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Title thesis: The dynamics of a monetary policy shock in GIIPS countries

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Abstract

This paper aims to study the effects of monetary policy shocks on output and inflation in Greece, Ireland, Italy, Spain, and Portugal (GIIPS). All GIIPS countries bar Italy required a bailout following the eurozone crisis and attention has been paid to revisiting the monetary dynamics of the GIIPS such as Georgiadis (2015) but little to no research since then. A Structural Vector Autoregressive model (SVAR) is constructed using output, inflation, and short-term interest rates as a proxy for monetary policy shocks. This paper thus adds to the literature by using new up to date which captures the Covid-19 pandemic as well as the ongoing war in Ukraine which continue to cause economic and social disruptions across the eurozone Liadze et. al (2023). The major findings are that Greece and Portugal show similar inflationary responses to a monetary policy shock, exhibiting an underlying business cycle and a much longer persistent shock than the other GIIPS. GIIPS countries also move in tandem with regards to the direction of output following a monetary policy shock, but the persistence differs substantially between countries implying heterogeneous economies and differences in underlying rigidities. This paper helps bring to light the future ramifications of a monetary shock among the GIIPS countries which is more relevant than ever with ongoing geopolitical tensions in Ukraine, Israel, and a cost-of-living crisis.

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1.0 Introduction

In the wake of inflation unseen for decades, the European central bank (ECB) alongside other central banks around the world have been continuously increasing interest rates since July 2022. In July 2022, the ECB increased interest rates, this was the first-time interest rates had been increased in the eleven years prior and it constituted the largest increase in the history of the ECB. With the annual growth rate of inflation for food at over 16% on average for the eurozone (OECD, 2023) it remains to be seen how high interest rates will rise or how hawkish the actions of the ECB will be to tame inflation and inflation expectations. Exasperated by the ongoing war in the Ukraine and the hangover from supply chain disruptions during the COVID-19 pandemic, the resilience of the euro once again must be analysed. Economic and social disruptions from the war in the Ukraine outlined by Liadze et. al (2023) persist and have pushed Germany into a recession (Treeck, 2023). This paper analyses how a sudden interest rate shock could affect the previously scapegoated (rightly or wrongly) GIIPS (Greece, Ireland, Italy, Portugal, and Spain) economies in the eurozone who were much scrutinised during the previous Global Financial Crisis (GFC) and the ensuing eurozone crisis. A decade on from the eurozone crisis, this paper will test the dynamism of these economies in relation to an interest rate shock. Great attention in the economic literature was focused on whether the eurozone could constitute an optimum currency area (OCA) prior to its adoption and regarding the dynamics of the euro crisis. However, substantially less attention has been paid in recent years to the GIIPS, who so notoriously dominated headlines just over a decade ago.

Instead, much of the recent literature with regards to monetary policy is centred around the zero lower bound, this era of potential stagflation now poses a newfound threat to the eurozone project. With his threat in mind, the nations that almost ended the eurozone project over a decade ago will be revisited.

All GIIPS countries required bailout programmes bar Italy which narrowly avoided this fate. The GIIPS countries ran substantial and increasing current account deficits prior to the GFC. (Baldwin & Giavazzi, 2015). This paper will ultimately help gain a broad updated insight into understanding the current macroeconomic environment of the GIIPS and analysing the dynamics of each country in reference to one another. Baldwin & Giavazzi´s work can help give guidance on the policy trade-off of monetary policy, the timing and adjustment and the unique interplay between monetary policy and the economy.

2.0 Literature Review

2.1 Overview of monetary policy objectives in the European Union

Firstly, monetary policy is defined as the rules and commitments in which central banks affect the money circulating in the economy (ECB, 2023). The central bank responsible for monetary policy in the eurozone (the members of the European Union which have adopted the euro), is the ECB.

The ECB is the focal point of the European System of central Banks (ESCB). The ESCB is composed of all national central banks belonging to each respective European union member state. The governing council within the ECB is responsible for conducting monetary policy and creating guidelines within the eurozone. Article 127(1) in the treaty of the Functioning of the European Union outlines the ECBs mandate. The ECB is mandated to maintain price stability as its primary objective from which it defines currently as aiming for 2% inflation over the medium term[1]. The ECB has a secondary objective of supporting the general economic policies of the EU however this objective can never take precedence over the ECB´s primary objective, price stability. Price stability is assessed using the Harmonized Index of Consumer Prices (HICP) across the eurozone. The ECB adopts a two-pillar approach in order to achieve its mandate: economic analysis and monetary analysis. (Rakić, 2023)

Similarly, to the FED and other central banks, the ECB performs broad macroeconomic analysis into the dynamics of key variables including forecasts. The ECB’s monetary pillar is a detailed analysis of the repercussions of money and credit developments for price levels and output over the medium to long run. The ECB gathers data from a wide variety of sources and integrates an array of security classes and yields to help gain a holistic understanding of the dynamics of key monetary aggregates and other financial variables. This detailed analysis is published in the ECB`s Quarterly Monetary Assessment. (Kahn & Benolkin, 2007)

2.2 Monetary Policy Tools

The tools that the ECB uses broadly fit into two categories: conventional and unconventional monetary policy. Conventional monetary policy involves the adjustment of interest rates, where the lowering of interest rates is expansionary and the increasing of interest rates is contractionary.

[1] The definition of 2% inflation over the medium run replaced the previous mandate in July 2021 of close but below 2% over the medium run which was in effect since 2003.

Unconventional monetary policy does not directly aim to influence the interest rate, it can, however, aim to affect asset prices, liquidity, expectations, and conditions of credit in order to pursue overall price stability.

2.21 Short term interest rates

The term conventional monetary policy has come to mean the adjustment of the short-term interest rate to meet a central bank's macroeconomic goals. Short term interest rates controlled by the ECB also have implications for banking reserves. Banks must meet certain minimum reserve requirements for given risk weights of assets held to meet legal standards set by the ECB. Excess reserves can be lent to other banks overnight while a shortfall in reserves can be made up for through a lending market. Both facilities allow banks to engage in short term transactions to optimise reserves i.e. holding as much reserves as legally required. The tools that the ECB uses in managing the short-term interest are the main refinancing operation (MRO), the marginal lending facility (MLF) and the deposit facility (DFR). (ECB, 2016b)

The MRO is one of the ECB’S main tools in monetary policy. An MRO provides participating banks with regular liquidity with a duration of up to one week. Banks must provide collateral when they engage in an MRO. The MRO rate set by the ECB is considered a benchmark for other interest rates but also helps to indicate the ECB´s current monetary policy stance. An increase in the MRO (monetary tightening) implies an increase in bank lending costs which discourages banks from borrowing from the ECB and in turn lowers liquidity and thus the market interest rate. A decrease in the MRO (monetary loosening) implies a decrease in bank lending costs which encourages banks to borrow from the ECB. This in turn increases liquidity and the supply of credit, therefore putting downward pressure on market interest rates. (ECB, 2018a)

The DFR allows banks with excess reserves to receive short term interest through depositing excess reserves in the ECB´s overnight deposit facility. The deposit facility rate is always lower than the other short-term ECB i.e. the MRO and the MLF. The DFR is the lowest rate as no bank will lend to another for a lower interest rate than they can receive from the ECB´s deposit facility and the deposit facility is virtually risk free as the risk of an ECB default is extremely low. (ECB, 2016d)

The marginal lending facility is an emergency short term facility rate controlled by the ECB which covers overnight transactions. It is the rate at which banks can refinance overnight, for this benefit, they must pay a premium above market interest rates. It allows banks who do not meet the minimum legally binding reserve requirements to gain short term sources of reserves to meet requirements while also providing collateral on the reserves borrowed. (ECB, 2018b)

The interbank rate is not directly set by the ECB but is influenced by the short term interest rates set by the ECB. The interbank rate is the rate at which other banks lend to one another. Lending can be secured or unsecured i.e. lending can occur with and without providing collateral and the duration of the loan is flexible. The interbank rate sits in between the three main short term interest rates set by the ECB. The interbank is bound by the marginal lending facility as no bank has the ability to lend at a higher rate than the marginal lending facility. It is also bound by the deposit facility as no bank would lend to another bank at a lower rate than they could receive from the ECB´s deposit facility.

2.3 Unconventional monetary policy

The ECB has engaged in “unconventional” monetary policy since the GFC. Since then it has expanded its toolkit in order to cope with the complexities associated with the zero lower bound that has constrained traditional monetary policy in recent years. The following is a list of unconventional monetary policies conducted by the ECB.

2.31 Securities market programme

The securities market programme (SMP) was unveiled by the ECB's governing council in May 2010. The SMP allowed the ECB to purchase debt securities. This ensured liquidity and depth, in imperfect debt security markets and helped aid in monetary transmission. The SMP did not increase overall liquidity as all purchases were sterilised by other instruments being sold. (ECB, 2010)

2.32 Outright monetary transactions

Outright monetary transactions (OMTs) were announced by the governing council of the ECB in 2012 and replaced the SMP. OMTs involve the use of secondary bond markets to buy sovereign debt while also sterilising the transaction through the sale of bonds. OMTs are conditioned to be used in accordance with the European Financial Stability Mechanism (EFSM) and are used when member states are going through periods of macroeconomic adjustment. OMTs are usually, but not always, concerned with short term yields (sovereign bonds with maturity of 1 to 3 years). (ECB, 2012)

2.33 Forward guidance

Forward guidance (FG) has been used by the ECB since 2013. FG is explicit communications provided by the Governing Council on the ECB´s intentions regarding future conduct of its monetary policy. The goal of FG is to help align the sentiment/market views of economic agents regarding the future intended path of monetary policy. There are caveats to the use of FG as it is conditional on existing mandates held by the ECB, and FG may not accurately reflect future changes in monetary policy. FG also aims to provide further clarity to economic agents and increase the transparency of monetary operations, which in turn helps the ECB maintain its mandate of price stability over the medium turn. (ECB, 2014)

2.34 Breaking the zero lower bound

Negative interest rate policy was implemented by the ECB in 2014 as inflation expectations were significantly below objective in the medium term. The ECB broke past the Zero Lower Bound (ZLB) to make spending and borrowing relatively more attractive than saving in an effort to heat up the economy and thus increase inflation. (ECB, 2014)

2.35 Targeted long-term refinancing operations

Targeted long-term refinancing operations (TLTRO) are long term loans to financial institutions at and below market rates to encourage these institutions to lend to economic agents within the eurozone. The term “targeted” comes from the condition that banks must not hoard the liquidity but the refinancing must be lent out to consumers. The more a financial institution pledges to companies and individuals prior to the beginning of TLTRO, the higher the amount it can receive. This is in the best interest of the financial institution as it allows them to gain access to favourable financing in terms of costs. TLTROs ultimately are a volatile, free, and consistent form of funding. The use of TLTRO will be elaborated further in the episodes of monetary policy. (ECB, 2021)

2.36 Asset purchase programme

The Asset purchase programme (APP) ran from 2014 until 2022 and similar to the negative interest rate policy, it was used by the ECB to help increase inflation, and to further contribute to its inflation mandate of two percent. The APP has two functions, firstly, the ECB directly buys private assets from the market, thus increasing demand, asset prices and liquidity. Secondly, the APP is a signal to the market from the ECB that interest rates are planned to be kept low for the medium term, this helps reiterate other measures like FG and to reduce volatility and uncertainty around interest rates, allowing financial institutions and consumers alike to better plan with reduced interest rate risk. (ECB, 2016a)

2.4 Transmission mechanism of monetary policy shocks

The ECB can slow down economic activity and control inflationary pressures through contractionary monetary policy. On the contrary, the objective of expansionary monetary policy is generally to stimulate economic growth and combat deflationary pressures. Changes in monetary policy affect economies through a multitude of transmission mechanisms including the interest rate, credit, asset prices, expectations and exchange rates. In the following sections I will provide a concise summary of each, analysing both their significance and implications. Figure 1 provides a clear and concise visual interpretation of each mechanism.

2.41 Interest rate channel

One vital tool, mentioned earlier, is the MRO, which serves as a reference rate for short term interest rates and thus influences borrowing costs and lending activity which in turn affects consumption and investment. Changes in the interest rate can affect the availability of credit as it changes banks' cost of lending and therefore the potential for individuals and businesses to borrow.

2.42 Asset price channel

Tobin's q provides one apparatus for analysing the asset price channel. Tobin's q is defined as the ratio of the market value of firms and the replacement cost of capital. Asset prices tend to change in value in response to monetary policy as their present value is calculated using a new discount factor (Tobin, 1969). Expansionary monetary policy also reduces the yield of bonds and government securities thus making equities more attractive and increasing asset prices in the process. Households that own assets benefit from the increased wealth gains from expansionary monetary policy and feel more comfortable increasing spending and consumption, thus increasing aggregate demand. With better collateral from higher asset prices, households may also be able to access credit at more favourable rates.

2.43 Bank Lending Channel

The credit channel of monetary policy is commonly made up of two categories. The bank lending channel and the balance sheet channel. The bank lending channel stems from the idea that changes in monetary policy have a direct effect on deposits and that deposits play a crucial role in the supply of loans. Disyatat (2011) however argues that the relevance in the bank lending channel is lesser in advanced capital markets where non binding reserve requirements and non deposit sources of financing are commonplace. In times of financial crisis however, when bank balance sheets are weak, expansionary monetary policy supports the creation of credit supplies (Jiménez et al., 2011). Failure to conduct expansionary monetary policy in times of crisis can lead to the credit rationing phenomena developed by Stiglitz and Weiss (1981), in which banks are unwilling to lend to borrowers for fear of contagion and the riskiest of borrowers dominate the market and are willing to pay the highest interest rate. Monetary policy effects can differ between countries if countries have a higher or lower proportion of small or large businesses. Black & Rosen (2007) find that in times of monetary contraction, banks opt for creating shorter loans and give preference to larger firms.

2.44 Balance sheet channel

The balance sheet channel can also be viewed through Tobin's q. Expansionary monetary policy increases Tobin's q, which in turn allows the business more favourable terms of credit thereby increasing investment spending which will then increase aggregate demand. Expansionary monetary policy also reduces the debt burden of firms as debt payments are nominal terms and an increase in the price level reduces a business' debt in real terms which increases the worth of the business.

2.45 Expectations channel

A change in the stance of the ECB can also affect future expectations of individuals, businesses, investors and governments, if interest rates are believed to rise, agents may hold off on consumption and investments. The ECB uses careful communication strategies as well as press releases in order to help manage expectations and therefore manage price stability.

2.46 Exchange rate channel

Expansionary monetary policy not only stimulates domestic aggregate demand but through lowering the domestic interest rate, the domestic currency becomes less attractive to investors and depreciates. Currency depreciation stimulates export demand as home produced goods become relatively more competitive abroad. The benefits and costs of a change in value of currency arising from changes in monetary policy are thus dependent on whether imports or exports to areas outside a currency union dominate, and whether they comprise a large part of the economy.

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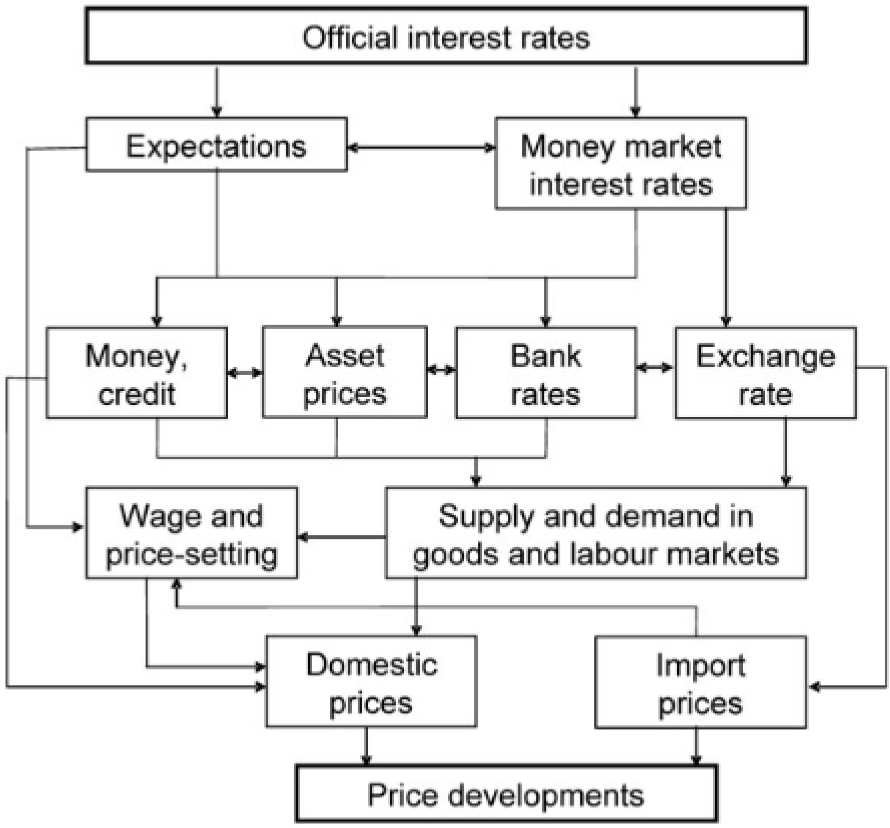
Figure 1

Transmission channels of monetary policy



Source: (ECB, 2016c)

2.5 Monetary policy episodes in the Eurozone

When the original frameworks, strategies and policies were first unveiled by the ECB, it was in the context of an 11-member group of countries within the eurozone. Now in 2023, with Croatia as the eurozone's newest member, the overall tally of countries in the eurozone has risen to 20 out of the 27 countries currently in the European Union. This section will give a brief overview of important episodes in monetary policy in the euro area and how they have affected the GIIPS countries. All of the GIIPS were members of the eurozone since it came into existence on the first of January 1999, excluding Greece.

2.51 Monetary policy in euro infancy

The first 2 years of ECB monetary policy was dominated by a series of upward price shocks which arose not due to ECB policy but external causes. In the first couple years of ECB policy, oil price shocks were most prevalent. Oil reached decade highs, resulting in increased import costs for the euro area as a whole. While oil prices regressed to lower levels in 2001, disease outbreaks increased the cost of food production and further exacerbated inflation increases. Withstanding high inflation, eurozone economies grew tremendously during the first couple of years, a heated stock market and surplus liquidity forced the ECB to consistently increase interest rates from November 1999 to mid 2001. In light of the terrorist attacks in the US in September 2001, wars in the middle east and a global slowing down of demand arising from geopolitical uncertainty, the ECB responded swiftly in reducing interest rates and reaffirming its medium term outlook. The ending of the Iraq war gave way to a calmer global economic climate in which market conditions became stronger and an economic recovery ensued. The strength and strategy of the ECB was put to the test again in 2004 when a surge in oil prices led to a dilemma wherein the increased oil prices pushed up inflation but lowered growth outlook. The ECB managed, through price shocks of varying causes and natures, to keep its price stability mandate in check by keeping the HICP in line with the 2% per annum goal (Issing, 2005).

2.52 The Eurozone sovereign debt crisis

The Global Financial Crisis (GFC) in the eyes of many economists started on September 15th 2008 when the global financial services firm Lehman Brothers, at the time the fourth largest investment bank in the world, filed for bankruptcy. The GFC would bring the inadequacies of the European Monetary Union (EMU) to the forefront and be especially pivotal in highlighting the difficulties in managing monetary policy in the case of heterogeneous economies with different needs.

The ECB was slower to reduce rates following the collapse of Lehman Brothers as compared to the Federal Reserve as fiscal authorities responded initially to the affected financial institutions. However, as the GFC quickly turned into a potential sovereign debt crisis, the ECB provided sizable medium term credit within the euro area in the form of LTROs. From the fall of Lehman Brothers until the end of the first quarter of 2012, the ECB's balance sheet almost doubled in response to providing vast amounts of liquidity to satisfy demand. (Cukierman, 2013).

2.53 Covid-19 response

Prior to the Covid-19 pandemic, eurozone economies experienced the threat of disinflation as eurozone inflation remained below the target of 2% despite interest rates breaking the ZLB. In response to the uncertainty regarding the pandemic the ECB instituted a new range of unconventional monetary policy tools. A new LTRO & targeted long term operation (TLTRO) was announced that provided banks with liquidity at favourable prices in return for promising to loan out a certain percentage. The TLTRO was aimed at stimulating the economy through the bank lending channel. The ECB also restarted the APP in November 2019. Sovereign and corporate debt interest rates increased sharply during the pandemic. The GIIPS countries being some of the most indebted, partly as a result of their bailouts in the GFC were some of the most affected. Increased sovereign debt rates increased government spending costs in terms of financing and firms also faced higher cost of capital and credit. To combat this tense financial situation the ECB launched the pandemic emergency purchase programme (PEPP) which cost over 1.3 trillion in June 2021. The PEPP ultimately bought various assets in the financial markets, providing much needed liquidity and putting downward pressure on interest rates. The PEPP is estimated to have had a 1.3% effect on real GDP in the eurozone in 2021. However, even with the unprecedented programme implemented by the ECB in navigating the Covid-19 crisis, the outlook in the medium term for Eurozone countries is projected to remain below target levels. (Aguilar García, 2020)

2.6 Empirical evidence on monetary policy transmission

A plethora of papers have been written on the dynamics of monetary policy in the eurozone ex ante implementation of the euro. One of the first and most influential was by Bayoumi & Eichengreen (1992) who used VAR analysis to gauge whether the EMU could be constituted as an OCA. They found that the core countries of the eurozone, in response to a monetary policy shock, tended to experience similar responses with regards to output while the periphery countries tended to experience greater fluctuations in the price level. Various papers such as Ehrmann (2000) and Wehinger (2000) using structural vector autoregressive (SVAR) analysis have found considerable heterogeneity in monetary policy across EU countries prior to the adoption of the euro. Frankel & Rose (1997) mention, the nature of these countries and regions change ex post entry into currency unions thus while papers focusing on data prior to the adoption of the euro can provide some interesting insight into the dynamics of monetary policy shocks in the periphery, they may not reflect the current reality. An issue thus arises, the popularity of SVAR research and monetary research in general in the eurozone and with respect to the notion of a defined periphery has diminished since the creation of the euro. Most papers were written in anticipation of the creation of the euro and immediately after adoption and there remains gaps in the literature still regarding the heterogeneity of monetary policy shocks on the makeup of a periphery.

An issue arises with monetary policy in the eurozone. The ECB must conduct monetary policy for the eurozone as a whole to maintain its mandate of price stability. Contractionary monetary policy helps cool down an overheated economy and expansionary policy helps increase economic activity when it's lacking. However, some countries' needs may be different to the needs of the monetary union as a whole which furthers the heterogeneous effects of monetary policy and may give rise to unexpected results.

2.61 Individual country effects

Georgiadis (2015), an exception, is one of the first papers to exclusively analyse the effects of individual European countries using post euro introduction data. Georgiadis finds that the transmission of monetary policy across Europe can be attributed to differences in the structures of economies, particularly in relation to the share of a country's output that is linked to sectors with interest rate sensitivity. Campos & Macchiarelli (2016) find evidence that the core periphery relationship identified by Bayoumi & Eichengreen (1992) has weakened in their data set from 1989 until 2015. The authors find a changing composition of the clustering of countries within the EMU, but their findings are again weakened by the inclusion of data points prior to the adoption of the euro.

Chionis & Leon (2006) found that while monetary policy transmission had increased in smoothness in Greece following the EMU period, transmission remained relatively ineffectual at adjusting the behaviour of debtors and investors. Chionis & Leon infer that poor banking competition impeded credit mobility within Greece and therefore monetary policy; they also reason that there were disparities in how economic variables behaved during different phases of the business cycle, as well as asymmetries with regards to the direction of the shock in the economy of Greece.

In the run up to the GFC crisis, Ireland experienced a property price boom. It was a period of conspicuous consumption and asset speculation. While Ireland lost the ability to set interest rates after joining the euro, the effects of interest rates in Ireland was drowned out by extremely loose bank regulation which resulted in highly leveraged building developments without collateral being provided. The thinking was as follows, if interest rates and thus prices are exogenous, local policy will have little effect. Prudence thus, was not pursued. The Irish central bank made no effort to cool down the credit bubble that eventually brought the country to its knees. Kelly (2010)

Monetary policy and its transmission is heavily influenced by the nominal rigidities present in an economy, some rigidities such as labour and price mobility can greatly alter the speed and effectiveness of monetary policy. Anagnostou & Papadamou. (2014) find that the effects of contractionary monetary policy in Greece and Portugal are larger and more persistent than in Spain or Italy.

3.0 VAR methodological approaches

There are many approaches to identifying shocks in SVAR analysis, the main ones being narrative, sign restriction and Cholesky decomposition. This paper uses Cholesky analysis but firstly a brief overview on the discussions in the literature surrounding the narrative and sign restriction approach will be given.

In terms of sign restrictions, many papers use weak sign restrictions that reduce economic interpretation but are more generally agreed upon. Such papers include Faust (1998), Canova and De Nicolo (2002), and Uhlig (2005). These papers do not readily impose zero contemporaneous restrictions on variables and are sometimes deemed “agnostics” given their approach. Ideally, this would result in more granular conclusions drawn but this methodology risks including structural parameters with implausible implications. (Cheng & Yang, 2020).

Uhlig (2005) proposes an agnostic identification scheme and defines a monetary policy shock as any shock that, for a previously defined (often quite large) number of periods, changes interest rates and inflation in contrary directions. Kilian & Murphy (2012) analyse oil shocks as opposed to monetary policy shocks, they argue that identifying SVARs utilising sign restrictions on IRFs display contestable values for the price-elasticity of oil supply to demand shocks. Given that there are potentially innumerable parameters that satisfy sign restrictions thus economic interpretation is weakened. Further criticism of the “agnostics" viewpoint comes from Arias et al (2019) who have pointed out that the identification scheme of Uhlig keeps structural parameters that have potential irrelevance for the transmission mechanism of monetary policy to output in a given economy. The authors argue that the challenge is to arrive at an outcome where the number of additional uncontentious sign restrictions is kept to a minimum. This approach facilitates economic interpretation and model validity.

Antolín-Díaz & Rubio-Ramírez (2018) mention that the narrative approach in which the use of sign restrictions and or zero contemporaneous restrictions are based on historical accounts can be biased by the subjective nature of historical accounts and imperfect information. Friedman & Schwarz (1963) pioneered the method of using historical sources to identify structural shocks, another more modern example of this method is evidenced in Romer & Romer (2004). Despite the potential bias, Antolín-Díaz & Rubio-Ramírez find that the use of an extended narrative sign approach compliments the orthodoxy in macroeconomics. The narrative viewpoint has also been critiqued by Ramey (2016) who finds that in absence of the narrative zero contemporaneous monetary surprises, derived from

Romer & Romer (2004), contractionary monetary policy appeared to be just the opposite in the short run. The narrative approach is not used in my analysis due to a lack of readily available and up to date data regarding the governing councils meetings and other ECB documents on monetary policy.

4.0 Introduction: Overview of data and methodology

This study employs a SVAR analysis to examine the effects of a monetary policy shock on inflation and output within the eurozone. Specifically, the responses of the core countries are compared against the periphery. The idea behind Structural Vector Autoregression was first pioneered by Sims (1980) who proposed the use of SVARs for assessing the dynamic effects of economic shocks with a simple set of identifying assumptions. The resulting impulse response functions (IRFs) offer a natural method for determining a structural model's parameters and evaluating the dynamics of monetary policy shocks in the core versus periphery.

4.1 Data description

The main source of data comes from the Federal Reserve Economic Data (FRED) and the OECD data portal. The variables chosen correspond to those that are most widely used in the literature when analysing monetary policy shocks, that being - output, inflation and the short term interest rate. To analyse the dynamics of a monetary policy shock amongst the GIIPS countries, the dependent variables are inflation and output, and the independent variable is the short-term interest rate.

The Deposit Facility Rate (DFR) is used as the short-term interest rate and as a proxy for monetary policy and consequently monetary policy shocks. The DFR rate is used as a proxy as there is reliable long-term data for it. The DFR is the facility rate at which banks may use to make overnight deposits within the eurosystem (ECB).

Real GDP, not seasonally adjusted, is used as a proxy for output and is indexed scale value 100 for 2015 for all countries. Likewise the Consumer Price Index (CPI), not seasonally adjusted, is used as a proxy for inflation and is indexed at scale value 2015 for all countries.

Seasonal data is not used for the following reasons, adjusting data to create non seasonality negatively affects the reduced form residuals by creating noticeable distortions which ultimately are absorbed in the structural parameters. By keeping the original data, seasonality can help identify structural parameters. Doppelt (2021). In some cases, which will be mentioned later, first differences may eliminate seasonality in the data but for the sole purpose of variables in SVAR needing to be stationary.

The data used is time series data. Frequency is in quarters, keeping in line with the SVAR literature. and quarterly data for all countries and all variables is reliable and available. The time series goes from the adoption of the euro in all GIIPS[2] countries, the first quarter (Q1) of 1999 to the latest available data, the second quarter (Q2) 2023.

4.2 Specification

The reduced form representation of the VAR model is a system of linear equations of the underlying structural shocks. Equation 1 states that the unexpected movement in the interest rate variable within a month is due to unexpected movements in past values of the interest rate, output and inflation. The same line of reasoning can be drawn with equation 2 & 3 i.e., the current value of a variable is a function of the previous value of its own past values and the past values of other variables. Thus, previous values of variables can have predictive power.

Equation 1 represents the underlying reduced form VAR. Vector Y_t contains the three variables, it thus equals, $Y_t = [DFR_t, INF_t, GDP_t]$. The matrices B_k represents the coefficients that will describe the dynamic responses to the k^{th} lags of the endogenous variables, where I is the number of variables and k is the number of lags. The number of lags for each GIIPS country will be explained in the following sections.

The system can be specified as follows:

(1) $Yt = \sum_{k=1}^{n} [B_k Y_{,t\text{-}k}]$

(2) $\sum = (\varepsilon_{it}, \varepsilon'_{it})$

(3) $\varepsilon_{it} = Mu_{it}$, i =1,2,3

Equation (1) represents the underlying reduced-form VAR. Vector Y_t contains our three variables, thus $Y_t = [DFR_t, INF_t, GDP_t]$. The matrices B_k represents the coefficients that describe the dynamic responses to the k^{th} lags of the endogenous variables, where i is the number of variables and n is the number of lags. The number of lags will be discussed in later sections along with lag selection criteria. Equation (3) represents the relationship between the reduced form and the structural shocks, ε_{it} and u_{it} respectively. Equation (2) is the estimated variance-covariance matrix of the reduced form errors ε_{it} that were found through estimating equation (1). Cholesky decomposition is then implemented and matrix M is forced to be a lower triangular. After introducing the Cholesky decomposition, the matrix M thus becomes:

[2] Except for Greece which formally adopted the euro in 2001

$$M = \begin{bmatrix} \mu_{11} & 0 & 0 \\ \mu_{21} & \mu_{22} & 0 \\ \mu_{31} & \mu_{32} & \mu_{33} \end{bmatrix}$$

Incorporating equation (3) into equation (1), the SVAR for which will be estimated for every GIIPS country will take the following form:

(4) $Yt = \sum_{k=1}^{n} [B_k Y_{,t\text{-}k}] + Mu_{it}$

After this transformation, every variable will be dependent on the optimum number of lags of itself and the other variables. Variables are ordered in terms of exogeneity. Short-term interest rates will respond contemporaneous to its own shock. The second variable, inflation, will respond contemporaneous to its own shock and to a shock in short-term interest rates. Finally, the third variable, output, will respond to its own shock as well as to short-term interest rates and inflation.

The ordering of variables is of utmost importance as it determines which variables are allowed to contemporaneously respond to shocks in the other variables in the model. The analysis of monetary policy transmission using SVAR models can be influenced by the set of identifying restrictions that are imposed (Rudebusch, 1998). In this study the ordering of variables is as follows: short-term interest rate, inflation then output. Short-term interest rates are considered as exogenous as they are determined by the ECB. The ECB conducts monetary policy based on price stability within the eurozone, thus no individual member of the GIIPS can solely influence short-term interest rates. Inflation is ordered next to keep in line with literature, Arquete & Júnior (2003), Holtemöller (2002) and Castelnuovo (2010) all order inflation before real GDP in their respective papers. The ordering of variables is kept the same for all GIIPS countries to keep the models homogenous. This may not be ideal if drastically different rigidities are present among GIIPS countries thus output may respond more quickly than inflation in a given country. as Stata is the statistical software package used to conduct the analysis.

4.3 Unit root and stationarity testing

A key fundamental of SVAR analysis requires all data to be stationary i.e. the mean and variance of the data do not change over time. If the variables used in the model are not stationary, the estimates that follow may be biased. To gauge whether the variables used are stationary, an Augmented Dicky Fuller (1979) (ADF) test and a Perron & Phillips (1988) (PP) test are applied to each variable's time series to guarantee stationarity. When necessary, first differencing or logs may be taken and the ADF and PP tests will be repeated until such that transforming the variable generates a stationary time series.

The ADF test is performed using the following regression:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \varepsilon_t$$

Where ΔY_t is the first difference of the series, Y_{t-1} is the series lagged by one period and ε_t is the error period

The PP test is also performed as a complementary analysis to the ADF test as it accommodates a more flexible lag structuring.

The PP test is performed using the following regression:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \gamma_2 \Delta Y_{t-2} + \ldots + \gamma_n \Delta Y_{t-n} + \varepsilon_t$$

4.4 Lag order selection

Lag order selection will be determined based on the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and the Hannan-Quinn criterion (HQ).The optimal lag length, which best captures the dynamics of output and inflation in relation to a monetary policy shock, will be chosen based on the lowest values of the AIC, BIC, and HQ criteria

4.5 Stability condition

It is a condition of VAR models that they are not only stationary but also stable. Stationarity does not automatically imply stability and eigenvalue tests are conducted for each country model. A VAR model is considered stable if all eigenvalues have a modulus that is less than 1. The stability condition in the country models ensures that meaningful economic relationships between output, inflation and short-term interest rates are present in the models.

4.6 Check for autocorrelation

In order to test for autocorrelation a Lagrange multiplier test is carried out for each respective GIIPS country. Performing this test is motivated by the fact that in SVAR analysis, shocks are assumed to be serially uncorrelated. The null hypothesis of the Lagrange multiplier test is that the variable, at the given lag, has no autocorrelation. If the p-value for the given optimum lag is above 0.05 then the variable passes the test as there is no autocorrelation.

4.7 Granger causality test

A Granger causality test is performed for each respective GIIPS country model to determine the relationship between the variables in the context of time series. The results of the test help determine whether past values of certain variables help predict future values of other variables and therefore can help evaluate impulse response functions (IRF). The Granger causality test most importantly helps determine the direction of causality between the variables in the models.

4.8 Impulse response functions and variance decomposition

Impulse response functions indicate the response of the present and future predicted values of each variable in relation to a one unit increase in the present value of one of the VAR errors. It is assumed that the error regresses to zero, holding all other errors at zero. IRFs allows for a visual representation of the instantaneous impact of shocks and their propagation over several periods into the future to allow the study of persistence. The IRFs in this paper will help contrast the responses of output and inflation in individual countries in the core versus periphery of the eurozone. Confidence intervals will be included in the IRFs to provide greater visual clarity regarding the substance of the results and how these confidence intervals differ between the core and periphery countries. Standard errors will be listed to gain insight about the statistical significance of the results provided and thus help give an indication of the validity of results and the potential policy implications that can be taken away from them.

4.9 Decomposition of variance

Forecast error variance decomposition (FEVD) is employed to help determine the economic significance of each monetary policy shock for each GIIPS country. The variance decomposition is conducted for each respective GIIPS country model to help identify and quantify each variable's statistical relevance to other variables in the model i.e., how much each variable helps explain other variables in the model for a given forecast error variance. Similarl to the IRF, the variance decomposition also utilises Cholesky decomposition for identification.

4.10 Robustness Checks

The first set of robustness checks will be to use alternative lag lengths in the model. When using AIC, BIQ and HQ tests it can occur that not all criterions point to using the same lag length and this will serve as the basis for testing the robustness of the model, by using these alternative lag lengths to see if the results replicate. Additional robustness includes using an alternative ordering of the variables i.e. it includes ordering output before inflation and comparing the results.

4.11 Limitations

The main limitations in this paper are associated with the model used. In SVAR analysis, one of the assumptions is linearity between the variables. In practice the relationship between the interest rate, output and inflation may not be fully linear as the relationship may not be constant over time given the wider economic intricacies. The use of Cholesky decomposition for the identification of the SVAR model takes on a recursive ordering which may not hold up in reality i.e. how central banks conduct monetary policy may not reflect the ordering used in this paper and thus lead to biased response functions. The model used in this paper uses a very limited set of variables that can only provide a very broad overview of macroeconomic realities and omit other potentially significant variables such as international spillovers or fiscal policy. Despite these limitations, this study still can provide valuable insights into the effects of a monetary policy shock on output and inflation in the GIIPS.

5.0 Results

5.1 Stationarity of Variables

Table 2.1 in appendix A shows the results of the DF and PP test for output, inflation for all GIIPS countries respectively and for the short-term interest rate. If the test statistic Z(t) is below the critical value at the 5% significance level, then it is determined that the variable is stationary. If the test statistic Z(t) is less negative i.e., greater than the critical value then it is determined that the variable is non-stationary at the 5% significance level and needs to be transformed. One of the key assumptions of SVAR is stationarity of the variables included in the model. If a variable is found to be non-stationary at the 5% significance level, then first differences are taken. Following first differences, DF and PP tests are taken with the new first difference variable and checked again for stationarity.

5.2 Lag length selection

The tables containing the optimum lag order length can be found in appendix B. The significant values according to the AIC, HQIC & SBIC are denoted by an asterisk. In certain circumstances multiple optimum lags were given i.e., there was an asterisk for different lag lengths. In the case where there wasn't a clear optimum lag length, the lag length with the most asterixis was chosen. The logic for this way of selecting from optima comes from Lütkepohl (2005) who details that selecting a higher lag length than optimal leads to an increase in the mean square forecast errors of the VAR and thus results in overfitting and that choosing a lower lag than optimal leads to underfitting and this can cause autocorrelated errors.

5.3 Stability condition test

Appendix C shows the result of the eigenvalue stability condition for each GIIPS country model. No modulus has a unit root larger than one and therefore it is determined that the stability condition is satisfied and all roots lie within the unit circle.

5.4 Autocorrelation test

In appendix D the lagrange multiplier tests are carried out for each respective GIIPS country model with their given optimum lags taken into account. All p values for each GIIPS country at the optimum lag length were found to be greater than 0.05 and thus show no signs of autocorrelation.

5.5 Granger causality test

Appendix E shows the results of the Granger causality test for each respective GIIPS country. On the furthermost left side, the column “Equation” relates to the dependent variable while the column “Excluded” contains the independent variables in the model. P values that are less than 0.05 imply that the excluded variable granger causes the equation variable. In Table 5.1 for Greece there is no variable that is greater causal to another. Therefore there is a lack of predictive power in the Greece model.

In Table 5.2 for Ireland, the DFR was found to be granger causal for real GDP, therefore the DFR significantly affects output in Ireland. Granger causality was not found amongst the other variables.

In Table 5.3 for In Italy, CPI was found to be granger causal for GDP, therefore inflation in Italy significantly affects output.

In Portugal, in Table 5.4, CPI was found to Granger cause GDP and vice versa. Therefore past values of GDP and inflation have information contained in them that can help predict one another. CPI surprisingly was also found to be Granger causal for the DFR.

In Spain, in Table 5.5, no Granger causality was found amongst the variables. Thus past values of the variables had no information within them to significantly predict another.

5.6 Impulse response functions

Appendix F shows the results of the IRFs obtained for each GIIPS country from the estimated SVAR. In each box of the Figures, the horizontal axis represents quarters after the shock i.e., time periods after the shock and the vertical axis represents changes in the corresponding variables. The shaded areas represent the 95% confidence interval of the estimates in the model. This paper analyses the results of each country one by one, focusing on the effects of inflation and output for each, comparing and contrasting the results to one another and to economic theory.

Each IRF shows the response of output and inflation in response to a one standard deviation shock to the short-term interest rates. Starting with a shock to inflation in Greece in Figure 3.1, inflation as expected decreases one quarter after the interest rate shock but surprisingly increases in the second quarter before the effect regresses around closer and closer to the zero in the periods following. The increases in inflation could maybe be attributed to the so-called “price puzzle” where counterintuitively, inflation responds positively in the short run to a monetary policy shock in the short run before decreasing later. Output in Greece is higher in the period after the monetary shock before decreasing the next period. Output increases again for the next period and the effect persists until the 10th period.

Ireland´s IRFs are shown in Figure 3.2. Inflation in Ireland also exhibits the price puzzle after a monetary policy shock. Inflation does not immediately decrease as in economic theory but is elevated in the period after the shock before decreasing and the effect dies out in the 5th period. Output in Ireland is slightly higher following a monetary policy shock, but the lagged effect is seen in the second quarter when GDP falls, this effect of lower output persists until approximately period 6 when the effect disappears.

Italy's IRFs are shown in Figure 3.3. Inflation, like Ireland and Greece, is elevated after a monetary policy shock in period one. Inflation in period 2 onwards starts decreasing, the effect diminishes quickly, and the shock wears off by period 4. Output increases following a monetary policy shock in period 1, further increases in period 2 and the positive effect persists but diminishes until period 6.

Portugal's IRF are shown in Figure 3.4. Similarly, to Greece, inflation in Portugal appears more cyclical with a wide confidence interval displayed in the IRFs. Output responds positively to a monetary policy shock in the first two periods but in the third period output responds negatively to the shock before increasing again in the fourth quarter and after the effect wears off after period 8.

Spain's IRFs are shown in Figure 3.5. A monetary policy shock has a near immediate effect on inflation in Spain and keeps decreasing until period 2. Inflation slowly starts rising from period 2 onwards and this effect persists until the 8th period. Output in Spain is higher in the first period after the shock, decreases until the second period before increasing again in the third. Eventually returns to zero in the 6th period.

5.7 Variance decomposition

Appendix G shows the results of the variance decomposition from the IRFs of each respective GIIPS country. The left-hand column, “Steps,” represents the different time periods for which the decomposition of variance is measured. “Step(s)1” refers to the immediate response of the shock in the first-time post shock and the following steps correspond to the following time periods. The steps indicate the percentage of the sum of the variability that can be credited to a variable's own behaviour and to the behaviour of other variables during the corresponding time post shock. The first FEVD column for each respective GIIPS country corresponds to the effect of short-term interest rate on inflation while the second FEVD column corresponds to the effect of short-term interest rate on output.

The results for Greece are found in Table 6.1. For the first period for all countries, the first value is always zero due to Cholesky ordering and no impulses imposed during the first period. After 16 periods, just 4% of the changes in CPI can be explained by the DFR and only 8% of output can be explained by the DFR.

Table 6.2 shows the variance decomposition for Ireland. Ireland, like Greece, exhibits very low predictive power of short-term interest rates on output and inflation. After 16 periods, the DFR rate can explain 6% of inflation and just 3% of output.

The results for Italy can be found in table 6.3 The short-term interest rates in Italy have a much higher explanatory power for inflation and output than is the case in Ireland or Greece. After 16 periods, the DFR explains 12% of the changes in inflation and 11% of the changes in output.

The variance decomposition for Portugal and Spain is shown in Tables 6.4 and 6.5 respectively. The DFR shows extremely little explanatory power for changes in output and inflation in both countries, helping to 2% or less after 16 periods in both cases.

5.8 Robustness checks

As mentioned in the lag length results section, alternative lag lengths were chosen when multiple optima presented themselves. Models were created for each respective GIIPS country using the methodology outlined above and the lag which corresponds to the lowest autocorrelation amongst the variables in the model were chosen.

6. Conclusion

Following the SVAR analysis of the GIIPS countries conducted in this report, it was found that there was significant heterogeneity in the responses of output and inflation with respect to a short-term interest rate shock amongst the GIIPS countries.

With regards to the heterogeneity in responses to output, this mainly consisted of the persistence of the shock. Most countries experienced higher levels of output following a monetary policy shock followed by a decrease. Greece took the longest for the shock to output to die out, while in Ireland the effect died off the quickest, implying faster adjustment.

Similarities were seen most in the monetary policy shock to Greek and Portuguese inflation increased and decreased many times over the 16-year period and exhibited no clear pattern thus an underlying business cycle pattern may dominate both economies. This could indicate similar underlying responses to monetary policy shocks. Heterogeneity in results is in line with Georgiadis (2015) who found that monetary policy transmissions across Europe varies still and has not converged fully due to differences in economic and institutional structures across countries.

Interestingly, the only country that showed short-term interest rates Granger causing inflation or output was Ireland which Mccoy (1997) describes SVAR being underutilised in analysing leading economic indicators in Ireland. Thus, future research could look at pre and post euro adoption data for Ireland and track the dynamics of monetary shocks over time.

These results include the Covid-19 pandemic data and data coinciding with the ongoing war in Ukraine. Some heterogeneity in results may be explained by including the Covid-19 period and beyond in the study as unprecedented unconventional monetary and fiscal policy was employed and in the case of fiscal policy, was employed heterogeneously across the eurozone. Future analyses may want to incorporate breaks in the data when analysing the dynamics of monetary policy in the GIIPS. This was not done in this analysis as there is not enough data post Covid-19.

Particularly the results contribute to furthering the discussions on whether the GIIPS deserve to be grouped together given there vastly different responses to a monetary policy shock. Whether the GIIPS could also be the focus of the next financial crisis remains to be seen.

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Appendix
Appendix A

Table 1.1 Phillips Perron & Dicky Fuller

	Test	T-Statistic	1% CV	5% CV	10% CV	Stationarity
DFR	DF	-0.87	-3.51	-2.89	-2.58	No
DFR	PP	-1.66	-3.51	-2.89	-2.58	No
DFR*	DF	-4.07	-3.52	-2.89	-2.58	Yes
DFR*	PP	-4.31	-3.52	-2.89	-2.58	Yes
CPI_GRE	DF	-16.44	-3.51	-2.89	-2.58	Yes
CPI_GRE	PP	-14.71	-3.51	-2.89	-2.58	Yes
CPI_GRE**	DF	-69.31	-3.52	-2.89	-2.58	Yes
CPI_GRE**	PP	-128.82	-3.52	-2.89	-2.58	Yes
GDP_GRE	DF	-2.86	-3.51	-2.89	-2.58	No
GDP_GRE	PP	-2.22	-3.51	-2.89	-2.58	No
GDP_GRE**	DF	-11.98	-3.52	-2.89	-2.58	Yes
GDP_GRE**	PP	-32.09	-3.52	-2.89	-2.58	Yes
CPI_IRE	DF	-1.31	-3.51	-2.89	-2.58	No
CPI_IRE	PP	-2.33	-3.51	-2.89	-2.58	No
CPI_IRE*	DF	-4.50	-3.52	-2.89	-2.58	Yes
CPI_IRE*	PP	-4.79	-3.52	-2.89	-2.58	Yes
GDP_IRE	DF	0.570	-3.51	-2.89	-2.58	No
GDP_IRE	PP	1.453	-3.51	-2.89	-2.58	No
GDP_IRE*	DF	-12.36	-4.50	-3.52	-2.89	Yes
GDP_IRE*	PP	-12.95	-4.79	-3.52	-2.89	Yes
CPI_ITA	DF	1.57	-3.51	-2.89	-2.58	No
CPI_ITA	PP	0.78	-3.51	-2.89	-2.58	No
CPI_ITA*	DF	-5.53	-3.52	-2.89	-2.58	Yes
CPI_ITA*	PP	-5.55	-3.52	-2.89	-2.58	Yes
GDP_ITA	DF	-6.43	-3.51	-2.89	-2.58	Yes

Table 1.1 Phillips Perron & Dicky Fuller continued

	Test	T-Statistic	1% CV	5% CV	10% CV	Stationarity
GDP_ITA	PP	-6.44	-3.51	-2.89	-2.58	Yes
CPI_POR	DF	-0.11	-3.51	-2.89	-2.58	No
CPI_POR	PP	-0.14	-3.51	-2.89	-2.58	No
CPI_POR*	DF	-11.53	-3.52	-2.89	-2.58	Yes
CPI_POR*	PP	–11.41	-3.52	-2.89	-2.58	Yes
GDP_POR	DF	-2.29	-3.51	-2.89	-2.58	No
GDP_POR	PP	-1.80	-3.51	-2.89	-2.58	No
GDP_POR*	DF	-11.69	-3.52	-2.89	-2.58	Yes
GDP_POR*	PP	-12.51	-3.52	-2.89	-2.58	Yes
CPI_SPA	DF	-2.23	-3.51	-2.89	-2.58	No
CPI_SPA	PP	-2.95	-3.51	-2.89	-2.58	Yes
CPI_SPA*	DF	-6.13	-3.52	-2.89	-2.58	Yes
CPI_SPA*	PP	-6.26	-3.52	-2.89	-2.58	Yes
GDP_SPA	DF	-3.13	-3.51	-2.89	-2.58	Yes
GDP_SPA	PP	-2.63	-3.51	-2.89	-2.58	No
GDP_SPA*	DF	-21.44	-3.51	-2.89	-2.58	Yes
GDP_SPA*	PP	-23.09	-3.51	-2.89	-2.58	Yes

Notes: Asterisk corresponds to first differencing of variable.

Appendix B Lag Order Selection

Table 2.1 Lag order selection criteria Greece

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-644.565				356.632	14.3903	14.4239	14.4737
1	-486.004		9	0.000	12.8496	11.0668	11.2012	11.4001
2	-447.803		9	0.000	6.72039	10.4178	10.653	11.0011
3	-356.108		9	0.000	1.07178*	8.58019*	8.91621*	9.41346*
4	-348.454		9	0.083	1.108	8.61009	9.04692	9.69334
5	-341.217		9	0.106	1.15845	8.64926	9.1869	9.98249
6	-338.528		9	0.800	1.34342	8.78952	9.42796	10.3727

Note: * denotes the optimal lag

Table 2.2 Lag order selection criteria Ireland

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-949.30				246707.00	20.93	20.96	21.01
1	-894.54	109.51	9	0.00	90267.30	19.92	20.06*	20.25*
2	-887.79	13.51	9	0.14	94903.10	19.97	20.21	20.55
3	-876.75	22.07	9	0.01	90917.00	19.93	20.26	20.76
4	-858.74	36.03*	9	0.00	74817.50*	19.73*	20.16	20.81
5	-854.78	7.93	9	0.54	84010.70	19.84	20.38	21.17
6	-847.12	15.31	9	0.08	87190.50	19.87	20.51	21.44

Note: * denotes the optimal lag

Table 2.3 Lag order selection criteria Italy

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-367.33				0.69	8.15	8.17	8.22
1	-313.71	107.23	9	0.00	0.26	7.16	7.29	7.49*
2	-298.22	30.98	9	0.00	0.22	7.016	7.25	7.60
3	-283.33	29.79	9	0.00	0.20	6.89	7.22	7.71
4	-261.34	43.98	9	0.00	0.15	6.60	7.035*	7.68
5	-249.41	23.87*	9	0.01	0.14*	6.54*	7.07	7.86
6	-247.18	4.46	9	0.88	0.16	6.69	7.32	8.26

Note: * denotes the optimal lag

Table 2.4 Lag order selection criteria Portugal

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-381.14				0.93	8.44	8.48	8.52
1	-344.69	72.91	9	0.00	0.51	7.84	7.97	8.17
2	-316.40	56.57	9	0.00	0.33	7.42	7.65	7.99*
3	-302.72	27.37	9	0.00	0.30	7.31	7.65	8.14
4	-284.65	36.15	9	0.00	0.25	7.11	7.55*	8.19
5	-272.75	23.78*	9	0.01	0.23*	7.05*	7.58	8.37
6	-270.66	4.18	9	0.90	0.27	7.20	7.84	8.77

Note: * denotes the optimal lag

Table 2.5 Lag order selection criteria Spain

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-986.67				560886	21.75	21.78	21.83
1	-922.81	127.70	9	0.00	168030	20.55	20.68	20.88*
2	-916.70	12.24	9	0.20	179151	20.61	20.84	21.19
3	-899.04	35.32	9	0.00	148361	20.41	20.75	21.25
4	-881.79	34.50*	9	0.00	124166*	20.24*	20.67*	21.31
5	-880.24	3.10	9	0.96	147008	20.40	20.94	21.73
6	-873.97	12.54	9	0.19	157297	20.46	21.10	22.034

Note: * denotes the optimal lag

Appendix C Eigenvalue Stability Check

Table 4.1 To check for stability condition: Greece

Eigenvalue		Modulus
-1.00		0.99
-0.01 +	0.99ι	0.99
-0.01 -	0.99ι	0.99
-0.91		0.91
-0.04 +	0.83ι	0.83
-0.04 -	0.83ι	0.83
0.62		0.62
0.16 +	0.42ι	0.45
0.16 -	0.42ι	0.45

Note: All the eigenvalues lie inside the unit circle. VAR satisfies the stability condition.

Table 3.2 To check for stability condition: Ireland

Eigenvalue		Modulus
0.63 +	0.07ι	0.64
0.63 -	0.07ι	0.64
-0.28		0.28

Note: All the eigenvalues lie inside the unit circle. VAR satisfies the stability condition.

Table 4.3 To check for stability condition: Italy

Eigenvalue		Modulus
-0.93		0.93
0.91		0.91
-0.41 +	0.72ι	0.82
-0.41 -	0.72ι	0.82
0.03 +	0.76ι	0.76
0.03 -	0.76ι	0.76
0.71 +	0.24ι	0.75
071 -	0.24ι	0.75
0.63 +	0.34ι	0.72
0.63 -	0.34ι	0.72
-0.18 +	0.55ι	0.58
-0.18 -	0.55ι	0.58

Note: All the eigen-0.41values lie inside the unit circle. VAR satisfies the stability condition.

Table 3.4 To check for stability condition: Portugal

Eigenvalue		Modulus
-0.77		0.77
0.75		0.75
-0.13 +	0.58ι	0.59
-0.13 -	0.58ι	0.59
0.38 +	0.44ι	0.58
0.38 -	0.44ι	0.58

Note: All the eigenvalues lie inside the unit circle. VAR satisfies the stability condition.

Table 3.5 To check for stability condition: Spain

Eigenvalue	Modulus
-0.67	0.67
0.64	0.64
0.45	0.45

Note: All the eigenvalues lie inside the unit circle. VAR satisfies the stability condition.

Appendix D: Test for Autocorrelation

Table 4.1. Lagrange multiplier test to test for autocorrelation: Greece

Lag	chi2	df	Prob>chi2
1	10.71	9	0.30
2	9.88	9	0.36
3	5.88	9	0.75

Note: H0: no autocorrelation at lag order

Table 4.2. Lagrange multiplier test to test for autocorrelation: Ireland

Lag	chi2	df	Prob>chi2
1	16.55	9	0.06

Note: H0: no autocorrelation at lag order

Table 4.3. Lagrange multiplier test to test for autocorrelation: Italy

Lag	chi2	df	Prob>chi2
1	19.54	9	0.02
2	10.58	9	0.31
3	4.48	9	0.88
4	7.44	9	0.59

Note: H0: no autocorrelation at lag order

Table 4.4. Lagrange multiplier test to test for autocorrelation: Portugal

Lag	chi2	df	Prob>chi2
1	18.87	9	0.03
2	20.01	9	0.02
3	13.68	9	0.13
4	8.88	9	0.45

Note: H0: no autocorrelation at lag order

Table 4.5. Lagrange multiplier test to test for autocorrelation: Spain

Lag	chi2	df	Prob>chi2
1	14.38	9	0.11

Note: H0: no autocorrelation at lag order

Appendix E: Granger causality Wald test

Table 5.1. Granger causality Wald test: Greece

Equation	Excluded	chi2	df	Prob > chi2
DFR*	CPI	0.35	3	0.85
DFR*	GDP*	1.25	3	0.74
DFR*	ALL	1.82	6	0.94
CPI	DFR*	3.76	3	0.29
CPI	GDP*	3.57	3	0.31
CPI	ALL	9.04	6	0.17
GDP*	DFR*	0.88	3	0.83
GDP*	CPI	3.76	3	0.29
GDP*	ALL	5.22	6	0.52

Table 5.2. Granger causality Wald test: Ireland

Equation	Excluded	chi2	df	Prob > chi2
DFR*	CPI	2.34	1	0.13
DFR*	GDP*	1.85	1	0.17
DFR*	ALL	4.91	2	0.09
CPI	DFR*	0.00	1	0.98
CPI	GDP*	4.46	1	0.04
CPI	ALL	4.51	2	0.11
GDP*	DFR*	4.20	1	0.04
GDP*	CPI	2.56	1	0.11
GDP*	ALL	4.72	2	0.09

Table 5.3. Granger causality Wald test: Italy

Equation	Excluded	chi2	df	Prob > chi2
DFR*	CPI	8.05	4	0.09
DFR*	GDP*	1.06	4	0.90
DFR*	ALL	8.36	8	0.40
CPI	DFR*	6.60	4	0.16
CPI	GDP*	7.88	4	0.10
CPI	ALL	12.00	8	0.15
GDP*	DFR*	3.59	4	0.46
GDP*	CPI	31.40	4	0.00
GDP*	ALL	39.84	8	0.00

Table 5.4. Granger causality Wald test: Portugal

Equation	Excluded	chi2	df	Prob > chi2
DFR*	CPI	15.35	2	0.00
DFR*	GDP*	0.96	2	0.92
DFR*	ALL	18.23	4	0.02
CPI	DFR*	2.09	2	0.72
CPI	GDP*	24.05	2	0.00
CPI	ALL	23.14	4	0.01
GDP*	DFR*	2.89	2	0.58
GDP*	CPI	12.02	2	0.02
GDP*	ALL	13.04	4	0.11

Table 5.5. Granger causality Wald test: Spain

Equation	Excluded	chi2	df	Prob > chi2
DFR*	CPI	2.30	1	0.13
DFR*	GDP*	0.19	1	0.67
DFR*	ALL	2.34	2	0.31
CPI	DFR*	0.91	1	0.34
CPI	GDP*	0.03	1	0.86
CPI	ALL	0.96	2	0.62
GDP*	DFR*	0.83	1	0.36
GDP*	CPI	1.39	1	0.24
GDP*	ALL	2.28	2	0.32

Appendix F Impulse Response Functions

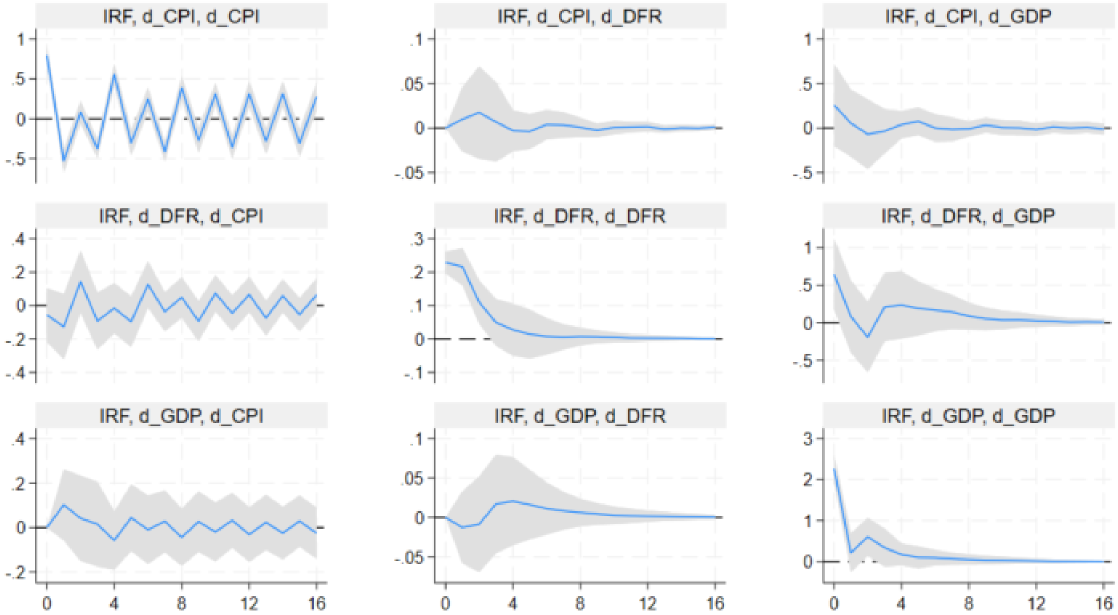

Figure 3.1 Greece

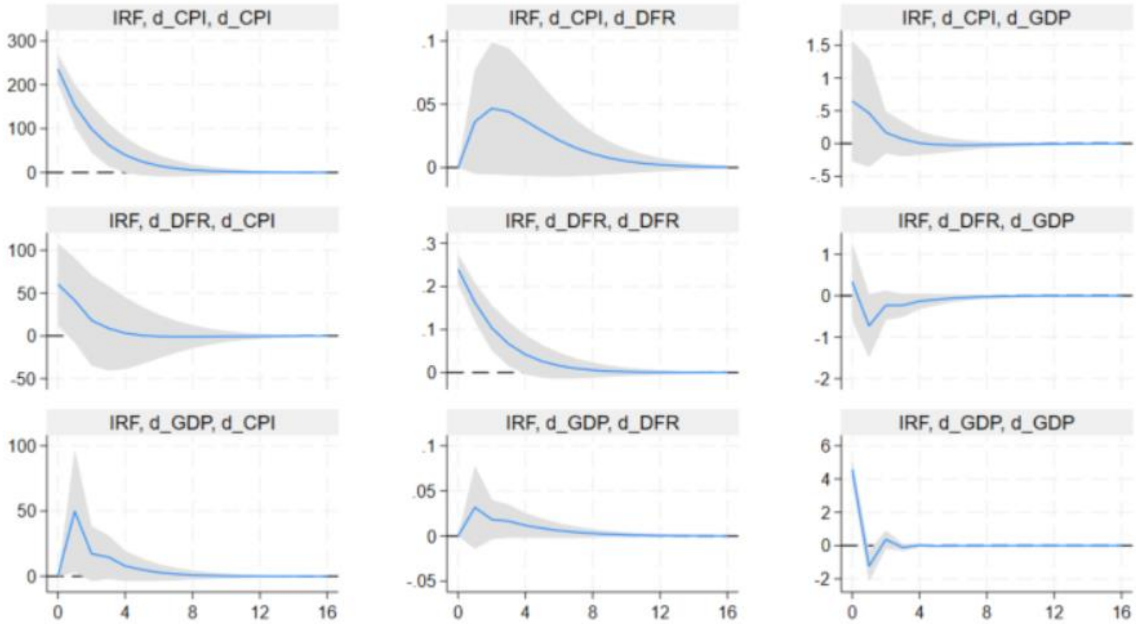

Figure 3.2 Ireland

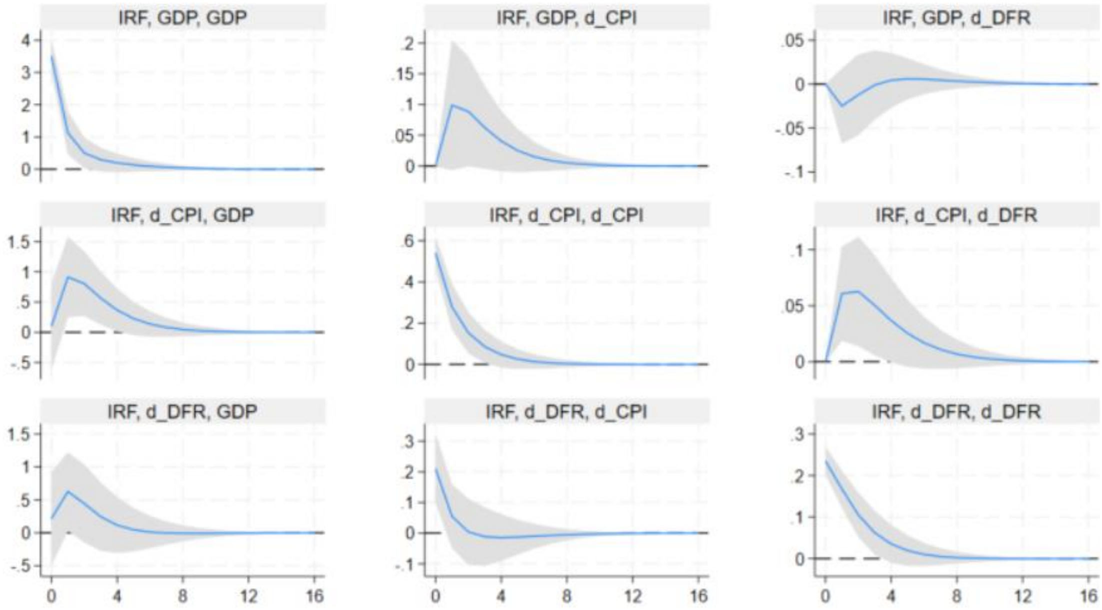

Figure 3.3 Italy

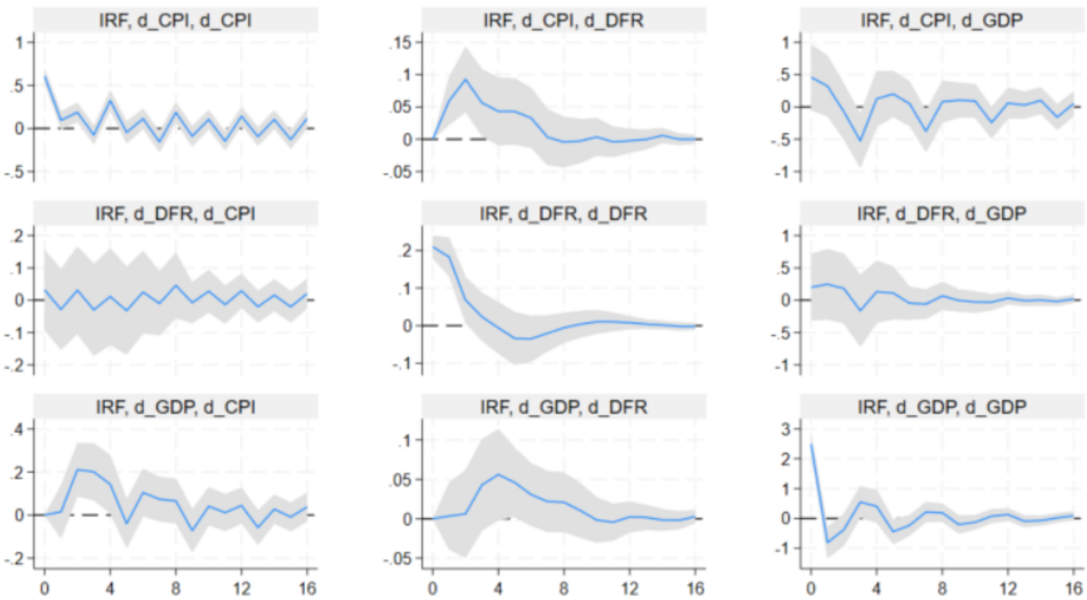

Figure 3.4 Portugal

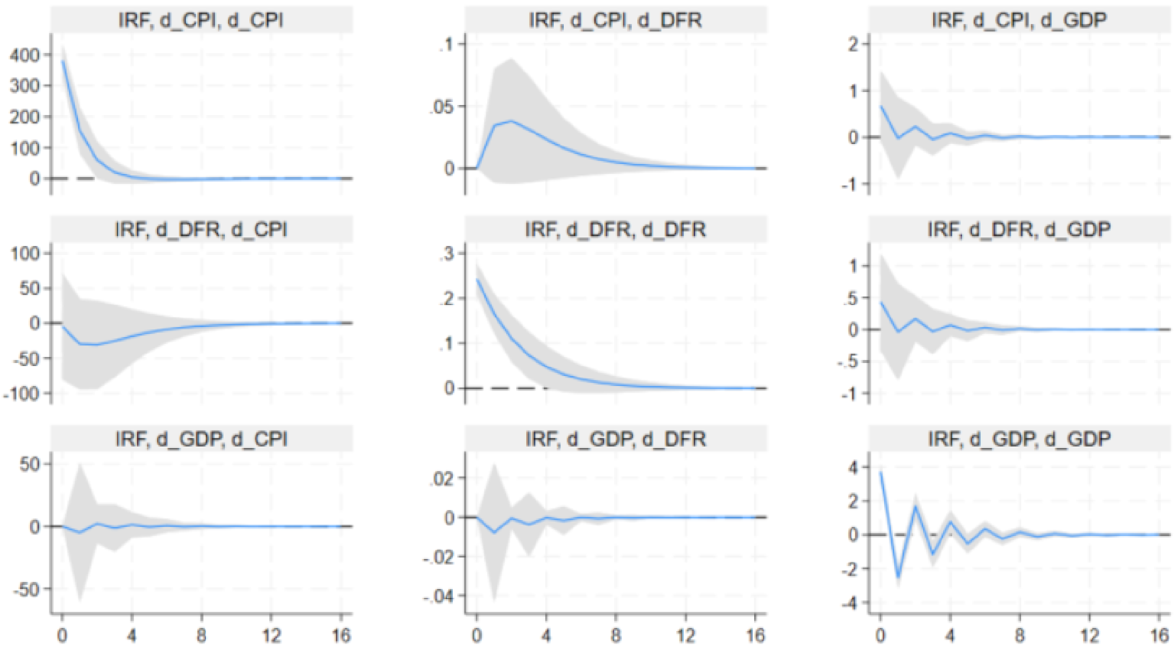

Figure 3.5 Spain

Appendix G: Variance decomposition

Table 6.1. Variance decomposition results of variables in model: Greece

Steps	(1) fevd	(2) fevd
0	0	0
1	0.01	0.06
2	0.01	0.08
3	0.03	0.08
4	0.04	0.08
5	0.03	0.07
6	0.03	0.08
7	0.03	0.08
8	0.04	0.08
9	0.03	0.07
10	0.03	0.08
11	0.03	0.08
12	0.04	0.08
13	0.03	0.08
14	0.03	0.08
15	0.03	0.08
16	0.04	0.08

Note: (1) Effect of DFR on CPI (2) Effect of DFR on GDP*

Table 6.2. Variance decomposition results of variables in model: Ireland

Steps	(1) fevd	(2) fevd
0	0	0
1	0.06	0.01
2	0.06	0.03
3	0.06	0.03
4	0.06	0.03
5	0.06	0.03
6	0.06	0.03
7	0.06	0.03
8	0.06	0.03
9	0.06	0.03
10	0.06	0.03
11	0.06	0.03
12	0.06	0.03
13	0.06	0.03
14	0.06	0.03
15	0.06	0.03
16	0.06	0.03

Note: (1) Effect of DFR on CPI (2) Effect of DFR on GDP*

Table 6.3 Variance decomposition results of variables in model: Italy

Steps	**(1) fevd**	**(2) fevd**
0	0	0
1	0.14	0.04
2	0.12	0.08
3	0.14	0.10
4	0.11	0.10
5	0.10	0.09
6	0.12	0.11
7	0.11	0.11
8	0.11	0.11
9	0.12	0.11
10	0.12	0.11
11	0.12	0.11
12	0.12	0.11
13	0.12	0.11
14	0.12	0.11
15	0.12	0.11
16	0.12	0.11

Note: (1) Effect of DFR on CPI (2) Effect of DFR on GDP*

Table 6.4. Variance decomposition results of variables in model: Portugal

Steps	(1) fevd	(2) fevd
0	0	0
1	0.00	0.00
2	0.00	0.01
3	0.01	0.02
4	0.01	0.02
5	0.01	0.02
6	0.01	0.02
7	0.01	0.02
8	0.1	0.02
9	0.01	0.02
10	0.01	0.02
11	0.01	0.02
12	0.01	0.02
13	0.01	0.02
14	0.1	0.02
15	0.02	0.02
16	0.03	0.02

Note: (1) Effect of DFR on CPI (2) Effect of DFR on GDP*

Table 6.5. Variance decomposition results of variables in model: Spain

Steps	**(1) fevd**	**(2) fevd**
0	0	0
1	0.00	0.01
2	0.01	0.01
3	0.01	0.01
4	0.01	0.01
5	0.02	0.01
6	0.02	0.01
7	0.02	0.01
8	0.02	0.01
9	0.02	0.01
10	0.02	0.01
11	0.02	0.01
12	0.02	0.01
13	0.02	0.01
14	0.02	0.01
15	0.02	0.01
16	0.02	0.01

Note: (1) Effect of DFR on CPI (2) Effect of DFR on GDP*