that do not change their prices during period t , the measure of indexation δ and the discount factor β. Without indexation, meaning $\delta = 0$, the above Phillips curve will turn to the traditional Phillips curve we know from the literature as the forward-looking New Keynesian Phillips curve. Both the Calvo probability and indexation parameter change the slope of the Phillips curve and, consequently, the ability of central bank to affect inflation expectation and stabilise the economy.

Prior to the New Neoclassical synthesis inflation was linked to output gap and not to marginal cost. Many policy makers continue to think in this way when they talk about the sparse capacity in the economy, which is summarised by the output gap. Galí (1996) and Woodford (2003) illustrate that in a model like the one described in this section marginal cost and output gap would coincide. This is going to be useful when we will discuss the estimation results since the idea of the output gap is better understood.

5.1.3 General Equilibrium

Aggregate demand and output

The market clearing condition for goods in the small open economy requires the domestic output to be equal to the sum of domestic consumption, exports and government spending.

$$y_t = (1-a)c_{H,t} + ac^*_{H,t} + g_t \tag{5.1.24}$$

In log-linear form the optimal demand functions are given by equations 5.1.25 and 5.1.26.

$$c_{H,t} = -\eta(p_{H,t} - p_t) + c_t$$

$$= a\eta s_t + c_t \tag{5.1.25}$$

$$c^*_{H,t} = -\eta(p_{H,t} - p^*_t) + c^*_t$$

$$= \eta s_t + c^*_t \tag{5.1.26}$$

If we substitute the above two equations into 5.1.24 we will get the goods clearing condition for the small open economy:

$$y_t = (1-a)c_t + (2-a)a\eta s_t + ay_t^* + g_t \tag{5.1.27}$$

According to this equation, the domestic supply equals to domestic consumption, to world demand and to demand that arises from improvement in the terms of trade. This means that an increase in the terms of trade i.e. an increase in domestic competitiveness relative to the rest of the union, agents in domestic economy will substitute foreign goods for domestic, with the magnitude of substitution depending on the openness of the economy which is given by α and the elasticity of substitution between home and foreign goods η. At the limiting case where $\alpha = 0$ we will have $y_t = c_t + g_t$.

Marginal cost and inflation dynamics

Substituting equation 5.1.11 into the linear production function 5.1.18 and equation 5.1.7 into the marginal cost equation 5.1.20 we get the following marginal cost condition:

$$mc_t = \frac{\sigma}{1-h}(c_t - hc_{t-1}) + \phi y_t + as_t - (1+\phi)a_t \tag{5.1.28}$$

The marginal cost is positively related to the domestic output, consumption

and the terms of trade and negatively on labour productivity.

5.1.4 The regional fiscal authority

The government in the domestic economy taxes households T_t and issues nominal debt B_t. These revenues are spent on public spending G_t and interest payments on outstanding debt $R_{t-1}B_{t-1}$. It is assumed that public spending does not yield any utility to households in our model. The aim of the introduction of the government sector into the model is to study how regional fiscal policies affect inflation differentials across regions. The log linear approximated government's budget constraint is given by:

$$b_t = \frac{R^*}{\pi^*}\left(r_{t-1} - \pi_t + b_{t-1}\right) + \frac{d^*}{b^*}\left(g_t - \tau_t\right) \tag{5.1.29}$$

More precisely, I want to examine the effects of alternative fiscal policies on inflation differentials when the economy is under the pressure of reducing public deficit by a certain percentage. Fiscal consolidation policies can be associated with either an increase in taxation or/and a reduction on spending. My assumption is that government's spending policy obeys the following rule

$$g_t = \rho_g g_{t-1} - \frac{g^*}{y^*}\left(b_{t-1} - y_{t-1}\right) + \sigma_g \varepsilon_{g,t} \tag{5.1.30}$$

where $|\rho_g| \prec 1$ and $\varepsilon_{g,t} \sim N(0, \sigma_g)$. The logic of the rule is obvious, govern-

ment increases spending as the debt to GDP ratio decreases while the persistence parameter captures the desire of the government to smooth spending cuts in order to avoid the political cost.

Taxes rise as the debt level in the economy increases, however, and they only gradually returns back to their steady-state level; this depends on the persistence parameter ρ_τ.

$$\tau_t = \frac{\tau^*}{b^*} b_t + \rho_\tau \tau_{t-1} + \sigma_\tau \varepsilon_{\tau,t} \tag{5.1.31}$$

The random disturbances $\varepsilon_{g,t}$ and $\varepsilon_{\tau,t}$ capture the unexpected parts of fiscal policies implemented by the government. In the following sections I am contacting a series of counterfactual experiments using these structural shocks to study the economic consequences of the fiscal consolidation targets requested by EU authorities in the case of Greece.

5.1.5 The Monetary Union

As mentioned at the beginning of this section, the monetary union is considered to be a closed economy meaning that $\alpha = 0$ is modeled as exogenous to the domestic economy since there are no feedback effects from the Greek economy. So, aggregate demand is equal to consumption and inflation equals the CPI inflation since there is no imported inflation. The monetary union economy is similar to the one in Clarida et al. (1999) and Cho and Moreno

(2006). The aggregate demand is given by the following AR(1) process:

$$y_t^* = \rho_{y^*} y_{t-1}^* + \sigma_{y^*} \varepsilon_{y^*,t} \tag{5.1.32}$$

Similarly, foreign inflation is given by:

$$\pi_t^* = \rho_{\pi^*} \pi_{t-1}^* + \sigma_{\pi^*} \varepsilon_{\pi^*,t} \tag{5.1.33}$$

The monetary union block closes with the introduction of a simple Taylor Rule which describes the behavior of the monetary authority:

$$r_t^* = \rho_{r^*} r_{t-1}^* + (1 - \rho_{r^*})(\beta \pi_t^* + \gamma y_t^*) + \varepsilon_{MP,t} \tag{5.1.34}$$

ρ_r is the degree of interest rate smoothing and the parameters β and γ denote the relative weight that the central bank puts on inflation and output respectively. The shock in the reaction function of the central bank is a white noise process.

5.2 Estimation Methodology

This section draws heavily from the work of Filippeli et al. (2012), they propose a quasi-bayesian methodology of estimating DSGE models. Similar procedures have been developed by Del Negro and Schorfheide (2004) and Christiano et al. (2010a,b).

5.2.1 Notation

The required notation is developed in this section. To be precise, $\mathbb{R}$ denotes the real line, da indicates the dimension of the vector a, $\mathbb{R}^{da} \equiv \mathbb{R} \times \mathbb{R} \times ... \times \mathbb{R}$ is the da-cartesian power of the real line, I_{da} stands for the $(da \times da)$ identity matrix, the vec and $vech$ operators transform a matrix with dimensions $da \times da$ to an $da^2 \times 1$ vector by stacking the columns, and to an $(da(da+1)/2) \times 1$ vector by stacking the elements of and below the main diagonal, respectively. The symbol $\otimes$ denotes the Kronecker product operator, while, $\nabla_a f(a)$ and $\nabla_a^2 f(a)$ represent the matrices of the first and second derivatives of the vector function $f(a)$ with respect to the vector a, respectively. $K_{dm,dn}$ is a commutation matrix, such that for any $dm \times dn$ matrix G, $K_{dm,dn} vec(G) = vec(G')$. The state space representation of a solved (log) linear approximated DSGE model ($\mathcal{M}$) is given by

$$y_t = A(\gamma)\xi_t \tag{5.2.1}$$

$$\xi_t = B(\gamma)\xi_{t-1} + \Upsilon(\gamma)\omega_t \tag{5.2.2}$$

where the equation (5.2.2) describes the evolution of the state vector $\left(\xi_t \in \mathbb{R}^{d\xi}\right)$ of the model, expression (5.2.1) illustrates the relation between the unobserved state of the economy and the observable variables $\left(y_t \in \mathbb{R}^{dy}\right)$, the vector of the structural shocks $\left(\omega_t \in \mathbb{R}^{d\omega}\right)$ is normally distributed with mean zero and I_{dy} covariance matrix $(N \sim (0, I_{dy}))$ and the elements of the matrices $A(\gamma)$, $B(\gamma)$, and $\Upsilon(\gamma)$ are nonlinear functions of the DSGE paymaster vector, which is also called the structural parameter vector, $\gamma \in \Gamma$. $\Psi(a)$ implies that the quantity Ψ is expressed as a function of a. The VAR(p) model ($\mathcal{T}$) is described by

$$y_t = \sum_{i=1}^{p} \Delta_i y_{t-i} + v_t \tag{5.2.3}$$

where v_t, the vector of the reduced form error, is normally distributed with zero mean and Σ_v variance-covariance matrix and its standard regression representation is

$$Y = \Delta X + U \tag{5.2.4}$$

where $\Delta = \begin{bmatrix} \Delta_1 & \cdots & \Delta_p \end{bmatrix}$ is the $dy \times pdy$ matrix of the VAR coefficients, T is the sample size, Y is the $dy \times T$ data matrix of the observed variables, X is the $pdy \times T$ matrix of the lagged data and U is the $dy \times T$ matrix of the VAR innovations. $\delta \equiv vec(\Delta)'$ and $\sigma_v \equiv vech(\Sigma_v)'$ are the components of the VAR parameter vector $\theta \equiv (\delta', \sigma_v')' \in \Theta$, which is called the reduced-form parameter vector; Γ and Θ are compact subsets of $\mathbb{R}^{d\gamma}$ and $\mathbb{R}^{d\theta}$, respectively. The OLS estimates of Σ_v, Δ, δ, σ_v and θ are defined as $\widehat{\Sigma}_v$, $\widehat{\Delta}$, $\widehat{\delta}$, $\widehat{\sigma}_v$ and $\widehat{\theta}$, re-

spectively. $C_{yy} = \mathbb{E}\left(Y_t Y_t'\right)$, $C_{xx} = \mathbb{E}\left(X_t X_t'\right)$, $C_{yx} = \mathbb{E}\left(Y_t X_t'\right)$, $\widehat{C}_{yy} = T^{-1} Y Y'$, $\widehat{C}_{xx} = T^{-1} X X'$, $\widehat{C}_{yx} = T^{-1} Y X'$ are data's population moments and their estimates. $N\left(\mu_\alpha, \Sigma_\alpha\right)$ stands for the normal distribution, where μ_α and Σ_α denote the mean and the covariance matrix of the vector α, respectively. The Wishart and its inverse distributions with η degrees of freedom and Π scale matrix are defined as $W\left(\Pi, \eta\right)$ and $IW\left(\Pi^{-1}, \eta\right)$, respectively. $p\left(a\right)$ denotes the prior distribution of a, $L_{\mathcal{T}}\left(Y|\theta\right)$ and $m_{\mathcal{T}}\left(Y\right) \equiv \int L_{\mathcal{T}}\left(Y|\theta\right) p\left(\theta\right) d\theta$ stand for the likelihood and marginal likelihood of the VAR, respectively, while the same quantities for the DSGE model are given by $L_{\mathcal{M}}\left(Y|\gamma\right)$ and $m_{\mathcal{M}}\left(Y\right) \equiv \int L_{\mathcal{M}}\left(Y|\gamma\right) p\left(\gamma\right) d\gamma$.

5.2.2 DSGE Estimation

Before the evolution of the MCMC methodology DSGE models were mainly estimated using classical limited information (LMI) methods (Smith, 1993; Rotemberg and Woodford, 1998; Christiano et al., 2005) and this was due to their good small samples properties (Ruge-Murcia, 2007; Theodoridis, 2011), the lack of the requirement the structural model to be viewed as the true data generation process and the non-smoothness of the DSGE likelihood.

As it is explained in Theodoridis (2011), the most attractive feature of the LMI methodology is that you actually observe the targets you are trying to "hit". This allows you to identify the "strengths" and the "weaknesses" of the model, once the structural parameters have been estimated, and to derive

some useful economic conclusions about the model. This does not seem so obvious in the full information (FLI) case where the estimated vector minimises the distance between the model and the true data generation process. Since that the latter is unknown, there no way to assess how big this distance is or/and what this implies the economics of the model.

Canova and Sala (2009) argue that FLI techniques deliver more accurate inference than LMI one. Their point is that the likelihood of the model conveys substantially more information than the LMI objective function and this helps the identification of the true parameter vector. However, Iskrev (2010) illustrates that DSGE models are inherently weakly identified and this symptom applies to both FLI and LMI estimation procedures. Theodoridis (2011) illustrates that when a sufficient number of instruments, which fully summarise the likelihood of the model under normality, and the optimal weighted matrix are used then, in small samples, LMI estimation techniques outperform even Bayesian FLI procedures with unrealistic tight priors around the true parameter vector.

The studies of Del Negro and Schorfheide (2004) and Christiano et al. (2010a) can be viewed as attempts to incorporate inside the Bayesian framework this long lasting knowledge about selecting structural parameters based on LMI metrics. The technique presented in this section walks along this path and illustrates how the structural parameters can be selected in order to minimise the distance between the posterior moments of the VAR parameter vector

and the one implied by the DSGE model.

To be precise, we know from the work of Del Negro and Schorfheide (2004, Section 3.3.1) that the posterior distribution of γ can be obtained by combining the marginal likelihood of the VAR with the prior distribution of the structural parameter vector – $p(\gamma)$ –, however, when no conjugate priors are used the marginal likelihood of the VAR – $m_{\mathcal{T}}\left(Y|\gamma,\widehat{\theta}\right)$ does not have an analytic form. This difficulty is bypassed using the "Laplace" approximation and the fact that under some conditions the DSGE model can re-expressed as a VAR of infinite order (Fernandez-Villaverde et al., 2007; Christiano et al., 2006; Ravenna, 2007). The latter implies that the VAR parameter vector can be viewed as function of the structural parameter vector, $\theta(\gamma)$.

Under the assumption that the likelihood is close to symmetric and highly picked around the mode

$$\theta^* = \arg\max L_{\mathcal{T}}(Y|\theta)\, p(\delta|\gamma)\, p(\sigma_v|\gamma) \tag{5.2.5}$$

then $m_{\mathcal{T}}\left(Y|\gamma,\widehat{\theta}\right)$ can be approximated by

$$\begin{aligned} m_{\mathcal{T}}(Y|\theta^*) &= (2\pi)^{d\theta}\left|-\nabla_\theta^2 \log p(\theta^*|Y)\right|^{-\frac{1}{2}} \\ &\quad \exp\left[\frac{1}{2}(\theta-\theta^*)'\nabla_\theta^2 \log p(\theta^*|Y)(\theta-\theta^*)\right] \end{aligned} \tag{5.2.6}$$

(see, Canova, 2005, Chapter 9), where $p(\theta^*|Y)$ denotes the posterior distribution of VAR parameter vector. At this point we apply the same assumption

adopted by Del Negro and Schorfheide and we replace θ by $\theta(\gamma)$, namely

$$\begin{aligned} m_{\mathcal{T}}(Y|\theta^*) &= (2\pi)^{d\theta} \left|-\nabla_\theta^2 \log p(\theta^*|Y)\right|^{-\frac{1}{2}} \\ &\quad \exp\left[\frac{1}{2}(\theta(\gamma)-\theta^*)' \nabla_\theta^2 \log p(\theta^*|Y)(\theta(\gamma)-\theta^*)\right] \end{aligned} \tag{5.2.7}$$

Consequently, (**??**) in the present framework can be expressed as

$$p(\gamma|Y,\theta^*) \propto m_{\mathcal{T}}(Y|\theta^*)\, p(\gamma) \tag{5.2.8}$$

and the posterior distribution of γ can be constructed through the random walk Metropolis-Hasting MCMC resampling scheme.

The theory regarding this type of limited information or Quasi Bayesian estimators is developed in a series of papers by Kwan (1999), Kim (2002) and Chernozhukov and Hong (2003).

Intuitively, we can think (5.2.8) as the set of γ values that minimise the distance between the posterior mode of the VAR parameter vector estimated in the data and the one implied by the model. The difference between this estimator and the one discussed in Del Negro and Schorfheide (2004) is the set of instrument for the estimation of γ. In our case it is the posterior mode of θ, while in their case is the OLS estimate.

5.3 Estimation Results

This section describes the estimation results.

5.3.1 Data

The data are in quarterly frequency and they are all taken from Eurostat. For average working hours I used average number of actual weekly hours of work, for the EMU policy rate I used the official refinancing operation rate and for consumption I used the final consumption aggregates in real prices using the consumption deflator.

5.3.2 Posterior Estimates

Table 5.1 reports the model parameters that have been calibrated. The value β implies an annual real interest rate of 4%, while π^* is consistent with ECB's inflation target. The values of $\frac{g^*}{y^*}$, $\frac{\tau^*}{b^*}$ and $\frac{d^*}{b^*}$ are their data averages.

Tab. 5.1: Calibrated Parameters

Parameters	Values
β	0.990
$\frac{d^*}{b^*}$	0.810
$\frac{g^*}{y^*}$	0.415
$\frac{\tau^*}{b^*}$	0.297
π^*	1.005

Table 5.2 puts together the prior and the posterior moments of the structural

parameters. It is perhaps worthwhile to be emphasised that the posterior distribution of all parameters – with only one exception σ – has shifted away from the prior one, indicating that data conveys enough information to move the posterior estimates away from their prior moments – Figure 5.1. In other words, the results discussed in this section are not driven by assumptions made about the prior distribution of the structural parameters.

Tab. 5.2: Parameter Moments

	Prior			Posterior		
Parameters	Density	Mean	STD	Median	5%	95%
α	Beta	0.700	0.100	0.782	0.726	0.835
h	Beta	0.700	0.100	0.628	0.575	0.685
σ	Normal	1.500	0.100	1.504	1.341	1.662
ϕ	Normal	2.000	0.750	2.896	2.174	3.426
η	Gamma	0.250	0.150	0.056	0.050	0.072
θ_H	Beta	0.700	0.100	0.914	0.889	0.943
δ_H	Beta	0.700	0.100	0.732	0.663	0.821
ρ_τ	Beta	0.500	0.200	0.281	0.116	0.580
ρ_a	Beta	0.500	0.200	0.347	0.182	0.561
ρ_{y^*}	Beta	0.500	0.200	0.627	0.491	0.736
ρ_{r^*}	Beta	0.500	0.200	0.690	0.585	0.802
ρ_{π^*}	Beta	0.500	0.200	0.619	0.518	0.714
ρ_g	Beta	0.500	0.200	0.441	0.358	0.540
ρ_{λ_p}	Beta	0.500	0.200	0.580	0.466	0.677
γ_π	Normal	1.500	0.250	1.463	1.337	1.587
γ_y	Normal	0.125	0.050	0.129	0.097	0.149
σ_{MP}	InvGamma	0.500	0.250	0.489	0.384	0.626
σ_a	InvGamma	0.500	0.250	0.213	0.179	0.260
σ_g	InvGamma	0.500	0.250	0.560	0.365	0.809
σ_{y^*}	InvGamma	0.500	0.250	0.075	0.061	0.092
σ_{π^*}	InvGamma	0.500	0.250	0.495	0.407	0.597
σ_{λ_p}	InvGamma	0.500	0.250	0.571	0.476	0.667
σ_τ	InvGamma	0.500	0.250	6.464	3.103	7.871

Canova and Sala (2006, 2009) argue that Chart 5.1 should not be used as a metric to inference that DSGE parameters are identified. Although I agree with this argument it also fair to say that the posterior mode – in almost all cases – is not only very different from the prior one but also the uncertainty around this estimate is significantly smaller – higher peak – than the prior variance. This evidence seems to support the view that the posterior estimates are significantly influenced by the data.

Figure 5.2 is another interesting metric that suggests that the model fits the data remarkably well given its simplicity. The black line is the data expressed as deviation of the steady-state and the red dashed line is the one step ahead Kalman filter predictions (see, Hamilton, 1994). This chart illustrates the fit of the model in the sample. The filtered estimates are slightly more volatile than the actual gdp and inflation data. Output in my economy is produced using only one factor – average hours – and the higher volatility of the model reflects the absence of capital, which is a highly slowly moving variable. A similar argument can be formed for inflation dynamics. Wages are assumed to be flexible and some degree of inertia – household monopoly power or job match and searching frictions – needs to be added in order the model to match inflation dynamics of the data.

As we can see from Table 5.2, the share of imported consumption on the consumption index is quite high. This is an interesting element of the model,

since from Equation (5.1.7) we can get the following expression

$$\pi_t = (1 - \alpha)\, \pi_{H,t} + \alpha \pi_t^* \tag{5.3.1}$$

meaning that we can decompose inflation between domestic generated inflation and imported one. Given that α is almost 0.8, it would be expected that domestic CPI comoves closely with the EU one. However, this is not obvious from Figure 5.2, where the difference $\pi_t - \pi_t^*$ is greater than zero for the entire sample. Interestingly, the consumption smoothing parameter – h – is significantly less than 0.7, implying that agents in Greece are more forward looking since their demand schedule is more sensitive to long-term real interest movements relative to closed economy countries such US (Christiano et al., 2005; Smets and Wouters, 2007). The intertemporal substitution is not well identified and it stays close to its prior mean. The labour supply parameter – ϕ – is significantly higher than 2 and from the equation (5.1.11) we know that high ϕ values reduce the importance of the wealth effect on the movements of n_t. The next two important parameters θ_H and δ_H indicate that domestic prices in Greece are very sticky. Firms in Greece are backward looking and form pricing decisions based on "rules of thumb". Prices do not seem to responds to changes in marginal cost, meaning that the Philips curve is almost flat. This significant degree of inflation persistence partly reflects the Greek labour market inefficiency. The reader should not forget that wages are flexible in this model, however, this is not true in the data and

labour market frictions are expected to show up on the price Philips curve. Another interesting feature of the estimation is that the exogenous driving forces are not persistent at all. The persistence of the shock is another place where model mispecifications are expected to show up. In other words, missing transmission mechanisms from the model would be eventually captured by persistent exogenous process, however, this is not the case in this model. This is another element that supports the view that the model fits the data well – with few exceptions discussed in this section.

Fig. 5.1: Prior versus Posterior Parameter Distribution

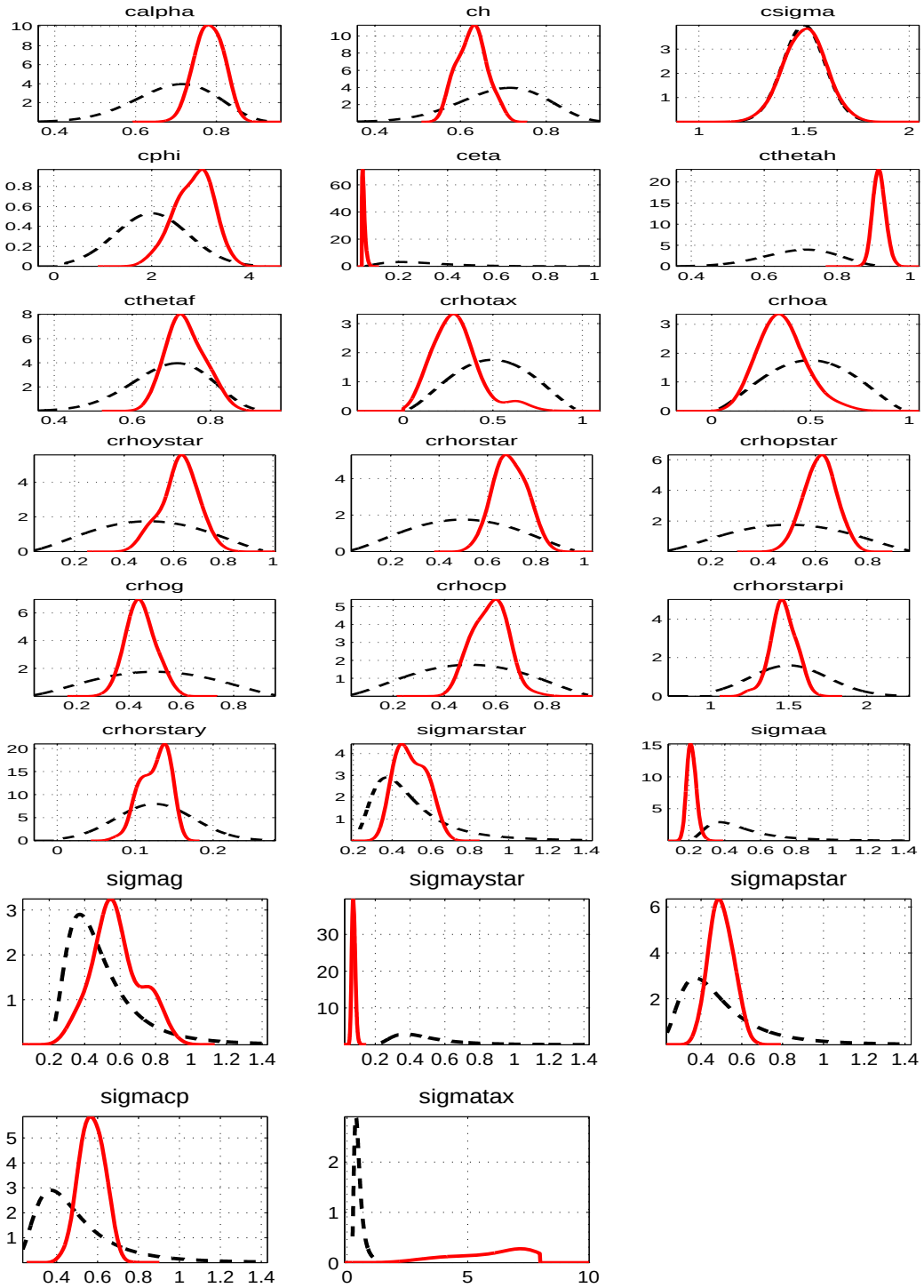
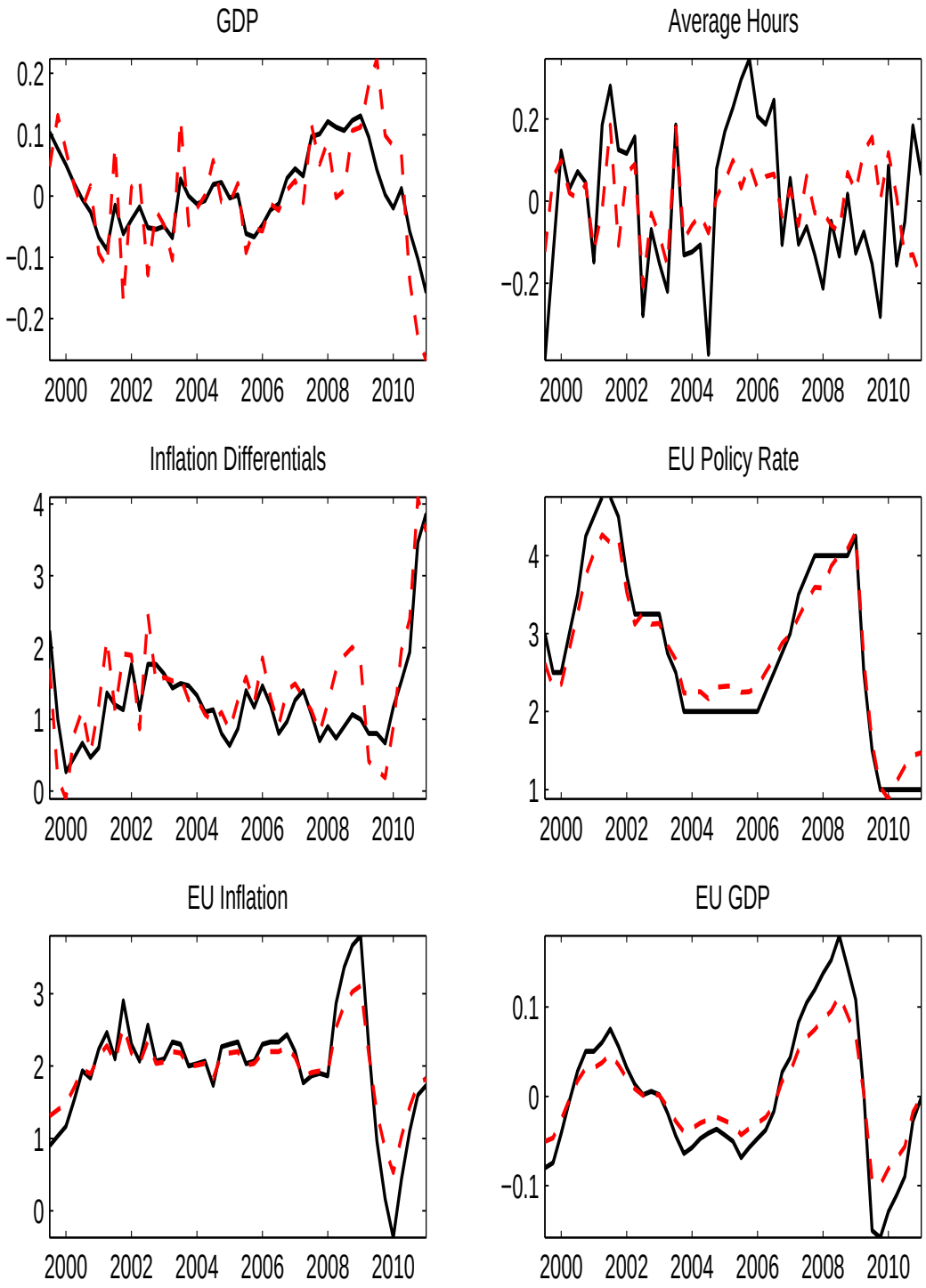


Fig. 5.2: In Sample Fit of the Model



5.3.3 Impulse Response Analysis

Productivity Shock

Labour becomes more productive and this increases output and lowers marginal cost, agents feel richer and they reduce hours of work – wealth effect. At the same time inflation decreases due to lower marginal cost. Lower domestic inflation implies that the terms of trade improve and this is translated to higher consumption. Although the economy booms the real value of the debt increases and this is caused by the lower inflation in the economy. Government increases the taxes and cuts back on spending initially to stabilize the debt. This reduces the deficit and brings the debt back to its steady state level – Figure 5.3.

Government Spending Shock

Government expands spending in the economy and this increases the demand and raises, consequently the demand for labour. Wages increase and put an upward pressure on marginal cost and inflation. Higher labour income increases consumption initially, however, this is quickly reversed by the deterioration of the terms of trade and the negative real interest rate in the economy. The government stimulus is initially founded by the creations of new deficits. This raises the debt and it cannot pursued for a long period of time as the government will respond to the high level of debt by increasing taxation and thus removing the stimulus from the economy – Figure 5.4.

Lump-Sum Tax Shock

Taxes in the model have no distortionary effects – lump-sum taxes. This implies that we can view this shock as an exogenous temporary decrease of the level of debt in the economy. Let us assume that the economy is at its steady-state level and the fiscal authorities raise taxes when there is no need to do so. This leads to an immediate fall of the level of debt in the economy. The policymaker realizes that the level of debt is below its steady-state and attempts to bring it back by expanding spending and reducing taxes. This turns to be an enormous demand shock in the economy that it is reversed by the deterioration of the terms of the trade and the negative interest rates – Figure 5.5.

Foreign Demand Shock

This is another demand shock, however, this time it comes from the foreign economy. Foreign GDP expands and this puts an upward pressure on the domestic demand through the increased demand for exports for the domestic economy. Labour demand increases to cope with the elevated domestic demand and this raises wages and marginal cost. Higher marginal cost pressures lead to higher inflation. This foreign demand shocks is further reinforced by fiscal authorities, who realize that the level of debt relative to GDP is lower and they respond by expanding spending, which stimulates domestic demand further and put even higher pressures on inflation. The deterioration of the terms of trade and the negative real interest rates partly offset the boosted

demand. The government stimulus leads to higher debt, which is stabilized by increasing taxation and reducing spending, which compresses demand further – Figure 5.6.

Foreign Price Markup Shock

This shock has two phases. Initially, it acts as a demand shock. There will be improvement in the terms of trade for Home country which will stimulate domestic demand. Domestic demand is further boosted by temporarily government spending expansion. However, this expansionary effect, which lasts for almost three years, goes away and the shock behaves as a negative productivity shock. This can be considered as an EMU price markup shock, meaning that the EMU monetary authorities raises the policy rate to bring inflation back to its target. Higher real rates suppress both domestic and foreign demand. Moreover, the economy discussed here is characterized by frictions – both real and nominal – meaning that supply is temporarily driven by demand. In other words, the supply side of the economy is significantly affected – Figure 5.7.

Monetary Policy Shock

As it can be seen from Figure 5.8 this is a really bad shock for the domestic economy. Higher real interest rates not only suppress domestic and foreign demand but also increase the value of the debt in the economy. As it was discussed in the beginning of this chapter fiscal authorities in this model are "passive" and they respond to high debt by creating a series of fiscal

surpluses that deepen the recession further.

Fig. 5.3: Productivity Shock

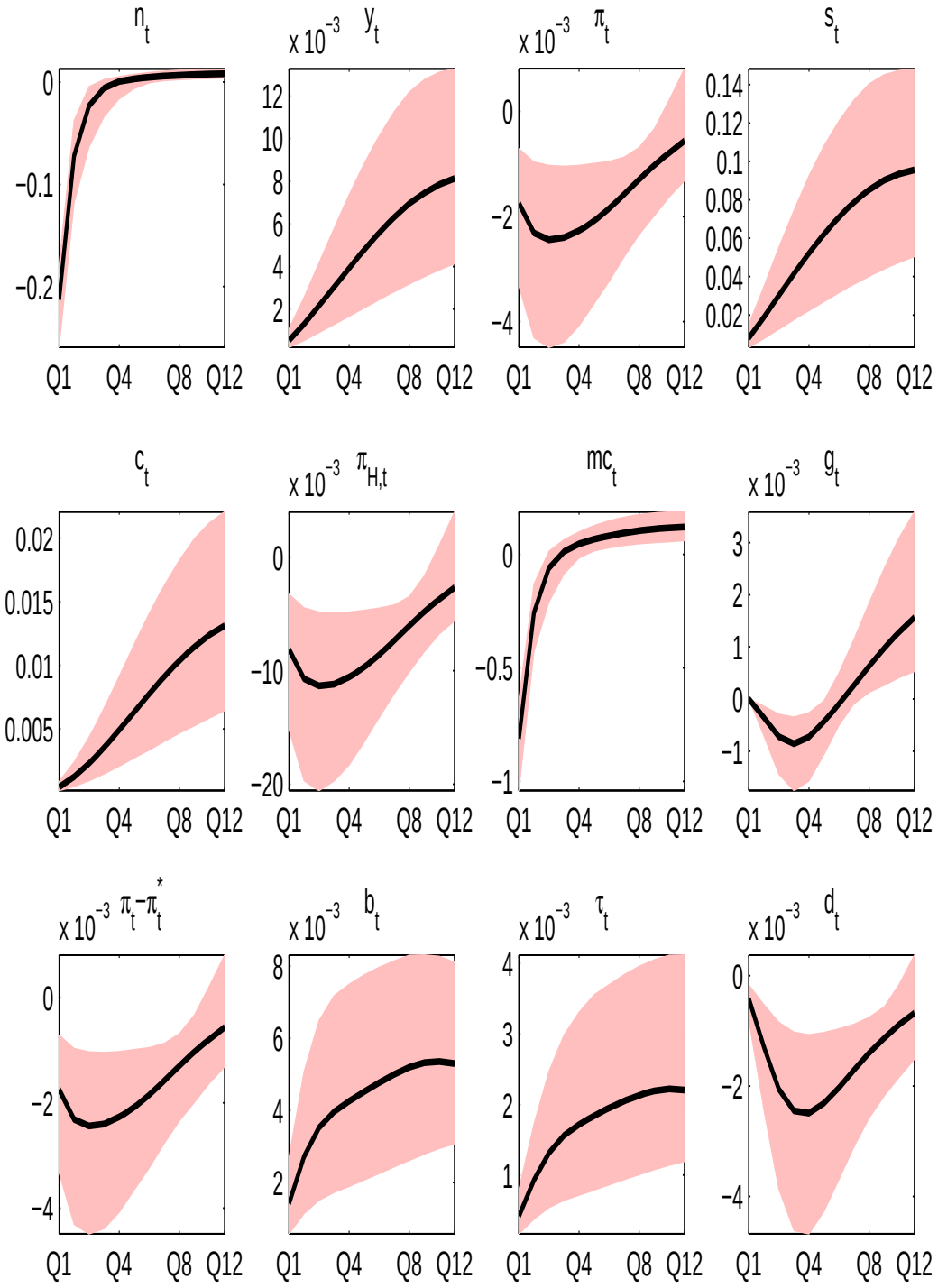


Fig. 5.4: Government Spending Shock

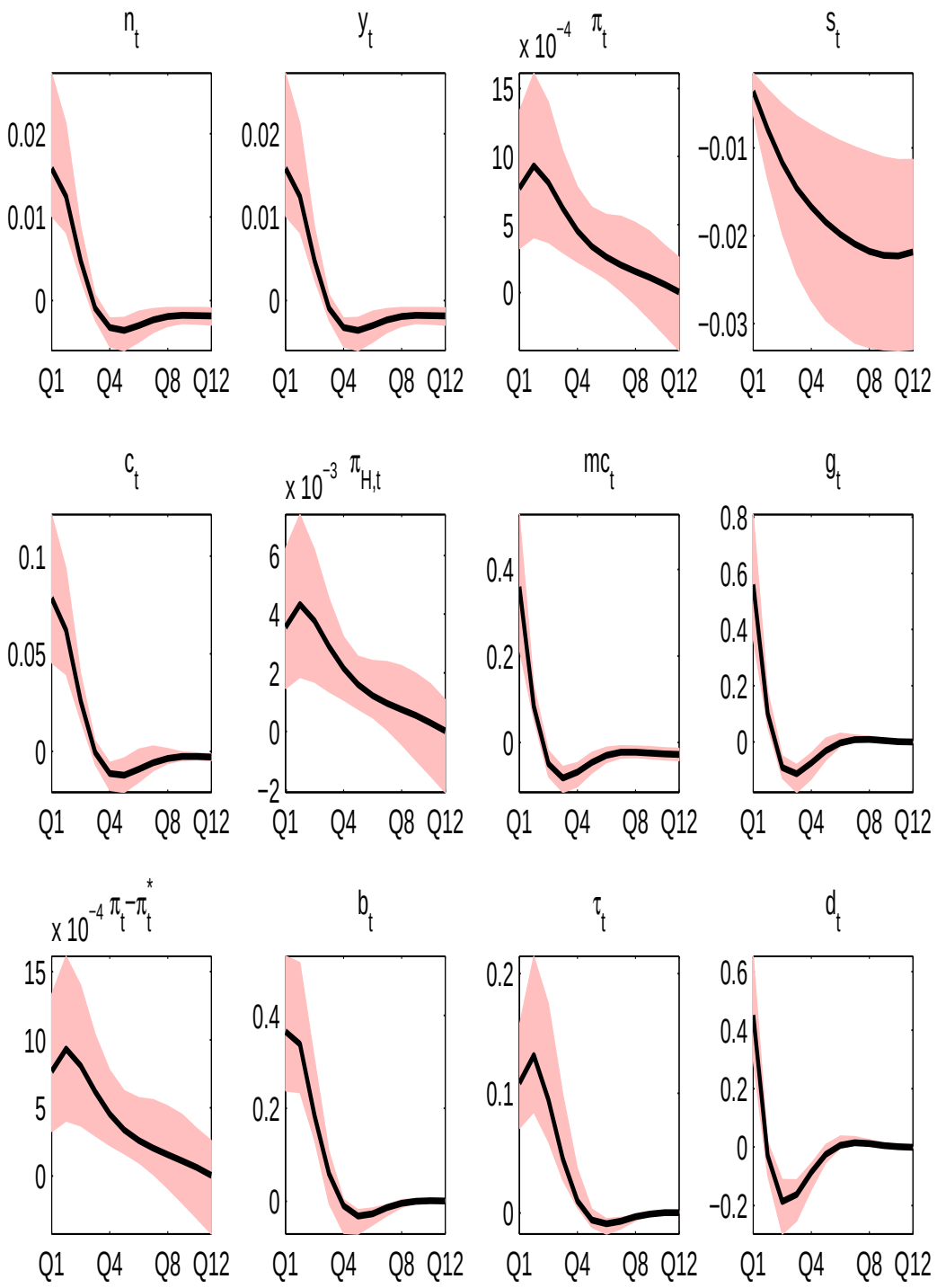


Fig. 5.5: Lump-Sum Tax Shock

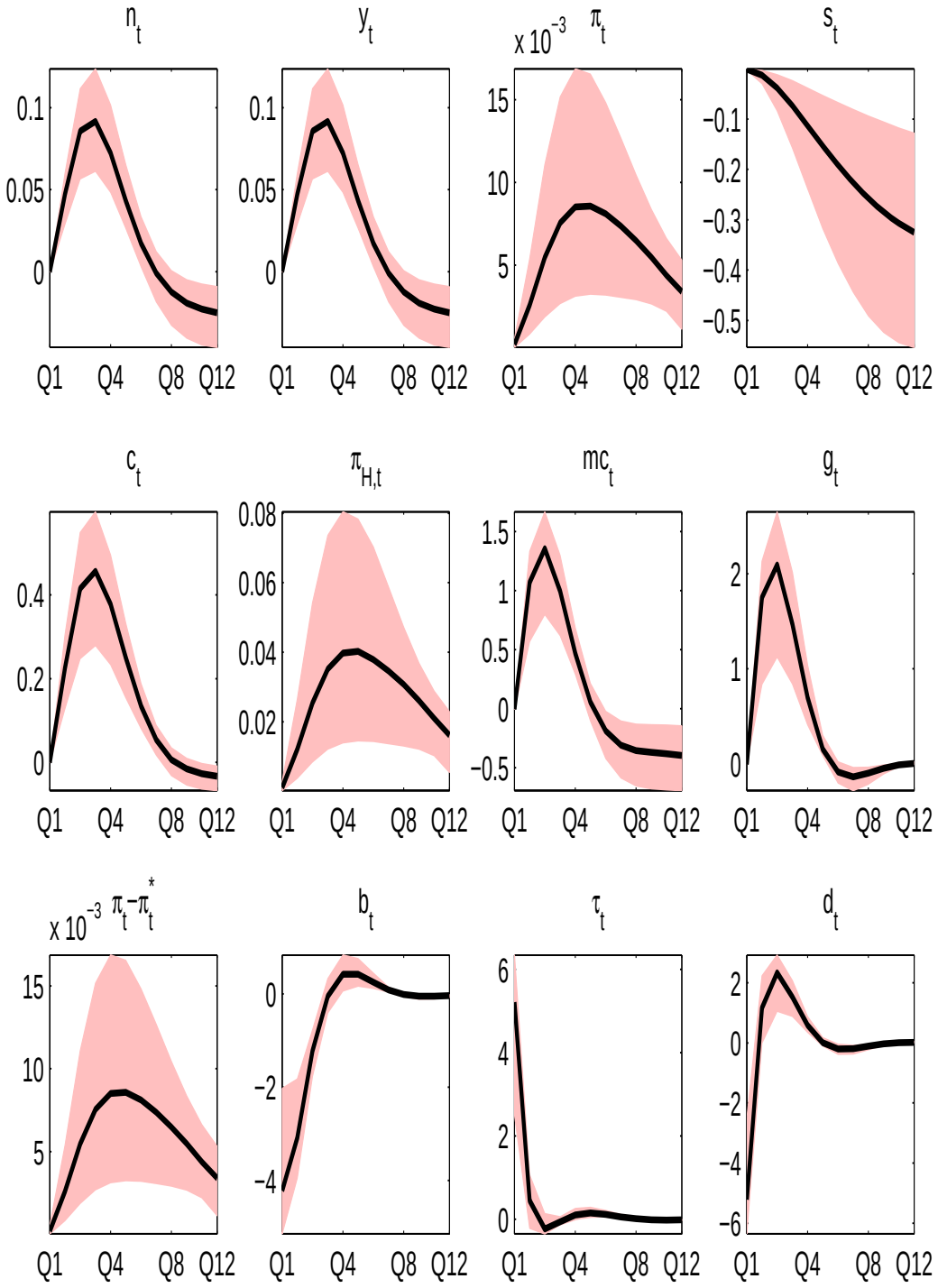


Fig. 5.6: Foreign Demand Shock

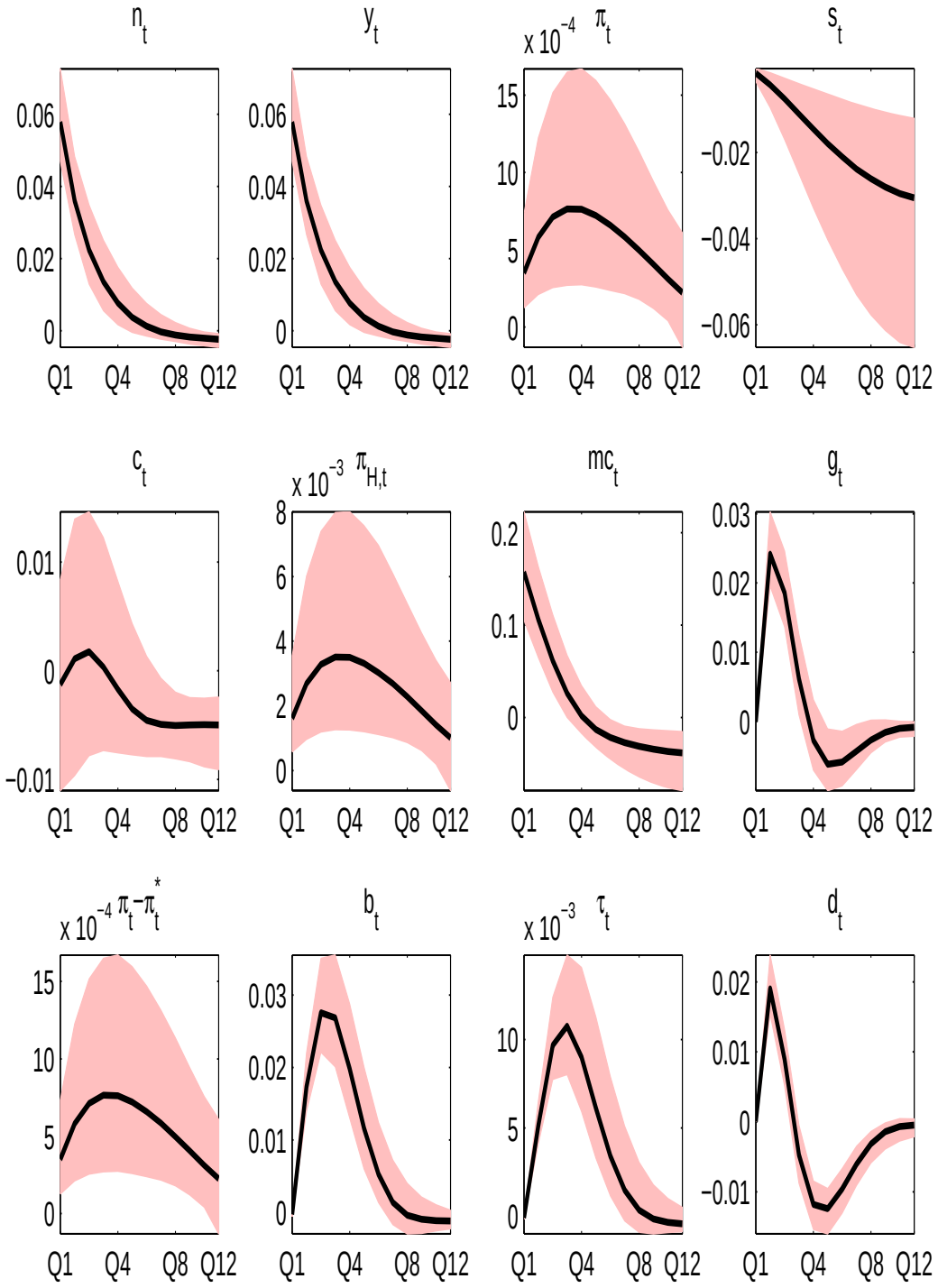


Fig. 5.7: Foreign Price Markup Shock

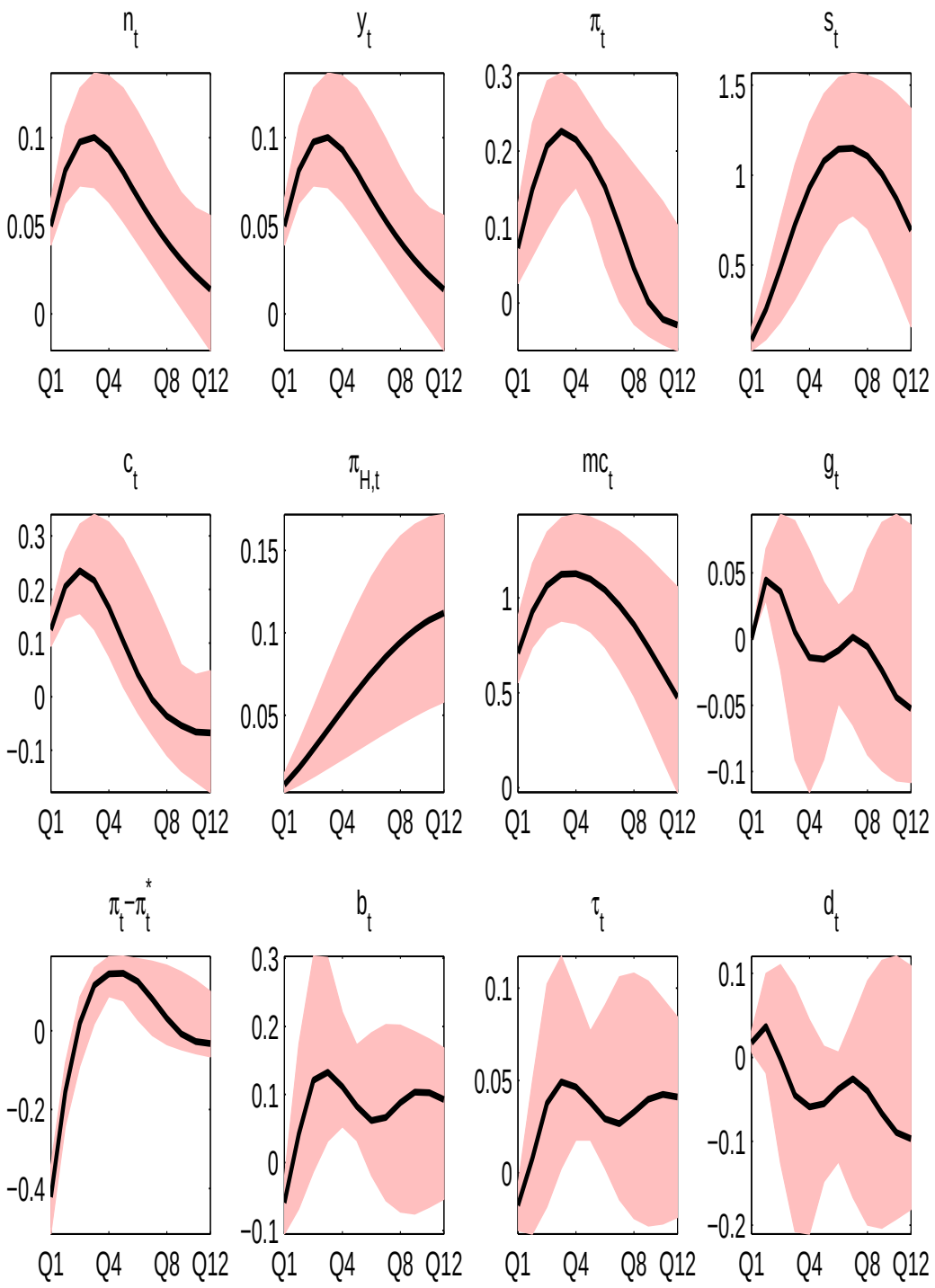
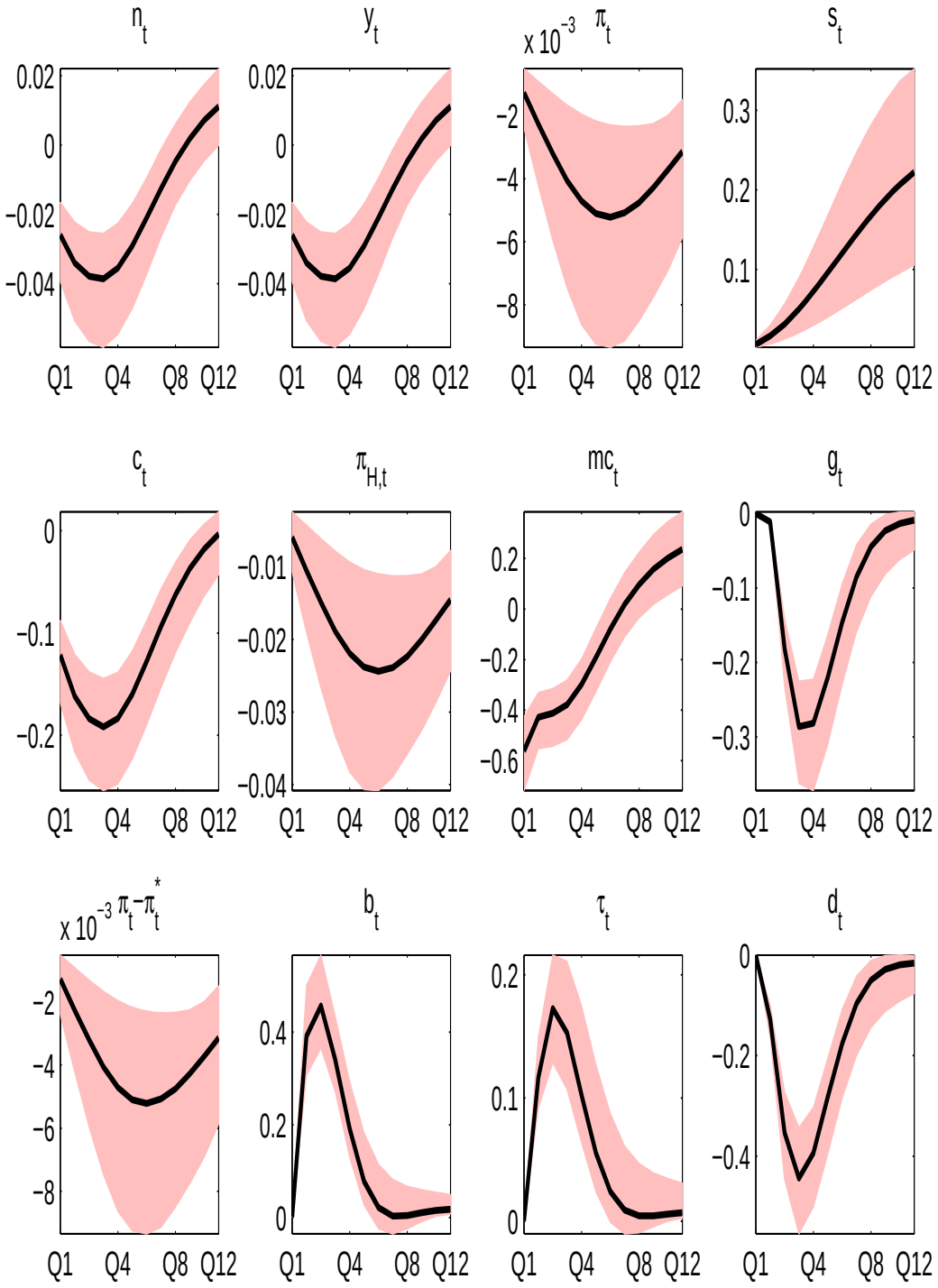


Fig. 5.8: Monetary Policy Shock

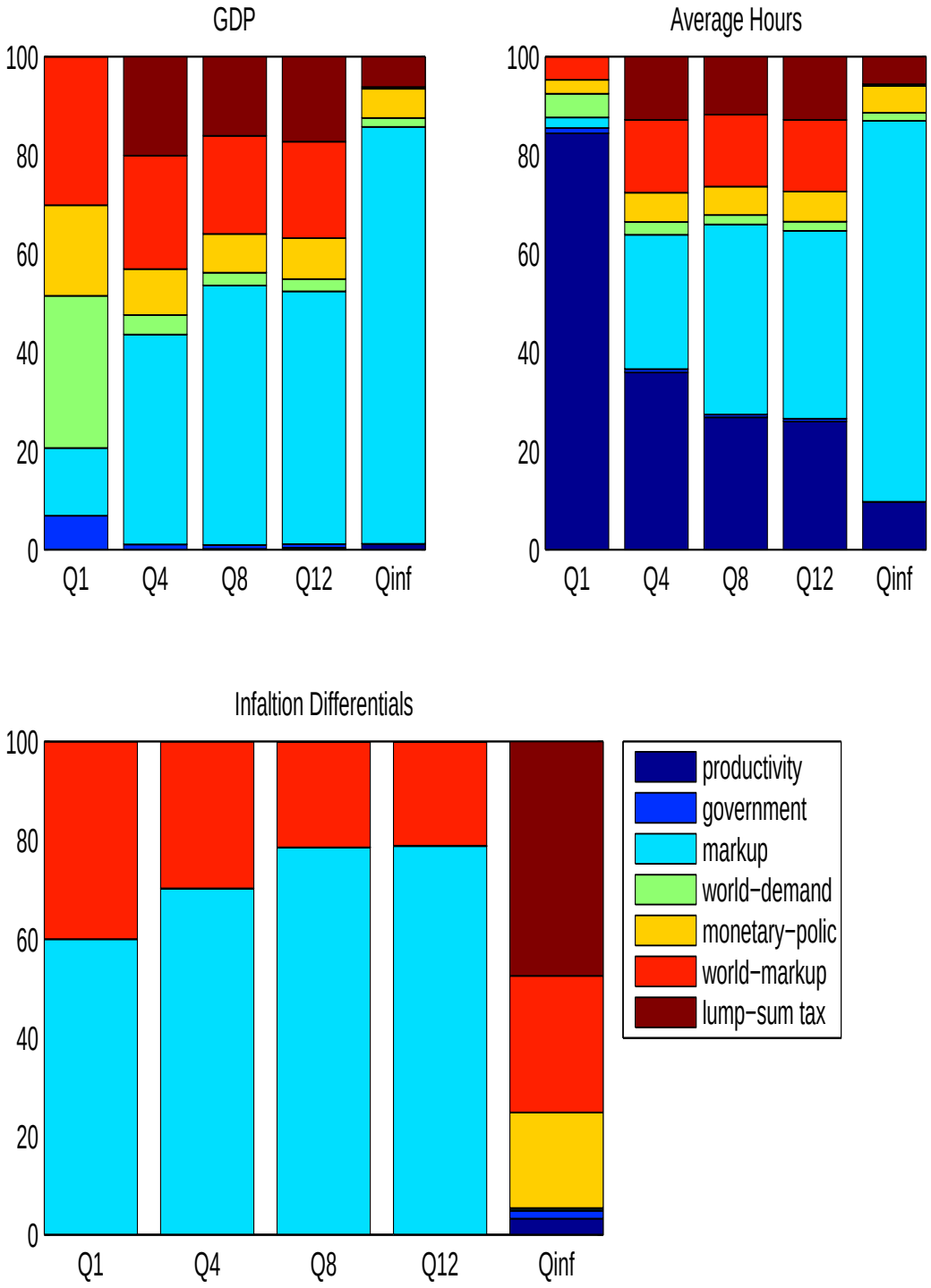


5.3.4 Forecast Variance Decomposition

Figure 5.9 illustrates the variance contribution of each shock to the total series forecasting uncertainty at different horizons; Qinf captures the long-run effect. I think this is a very interesting picture, since we can see that fiscal type shocks – government spending and lump-sum taxes – seem to contribute zero to the uncertainty of the observed domestic series. Prior to this exercise someone could have the impression that unexpected fiscal policies had been used by Greek authorities to keep demand elevated and unemployment low. Interestingly, this view does not seem to be directly supported by the data.

Another important feature of this decomposition is that supply type shocks explain most of the forecasting uncertainty. Particularly, the domestic price markup shock alone explains substantial proportion of the variance in the data. Since this shock is mapped to labour and goods markets frictions, it can be argued that Greece's efficiency loss in both markets is perhaps the main drive of future uncertainty.

Fig. 5.9: Forecast Variance Decomposition



5.3.5 Historical Decomposition

Finally, I use the model to investigate what kind of shocks drive the historical data. It is apparent from Figure 5.10 that the model has some difficulties to produce "sensible" shock estimates for the crisis period – this includes both the financial and the debt crisis. This should not surprise the reader since this is a log-linear approximate model developed to explain business cycle variations around the steady state and not severe long lasting crises.

I am going to focus on the historical decomposition of the inflation differential series, which is the main topic of this thesis. However, before doing so I would like to highlight that the pink bars called initial effects and capture both the effect of the initial conditions used for this decomposition and the effect of the constant.

The third subplot of Figure 5.10 seems to reproduce the results derived from the analysis Filippeli (2011). To be precise, from Equation (5.3.1) we know that

$$\pi_t - \pi_t^* = (1-\alpha)\left(\pi_{H,t} - \pi_t^*\right) \tag{5.3.2}$$

This further implies

$$\begin{aligned} E\left(\pi_t - \pi_t^*\right) &= (1-\alpha)\left[E\left(\pi_{H,t}\right) - E\left(\pi_t^*\right)\right] = (1-\alpha)\left[0-0\right] \\ E\left(\pi_t - \pi_t^*\right) &= 0 \end{aligned} \tag{5.3.3}$$

Meaning that the model implied unconditional mean of the inflation differential series is zero. This process is clearly persistent, however, according to the model, it should always return to zero. From the data we know that this series never crosses zero for the entire series and the data historical decomposition illustrates that this is not due to very persistent shocks.

The unconditional mean of the Greek inflation differential series over the studied period is definitely not zero. This seems quite important. In order for these series to sum to zero an equivalent period of negative inflation differentials is required. However, this sequence of negative inflation differentials can be produced either by another sequence of positive productivity shocks – this seems unlikely – or by a severe recession - which is the case now.

Alternatively, if the model is not the right one then this result implies that the domestic CPI is not only driven by the EMU nominal trend but also by a country specific one. Since the policy rate is designed to respond only to EMU CPI this outcome questions the effectiveness of the ECB to stabilise the Greek inflation.

Long-run inflation differentials can have catastrophic consequences for the domestic economy – continuous real exchange rate appreciation, permanent competitiveness loss, accumulated debt. – and they have to be structurally confronted.

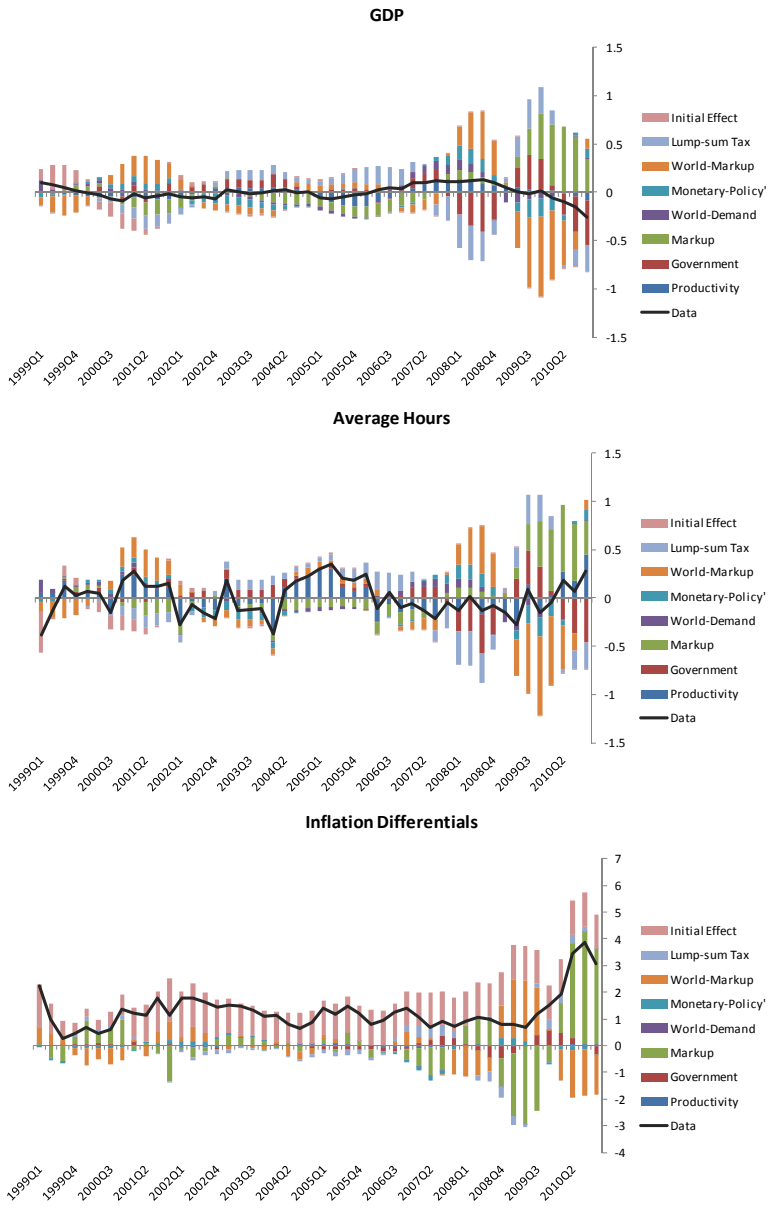
5.4 Conclusions

In this chapter I have used a standard Open Economy New Keynesian Model following closely **?** to study the inflation differential in Greece. I deviate from the latter specification by allowing the fiscal authority to run a non - balanced budget and I introduce two debt targeting fiscal rules. I do this in order to give the model the best sense to address concerns that fiscal policy was used by fiscal authorities to keep demand elevated - unemployment low - and contributing to domestic CPI being above the EMU one. From the empirical evidence presented to this section this stylized model replicates the macroeconomic aggregates relative well, and this allows us to interpret the results with some confidence. All parameter estimates and model dynamics seem to be in line with other studies regarding small open economy models (Justiniano and Preston, 2010a).

If someone wants to map these results to the current discussion about fiscal reforms then the model strongly predicts that inflation differentials in Greece is a structural phenomenon, meaning that firms' and households' prices and wages decisions display significant monopoly power. I find weak - almost zero - evidence that fiscal policies were used to keep inflation above the EMU average. Pushing the structural reforms and eliminating the inefficiencies in firms and labour markets would probably help the domestic CPI to converge to the target. The reason is that the EMU monetary instrument - short - term instrument - is not enough to ensure that individual countries' inflation

converges to the target but only the average does (Filippeli, 2011). As it is shown in chapter 3, this induces some countries to have inflation above the target and some others below, indicating that monetary policy alone is not sufficient to ensure that these inflation differentials are on average with respect to time. Adopting measures that aim to increase competitiveness inside the EMU as it is suggested by Germany seems - according to this model - to go to the right direction.

Fig. 5.10: Historical Decomposition



6. INFLATION DIFFERENTIALS IN EMU: CONCLUSIONS

The aim of this thesis is to investigate the main causes and consequences of inflation differentials in European Monetary Union since the introduction of the euro in 1999. Data support the existence of different inflation rates. After a noticeable convergence in inflation rates a few years before the launch of the euro, inflation rates started to divert again once the euro was adopted.

In the second chapter, I tried to expose the main causes of inflation differentials in eurozone for the period 1999 - 2010. The results based on a panel data model estimated using OLS and GMM suggest that one major factor of this divergences among member - countries is the Balassa - Samuelson effect (defined as productivity growth in the estimations) and the nominal effective exchange rates deviations. Inflation differentials seem to be the result of different position of the countries in the economic cycle (the output gap in the estimations). The empirical evidence shows that 1 percent increase in output gap will result to 30 basis points increase in the inflation rate of the countries in euro area. However, and even surprisingly, fiscal stance doesn't seem to affect strongly the inflation differentials, only slightly.

In the next chapter, I attempt to study the data of inflation differentials more closely and discuss whether the inflation process in Portugal, Ireland, Greece and Spain - countries that after the launch of the euro experienced national inflation rates above the weighted average of the union - has different time series properties from the EMU average and explains the possible implications of inflation differentials for the EMU and the national governments of member-countries. I present those stylized facts that justify the claim that the inflation characteristics in these countries differ from those in the other countries of the euro area. The existence of long-run inflation differentials questions the effectiveness of the common monetary policy instrument to stabilize inflation expectations. Higher inflation expectations imply lower real – short and long-run – interest rates and deterioration of the terms of trade through reduced competitiveness, characteristics that should not persist over long periods of time since they create imbalances among the EMU members and could possibly lead to the destabilization of the union. The continuous real exchange rate appreciation of the countries of south Europe has led to a significant loss of competitiveness and the creation of persistent current account deficits. The evidence does not show that inflation differentials will be eliminated in the near future, something that poses numerous doubts about the future of the euro area without major changes in the current framework especially in terms of fiscal rules. The creation of a new framework for national fiscal policies seems to be more urgent than ever before.

In chapter 4, I try to cite some of the literature that dealt with the issue

of one monetary policy but many different fiscal policies in EMU and the free - riding incentives that appear in a context like that and what are the implications for the inflation rates in the union. One possible explanation of the different inflation performance of the countries in the eurozone could be the Fiscal Theory of Price Level which states that the inflation rate is not only a monetary phenomenon but could also be a fiscal one. I discuss with detail the implications of this theory and I try to investigate the empirical plausibility of this theory in EMU. For the period under consideration, data about Greece show that the policies followed by the fiscal authorities were following a different fiscal regime in comparison to the ones followed by the governments of the other members. With the incorporation of the short and long term interest rates into the analysis, there is evidence that not only current fiscal policy can affect the price level but also agents' beliefs about future actions taken by the authorities that are also closely associated with the determination of their inflation expectations.

In the last chapter, I use a standard Open Economy New Keynesian Model following closely Gali and Monacelli (2008) to study the inflation differential in Greece. I deviate from the latter specification by allowing the fiscal authority to run a non - balanced budget and I introduce two debt targeting fiscal rules. I do this in order to give the model the best sense to address concerns that fiscal policy was used by fiscal authorities to keep demand elevated - unemployment low - and contributing to domestic CPI being above the EMU one. From the empirical evidence presented to this section this

stylized model replicates the macroeconomic aggregates relative well, and this allows us to interpret the results with some confidence.

Concerning the current discussion about fiscal reforms in some countries of EMU, the model strongly predicts that inflation differential in Greece is a structural phenomenon, meaning that firms and households prices and wages decisions display significant monopoly power. I find weak - almost zero - evidence that fiscal policies were used to keep inflation above the EMU average. Pushing the structural reforms and eliminating the inefficiencies in firms and labour markets would probably help the domestic CPI to converge to the target.

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