Fiscal consolidation and macroeconomic outcomes

FISCAL CONSOLIDATION AND MACROECONOMIC OUTCOMES

CHRYSANTHI RAPTI

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Declaration

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Abstract

This Thesis examines fiscal consolidation effects on unemployment and the labour market, focusing on differentiated outcomes based on austerity type and country specific labour market institutions. It also investigates how associated fiscal austerity is with the current account to examine international implications of austerity.

The First Chapter empirically investigates short-run and long-run effects of different austerity measures on unemployment, real wages, labour force participation, and hours worked in a panel of European countries. Unemployment significantly increases due to fiscal consolidation shocks, with spending oriented adjustment having significant effects both in the short-run and long-run. Labour force participation significantly decreases due to spending cuts while real wages fall in the long-run, although non-significantly, responding to increased taxation.

The Second Chapter examines how labour market structure can affect the transmission of fiscal consolidation to unemployment and labour market, by studying heterogeneous responses of unemployment to austerity across European countries. The analysis is based on theoretical and empirical models, i.e. a Dynamic Stochastic General Equilibrium model featured by frictional labour market with employment protection and a hierarchical Bayesian panel model encompassing differences in labour market institutions. Cutting spending increases cyclical unemployment by more as compared to tax hikes. Spending effect is stronger for total unemployment on impact, while the response of total unemployment to either spending or tax based adjustment is similar in the long-run. Labour market institutions can affect fiscal transmission to unemployment, with higher employment protection inducing stronger effects.

The Third Chapter empirically studies open-economy effects of austerity, by examining the relationship between government budget and current account balances in the UK after fiscal intervention, using Structural Vector Autoregression models. The results did not support the twin deficits hypothesis. Positive shocks in government budget balance and tax revenues induce real exchange appreciation but current account does not appear to significantly respond.

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Contents

List of Figures

List of Tables

Introduction

The time shortly after the Great Recession has been followed by a strong focus on the effectiveness of monetary policy under the zero lower bound, and on the subsequent use of expansionary fiscal policies to ameliorate the crisis implications. Scholars and policy makers have tried to understand the role played by the implementation of fiscal measures able to deal with the output contraction and the continuous rising of the unemployment rate.

Expansionary fiscal policies have been adopted to tackle economic slump. These policies however have gradually inflated public debts and government deficits which reflect an important threat for the sustainability of the public and financial sectors. Such a type of interventions has left many nations in a precarious position, with fears about debt sustainability and restrictions on future investment-led growth. Thus, in recent years, many governments have being imposing actions of consolidating their budget balances to maintain their deficits and government debt within sustainable limits, which yields to implications on output and unemployment. This alternative approach has promoted analysis of fiscal austerity measures assessing their implications on various aspects of the economy, for instance on output, labour market and debt evolution.

The success of fiscal consolidation in controlling government deficit turned out to be defended by those claiming that austerity has non-Keynesian effects, but simultaneously criticized by those who believe that such measures have produced negative output implications, without improving government budget balance. The first argument is supported by Giavazzi and Pagano (1990) who show that austerity policies are able to simultaneously achieve fiscal re-balancing and increase consumption. On the contrary, Sutherland et al. (1997) report evidence of a decrease in consumption due to a tax cut. Whereas, Afonso and Jalles (2011) outline the positive implications of decreased government consumption on the consumption of private sector. Along similar lines, Perotti (1999) and Bertola and Drazen (1993) suggest that in the presence of high debt, austerity has a positive effect on private consumption. The argument of conditional expansionary austerity is also supported by Alesina and Ardagna (2010) and Giavazzi and Pagano (1996). However, austerity measures are found to be contractionary for output with self-defeating effects; meaning that under recessionary periods, and in addition to restrictive monetary policy accommodation and export growth, expenditure retrenchment might not achieve deficit focused targets (see among others, Gros, 2011, Holland and Portes, 2012, and Sutherland et al., 2012). Guajardo et al. (2014) estimate the effects of fiscal austerity events for a number of OECD countries, showing that private consumption and output decrease in response to such episodes. Along these line, Bermperoglou, Pappa and Vella (2013), Dallari

(2014) and Turrini (2013) demonstrate negative effects generated by austerity measures on the labour market, through increased unemployment rate.

Focusing on the impact of austerity on government debt progression, Cafiso and Cellini (2012) show that the debt to GDP ratio is contained in the short-run whereas this ability vanishes in the medium-run, in an analysis for a set of European countries. Corsetti et al. (2011) outline the ineffectiveness of austerity under financial crisis, and Semmler and Semmler (2013) provide evidence on the dependence of fiscal multipliers on financial distress. Also, the negative implications of consolidation have been outlined under the zero lower bound by Linde and Erceg (2010b). Moreover, the timing of austerity has been shown to play an important role. It has been demonstrated that successful action comes from its implementation when the fiscal multiplier is low, meaning during periods characterised by high debt and sovereign risk (see Corsetti et al., 2012, and Corsetti et al., 2013).

In identifying austerity implications, controversial evidence on the effects of different types of consolidation are provided, i.e. expenditure versus revenue oriented policies. Recessionary implications of government policy retrenchment and the associated large spending multiplier have been supported by De Long and Summers (2012) and Gali (2007). Looking at the fiscal policy implemented in Europe, Blot et al. (2014) provide evidence on how spending based adjustment may be more detrimental than the policy focused on taxes. Within the European scenario, Turrini (2013) finds that spending oriented policy has more significant implications on unemployment as compared to the policy driven by tax hikes. On the other hand, Alesina et al. (2015) and Beetsma et al. (2015) claim that expenditure focused adjustment is less costly in terms of output in contrast to revenue oriented action. Along these lines, Guajardo et al. (2014) suggest that expenditure based austerity is less adverse for demand, as in that case monetary policy is more active. Erceg and Linde (2013) emphasize the role of independent monetary policy in affecting the contractionary fiscal impact, with tax increases having smaller negative output effects in the short-run as compared to these of spending cuts under a currency union or the zero lower bound; however tax effects become more profound in the long-run so that a mixed consolidation is preferred.

This discussion is associated with a large thread in the literature which focuses on the estimation of spending and tax multipliers of output. A lot of research has been developed, especially for the US, in order to measure the magnitude of these multipliers. Blanchard and Perotti (2002) and Mountford and Uhlig (2009) provide evidence for both multipliers. Based on different SVAR identification schemes, Blanchard and Perroti estimate a spending multiplier of 0.9 to 1.2 and a tax multiplier of -0.78 to -1.33, while Mountford and Uhlig provide a magnitude of 0.65 and -5 for expenditure and tax measures, respectively. US based fiscal multipliers are provided by Favero and Giavazzi (2012) and Mertens and Ravn (2014), estimated at the value of -0.5 and -3 for taxes respectively, and by Ben Zeev and Pappa (2015), estimated at the magnitude of 2.1 for spending. A lot of attention has been also centred to the non-linear effects of fiscal shocks and as a consequence to the state-dependent multipliers. For instance, Auerbach and Gorodnichenko (2012a) and Caggiano et al. (2013) provide evidence for different multipliers under recessions and expansions. Other studies claiming state-dependent fiscal multipliers include these of Baum and Koester (2011), Deak and Lenarcic (2012) and Ramey and Zubairy (2013). Gechert and Rannenberg (2014) show that although tax multipliers depend only moderately on the state of the economy, spending multipliers are quite large during recessions. Batini et al. (2012) estimate higher spending multipliers than these of taxation during periods of slump, and Coenen et al. (2012) find a higher magnitude of spending multiplier comparing to the one of taxes even in a set up without time-varying effects. From a more general point of view, Baunsgaard et al. (2013) summarize a big number of contributions on fiscal multipliers evaluated either through Dynamic Stochastic General Equilibrium (DGSE) or Structural Vector Autoregression (SVAR) models, suggesting a spending multiplier which lies in an interval between 0 and 2.1, and a tax multiplier in the range of -1.5 to 1.4, with an average value of 0.3.

Focusing on the labour market responses to austerity, unemployment fiscal multipliers have been less explored as compared to output fiscal multipliers. Relevant contributions in the literature include Monacelli et al. (2010) who provide an unemployment spending multiplier of -0.6, and Ravn and Simonelli (2007) who estimate a decline in unemployment rate by 1.5 percent in the third year following an increase in government spending. In addition to the effects of fiscal shocks on the labour market, Bruckner and Pappa (2012) show that an increase in government spending causes an increase in employment, unemployment and participation rates in a number of OECD countries. Finally, the global implications of fiscal austerity have attracted research attention, e.g. through the exploration of how associated the government budget balance is with the current account (see Bluedorn and Leigh, 2011, Badinger, 2015, Snable, 2013, and Xie, 2014).

Motivated by the ongoing debate on the various economic implications of fiscal consolidation, the work developed here provides evidence not only on the different effects of fiscal austerity focused on its type (spending versus tax based policies), but also on the heterogeneous implications driven by country specific structural characteristics which can affect the magnitude of fiscal multipliers. Driven by the belief that different austerity measures can have distinct effects on employment, the analysis proposed here focuses on the effects of fiscal austerity policy on labour market. As previously outlined, a lot of research has focused on how a response of output to fiscal innovations can depend on various factors as monetary policy, trade openness, exchange rate regime and debt level, along with the state of the economy. Despite the road literature developed around output effects, less attention has been devoted to fiscal austerity transmission to unemployment, which may depend on specific labour market characteristics. An investigation of the interaction between fiscal measures and country-specific labour market structures would be particularly fruitful in providing recommendations tailored ad hoc on countries' characteristics. Moreover, given the complexity associated with the impact of fiscal austerity on the international investment position of a country, the present analysis provides further evidence on the international implications of fiscal re-balancing actions.

By investigating the differentiated effects of austerity policies on labour market, and on the current account, this Thesis contributes to the literature on fiscal consolidation through both expenditure and revenue measures, with a particular focus on the labour market and on the international economic components. Looking at a group of twelve European countries, we assess both theoretically and empirically the link between fiscal austerity actions and heterogeneous labour market institutions, revealing their pivotal role in the implications of such a type of policy. The sample of countries consists of economies across Europe that considerably vary in terms of their labour market structure. By looking at the degree of employment protection and the generosity of unemployment benefits, we could identify three types of systems, i.e. the Anglo-Saxon, the Nordic and the continental system, a description of which can be found in OECD (2006) and Bertola et al. (2001). In short, the Anglo-Saxon system is recognized by low employment security and unemployment benefits, while the continental regime is generous in benefits and highly protective in employment. Between these two, the Nordic type is featured by a mediocre scale of employment security, high unemployment benefits, and active labour market policies. The presence of such differences in the labour market allows to take into account the characteristics of labour market institutions in examining their role on the fiscal pass-through. With regard to the international implications of consolidation, this Thesis provides empirical evidence on how contractionary fiscal policies in the UK are associated with the current account, by investigating the relevance of the hypothesis of the co-movement between the government budget balance and the current account balance (the "twin deficits" hypothesis).

Successful identification of the effects of real economic variables to fiscal austerity policies should be accompanied by exogeneity of such actions. Then, in the First and Second Chapters, the endogeneity concerns of fiscal measures are contained by using narrative estimates for fiscal consolidation, developed by Devries et al. (2011). These estimates are based on historical records, and are supposed to represent fiscal initiatives directly targeting budget deficit, which isolate fiscal re-balancing decisions from possible changes in the economic environment. In the Third Chapter, identification of contractionary fiscal shocks is achieved following two different methods; a recursive scheme in a SVAR model, following Sims (1980), and the proxy SVAR approach, initiated by Stock and Watson (2012) and Mertens and Ravn (2013), using narrative estimates for tax changes of Cloyne (2013).

More specifically, the First Chapter presents an analysis of the short-run and long-run effects of different measures of fiscal consolidation on labour market variables in a panel of European countries for the period from 1978 to 2009, allowing for cross-sectional dependence across countries. Following the methodological approach proposed by Pesaran and Smith (1995) and Pesaran, Shin and Smith (1997, 1999), we explore the effects of overall fiscal austerity and spending versus tax oriented consolidation on unemployment rate, labour force participation rate, real wages, and hours worked, by applying different econometric techniques depending on the assumptions about slope homogeneity or heterogeneity, i.e. fixed effects, and mean group and pooled mean group estimators for heterogeneous panels. To assess the effects of fiscal consolidation on unemployment rate, an Autoregressive Distributed Lag (ARDL) model is applied which leads to the estimation of an Error Correction Model (ECM), with a suggested long-run relationship between fiscal measures and unemployment rate. This methodological approach allows to capture the short-run and long-run effects on unemployment rates for the three different austerity actions (i.e. overall austerity, expenditure based and revenue based consolidation). An ARDL model is estimated for recovering the responses of real wage. To complete the set of labour market outcomes examined, an autoregressive model with exogenous factors (ARX) is selected for estimating the responses of the participation rate and hours worked. It emerges that unemployment rate, both cyclical and total, appears to significantly increase in response to overall fiscal consolidation shocks in the short-run and in the long-run, with the response of total unemployment rate being of higher magnitude. By looking at type-specific actions, spending oriented adjustment significantly increases cyclical and total unemployment rates in the short-run. Tax based austerity does not appear to be significant in affecting cyclical unemployment rate, but its impact is significant in increasing total unemployment rate in the long-run. Labour force participation is found to significantly decrease in response to expenditure oriented austerity. Real wage appears to fall in the long-run due to tax based consolidation, although the effect is not statistically significant. Hours worked do not seem to be significantly affected by contractionary fiscal policy.

With the aim to investigate why the responses of unemployment to fiscal austerity can differ across European countries, in the Second Chapter we examine the role of the labour market structure, more specifically labour market institutions, in affecting the transmission of fiscal consolidation to unemployment and the labour market. This analysis is developed using both theoretical and empirical modelling. First, building upon a DSGE model with specific features of the labour market and fiscal rules, accurate details on impulse responses of the variables under consideration are provided, focusing on unemployment multipliers for different fiscal shocks. Subsequently, allowing for unobserved heterogeneity and observed variability due to different labour market institutions across countries, a Bayesian hierarchical panel model is estimated to examine the corroboration of the theoretical predictions. The analysis considers a set of European countries spanning from 1978 to 2009. Our results suggest first that the unemployment spending multiplier is higher than the unemployment multipliers of labour income taxation and consumption taxation, and second that higher employment protection induces higher multipliers. Supporting the theoretical predictions, the empirical results highlight that cutting spending increases unemployment by more as compared to tax hikes, and labour market institutions, i.e. trade union density, unemployment benefits, and employment protection legislation, provide information on the effects of fiscal austerity on unemployment. More precisely, spending oriented fiscal adjustment increases cyclical unemployment rate by more as compared to tax based austerity. When considering total unemployment rate, even though the long-run effects of both spending and tax based consolidation appear to be of similar magnitude, spending based adjustment is sharp in increasing unemployment on impact while tax based fiscal re-balancing has gradual effects on unemployment throughout the time horizon. Besides, the labour market structure appears to play an important role in affecting the fiscal transmission to labour market. More specifically, when labour market is characterised by higher employment protection, unemployment increases by more in response to fiscal austerity innovations, compared to conditions of lower employment security. This empirical result endorses the theoretical predictions which imply that under contractionary fiscal policy, firms are reluctant to hire in an environment of strong employment protection legislation.

Finally, the Third Chapter considers the effects of fiscal austerity in an open-economy set-up. In particular, we empirically investigate the implications of contractionary fiscal shocks in the UK, specifically those to government budget balance and tax revenues, on current account balance, real GDP, real exchange rate and real interest rate. The relationship between the UK government budget and current account balances after fiscal intervention is examined for the period of 1970 to 2014, using different methods for identification of shocks in SVAR models. The results of this analysis did not endorse the argument of "twin deficits". More specifically, a SVAR model with short-run identifying restrictions is employed in order to capture innovations of the primary government budget balance. The effects of tax revenue shocks are explored through an identification method based on narrative approach, the proxy SVAR, which uses narrative estimates for tax changes to instrument for the structural tax shocks. A positive shock in the primary government budget balance, implying an improvement in public savings, induces a real exchange rate appreciation but its effect on the current account does not appear to be significant, based on the recursive identification scheme. Following the results from the "proxy SVAR" model, a positive shock in tax revenues decreases output growth, exhibiting a large on impact effect, and causes a real exchange rate appreciation in the long-run. Current account does not seem to significantly respond. The empirical evidence in this Chapter does not appear to support the twin deficits hypothesis for the UK for the time period considered, implying that fiscal austerity measures may not necessarily induce an improved current account position, depending on the reaction of the private sector when the public sector improves its budget position.

Chapter 1

Labour market responses to fiscal consolidation

1 Introduction

Many European countries have taken action to consolidate their government budget balance due to debt sustainability concerns. Fiscal adjustment has been implemented in the form of government spending cuts and/or tax hikes. A lot of attention has been focused on the impact of discretionary fiscal policy on output growth. Following the neoclassical theory and the associated wealth effect (Baxter and King, 1993), a government spending cut is followed by expectations about lower future taxation, and as a consequence a decline in labour supply (given a framework with lump-sum taxation). The decrease in labour supply can induce higher wages, rising unemployment, and a fall in output. The decline in output is not expected to be the same as the initial fall in expenditure, as private agents increase consumption while decreasing their labour supply. However, larger than unity output multipliers of government spending can be obtained in New Keynesian (NK) models, in which hand-to-mouth consumers are considered along with those who adopt an optimizing behaviour.[1] The responses of output to innovations in spending and taxation, namely the output fiscal multipliers, have been investigated by a large strand of the literature, examples of which consist in Blanchard and Perotti (2002), Mountford and Uhlig (2009) and Barro and Redlick (2011).[2] With regard to the dependence of output effects of fiscal shocks on the economic state and other specific factors, the differences of fiscal multipliers during booms and busts have been examined by among others, Auerbach and Gorodnichenko (2012 a,b), Afonso, Baxa and Slavi (2011), Baum and Koester (2011), Baum, Poplawski-Ribeiro and Weber (2012) and Batini, Callegari and Melina (2012). Along similar lines, Corsetti, Meier and Müller (2013) consider the role of exchange rate regime, public debt and financial turmoil in affecting fiscal implications on output, and Ilzetzki, Mendoza and Vegh (2013) highlight the difference in multipliers between developed and developing countries, along with the importance of trade openness and debt in affecting their magnitude.

As far as fiscal consolidation is concerned, the comparison between output and employment effects of spending versus tax oriented adjustment has been an ongoing debate. Guajardo, Leigh and Pescatori (2014) investigate the austerity implications on output and other variables, and the role that international trade, default risk and the form of fiscal measures have on affecting macroeconomic responses, suggesting that spending rebalancing is less negative for demand than tax action. Along these lines, Alesina, Favero and Giavazzi (2015), by exploring how output responses to austerity depend on the type of budget re-balancing and on the economic state (Alesina et al., 2016), argue that spending based adjustment is less costly in comparison to tax based action. On the other hand, tax adjustment appears to be preferable to spending cuts in terms of output (Blot et al., 2014) and employment (Turrini, 2013) based on European evidence.

The focus on the effects of fiscal policy on unemployment is non-negligible, and although the attention on output implications has been considerably higher, there is an increasing interest towards the fiscal implications on labour market variables. More specif-

[1] Models with such a type of consumer behaviour can be found in Eggertsson and Krugman (2012) and Justiniano, Primiceri and Tambalotti (2013).

[2] A summary of this topic can be found in Baunsgaard et al. (2013) who provide a number of contributions using either VAR or DSGE modelling to study fiscal multipliers.

ically, Burnside, Eichenbaum and Fisher (2004), by developing a VAR model with information from narrative estimates, show that a government expenditure increase in the US is associated with higher taxes and hours worked, and lower real wages. Pappa (2009) estimates the effects of innovations in government consumption, investment and employment on the US labour market at aggregate and state level, using a VAR model with sign restrictions originated from common implications in Real Business Cycle (RBC) and NK models. She shows that an increase in government consumption and investment leads to a rise of employment and real wages on impact; and an increase in government vacancies has a positive impact on real wage but employment is not always rising at state level. Monacelli, Perotti and Trigari (2010) develop a recursive SVAR model for the US to show that an increase in government spending results in higher employment, total hours worked, job finding rate, a delayed increase in real wage, and a decrease in unemployment and job destruction rate. Brückner and Pappa (2012) examine the effects of an increase in spending on labour market variables using a VAR model for OECD countries. Apart from an increase in real wage, in many cases they obtain an increase in unemployment and employment at the same time since participation rate increases. Bermperoglou, Pappa and Vella (2013) use a VAR model with sign restrictions to explore the effects of government variable (vacancies, consumption, investment and wages) cuts on output, unemployment and deficit, for Canada, Japan and the US and UK. Their results suggest a decrease in employment, participation rate and wages and an increase in unemployment due to a cut in government consumption, investment and vacancies. Dallari (2014), by employing a panel Bayesian VAR for eight Euro Area countries, shows that unemployment and participation rate are more responsive than wages and hours worked to fiscal shocks, with unemployment rising after a decrease in government consumption and investment, and participation rate falling after a government consumption cut. Also, Turrini (2013) explores the effects of fiscal consolidation on unemployment and job market flows, by estimating a panel model for European countries.

Motivated by the debate about the differences between consolidation measures in affecting real economic activity, the focus of this Chapter is to provide further evidence on the effects of austerity on unemployment and other labour market variables, by allowing for heterogeneous responses and cross-sectional dependence in a panel of European countries. The current analysis has a similar interest as in Turrini (2013) in terms of estimating the effects of different austerity policies on unemployment in European economies, but it differs in the methodology and estimation techniques implemented, in order to consider the inter-dependencies but also idiosyncrasies across countries in a panel specification. The results of this Chapter are used as a basis for the subsequent investigation of potential sources of heterogeneous unemployment responses to austerity measures across European nations in the second Chapter.

By treating fiscal innovations as demand shocks, a theoretical framework behind the relationship between unemployment and aggregate demand can be initially framed by Layard, Nickell and Jackman (1991), whose model is consistent with an RBC economy. Their framework implies that movements in unemployment are due to aggregate demand fluctuations and the other way round. A theoretical relationship between aggregate demand and unemployment would give ground for the empirical investigation of unemployment responses to fiscal innovations.

In this Chapter, we estimate the effects of austerity measures on unemployment rate, labour force participation rate, real wage and hours worked in a panel of twelve European countries since 1978 to 2009, taking into consideration three different types of fiscal adjustment. More specifically, overall fiscal consolidation, FC, refers to actions focused on both components of the government budget balance, spending cuts and tax hikes, while tax, T, and expenditure, G, oriented austerity measures are mainly directed by tax increases and spending cuts respectively. Fiscal consolidation shocks are identified based on the narrative estimates of Devries et al. (2011), who have isolated the fiscal actions which particularly target budget re-balancing and long-run debt from the business cycle effects. Given that the panel of countries under consideration exhibits cross-sectional dependence (CSD), following Pesaran (2004), we implement the Common Correlated Effect (CCE) method for dynamic analysis to capture the presence of this correlation, as developed by Pesaran and Chudik (2013). We select a panel Autoregressive Distributed Lag (ARDL) model in order to estimate both the short-run and long-run effects of the different types of fiscal re-balancing on unemployment. An ARDL model is chosen for real wage, while an Autoregressive (AR) model with exogenous variables is selected for participation rate and hours worked. The model exploring the fiscal implications on unemployment is estimated by applying three different techniques, in particular dynamic fixed effects, and mean group and pooled mean group estimators in heterogeneous panels, following Pesaran and Smith (1995) and Pesaran, Shin and Smith (1999). The responses of participation rate, real wage and hours worked to the different adjustment measures are estimated using dynamic fixed effects.

In summary, the results suggest that overall fiscal adjustment causes a significant increase in cyclical and total unemployment rates both in the short-run and long-run. Also, the response of total unemployment rate appears to be of higher magnitude. By focusing on different types of budget re-balancing, spending based austerity is found to significantly increase cyclical and total unemployment in the short-run. Cyclical unemployment does not appear to respond to tax oriented action, but total unemployment significantly increases in the long-run following tax hikes. A significant decrease in participation rate is estimated in the case of expenditure based measures. Tax elevation seems to cause a decrease in real wage in the long-run, but the effect is not significant. No significant responses of hours works are obtained.

The rest of this Chapter consists of the following parts. Section 2 outlines the empirical methodology including the data used, the model specification and evidence of cross-sectional dependence. The estimation results for cyclical and total unemployment rates, and for the other labour market variables are presented at Section 3 and Section 4 respectively. Finally, concluding remarks are provided in Section 5.

2 Empirical methodology

2.1 Data

The analysis is based on the period since 1978 to 2009 and the group of countries consists of twelve European economies, in particular Austria, Belgium, Denmark, Finland, France, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the UK.[3] For austerity measures, we use the narrative estimates of discretionary fiscal consolidation as percentage of GDP constructed by Devries et al. (2011), which are annual estimates that can possibly minimize concerns about expected policy changes.[4] This approach has the merit of capturing exogenous changes driven by the intentions to consolidate the budget in isolation from cyclical fluctuations.[5] There are three identified austerity actions. Overall fiscal consolidation, (FC), represents re-balancing coming from both spending retrenchment and tax increases. Spending oriented austerity, (G), and tax based austerity, (T), refer to actions mostly driven by the expenditure or the revenue side, respectively.

Regarding the labour market variables, unemployment rates are taken from the AMECO database of DG European Commission's Economic and Financial Affairs (ECFIN), with the cyclical unemployment rate expressed as the total unemployment rate minus the NAWRU. The NAWRU is the natural rate of unemployment in the long-run without any fluctuations. The estimation methodology of DG ECFIN distinguishes structural from cyclical components basically by estimating cyclical unemployment using a wage Phillips curve type of model, setting aside the structural component to unobserved factors. As the estimates for cyclical unemployment are based on this database, Germany is not included in the sample, as its series is relatively short, starting from 1991. By focusing on heterogeneous coefficients, the panel analysis includes countries for which longer time series are available. As the primary focus of this Chapter is the exploration of fiscal effects on unemployment, the patterns of cyclical unemployment and fiscal consolidation under the period of consideration, can be found in Appendix, section 5.1, for an initial impression about the correlation between these series.

With regard to the other labour market variables considered in the analysis, data on nominal compensation per employee expressed in national currency and GDP deflator in national currency with 2005 base year are also obtained from the AMECO database. Real wage is given by deflating nominal compensation per employee. We use real wages in logs in order to neutralize the measurement of different currency units, and have a more

[3]The choice of the specific time period is due to the availability of the dataset for the austerity estimates used, and the focus is on the European countries of it, apart from Germany. Details about exclusion of Germany will follow.

[4]In terms of anticipated policy changes, Mertens and Ravn (2010) consider the US tax changes as shocks if they occur within the quarter of the initial information release, and as expected policy changes if they take place after this quarter. In the current analysis, the use of annual data possibly makes the worries for anticipated policy shifts weaker comparing to the use of quarterly data.

[5]More specifically on Devries et al. (2011) dataset, they record a fiscal consolidation action even if it is followed by an adverse shock and an offsetting countercyclical discretionary stimulus (fiscal consolidation occurring simultaneously with fiscal responses to shocks). Moreover if austerity tends to be offset by tax changes not driven by cyclical fluctuations but long-run supply considerations, they sum up these effects and conclude that it refers to a consolidation episode if the overall effect causes budgetary savings. In their database, we see both negative and positive budgetary effects because they distinguish between temporary and permanent measures. Temporary measures have a positive effect on the budget for the period they apply but a negative impact when they expire. A permanent measure has a positive budgetary effect when it is implemented and zero afterwards.

meaningful and comparable explanation for the estimates of the fiscal coefficients.[6]

The series of labour force participation rates, meaning total labour force as percentage of total population, are taken from the Directorate for Employment, Labour and Social Affairs (LFS) of OECD.[7] The series for hours worked are collected from the OECD database for average annual hours worked per worker, expressed as total number of hours worked divided by the average number of employed (both part-time and full-time workers are considered).[8]

2.2 Country specific models

On the process of model selection, Augmented Dickey Fuller (Dickey and Said, 1984) and Elliott, Rothenberg and Stock (ERS, 1996) based on generalized least squares modified ADF (DF-GLS) tests are implemented to check for the presence of unit roots in our variables. According to DF-GLS, cyclical unemployment rates generally appear to be stationary for the group of countries. Fiscal consolidation variables appear to be stationary as well. Conditional on our series being stationary we may rely on standard inference. Prior to the estimation of a panel model, an ARDL(p, q) specification, with p and q standing for the lag number of the dependent and independent variables respectively, was chosen to estimate the effects of each type of fiscal austerity (F) on unemployment rate (u) for each country. The lag order is selected based on the Bayesian Information Criterion (BIC) in order to keep the specification as parsimonious as possible, ensuring though no serial correlation. The analysis spans from 1978 to 2009 for each of the twelve countries of our sample. The model is expressed in the following way:

$$u_{it} = \alpha_i + \sum_{p=1}^{P} \beta_i L^p u_{it} + \sum_{q=1}^{Q} \gamma_i L^q F_{it} + \epsilon_{it}. \tag{1.1}$$

Three specifications are used for each country, accounting for the different types of consolidation, FC, T and G. The BIC suggested two lags for cyclical unemployment and fiscal policy variables for ten out of twelve countries. While the second lag of unemployment is significant and crucial in addressing serial correlation, this is not the case for the lagged variables of fiscal policy for some countries. Hence, we start with the specification suggested by the BIC for each country, and sequentially drop the insignificant lags of fiscal policy.[9] Significant responses of unemployment rate to fiscal austerity are obtained for

[6]For illustrative purpose, by allowing real wage to be weighted by the exchange rate, E, in order to measure it in Euros, $(\frac{w}{p} * E)$, we would estimate the following simplified model, $\log(\frac{w}{p})_t + \log(E)_t = \alpha + \beta F_t + \epsilon_t$. Taking the logarithm of real wage, this specification reads as follow, $\log(\frac{w}{p})_t + \log(E)_t = \alpha + \beta F_t + \epsilon_t$, and consequently $\log(\frac{w}{p})_t = \alpha + \beta F_t + \epsilon_t$ where $\log(E)_t$ is incorporated in the constant α. Moreover, it is more sensible to obtain coefficients that are translated in percentage changes of real wages rather than changes in levels. This is useful in order to make comparisons across countries; for instance a similar change of real wage in absolute Euro value in Austria and Portugal is actually quite different.

[7]Participation rates for Spain, Italy, the Netherlands, Portugal, Finland and Sweden are provided since 1978. For Belgium, Denmark, Ireland and France the series starts from 1983, while for the UK and Austria it dates back to 1984 and 1994 respectively.

[8]For Denmark, Spain, France, the Netherlands, Finland, Sweden and the UK, data are provided since 1978, for Italy since 1980, for Ireland and Belgium since 1983, for Portugal since 1986, and for Austria since 1995.

[9]The chosen country-specific models are described as follow: an ARDL(1,1) for Austria, a modified with contemporaneous fiscal policy variable AR(2) for France, Ireland, Italy and Portugal, and an ARDL(1,2) for Denmark. The selected model for Belgium, Spain and Sweden is an ARDL(2,1), while the suggested specification for Finland, the Netherlands and the UK is an ARDL(2,2).

nine countries, with the majority of them suggesting a rise of it. More specifically, following austerity shocks, unemployment rate was found to increase in Belgium, Spain, France, Ireland, Sweden and the UK, but decrease in Finland and Denmark. In the Netherlands, it increases after one year but subsequently decreases.

2.3 Cross-sectional dependence

Towards the selection of a panel specification for the group of countries, country-specific estimations and robustness exercises suggested a general ARDL (2,1) model. Given that European countries are considerably linked to each other, we cannot exclude the likelihood of unobserved common factors driving the responses of unemployment, and of spill-over effects of fiscal policy from one country to another. It is possible that cross-sectional dependence exists across the countries that we look at, and ignoring unobserved common factors would result in inconsistent estimates. Hence, we formally examine whether cross-sectional correlation in the residuals is present, by testing for cross-sectional dependence (CSD) following Pesaran (2004),

$$CD_P = \sqrt{\frac{2T}{(N-1)}}(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\widehat{\rho}_{ij}).$$

The Pesaran test is based on the average of pair-wise correlation coefficients, $\widehat{\rho}_{ij}$, under the null hypothesis, H_0 of no CSD, $CD \sim N(0,1)$ as $N \to \infty$ and T being large. Cross-sectional correlation in the residuals was suggested in all of the three models (based on the use of different fiscal adjustments) for cyclical unemployment, with an average correlation of 0.135, 0.047 and 0.090 for FC, T and G specifications respectively. The results of this test are provided in Table 1.1.

Table 1.1: Cyclical unemployment and F

Residuals	*CD-test*	$p-value$	*corr*	*abs corr*
FC	6.22	0.000	0.135	0.224
T	2.15	0.032	0.047	0.160
G	4.15	0.000	0.090	0.204

Note: CSD Pesaran test, under the null hypothesis of no cross-sectional correlation, $CD \sim N(0,1)$.

In order to capture cross-sectional dependence, we apply the Common Correlated Effect (CCE) method as developed by Pesaran (2006) for static models and extended by Pesaran and Chudik (2013) for dynamic models. This approach incorporates the averages of dependent and independent variables, as additional regressors, in order to control for common unobserved factors which potentially drive the variables of interest in a panel data model.[10] Among the methods introduced to control for CSD in the residuals, Coakley, Fuertes and Smith (2002) suggest the inclusion of the estimated heterogeneous loadings from a Principal Component (PC) approach, i.e. a modified with PC OLS regression in which the unobserved common factors come from the estimated errors. Pesaran (2006)

[10] Following Pesaran (2006), a heterogeneous static panel model can be expressed as, $y_{it} = \alpha_i^{'} d_t + \beta_i^{'} x_{it} + e_{it}$, in which $e_{it} = \gamma_i^{\prime} f_t + \epsilon_{it}$, with d_t and f_t being the observed and unobserved common factors respectively.

proposes to proxy directly for the unobserved common factors and shows that averages of the dependent and independent variables across units is an appropriate way towards this direction. As emphasized in the survey of Chudik and Pesaran on CSD (2013), one should separate the situation of β being the same for all units (homogeneous slope) from this of β being unit specific, β_i, (heterogeneous slope) when recovering an average slope. Chudik and Pesaran (2013) refer to the case of obtaining consistent estimates by both averaging individual estimators and by pooled treatment given strict exogeneity of the independent variables, and departure of individual coefficients from the average not being associated with the residuals and the $x's$. Without this assumption, a consistent estimate of β is obtained by averaging individual $\beta_i s$. Along supporting lines of the CCE approach, Kapetanios, Pesaran and Yamagata (2011) show that even with non-stationary cross section means, the CCE method can still be used implying similar outcomes as in the case of stationary mean variables; and that Monte Carlo simulations outline the relative merits of using CCE method in small samples comparing to the partial components approach.

Thus, it is important to account for the unobserved common effects, as otherwise endogeneity bias would induce inconsistent estimates of the model's parameters. More specifically in our model, the inclusion of averaged unemployment rate can be interpreted as a flexible time trend capturing fluctuations which affect individual unemployment rates, and averaged fiscal policy can capture potential spill-over effects of fiscal actions across countries. Despite the assumption of fiscal measures being exogenous, controlling for the mean fiscal variable seems consistent with macroeconomic theory. The real economic effects of austerity action in an individual country may depend on fiscal policies implemented in other countries through trade links, and especially across European countries where such relationships are strong. As our model is dynamic, considering also lagged averaged variables is crucial in order to obtain valid and consistent estimates, following Pesaran and Chudik (2013).

On the basis of country-specific analysis, by modifying each of the individual specifications with the CSD terms, i.e. averages of unemployment and fiscal policy, we focus on the individual relationships between unemployment and fiscal action. Having as a reference point the ARDL model suggested by BIC, the model for each country is adjusted based on criteria for significance and no serial correlation, and the criterion for Root Mean Squared Error (RMSE) for model comparison. In particular, a modified AR(1,0,0,0) model was chosen for Austria and a modified AR(2,0,0,0) model was selected for Belgium and Portugal. An ARDL(1,0,1,0) was suggested for France and Sweden, while an ARDL(2,1,2,0) specification for Denmark and Spain, and an ARDL(2,2,1,0) model for Finland. An ARDL(1,1,1,1) for Ireland and the Netherlands, while an ARDL(2,1,1,1) for Italy were proposed. Finally for the UK, an ARDL(2,0,2,0) was suggested. Significant effects of fiscal policy measures on unemployment were obtained in half of the countries of our sample. Even if we are not primarily interested in the coefficients of lagged unemployment and average unemployment we shortly summarize their estimated impact. Unemployment responds significantly to its first and second lags for almost all countries. Strongly positive coefficients are estimated for the first lags indicating some persistence and lower negative estimates for the second lags implying relatively quick reversion. Finally, unemployment in almost all countries responds positively and significantly to a percentage increase of averaged unemployment. Also, the responses to first and second lags of averaged unemployment are significant for some countries.

2.4 Panel specifications

A panel model consisting of twelve European countries is chosen to estimate the effects of different austerity policies on unemployment rate for the period from 1978 to 2009. A merit of estimating a panel specification is that we can make as efficient use as possible of our sample which is of relatively short time period. By estimating the panel model using dynamic fixed effects (DFE), we allow for heterogeneity across countries via unobserved time-invariant factors, by attributing fixed effects to each country. However, in the fixed effects estimation, slope homogeneity is assumed across countries. Apart from the fixed effects method that treats heterogeneity only via different intercepts, we adopt the Mean Group (MG) estimator developed by Pesaran and Smith (1995) which allows for all the coefficients and the error variances to differ across countries. The proposed mean estimates are non-weighted averages of the individual estimates. As proposed by Pesaran, Shin and Smith (1999), we also apply the Pooled Mean Group (PMG) estimator which assumes that the long-run parameters are the same but the intercepts, the short-run parameters and the error variances can vary across countries; a methodology allowing data pooling to lead to efficiency gains if such an assumption holds.

By including the averages of the explained and explanatory variables as additional controls, the DFE, MG and PMG estimators are augmented with Common Correlated Effects (CCE), and they are expressed as FE-CCE, MG-CEE and PMG-CCE respectively. The different estimators are compared using Hausman test to choose the most efficient among consistent estimators in obtaining mean response coefficients.[11]

Followed by country-specific estimations, a general ARDL (2,1,2,1) specification is selected for the panel analysis to ensure no serial correlation for almost all countries. In particular, the model is comprised by two lags of unemployment rate and of averaged unemployment rate, and one lag of fiscal policy and of averaged fiscal policy, along with the contemporaneous fiscal policy variables. The choice of a common model for all countries is based on significance along with no serial correlation criteria. The second year lag of unemployment is important for no serial correlation to be satisfied for half of the countries. The second lag of the averaged unemployment, while usually insignificant, it is highly significant for Denmark, Ireland and the UK, so it is included in the panel specification. Since we are interested in the effects of fiscal measures and we are concerned about delayed responses of unemployment to fiscal policy, we include a lagged variable of fiscal austerity actions. The model is consistent with the dynamic CCE specification suggested by Pesaran and Chudik (2013) to include lagged along with the contemporaneous averages of the dependent and independent variables, and it is expressed as follow:

$$u_{it} = \alpha_i + \beta_{1i} u_{it-1} + \beta_{2i} u_{it-2} + \gamma_{0i} F_{it} + \gamma_{1i} F_{it-1} + \delta_{0i} \overline{u}_t + \delta_{1i} \overline{u}_{t-1} + \delta_{2i} \overline{u}_{t-2} + \zeta_{0i} \overline{F}_t + \zeta_{1i} \overline{F}_{t-1} + \epsilon_{it} \quad (1.2)$$

[11]The Hausman test (Hausman, 1978) is used to compare estimators when the focus is on providing an efficient estimate for the average response of the variable of interest.

In general, ARDL modelling is useful in examining any long-run relationships that our variables might exhibit, and it corresponds to an error correction model in a straightforward way. Even though ARDL models are widely used in macroeconomics, given that both long-run and short-run coefficients can be estimated, we can still explicitly test for the existence of a long-run relationship across the variables of our model. Such a long-run relation would be given as follow:

$$u_t = \theta_0 + \theta_1 F_t + \theta_2 \overline{u}_t + \theta_3 \overline{F}_t + v_t \tag{1.3}$$

At this point, it should be noted that the intention here is not to explicitly model equilibrium unemployment rate, but instead to explore how the long-run unemployment rate could be possibly affected by fiscal exogenous shocks, controlling also for the averages of unemployment rates and fiscal variables. A relationship between individual unemployment and averaged unemployment rates is suggested, implying the existence of common dynamics driving individual unemployment rates in European countries. With regard to how unemployment is related to fiscal policy shocks, increasing European unemployment rates since late 1970s may have been partially attributed to fiscal policies.[12]

The ARDL model is re-expressed as an ECM, such that both long-run and short-run coefficients can be estimated, and the rate of adjustment of unemployment rate when the figure is away from its steady state value can be obtained too.[13] We estimate the unrestricted ECM (UECM), since all the parameters including these of the error correction terms are allowed to be estimated. The ECM implied by the ARDL(2,1,2,1), the derivation of which is provided in Appendix, section 5.2, reads as follow:

$$\begin{aligned}\Delta u_{it} =& \beta_{i0} + \sum_{j=1}^{J} \beta_{ij} \Delta u_{it-j} + \sum_{q=0}^{Q} \gamma_{iq} \Delta F_{it-q} + \sum_{k=0}^{K} \delta_{ik} \Delta \overline{u}_{t-k} + \sum_{l=0}^{L} \zeta_{il} \Delta \overline{F}_{t-l} \\ &+ \theta_0 u_{it-1} + \theta_1 F_{it-1} + \theta_2 \overline{u}_{t-1} + \theta_3 \overline{F}_{t-1} + \epsilon_{it}.\end{aligned} \tag{1.4}$$

In essence, cyclical unemployment (u_t) and fiscal shocks (F) are stationary, so we can explore potential long-run and short-run effects in this specification. However, if we are further concerned about the stationarity of the series, we can formally test whether a long-run level relationship across the variables is suggested. We apply the method proposed by Pesaran, Shin and Smith (2001) based on a bound F-test and use the critical values reported by them.[14] An advantage of this test is that the order of integration of the variables does not have to be known ex-ante.

[12] See Fitoussi and Phelps (1986) for an analysis on the causes of European unemployment in the 1980s.

[13] In the specification of $u_t = \alpha + \beta_1 u_{t-1} + \beta_2 u_{it-2} + \gamma_0 F_t + \gamma_1 F_{t-1} + \delta_0 \overline{u}_t + \delta_1 \overline{u}_{t-1} + \delta_2 \overline{u}_{t-2} + \zeta_0 \overline{F}_t + \zeta_1 \overline{F}_{t-1} + \epsilon_t$, the implied rate of adjustment is given by $\lambda = 1 - \beta_1 - \beta_2$ and the long-run fiscal coefficient by $\theta = \frac{\gamma_0 + \gamma_1}{1 - \beta_1 - \beta_2}$. Coefficients of fiscal policy at time t are translated into short-run effects on unemployment rate at the same period t. Although estimates of lagged policy are direct effects on unemployment at time t, in order to measure the short run impact, one should consider both the direct and the indirect effects through lagged unemployment rate, i.e. $\frac{du_t}{dF_{t-1}} = \frac{\theta u_t}{\theta F_{t-1}} + \frac{\theta u_t}{\theta u_{t-1}} * \frac{\theta u_{t-1}}{\theta F_{t-1}}$.

[14] Once evidence for a long-run relationship is found, the critical values for the t-test of the lagged dependent variable are also checked to further support the presence of this long-run link (Table CI and CII, p.300-304).

Testing for long-run level relationship

At this stage, in order to formally test for the existence of long-run relationship between the variables, we implement the methodology of Pesaran, Shin and Smith (2001) based on estimation of an UECM separately for each country, which takes the following form:

$$\Delta u_t = \beta_{i0} + \beta_i \Delta u_{t-1} + \gamma_i \Delta F_t + \delta_i \Delta \overline{u}_t + \zeta_i \Delta \overline{F}_t + c_0 u_{t-1} + c_1 F_{t-1} + c_2 \overline{u}_{t-1} + c_3 \overline{F}_{t-1} + e_t \quad (1.5)$$

The null hypothesis of the F-test assumes that all coefficients of the error correction terms are zero ($H_0 = c_0 = c_1 = c_2 = c_3 = 0$). Rejection of the null hypothesis suggests a long-run relationship between the level variables, $u, F, \overline{u}, \overline{F}$. Interestingly, for more than half of the countries of our sample, a long-run relationship is proposed. Specifically, a long-run link is suggested at 10% for Belgium and moreover the t-statistic of the estimated coefficient of the lagged unemployment enhances this relationship at 10% significance level. The F-statistic for Denmark suggests a long-run relationship at 5% level of significance (but the t-statistic does not seem to further support this link). The null hypothesis is rejected at 5% for Finland (but the t-statistic is inconclusive). We find evidence for a long-run relation at 5% for France, however it is not implied by the t-statistic. An equilibrium link is also suggested at 5% for Ireland and the Netherlands (t-statistics are inconclusive). Finally, we reject the null hypothesis at 1% significance level and the evidence for a long-run relationship is also highly supported by the t-statistic for Portugal. In general, even if the t-tests are in some cases inconclusive, the values are not far from the intervals of accepting the presence of a long-run relationship.

Choice of the panel specification

In terms of the chosen panel model, we estimate the ECM of the ARDL panel specification, based on BIC, ensuring that no serial correlation is present. The ECM implied by the selected ARDL(2,1,2,1) model reads as follow:

$$\Delta u_t = \varphi(u_{t-1} - \theta_0 - \theta_1 F_{t-1} - \theta_2 \overline{u}_{t-1} - \theta_3 \overline{F}_{t-1}) - \beta_2 \Delta u_{t-1} + \gamma_0 \Delta F_t + \delta_0 \Delta \overline{u}_t - \delta_2 \Delta \overline{u}_{t-1} + \zeta_0 \Delta \overline{F}_t + e_t \quad (1.6)$$

where $\varphi = -(1 - \beta_1 - \beta_2), \theta_0 = \frac{\beta_0}{1-\beta_1-\beta_2}, \theta_1 = \frac{\gamma_0+\gamma_1}{1-\beta_1-\beta_2}, \theta_2 = \frac{\delta_0+\delta_1+\delta_2}{1-\beta_1-\beta_2}, \theta_3 = \frac{\zeta_0+\zeta_1}{1-\beta_1-\beta_2}$.

By estimating the ECM, both the short-run and the long-run coefficients can be recovered. The implied long-run equation is expressed as:

$$u_t = \theta_0 + \theta_1 F_t + \theta_2 \overline{u}_t + \theta_3 \overline{F}_t + v_t. \quad (1.7)$$

More specifically, we obtain estimates for the long-run coefficients, $\theta' s$, the rate of adjustment of unemployment rate, $(1 - \beta_1 - \beta_2)$, and the short-run coefficients, $\beta_2, \gamma_0, \delta_0, \delta_2, \zeta_0$. The model is non-linear in the long-run coefficients, which are estimated by Maximum Likelihood in an iterative way, and consequently the remaining coefficients are obtained by OLS, as explained in Pesaran, Shin and Smith (1999). More details on the estimation method are provided in the next section.

3 Estimation methods and results

3.1 Cyclical unemployment

Our panel ECM is estimated using CCE estimators, as proposed by Pesaran (2006). Based on this methodology, individual regressions are initially run and an average of the individual CCE estimators corresponds to the Common Correlated Effects Mean Group estimator, MG-CCE (Pesaran and Smith, 1995). Also, given the assumption imposed for long-run slope equality, a Common Correlated Effect Pooled estimator, PMG-CCE (Pesaran, Shin and Smith, 1999) is implemented. Chudik and Pesaran (2013) develop the dynamic version of the static CCE model, which is applied here given our model specification. Chudik and Pesaran (2013) suggest that MG-CCE estimators are consistent in dynamic models, given that appropriate lags of the cross sectional means are included, and the cross sectional averages are at least equal or more than the unobserved common elements.[15] Dynamic fixed effects (DFE-CCE) with robust standard errors is also implemented in estimating the effects of fiscal consolidation on unemployment rate. Apart from using the CCE specification, by including the averaged dependent and independent variables, we also employ the standard two-way fixed effects estimation. These methods are expected to be similar, as instead of controlling for the averaged variables in the fixed effects model, a time specific effect is considered by the inclusion of annual dummies.

The model, being non-linear in the long-run coefficients and rate of adjustment, is estimated by Maximum Likelihood (ML), as proposed by Pesaran, Shin and Smith (1999). In particular, the ML estimators are the PMG estimators, which are computed by the Newton-Raphson algorithm or by a back-substitution algorithm which makes use of the first derivatives of the ECM. The latter algorithm is implemented.[16] More specifically on the back-substitution procedure, it starts with initial estimates of θ, the long-run vector, and then estimates short-run coefficients and rate of adjustment. As a next step, it substitutes those estimates back to the long-run vector to take a new estimate for θ. The iterations of this procedure continue until convergence of θ is achieved. The asymptotic distribution of θ is also derived. Once the ML estimator of θ is obtained, short-run coefficients and rate of adjustment can be estimated by OLS. The results from panel estimations are shown in Tables 1.2, 1.3 and 1.4 for the models investigating the effects of different types of austerity, FC, G and T respectively. For the specifications exploring the effects of policy mainly driven by one component of the budget (G or T), a control variable is included to capture any simultaneous change in the other component. Columns 1 to 3 provide the MG, PMG and FE estimates respectively, and the last column reports the estimated coefficients obtained from the standard two-way fixed effects method.

In general, the estimated coefficients are robust across different methods, when they are found to be statistically significant. It is suggested that (cyclical) unemployment rate significantly increases in response to overall fiscal consolidation (FC), both in the short-run and in the long-run. For instance, by looking at the estimates of the PMG method, 1

[15] However, Chudik and Pesaran (2013) outline that including lagged dependent variable as a regressor sometimes generates concerns about the pooled estimator's consistency. Since in dynamic panels the issue of endogeneity can arise, diverse individual estimators imply consistency loss after pooling, as suggested by Pesaran and Smith (1995).

[16] The back-substitution algorithm is applied based on Stata routine.

Table 1.2: Cyclical unemployment and FC

Δu_t	***MG-CCE***	***PMG-CCE***	***FE-CCE***	***FE-2 WAY***
		Long Run		
FC_{t-1}	0.204	0.237**	0.214+	0.214+
	(0.162)	(0.078)	(0.116)	(0.12)
$\overline{u}_{t-1}$	1.203**	1.089**	1.000**	
	(0.204)	(0.095)	(0.113)	
$\overline{FC}_{t-1}$	-0.676+	-0.555*	-0.214	
	(0.386)	(0.23)	(0.263)	
		Short Run		
RoA	-0.442**	-0.388**	-0.443**	-0.443**
	(0.049)	(0.042)	(0.03)	(0.032)
Δu_{t-1}	0.442**	0.453**	0.603**	0.603**
	(0.048)	(0.043)	(0.034)	(0.036)
ΔFC_t	0.113*	0.107**	0.718	0.072
	(0.048)	(0.048)	(0.051)	(0.053)
$\overline{\Delta} u_t$	1.069**	1.031**	1.000**	
	(0.187)	(0.143)	(0.166)	
Δu_{t-1}	-0.489**	-0.459**	-0.603**	
	(0.142)	(0.09)	(0.141)	
ΔFC_t	-0.244	-0.201	-0.072	
	(0.181)	(0.15)	(0.199)	
constant	0.0183	0.0255	0	0.257
	(0.039)	(0.023)	(0.063)	(0.189)
N	360	360	360	360

Note: +, *, ** stand for significant estimates at 10%, 5% and 1% level of significance respectively. LR and SR correspond to long-run and short-run estimated coefficients respectively. Asymptotic standard errors are in parentheses. Fixed effects estimations are employed using robust standard errors allowing for no constant variance and non-independence across countries. Standard two-way fixed effects method includes country and time specific effects (i.e. time dummies instead of CCE variables).

Table 1.3: Cyclical unemployment and G

Δu_t	***MG-CCE***	***PMG-CCE***	***FE-CCE***	***FE-2 WAY***
		Long Run		
G_{t-1}	-0.132	0.223	0.233	0.233
	(0.360)	(0.147)	(0.147)	(0.152)
CT_{t-1}	0.801	0.299	-0.086	-0.085
	(0.909)	(0.280)	(0.320)	(0.331)
$\overline{u}_{t-1}$	1.235**	1.042**	1.000**	
	(0.177)	(0.097)	(0.132)	
$\overline{G}_{t-1}$	-0.308	-0.53	-0.233	
	(1.136)	(0.384)	(0.565)	
$\overline{CT}_{t-1}$	-1.521	0.217	0.086	
	(3.207)	(0.867)	(1.223)	
		Short Run		
RoA	-0.487**	-0.372**	-0.442**	-0.442**
	(0.060)	(0.043)	(0.029)	(0.03)
Δu_{t-1}	0.459**	0.463**	0.593**	0.593**
	(0.052)	(0.052)	(0.032)	(0.033)
ΔG_t	0.192+	0.248**	0.192*	0.192*
	(0.107)	(0.061)	(0.084)	(0.087)
ΔCT_t	-0.277	-0.337*	-0.236*	-0.236*
	(0.177)	(0.135)	(0.113)	(0.117)
$\overline{\Delta u}_t$	1.047**	0.980**	1.000**	
	(0.160)	(0.118)	(0.150)	
$\overline{\Delta u}_{t-1}$	-0.481**	-0.452**	-0.593**	
	(0.165)	(0.117)	(0.140)	
$\overline{\Delta G}_t$	-0.438	-0.168	-0.192	
	(0.342)	(0.300)	(0.318)	
$\overline{\Delta CT}_t$	0.375	0.0655	0.236	
	(0.699)	(0.561)	(0.639)	
constant	0.047	0.020	0	0.264
	(0.052)	(0.024)	(0.05)	(0.184)
N	360	360	360	360

Note: +, *, ** stand for significant estimates at 10%, 5% and 1% level of significance respectively. LR and SR correspond to long-run and short-run estimated coefficients respectively. Asymptotic standard errors are in parentheses. Fixed effects estimations are employed using robust standard errors allowing for no constant variance and non-independence across countries. Standard two-way fixed effects method includes country and time specific effects (i.e. time dummies instead of CCE variables). To estimate the effects of G based austerity, potential simultaneous tax action is controlled for. CT stands for this tax control variable.

Table 1.4: Cyclical unemployment and T

Δu_t	***MG-CCE***	***PMG-CCE***	***FE-CCE***	***FE-2 WAY***
		Long Run		
T_{t-1}	0.679	0.239	0.139	0.139
	(0.673)	(0.181)	(0.260)	(0.269)
CG_{t-1}	-0.821	-0.006	0.097	0.097
	(0.910)	(0.280)	(0.330)	(0.341)
$\overline{u}_{t-1}$	1.24**	1.043**	1.000**	
	(0.176)	(0.096)	(0.132)	
$\overline{T}_{t-1}$	-1.812	-0.3	-0.139	
	(2.278)	(0.624)	(0.800)	
$\overline{CG}_{t-1}$	1.477	-0.241	-0.098	
	(3.275)	(0.889)	(1.274)	
		Short Run		
RoA	-0.489**	-0.373**	-0.442**	-0.442**
	(0.060)	(0.043)	(0.028)	(0.029)
Δu_{t-1}	0.456**	0.462**	0.593**	0.593**
	(0.051)	(0.05)	(0.032)	(0.033)
ΔT_t	-0.086	-0.096	-0.047	-0.047
	(0.141)	(0.109)	(0.068)	(0.071)
ΔCG_t	0.279	0.35**	0.241*	0.241*
	(0.178)	(0.132)	(0.115)	(0.119)
$\overline{\Delta u}_t$	1.049**	0.983**	1.000**	
	(0.162)	(0.120)	(0.152)	
$\overline{\Delta u}_{t-1}$	-0.480**	-0.451**	-0.593**	
	(0.164)	(0.116)	(0.141)	
$\overline{\Delta T}_t$	-0.044	-0.095	0.047	
	(0.415)	(0.311)	(0.413)	
$\overline{\Delta CG}_t$	-0.406	-0.084	-0.241	
	(0.702)	(0.55)	(0.635)	
constant	0.047	0.02	0	0.265
	(0.050)	(0.024)	(0.05)	(0.184)
N	360	360	360	360

Note: +, *, ** stand for significant estimates at 10%, 5% and 1% level of significance respectively. LR and SR correspond to long-run and short-run estimated coefficients respectively. Asymptotic standard errors are in parentheses. Fixed effects estimations are employed using robust standard errors allowing for no constant variance and non-independence across countries. Standard two-way fixed effects method includes country and time specific effects (i.e. time dummies instead of CCE variables). To estimate the effects of T based austerity, potential simultaneous spending action is controlled for. CG stands for this (government spending) control variable.

percentage point of *GDP FC* causes an increase of almost 2.4/10 and 1/10 of a percentage point of cyclical unemployment rate in the long-run and short-run respectively. The effect of spending based austerity on cyclical unemployment is found to be significant in the short-run. More specifically, 1 percentage point of *GDP G* based austerity tends to increase unemployment by 2/10 or 2.5/10 (in the case of the PMG estimator) of a percentage point of unemployment. Although tax based consolidation is associated with signs of increased unemployment in the long-run, the effect does not appear to be significant in affecting the cyclical series.

A significant relationship is suggested between cyclical unemployment rate and its corresponding averaged variable, providing additional support for capturing common correlated effects in the analysis. Also, the averaged fiscal consolidation is found to be significant at 10% significance level, implying the existence of fiscal spill-over effects across countries. In particular, it is suggested that averaged fiscal consolidation tends to have positive externalities for employment outcomes of the representative economy.

The significance of the coefficients of the control fiscal variables, when the specification focuses on one component of the budget, outlines the importance of controlling for the simultaneous potential changes that occur in the other side of the government budget.

As a next step, Hausman test is employed for the selection of an efficient estimator across consistent estimators. The PMG-CCE estimator is preferred to the MG-CCE one, and the FE-CCE estimator is preferred to the PMG-CCE one. At this point we refer to the concern of dynamic fixed effects being associated with the Nickell endogeneity bias (Nickell, 1981). Following Baltagi, Griffin and Xiong (2000), the dynamic fixed effects estimation falls into issues of endogeneity observed across the residuals and the lagged explained variable. This impediment may be treated by including additional lags but a formal Hausman test can show whether the presence of potential bias is problematic. Despite the fact that we have already included two lags of unemployment rate to deal with serial correlation, we formally conduct a Hausman test to check whether there is a significant bias. Since the fixed effect estimator is preferred to the other estimators in estimating the average coefficients, the endogeneity issue may not appear to be of high concern.

The results based on DFE-CCE estimation of the ECM suggest that cyclical unemployment rate significantly increases by 0.214 percentage points in the long-run, as a response to one percentage point of *GDP* fiscal consolidation. The short-run coefficient of *G* consolidation is significantly estimated at 0.192 percentage points. The two-way fixed effects method provides very similar estimates.

In comparison of different estimation methods, MG-CCE and PMG-CEE estimators allow for the estimation of a potentially heterogeneous panel. Countries are allowed to respond differently to fiscal policy shocks, and to the common correlated factors as well. The methods of DFE-CCE and standard two-way fixed effects assume that fiscal implications, as well as responses to common correlated effects or time effects are homogeneous across countries.

3.2 Total unemployment

As a next step, we explore the responses of total unemployment rate to fiscal austerity measures. Testing for stationarity of individual total unemployment rates, a unit root could not be rejected for some countries. However, the inclusion of lags of unemployment rate as controls led to the sum of their estimated parameters being less than unity, so unemployment rate did not appear to be explosive in any case. The individual estimates suggested similar significance levels as in the specifications of cyclical unemployment but the effects were larger for some countries, implying that fiscal action may affect the NAWRU. Long run effects appeared to be high for some countries, for which the sum of the estimated lagged unemployment coefficients was close to unity with the rate of adjustment being slow. Thus, we are cautious regarding the use of total unemployment rate since some individual rates are close to unit root and structural breaks are not eliminated. However, the inclusion of averaged total unemployment rate in the specifications can contain concerns of non-stationarity.

The Pesaran test for cross-sectional dependence was implemented for the models of total unemployment, the results of which are provided in Table 1.5. The presence of cross-sectional correlation across countries could not be rejected, hence the averaged values of the dependent and independent variables were included in the specifications, as explained for the models for cyclical unemployment.

Table 1.5: Total unemployment and F

Residuals	*CD-test*	$p-value$	*corr*	*abs corr*
FC	6.42	0.000	0.142	0.236
T	2.15	0.032	0.047	0.160
G	4.15	0.000	0.090	0.204

Note: CSD Pesaran test, under the null hypothesis of no cross-sectional correlation, $CD \sim N(0,1)$.

Tables 1.6, 1.7 and 1.8 report the estimated parameters of the models for total unemployment rate. The effects of overall fiscal consolidation on total unemployment rate are found to be statistically significant both in the long-run and short-run, and of larger magnitude as compared to the impact on cyclical unemployment. Comparing the PMG-CCE and the DFE-CCE methods, the estimated short-run effects are very similar, in particular the values of 0.14 and 0.12 percentage points increase of unemployment rate in response to 1 % of $GDP\ FC$ are estimated respectively. Total unemployment rate appears to significantly increase by 1.3 and 0.5 percentage points in response to 1 percentage point of $GDP\ FC$ in the long-run, according to DFE-CCE and PMG-CCE estimators respectively. Spending based adjustment is found to be significant in increasing total unemployment in the short-run. DFE-CCE and two-way FE estimates are of 0.173 percentage point change in unemployment rate, while the MG estimator is of 0.62 percentage point increase in unemployment rate, after a 1 percentage point change in spending oriented austerity. Interestingly, in contrast to the effects of tax driven action not being found to be significant in affecting cyclical unemployment, tax based austerity is suggested to significantly increase total unemployment rate in the long-run, by approximately 2.7 (in the case PMG estimates) and 3.2 (in the case of DFE-CCE and two-way FE estimates) percentage points.

Table 1.6: Total unemployment and FC

Δu_t	***MG-CCE***	***PMG-CCE***	***FE-CCE***	***FE-2 WAY***
		Long Run		
FC_{t-1}	15.36	0.489^{+}	1.267^{*}	1.267^{*}
	(12.32)	(0.261)	(0.591)	(0.614)
$\overline{u}_{t-1}$	-1.972	1.543^{**}	1.000^{**}	
	(4.551)	(0.32)	(0.254)	
$\overline{FC}_{t-1}$	1.586	-2.384^{*}	-1.267	
	(8.678)	(1.162)	(1.360)	
		Short Run		
RoA	-0.139^{**}	-0.118^{**}	-0.131^{**}	-0.131^{**}
	(0.035)	(0.016)	(0.024)	(0.025)
Δu_{t-1}	0.399^{**}	0.464^{**}	0.584^{**}	0.584^{**}
	(0.061)	(0.054)	(0.049)	(0.051)
ΔFC_t	0.262^{**}	0.140^{*}	0.115^{+}	0.115
	(0.082)	(0.062)	(0.069)	(0.07)
$\overline{\Delta u}_t$	1.028^{**}	1.039^{**}	1.000^{**}	
	(0.171)	(0.151)	(0.155)	
$\overline{\Delta u}_{t-1}$	-0.431^{**}	-0.507^{**}	-0.584^{**}	
	(0.142)	(0.118)	(0.173)	
$\overline{\Delta FC}_t$	-0.293	-0.218	-0.115	
	(0.243)	(0.231)	(0.240)	
$constant$	-0.277	-0.413^{+}	0	0.969^{**}
	(0.488)	(0.130)	(0.224)	(0.173)
$\boldsymbol{N}$	360	360	360	360

Note: +, *, ** stand for significant estimates at 10%, 5% and 1% level of significance respectively. LR and SR correspond to long-run and short-run estimated coefficients respectively. Asymptotic errors are in parentheses. Fixed effects estimations are employed using robust standard errors allowing for no constant variance and non-independence across countries. Standard two-way fixed effects method includes country and time specific effects (i.e. time dummies instead of CCE variables).

Table 1.7: Total unemployment and G

Δu_t	***MG-CCE***	***PMG-CCE***	***FE-CCE***	***FE-2 WAY***
		Long Run		
G_{t-1}	9.307	0.365	0.185	0.185
	(6.713)	(0.959)	(0.368)	(0.381)
CT_{t-1}	-14.41^{+}	6.232**	2.983^{+}	2.983^{+}
	(8.696)	(2.347)	(1.731)	(1.791)
$\overline{u}_{t-1}$	-3.517	1.458*	1.000	
	(4.458)	(0.592)	(0.634)	
$\overline{G}_{t-1}$	-3.363	-2.9	-0.185	
	(26.7)	(4.488)	(5.712)	
$\overline{CT}_{t-1}$	39.358	-0.466	-2.983	
	(52.27)	(7.793)	(10.74)	
		Short Run		
RoA	-0.142**	-0.085**	-0.123**	-0.123**
	(0.034)	(0.018)	(0.023)	(0.024)
Δu_{t-1}	0.399**	0.476**	0.576**	0.576**
	(0.077)	(0.057)	(0.052)	(0.053)
ΔG_t	0.620**	0.151	0.173^{+}	0.173^{+}
	(0.199)	(0.130)	(0.088)	(0.091)
ΔCT_t	-0.768*	0.007	-0.069	-0.069
	(0.313)	(0.260)	(0.132)	(0.136)
$\overline{\Delta u}_t$	1.009**	0.998**	1.000**	
	(0.137)	(0.121)	(0.134)	
$\overline{\Delta u}_{t-1}$	-0.355*	-0.51**	-0.576**	
	(0.173)	(0.149)	(0.168)	
$\overline{\Delta G}_t$	-0.818	-0.361	-0.173	
	(0.618)	(0.456)	(0.518)	
$\overline{\Delta CT}_t$	0.721	0.299	0.069	
	(1.258)	(0.766)	(1.021)	
constant	-0.566	-0.262*	0	0.924**
	(0.591)	(0.127)	(0.528)	(0.171)
N	360	360	360	360

Note: +, *, ** stand for significant estimates at 10%, 5% and 1% level of significance respectively. LR and SR correspond to long-run and short-run estimated coefficients respectively. Asymptotic errors are in parentheses. Fixed effects estimations are employed using robust standard errors allowing for no constant variance and non-independence across countries. Standard two-way fixed effects method includes country and time specific effects (i.e. time dummies instead of CCE variables). To estimate the effects of G based austerity, potential simultaneous tax action is controlled for. CT stands for this (tax) control variable.

Table 1.8: Total unemployment and T

Δu_t	***MG-CCE***	***PMG-CCE***	***FE-CCE***	***FE-2 WAY***
		Long Run		
T_{t-1}	-7.053	2.683**	3.157+	3.158+
	(10.28)	(0.944)	(1.646)	(1.703)
CG_{t-1}	16.66	-5.042**	-2.968+	-2.969
	(10.22)	(1.659)	(1.774)	(1.835)
$\overline{u}_{t-1}$	-3.86	2.519**	1.000	
	(4.898)	(0.479)	(0.642)	
$\overline{T}_{t-1}$	36.00	-12.11**	-3.157	
	(4.898)	(3.962)	(5.671)	
$\overline{CG}_{t-1}$	-36.89	18.79*	2.968	
	(57.24)	(7.547)	(11.17)	
		Short Run		
RoA	-0.142**	-0.071*	-0.123**	-0.123**
	(0.035)	(0.03)	(0.023)	(0.024)
Δu_{t-1}	0.395**	0.446**	0.576**	0.576**
	(0.077)	(0.06)	(0.052)	(0.054)
ΔT_t	-0.146	-0.058	0.101	0.101
	(0.267)	(0.155)	(0.107)	(0.111)
ΔCG_t	0.763*	0.176	0.074	0.074
	(0.308)	(0.245)	(0.134)	(0.138)
$\overline{\Delta u}_t$	1.012**	1.044**	1.000**	
	(0.139)	(0.141)	(0.135)	
$\overline{\Delta u}_{t-1}$	-0.352*	-0.582**	-0.576**	
	(0.173)	(0.163)	(1.169)	
$\overline{\Delta T}_t$	-0.073	-0.131	-0.101	
	(0.705)	(0.5)	(0.584)	
$\overline{\Delta CG}_t$	-0.761	0.144	-0.074	
	(1.258)	(0.851)	(1.013)	
constant	-0.576	-0.627**	0	0.924**
	(0.590)	(0.173)	(0.535)	(0.171)
N	360	360	360	360

Note: +, *, ** stand for significant estimates at 10%, 5% and 1% level of significance respectively. LR and SR correspond to long-run and short-run estimated coefficients respectively. Asymptotic errors are in parentheses. Fixed effects estimations are employed using robust standard errors allowing for no constant variance and non-independence across countries. Standard two-way fixed effects method includes country and time specific effects (i.e. time dummies instead of CCE variables). To estimate the effects of T based austerity, potential simultaneous spending action is controlled for. CG stands for this (government spending) control variable.

3.3 Other labour market variables

This section provides an analysis of fiscal austerity implications on a number of labour market variables, besides unemployment rates. From the perspective of extensive and intensive margin, we examine the responses of participation rate and hours worked respectively, but also these of real wage to fiscal consolidation measures. Based on BIC, an augmented AR(1) model with exogenous fiscal consolidation is chosen for participation rate and hours worked, and an ARDL(2,1,2,1) specification is selected for the real wage. To capture cross-sectional correlation, the averages of dependent and independent variables are included in the specifications, as previously implemented in the case of unemployment. Augmented AR models with exogenous fiscal policy, estimated using fixed effects, are selected for the study of these labour market variables; for parsimony reasons given that these series are not available for long enough periods for some countries of our panel, especially for participation rates and hours worked. In these cases, pooled estimation may be appropriate to achieve efficiency gains. Moreover, as these variables do not exhibit the same degree of heterogeneity as in the case of unemployment rates across the countries of our panel, the analysis is not headed to heterogeneous panel estimations. Heterogeneity is allowed only through individual fixed effects.

Focusing on the estimation of fiscal austerity effects on participation rate, preliminary country-specific analysis generally suggested that participation rate appeared to fall due to overall and spending based consolidation in most of our countries, while the response was less clear following tax based consolidation, with an increasing rate in half and a falling rate in the other half of the countries. As a response to one percentage point of $GDP\ FC$, participation rates significantly fell in Ireland, Italy, Finland and Sweden by almost 0.31, 0.17, 0.31 and 0.32 percentage points respectively. For tax based consolidation, we significantly estimated negative coefficients for Ireland and Italy, of -0.588 and -0.244 respectively, but participation rate in the Netherlands significantly increased to tax hikes with an estimate of 1.815 percentage points. When models were estimated using spending based austerity, significantly negative and of high magnitude coefficients were obtained for Ireland, Italy, the Netherlands, Finland and Sweden, at the values of -0.484, -0.314,-0.792,-0.352 and -0.551 percentage points respectively. Estimates for lagged participation rate were highly positive and significant for all countries. Moreover, for Ireland, Spain, Sweden, Finland, the UK and Belgium estimates for simultaneous averaged participation rate were significant and positive; and for the lagged averaged participation rate, estimates were negative and significant (apart from Belgium and Spain). The common factor here, expressed as averaged participation rate, was less strong as compared to the averaged unemployment in the unemployment focused estimations; an outcome that seems sensible since participation rate of each country may be notably subject to individual characteristics.

For the panel analysis, we choose a general model potentially applicable for the group of countries. The specification is selected after checking for lags of participation rate, fiscal policy and averaged participation rate in terms of significance and not serial correlation. A fiscal policy lag is not included as suggested to be insignificant for all countries apart from Italy. A second lag of participation rate was also insignificant apart from the UK and Sweden. While the inclusion of lagged averaged participation rate did not seem to be important in terms of significance and not serial correlation for many countries, we control for it since it is crucial for Finland, Sweden, Ireland and the UK in dealing with serial correlation. This formulation is consistent with the CCE specification. The selected model reads as follow:

$$pr_{it} = \alpha + \beta pr_{it-1} + \gamma F_{it} + \zeta \overline{F}_{it} + \delta_0 \overline{pr}_t + \delta_1 \overline{pr}_{t-1} + e_{it}, \tag{1.8}$$

where $\overline{F}$ and $\overline{pr}$ stand for averaged fiscal consolidation and participation rate respectively. The two-way fixed effects model (where d_t represents time dummies) is expressed as follow:

$$pr_{it} = \alpha + \beta pr_{it-1} + \gamma F_{it} + \delta d_t + e_{it}. \tag{1.9}$$

The results from both specifications are quite similar, as presented in Table 1.9. Participation rate is found to significantly fall in response to spending based consolidation. More specifically, 1% of GDP spending oriented adjustment appears to negatively affect participation rate by almost 0.3 percentage points.

Table 1.9: Participation rate

pr_t	FE-CEE	FE-2 way	FE-CCE	FE-2 way	FE-CCE	FE-2 way
	FC		G		T	
pr_{t-1}	0.98**	0.984**	0.975**	0.979*	0.975**	0.979*
	(0.022)	(0.022)	(0.023)	(0.022)	(0.023)	(0.022)
F_t	-0.08	-0.079	-0.273*	-0.263*	0.226	0.210
	(0.05)	(0.053)	(0.126)	(0.129)	(0.218)	(0.216)
CT_t			0.498	0.473		
			(0.327)	(0.326)		
CG_t					-0.5	-0.473
					(0.327)	(0.326)
$\overline{pr}_t$	0.485**		0.489**		0.489**	
	(0.131)		(0.128)		(0.000)	
$\overline{pr}_{t-1}$	-0.466**		-0.471**		-0.471**	
	(0.123)		(0.119)		(0.119)	
$\overline{F}_t$	-0.205		-0.176		-0.202	
	(0.134)		(0.33)		(0.488)	
$\overline{CT}_t$			-0.01			
			(0.758)			
$\overline{CG}_t$					0.033	
					(0.775)	
constant	0.366	1.014	0.665	1.301	0.654	1.301
	(1.375)	(1.628)	(1.431)	(1.653)	(1.433)	(1.653)
N	330	330	330	330	330	330

Note: F stands for FC, G and T in either specification. +, *, ** stand for significant estimates at 10%, 5% and 1% level of significance respectively. Robust standard errors are in parentheses. Standard two-way fixed effects method includes country and time specific effects (i.e. time dummies instead of CCE variables). To estimate the effects of G or T based austerity, potential simultaneous tax or spending action in either case is controlled for. CT and CG stand for these control tax and control spending variables respectively.

Considering the effects of austerity measures on real wage, country-specific estimations suggested that lagged fiscal policy significantly affected real wage in some countries of our group although in different directions. More specifically, the real wage of Ireland decreased after two years by 0.013 and 0.033 in response to FC and G respectively, meaning that the direct effect of one percentage point of FC on annual real wage was a decrease by 1.3 and 3.3 percent. In Austria, the direct effect of FC and T on real wage after one year was a fall 0.4 and 1 percent respectively. In the UK, real wage responded on impact to T by falling by 2.5 percent, while increased to G after a year with a direct effect of 8 percent. As a response to FC, real wage appeared to significantly fall by 0.7 percent on impact and with a two year lagged effect in the Netherlands, while it seemed to increase on impact by 1.3 percent in Portugal. Looking at the direct effects of lagged fiscal policy, real wage fell by 0.7 percent responding to T in Spain, while it increased by 0.7 percent after two years as a response to G in Italy. The first lag of logged real wage was significant for all countries while significance of the second lag was obtained for nine out of twelve countries. Averaged across countries logged real wage was also significant for the majority of countries and the lagged logged averaged real wage for approximately half of them.

In an effort to fit one model for all countries, the lagged fiscal variable is included in the specification. A second lag of real wage is significant for most of the countries, and a second lag of averaged real wage is significant for four countries so it is included to be consistent with the CCE formation. Part of the common factors proxied by the averaged real wage can have an important role in driving individual country wages due to labour mobility as an example. We also include a second lag of fiscal policy since it is significant for Ireland, the Netherlands and Spain. Finally, one lag of averaged real wage appears to be important for half of the countries.

Hence, a model of two lags of real wage, two lags of fiscal policy and one lag of averaged real wage, ARDL(2,1,2,1) is selected. The model's choice seems to apply reasonably well for the set of countries, maintaining the balance between not serial correlation, small root mean square error (RMSE) and significance of lagged variables.

$$w_{it} = \alpha + \beta_1 w_{it-1} + \beta_2 w_{it-2} + \gamma_0 F_{it} + \gamma_1 F_{it-1} + \zeta_0 \overline{F}_t + \zeta \overline{F}_{t-1} + \delta_0 \overline{w}_t + \delta_1 \overline{w}_{t-1} + \delta_2 \overline{w}_{t-2} + e_{it}, \tag{1.10}$$

where w is the logarithm of real wage, $\overline{F}$ and $\overline{w}$ express averages of the fiscal measure and real wage respectively.

And the two-way fixed effects model reads as follow:

$$w_{it} = \alpha + \beta_1 w_{it-1} + \beta_2 w_{it-2} + \gamma_0 F_{it} + +\gamma_1 F_{it-1} + \delta d_t + e_{it}. \tag{1.11}$$

The ECM implied by the ARDL(2,1,2,1) model for real wage is the following:

$$\begin{aligned}\Delta w_t = {} & \varphi(w_{t-1} - \theta_0 - \theta_1 F_{t-1} - \theta_2 \overline{w}_{t-1} - \theta_3 \overline{F}_{t-1}) - \beta_2 \Delta w_{t-1} + \gamma_0 \Delta F_t + \delta_0 \Delta \overline{w}_t - \delta_2 \Delta \overline{w}_{t-1} \\ & + \zeta_0 \Delta \overline{F}_t + e_t\end{aligned} \tag{1.12}$$

The responses of real wage to the three different types of austerity are presented in Table 1.10. Looking at FE-CCE results, real wage seems to decline in the long-run following tax oriented consolidation, i.e. 1% of GDP tax based austerity decreases real wage by almost 12%, although the effect does not appear to be significant.

We finally estimate the responses of hours worked to different measures of austerity. The results of this panel analysis are presented in Table 1.11. Preliminary country-specific estimates of the overall consolidation effect on hours worked were significant and positive for Finland and Sweden (4.9 and 9.3 respectively), while significantly negative for the UK (-16.3), i.e. that one percentage of *GDP FC* causes a decrease in average annual hours worked per worker in the UK by almost 16. Coefficients for tax based austerity were significant and negative for Spain (-7.9), the Netherlands (-6.32) and the UK (-21.8). Hours worked in Sweden responded significantly and positively to one percent of *GDP T* with a value of almost 22. In response to G, significant and positive estimates were found for Finland and Sweden, being 4.7 and 15 respectively. High and significant estimates for lagged hours worked were generally suggested; apart from Austria, Portugal and the UK, for which the estimates were lower but still significant, implying less persistent hours worked. The common factor captured by averaged hours worked was found to be significant and positive for half of the countries. One expects that such a common effect driving individual hours would be less strong comparing to common elements driving individual unemployment rates. Overall, hours worked did not appear to respond as much as unemployment rates to fiscal measures. Based on BIC, the selected model for hours worked is expressed in the following way:

$$hrs_{it} = \alpha + \beta hrs_{it-1} + \gamma F_{it} + \zeta \overline{F}_{it} + \delta_0 \overline{hrs}_t + \delta_1 \overline{hrs}_{t-1} + e_{it}, \tag{1.13}$$

where $\overline{F}$ and $\overline{hrs}$ stand for the averaged fiscal consolidation and hours worked respectively. The two-way fixed effects model is:

$$hrs_{it} = \alpha + \beta hrs_{it-1} + \gamma F_{it} + \delta d_t + e_{it}. \tag{1.14}$$

The chosen specification is simple to retain parsimony and efficiency, given the short time series for some countries. However, we might face some bias concerns for countries with more observations for which a model with additional lags would be more appropriate in some cases.[17] Also, one can think that common factors proxied by averaged across countries hours worked, may be less important comparing to averaged unemployment in affecting individual unemployment rates. It is plausible that common elements can drive

[17]For Ireland, the model with the minimum RMSE would suggest the inclusion of one lag of averaged hours. For Italy, there is no serial correlation in the simple model, but by including one lag of fiscal policy, the RMSE was smaller and the lagged variable was significant for FC and T. For the Netherlands, the benchmark model did not suggest serial correlation but a model with a lag of FC, G and a lag of hours had the minimum RMSE (with the lag of G being significant). For the T specification though, the benchmark model seemed to be appropriate. The simple model for Portugal implied no serial correlation at 1% and the inclusion of a lagged averaged hours was significant, suggesting smaller RMSE. For Sweden, the benchmark model did not imply autocorrelation, but first lags of fiscal policy and averaged hours were significant and their inclusion provided smaller RMSE (with no autocorrelation at 1%). For the UK, the simple model exhibited no serial correlation (apart from the third lag in the residuals) but the inclusion of two lags of fiscal policy made the second lag significant giving lower RMSE, but did not satisfy no serial correlation in the third lag. For the rest of the countries, the benchmark model seemed to be appropriate in the sense of minimum RMSE and no serial correlation.

Table 1.10: Real wage

Δw_t	FE-CEE	FE-2 way	FE-CCE	FE-2 way	FE-CCE	FE-2 way
	FC		G		T	
			Long Run			
F_{t-1}	-5.875	-5.878	-3.113	10.19	-11.98	2.517
	(4.312)	(4.473)	(5.116)	(8.653)	(9.331)	(3.848)
CT_{t-1}			-8.489	-7.63		
			(10.76)	(8.026)		
CG_{t-1}					9.02	7.706
					(11.00)	(7.982)
$\overline{w}_{t-1}$	1.000^{+}		1.000		1.000	
	(0.6)		(0.6)		(0.710)	
$\overline{F}_{t-1}$	5.878		3.113		11.98	
	(8.589)		(39.05)		(48.14)	
$\overline{CT}_{t-1}$			8.489			
			(84.03)			
$\overline{CG}_{t-1}$					-9.02	
					(87.86)	
			Short Run			
RoA	-0.024^{**}	-0.0236^{**}	-0.0236^{**}	-0.0238^{**}	-0.0236^{**}	-0.0238^{**}
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Δw_{t-1}	0.451^{**}	0.451^{**}	0.451^{**}	0.451^{**}	0.451^{**}	0.451^{**}
	(0.015)	(0.015)	(0.016)	(0.019)	(0.016)	(0.019)
ΔF_t	0.083	0.083	0.224	0.243	-0.08	0.059
	(0.098)	(0.102)	(0.218)	(0.214)	(0.079)	(0.092)
ΔCT_t			-0.298	-0.182		
			(0.277)	(0.198)		
ΔCG_t					0.308	0.183
					(0.280)	(0.197)
$\overline{\Delta w}_t$	1.000^{+}		1.000^{+}		1.000^{+}	
	(0.592)		(0.6)		(0.601)	
$\overline{\Delta w}_{t-1}$	-0.451^{+}		-0.451^{*}		-0.451^{*}	
	(0.234)		(0.219)		(0.04)	
$\overline{\Delta F}_t$	-0.083		-0.224		0.08	
	(0.102)		(0.393)		(0.483)	
$\overline{\Delta CT}_t$			0.298			
			(0.733)			
$\overline{\Delta CG}_t$					-0.308	
					(0.795)	
constant	0	1.993^{**}	0	1.984^{**}	0	2.912^{**}
	(1.743)	(0.540)	(2.129)	(0.543)	(2.140)	(0.195)
N	360	360	360	360	360	360

Note: +, *, ** stand for significant estimates at 10%, 5% and 1% level of significance respectively. LR and SR correspond to long-run and short-run estimated coefficients respectively. Robust standard errors are in parentheses. Standard two-way fixed effects method includes country and time specific effects (i.e. time dummies instead of CCE variables). To estimate the effects of T/G based austerity, potential simultaneous spending/tax action is controlled for. CG and CT stand for these control variables respectively.

individual unemployment rates but individual hours worked may depend much more on idiosyncratic features. However, we follow similar model specification as in the previous labour market variables for consistent and comparable results, and also because our focus is on implications of fiscal policy on hours worked and not on the explicit specification of common factors.

Table 1.11: Hours worked

hrs_t	FE-CEE	FE-2 way	FE-CCE	FE-2 way	FE-CCE	FE-2 way
	FC		G		T	
hrs_{t-1}	0.932**	0.943**	0.936**	0.943**	0.936**	0.943**
	(0.020)	(0.021)	(0.02)	(.021)	(0.02)	(0.021)
F_t	-0.288	-0.417	0.761	0.784	-2.25	-2.318
	(1.605)	(1.487)	(1.679)	(1.653)	(2.95)	(2.968)
CT_t			-3.017	-3.116		
			(3.442)	(3.527)		
CG_t					3.019	3.093
					(3.445)	(3.523)
$\overline{hrs}_t$	0.561**		0.494**		0.492**	
	(0.126)		(0.123)		(0.123)	
$\overline{hrs}_{t-1}$	-0.501**		-0.455**		-0.452**	
	(0.13)		(0.127)		(0.127)	
$\overline{F}_t$	0.289		12.97*		-21.31*	
	(3.48)		(6.28)		(8.643)	
$\overline{CT}_t$			-34.05^{8*}			
			(12.830)			
$\overline{CG}_t$					34.29*	
					(13.19)	
constant	8.695	74.25*	35.827	74.949*	35.766	74.943*
	(40.26)	(35.91)	(0.384)	(35.77)	(41.19)	(35.778)
N	338	338	338	338	338	338

Note: F stands for FC, G and T in either specification. +, *, ** stand for significant estimates at 10%, 5% and 1% level of significance respectively. Robust standard errors are in parentheses. Standard two-way fixed effects method includes country and time specific effects (i.e. time dummies instead of CCE variables). To estimate the effects of G or T based austerity, potential simultaneous tax or spending action in either case is controlled for. CT and CG stand for these control tax and control spending variables respectively.

Although the results suggest that hours worked appear to decrease as a response to overall and tax fiscal adjustment, the effects are very small and not significant. In the following subsection, we provide a short discussion on individual estimates for unemployment, participation rate, real wage and hours worked for the twelve countries of our panel. This briefly outlines the findings of the country-specific analysis, and the way labour market variables may have been interacted with each other during the implementation of austerity policies.

3.4 Summary of country-specific estimates

For some countries, significant responses of unemployment and other labour market variables were simultaneously estimated. More specifically in Ireland, FC and G were found to increase unemployment on impact and decrease participation rate, as potential workers were potentially more reluctant to participate in the labour force given high unemployment rate. Real wage appeared to fall after two years. Hence, given the upward change in unemployment, wages might have adjusted downwards (which is consistent with the model of Layard, Nickell and Jackman 1991, as previously outlined, in terms of wages being responsive to changes in unemployment).

In Spain, average annual hours fell in response to tax hikes on impact but the fall was not sufficient to prevent unemployment from rising after one period. Real wage declined in response to a tax increase also after one period (implicitly responding to unemployment changes).

In the Netherlands, unemployment rate appeared to decline after two years due to FC. Real wage also fell on impact and after two years following FC. The fast downward adjustment of real wage might have contributed to unemployment falling after two years.

In Finland, participation rate decreased while hours worked increased on impact to FC and G, and unemployment rate increased after two years. Lower participation rate could be associated with higher unemployment if the existing labor supply could not satisfy the job needs. Increased hours worked during demand shrinking could imply that the same number of people cannot be employed without wage adjustments. In the case of FC, there was also a decrease in unemployment after one period. This might have been associated with the lower participation rate, when unemployment can be initially contained as the workforce is getting smaller but then it starts to increase.

Swedish labour market appeared to respond in a similar way as this of Finland. Participation rate fell and hours worked increased on impact in response to FC and G. Although insignificant, unemployment estimates were very close to ten percent significance level, suggesting a rise in unemployment on impact and after two periods. An increase of unemployment rate to T was found to be significant.

The responses of participation rate, hours worked and real wage for the rest of the countries, although sometimes significant, were not generally associated with significant unemployment responses at the same time. Nevertheless, in Italy, where participation rate significantly fell on impact responding to any type of austerity and real wage increased two periods after spending action, unemployment appeared mainly to increase. In the UK, hours significantly fell at the same period of FC and T and real wage fell in response to T. Unemployment seemed to fall after one period which may have been associated with the signs of significant estimates for hours worked and real wage of the previous period. However, when real wage significantly increased one period after spending action, unemployment seemed to increase two periods after. Finally, in Austria, real wage appeared to significantly decline following FC and T one period after, and the unemployment rate appeared to decrease in response to FC (with the estimate close to 10% level of significance).

4 Conclusion

In this Chapter, we investigated the implications of different fiscal austerity measures on unemployment rate and other labour market variables, in a panel of European countries for the period of 1978 to 2009. Distinct types of government budget re-balancing were explored, including overall consolidation (driven by both the expenditure and revenue sides of the government budget balance), spending oriented and tax based adjustments. In an effort to allow for heterogeneity in the panel and cross-sectional dependence, mean group and pooled mean group estimators were employed, along with dynamic fixed effects to estimate the responses of cyclical and total unemployment to the various fiscal austerity actions. Also, fixed effects estimation was implemented to explore the responses of participation rate, real wage and hours worked to overall fiscal austerity, spending based and tax oriented shocks.

Overall, fiscal consolidation was found to significantly increase cyclical and total unemployment rates both in the short-run and long-run, with the implications on total unemployment rate being larger. By decomposing fiscal impact into spending versus tax driven austerity, spending based shocks appeared to significantly increase cyclical and total unemployment in the short-run. Tax oriented shocks were not found to be significant in affecting cyclical unemployment, but their effects were significant in the case of total unemployment. In particular, total unemployment rate was found to significantly increase in the long-run as a response to one percentage point increase of GDP tax based austerity. This result can imply further considerations about the implications of tax hikes on the natural rate of unemployment.

The current analysis outlines the potential trade-off which characterizes the implementation of spending versus tax focused fiscal re-balancing. With the focus on cyclical unemployment rate, budget re-balancing driven mainly by tax increases appeared to cause lower employment losses as compared to government spending retrenchment. Moreover, the effect on cyclical unemployment rate appeared to be significant in the short-run when the consolidation was driven by the spending side of the government budget. By looking at the response of total unemployment rate, spending adjustment was found to significantly increase it in the short-run, while the effect of tax adjustment was small and not significant. However, tax oriented policy appeared to significantly increase total unemployment rate in the long-run, with an effect of relatively high magnitude.

With regard to austerity implications on other variables of the labour market, participation rate was found to significantly decrease as a response to one percentage point change in spending based austerity. Real wage appeared to fall in the long-run due to tax oriented adjustment, although the effect was not significant. Hours worked did not exhibit a significant response to fiscal re-balancing.

5 Appendix

5.1 Unemployment and fiscal consolidation

Cyclical unemployment

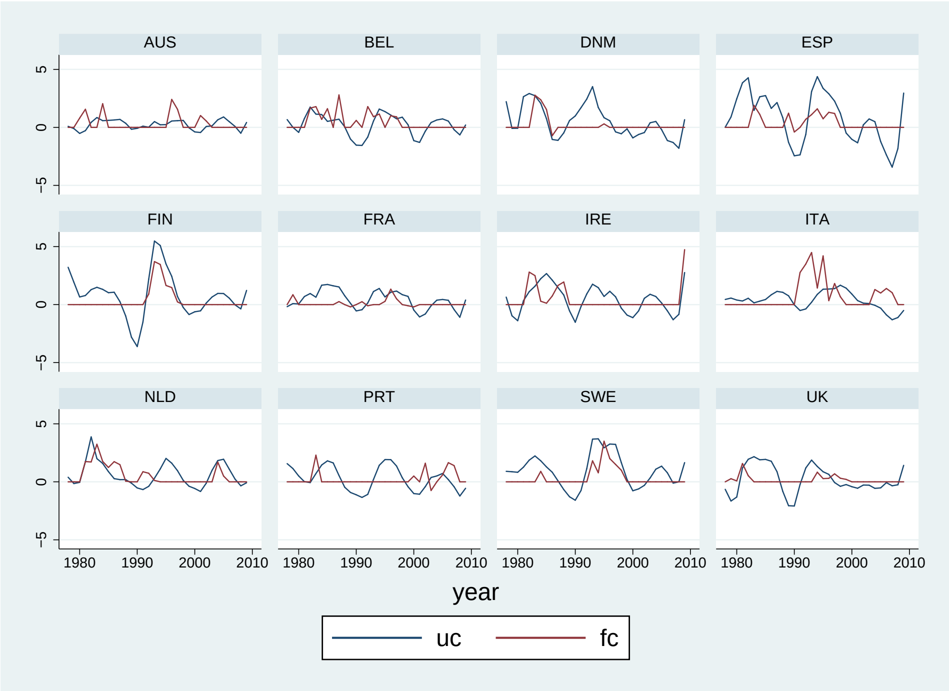

Figure 1.1: Cyclical unemployment rate and fiscal consolidation episodes as (% of GDP), 1978-2009.

Total unemployment

Figure 1.2: Total unemployment rate and fiscal consolidation episodes as (% of GDP), 1978-2009.

5.2 ECM derivation

$$
\begin{aligned}
u_{it} &= \alpha_i + \beta_{1i}u_{it-1} + \beta_{2i}u_{it-2} + \gamma_{0i}F_{it} + \gamma_{1i}F_{it-1} + \delta_{0i}\overline{u}_t + \delta_{1i}\overline{u}_{t-1} + \delta_{2i}\overline{u}_{t-2} + \\
&\quad \zeta_{0i}\overline{F}_t + \zeta_{1i}\overline{F}_{t-1} + \varepsilon_{it} \Rightarrow \\
\Delta u_{it} &= \alpha_i + (\beta_{1i} + \beta_{2i} - 1)u_{it-1} - \beta_{2i}\Delta u_{it-1} + \gamma_{0i}\Delta F_{it} + (\gamma_{0i} + \gamma_{1i})F_{it-1} + \\
&\quad \delta_{0i}\Delta\overline{u}_t + (\delta_{0i} + \delta_{1i} + \delta_{2i})\overline{u}_{t-1} - \delta_{2i}\Delta\overline{u}_{t-1} + \zeta_{0i}\Delta\overline{F}_t + (\zeta_{0i} + \zeta_{1i})\overline{F}_{t-1} + \varepsilon_{it} \Rightarrow \\
\Delta u_{it} &= \alpha_i + (\beta_{1i} + \beta_{2i} - 1)(u_{it-1} + \frac{\gamma_{0i} + \gamma_{1i}}{\beta_{1i} + \beta_{2i} - 1}F_{it-1}) + \frac{\delta_{0i} + \delta_{1i} + \delta_{2i}}{\beta_{1i} + \beta_{2i} - 1}\overline{u}_{t-1} + \\
&\quad \frac{\zeta_{0i} + \zeta_{1i}}{\beta_{1i} + \beta_{2i} - 1}\overline{F}_{t-1}) - \beta_{2i}\Delta u_{it-1} + \gamma_{0i}\Delta F_{it} + \delta_{0i}\Delta\overline{u}_t - \delta_{2i}\Delta\overline{u}_{t-1} + \zeta_{0i}\Delta\overline{F}_t + \varepsilon_{it} \Rightarrow \\
\Delta u_{it} &= (\beta_{1i} + \beta_{2i} - 1)(u_{it-1} + \frac{\alpha_i}{\beta_{1i} + \beta_{2i} - 1} + \frac{\gamma_{0i} + \gamma_{1i}}{\beta_{1i} + \beta_{2i} - 1}F_{it-1} + \frac{\delta_{0i} + \delta_{1i} + \delta_{2i}}{\beta_{1i} + \beta_{2i} - 1}\overline{u}_{t-1} + \\
&\quad \frac{\zeta_{0i} + \zeta_{1i}}{\beta_{1i} + \beta_{2i} - 1}\overline{F}_{t-1}) - \beta_{2i}\Delta u_{it-1} + \gamma_{0i}\Delta F_{it} + \delta_{0i}\Delta\overline{u}_t - \delta_{2i}\Delta\overline{u}_{t-1} + \zeta_{0i}\Delta\overline{F}_t + \varepsilon_{it} \Rightarrow \\
\Delta u_{it} &= -(1 - \beta_{1i} - \beta_{2i})(u_{it-1} - \frac{\alpha_i}{1 - \beta_{1i} - \beta_{2i}} - \frac{\gamma_{0i} + \gamma_{1i}}{1 - \beta_{1i} - \beta_{2i}}F_{it-1} - \frac{\delta_{0i} + \delta_{1i} + \delta_{2i}}{1 - \beta_{1i} - \beta_{2i}}\overline{u}_{t-1} - \\
&\quad \frac{\zeta_{0i} + \zeta_{1i}}{1 - \beta_{1i} - \beta_{2i}}\overline{F}_{t-1}) - \beta_{2i}\Delta u_{it-1} + \gamma_{0i}\Delta F_{it} + \delta_{0i}\Delta\overline{u}_t - \delta_{2i}\Delta\overline{u}_{t-1} + \zeta_{0i}\Delta\overline{F}_t + \varepsilon_{it} \Rightarrow \\
\Delta u_{it} &= \varphi_i(u_{it-1} - \theta_{0i} - \theta_{1i}F_{it-1} - \theta_{2i}\overline{u}_{it-1} - \theta_{3i}\overline{F}_{t-1}) - \beta_{2i}\Delta u_{it-1}\gamma_{0i}\Delta F_{it} + \\
&\quad \delta_{0i}\Delta\overline{u}_t - \delta_{2i}\Delta\overline{u}_{t-1} + \zeta_{0i}\Delta\overline{F}_t + \varepsilon_{it}
\end{aligned}
$$

where $\varphi_i = -(1 - \beta_{1i} - \beta_{2i})$ with $(1 - \beta_{1i} - \beta_{2i})$ being the speed of adjustment, $\theta\prime$ is the vector of long-run coefficients with $\theta_{0i} = \frac{\alpha_i}{1-\beta_{1i}-\beta_{2i}}, \theta_{1i} = \frac{\gamma_{0i}+\gamma_{1i}}{1-\beta_{1i}-\beta_{2i}}, \theta_{2i} = \frac{\delta_{0i}+\delta_{1i}+\delta_{2i}}{1-\beta_{1i}-\beta_{2i}}, \theta_{3i} = \frac{\zeta_{0i}+\zeta_{1i}}{1-\beta_{1i}-\beta_{2i}}$, and $\gamma_{0i}, \delta_{0i}, \zeta_{0i}$ are the short-run coefficients.

Chapter 2

Fiscal austerity and labour market performance

1 Introduction

Labour market responses to fiscal consolidation are crucial for the assessment of austerity implementation and the selection of fiscal packages that can mitigate potential negative implications on employment. Some examples of studies exploring the fiscal effects on labour market variables consist in Brückner and Pappa (2011), Monacelli, Perotti and Trigari (2010), Bermperoglou, Pappa and Vella (2013) and Dallari (2014). How unemployment responds to fiscal contraction can depend not only on the specific type of government budget re-balancing but quite likely on the country-specific labour market structure, namely its labour market institutions, as well. The latter is very relevant especially when considering European labour markets which are characterised by heterogeneous institutional features, for instance distinct employment protection laws.

Following the analysis in the First Chapter, the Second Chapter is concerned with a deeper investigation of the effects of fiscal consolidation on labour market. The goal is twofold. First, we study a theoretical model which captures not only the differentiated effects of contractionary fiscal policies on unemployment but also their potential interaction with the labour market structure, particularly the employment protection legislation. We focus on the role that employment security has on affecting unemployment fiscal multipliers. The theoretical framework allows us to figure out the channels through which fiscal intervention affects labour market and how employment protection interferes with the fiscal pass through. Second, in an effort to provide empirical evidence and test the theoretical predictions of the model, we empirically investigate the implications of different types of austerity on unemployment along with their interactions with labour market institutions, including employment protection legislation, along with trade union density and unemployment benefits. We aim to answer to what extend distinct labour market institutions affect the transmission of different consolidation actions to unemployment and contribute to its persistence. A such type of question is relevant for the ongoing discussions about the combination of fiscal action and labour market reforms.

For the theoretical analysis we emphasize employment protection legislation (EPL) because its role on labour markets, especially the European ones, has received a lot of attention. Employment protection laws are usually expressed as firing costs in the related literature (i.e. high firing costs stand for high employment protection). In an influential study, Bentolila and Bertola (1990) use a partial equilibrium model to claim that high firing costs, which become more relevant in periods of uncertainty, can affect firms' firing margin more than the hiring one, so equilibrium employment can be moderately higher. However, they outline that under a general equilibrium model, higher firing costs may result in lower steady state employment. Besides, the presence of highly protected employment contracts can distort the flows into and out of unemployment and contribute to long-term unemployment which is an important concern for many European countries.[1] High EPL is associated with relatively low exit from employment but at the same time firms are more reluctant to hire especially after a contractionary shock. If a contractionary fiscal shock makes unemployment rise, a highly protected labour market may increase the unemployment response further since firms have more disincentives for posting vacancies.

[1] See Blanchard (2006) for a thorough study on the distinct European unemployment rates and the role of labour market institutions.

Potential gains may arise from reforming the labour market in order the effects on unemployment to be mitigated. This is particularly interesting when we think of initiatives in a number of European countries with regard to simultaneous conduct of fiscal retrenchment and structural reforms.

In order to explore the effects of fiscal austerity on labour market and unemployment, and its interaction with employment protection, we elaborate a dynamic stochastic general equilibrium (DSGE) model with search and matching frictions and endogenous job destruction in the style of Mortensen and Pissarides (1994). The model consists of a fiscal authority which follows rules for government consumption and tax policies, and encompasses employment protection in the labour market. More specifically, jobs can be endogenously separated and employment protection is expressed as firing taxes paid by the firms for the endogenous job destruction, as in Thomas and Zanetti (2009).[2]

For the empirical analysis, the institutional characteristics we examine are trade union density, unemployment benefits and employment protection legislation. Fiscal austerity takes three forms based on the narrative estimates dataset of Devries et al. (2011), which are spending based adjustment, tax oriented austerity and overall consolidation for government budget balance improvement. We estimate a panel hierarchical (random coefficient) model for a number of European countries using Bayesian analysis, the results of which provide empirical support to the theoretical predictions. In particular, we compare the effects of different types of consolidation on unemployment across countries, along with their interactions with labour market institutions. The purpose is to draw some suggestions about more and less employment friendly measures, along with the labour market institutional role on the transmission mechanism of fiscal policy.

A relevant empirical panel study on fiscal consolidation effects on unemployment is the analysis developed by Turrini (2013) who explores whether variables of labour market in countries with high employment protection respond differently to fiscal shocks comparing to countries with low employment protection. Turrini splits the sample into sub-groups of high and low employment protection and applies classical estimation methods in order to answer this question. However, some complications might arise with this approach when the sample is characterised by a small number of countries and short period. For instance the size of the cross-sectional dataset is crucial for its division, and the separation into subsamples based on a threshold value may not properly rank countries close to this average value. To avoid such complications and maintain a tractable but informative set-up, we follow a Bayesian approach which is adequate in capturing potential heterogeneity and is preferably applicable when the sample period is relatively short.[3] We also extend the analysis to consideration of additional labour market institutions, apart from employment protection.

Some studies of panel random coefficient Bayesian VAR models include these of Canova and Pappa (2007), Jarocinski (2010) and Dallari (2014). A close application to the empirical analysis we conduct here, is of Dallari (2014) who studies the effects of austerity

[2]The theoretical framework is similar to Krause and Lubik (2007) and Thomas and Zanetti (2009) who develop New Keynesian models with search and matching frictions and endogenous separation, and to Corsetti, Meier and Müller (2013) and Bermperoglou, Pappa and Vella (2013) from the perspective of fiscal policy rules.

[3]In small samples, uncertainty around estimates restricts the dependence on large sample approximation, as stressed in Rossi, McCulloch and Allenby (1996).

on European labour markets using a hierarchical panel VAR approach. Dallari estimates the parameters' vector by imposing a common mean across countries, allowing for unobserved variation around it. We differentiate from his specification by attributing part of the potential heterogeneity to different labour market institutions across countries, and still allowing for unobserved heterogeneity. We keep a panel single-equation analysis to consider these interactions. With regard to how labour market structure affects the transmission of shocks to unemployment, Blanchard and Wolfers (2000) outline the significance of interaction between institutions and shocks in productivity, labour demand and real interest rate, in order to explain unemployment in a panel of OECD countries, stressing out the long-term implications. We focus instead on fiscal contractionary shocks and follow different estimation techniques, using a Bayesian random coefficient model to capture across country heterogeneity in a set of European economies.[4]

The contribution of this Chapter is important from different perspectives. Apart from contributing to the ongoing research on the comparison between tax versus spending oriented consolidation, it also investigates the role that labour market structure has for the implications of fiscal austerity on unemployment. The empirical model developed here is tractable; allowing to estimate country specific responses of unemployment to fiscal contraction and to express potential across country heterogeneity without the need of relying on large sample approximation. As far as I am concerned, this is the first study of modelling the interaction of fiscal action with labour market features in affecting unemployment in European countries, in an effort to attribute some of the heterogeneous unemployment responses to specific labour market characteristics. From the theoretical perspective, this model specification is among the first to bridge a rich labour market structure as described, with fiscal policy rules in order to study the effects of fiscal innovations on labour market.[5] A close study is of Gehrke (2016) who uses US data to estimate fiscal multipliers in a New Keynesian model with endogenous job destruction. Her findings suggest that multipliers are not very big, all below unity, with government spending multiplier being higher than consumption tax multiplier while income labour taxation having close to zero effects. However, there is no focus on how employment protection can affect the multipliers and this is particularly interesting when discussing about fiscal policy implications on unemployment in European countries. In this framework we consider employment protection and consumers valuing government consumption, calibrating the model for a representative EU economy. We obtain different in magnitude multipliers than Gehrke (2016).

In summary, concerning the predictions of the DSGE model and focusing on contractionary fiscal policy, a government consumption shock increases unemployment by more

[4]In the broader strand of the empirical literature, Nickell (1997) estimates a random effect model with generalized least square method to study the relevance of labour market institutions in affecting unemployment. The contribution of Nickell, Nunziata and Ochel (2005) gives support to institutions in explaining unemployment in OECD countries, instead of their interactions with shocks as expressed by time dummies. Smith and Zoega (2008) show that the estimated global element based on principal component analysis is important in understanding steady state unemployment while institutions affect the adjustment mechanism. Ljungqvist and Sargent (1998) argue that under increasing turbulence, high unemployment benefits can contribute to rising unemployment.

[5]The study belongs to the area of exploring fiscal policy effects on unemployment and labour market using general equilibrium models; some examples are Brückner and Pappa (2012), Campolmi, Faia and Winkler (2011), Monacelli, Perotti and Trigari (2010) and Stähler and Thomas (2012).

and has more persistent effects as compared to tax shocks. Precisely the one year cumulative unemployment fiscal multiplier for government consumption is -2.55, for labour income taxation is 1.42 and for consumption taxation is 0.56. Higher employment protection tends to increase the unemployment fiscal multipliers, as firms' incentives to hire are non-negligibly affected. The empirical results match the theoretical suggestions, showing that average unemployment rises in response to fiscal austerity, with spending oriented adjustment increasing cyclical unemployment by more compared to tax based action. More specifically, a 1% of GDP spending based consolidation increases cyclical unemployment by 1.51 percentage points while a 1% of GDP tax based austerity increases it by 0.62 percentage points on impact. The effect of overall fiscal austerity lies between spending and tax oriented policies, with cyclical unemployment rising by 0.86 percentage points as a response to an analogous shock. Labour market institutions appear to have moderate but non-negligible impact on the fiscal transmission. Overall employment protection seems to favour the increase in unemployment rate, as well as the unemployment benefits as percentage of GDP especially on impact.

The remaining of the present Chapter is as follow. Section 2 outlines a dynamic stochastic general equilibrium model with search and matching frictions, endogenous job separation, employment protection and fiscal rules for government consumption and revenue components. Section 3 deals with the effects of contractionary fiscal innovations, specifically of a government consumption cut, an increase in labour income taxation and an increase in consumption taxes. Unemployment fiscal multipliers are presented, along with their interactions with higher employment protection. Section 4 describes the methodology, the techniques and the data used for the empirical analysis. Section 5 presents the estimation results. Finally, Section 6 concludes.

2 Theoretical analysis

This section provides a theoretical model in order to investigate the effects of contractionary fiscal shocks, disentangle the channels of fiscal transmission to the labour market and unemployment, and explore the role of employment protection in affecting the fiscal pass through. The current framework is a dynamic stochastic general equilibrium model which combines search and matching frictions and endogenous job destruction with fiscal rules for spending and revenue components.[6] The only frictions in this environment come from the labour market. Firing taxes, which capture the degree of employment protection, are paid by the firms for the jobs of endogenous separation, following Zanetti (2011) and Thomas and Zanetti (2009) to whom the model specification is close. The analysis is extended towards a fiscal policy set-up in order to allow us to study unemployment fiscal multipliers of different government policy measures, and see how they interact with stronger employment protection legislation.

2.1 Labour market

There are search and matching frictions and endogenous separation modelled in the style of Mortensen and Pissarides (1994). Workers are either employed or unemployed and searching for a job, and entire participation of the labour force is assumed. Idiosyncratic productivity, a_t, is log-normally distributed and if it falls below the point that firms do not find profitable any more, workers are fired. This point is the cut-off productivity level, $\widetilde{a}_t$, which is optimally decided by the firms. Workers are subject to idiosyncratic productivity shocks independently of being already on the job or just being hired. The total separation rate, s_t, is given by:

$$s_t = s^x + (1 - s^x)F(\widetilde{a}_t), \tag{2.1}$$

where s^x is the exogenous separation rate and $F(\widetilde{a}_t)$ is the endogenous separation rate, s_t^n, which is the *cdf* of the idiosyncratic productivity distribution, $f(a_t)$, expressing the fraction of workers whose productivity goes below $\widetilde{a}_t$. The law of motion for employment, l_t, is given by:

$$l_t = [1 - F(\widetilde{a}_t)][(1 - s^x)l_{t-1} + q_t v_t]. \tag{2.2}$$

where v_t stands for the vacancies and q_t for the rate of vacancy filling. The law of motion of those searching for a job, u_t, is expressed as:

$$u_t = 1 - l_{t-1} + s^x l_{t-1}. \tag{2.3}$$

The matching function, representing matches (m_t), has the standard Cobb Douglas form with matching efficiency, e, inputs of unemployment and vacancies, and elasticity with respect to unemployment, ρ. The rates of vacancy filling (q_t) and job finding (f_t) are

[6] The fiscal policy setting is close to Bermperoglou, Pappa and Vella (2013).

expressed in terms of the labour market tightness, θ_t,

$$m_t = e(v_t)^{1-\rho}(u_t)^{\rho}, \tag{2.4}$$

$$q_t = e(\theta_t)^{-\rho}, \tag{2.5}$$

$$f_t = e(\theta_t)^{1-\rho}, \tag{2.6}$$

$$\theta_t = \frac{v_t}{u_t}. \tag{2.7}$$

2.2 Households

There are infinitely lived households who derive utility from the consumption of private good, c_t, and public good, g_t, and from the non-work status, u_t, as well. Households' members do not face consumption constraints due to their heterogeneous employment position but they collect and equally enjoy the proceeds, following Merz (1995). The representative household has constant elasticity of substitution (CES) preferences in logs to enclose complementarities between the government and the private goods, and derives utility also from non-work activities, as in Gomes (2015). The parameter γ shows the relationship between the two goods.[7] The parameter ζ stands for the utility the members extract from consuming the public good and the parameter χ expresses the gain from the non-work activities. Households maximise the following utility function:

$$\max U(c, g, u) = \max \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{\gamma} \ln(c_t^{\gamma} + \zeta g_t^{\gamma}) + \chi u_t \right]. \tag{2.8}$$

They solve their maximisation problem, $max \sum_{t=0}^{\infty} \beta^t U(c, g, u)$ with β being the discount factor, choosing private consumption and one period government bonds, (B_{t+1}), subject to their budget constraint,

$$(1 + \tau_t^c)c_t + B_{t+1} = l_t(1 - \tau_t^w) \int_{\widetilde{a}_t} \frac{w_t(a) f(a)}{1 - F(\widetilde{a}_t)} da + rr_b \overline{w} u_t + (1 + r_t) B_t - T_t, \tag{2.9}$$

where w_t is the wage given a_t realization and $\int_{\widetilde{a}_t} \frac{w_t(a) f(a)}{1 - F(\widetilde{a}_t)} da$ represents the average wage, rr_b is the unemployment insurance replacement rate, $\overline{w}$ is the equilibrium wage, r is the interest rate payment and τ_t^c, τ_t^w are the tax rates for consumption and labour income respectively. T_t stands for lump-sum transfers. The marginal utility with respect to private consumption (U_{ct}) and the marginal utility with respect to non-work activities in terms of current private consumption (V_{ut}) are given by:

$$U_{ct} = \frac{c_t^{\gamma-1}}{c_t^{\gamma} + \zeta g_t^{\gamma}} \frac{1}{(1 + \tau_t^c)} \tag{2.10}$$

$$V_{ut} = \frac{\chi}{U_{ct}}. \tag{2.11}$$

[7] When $\gamma = 0$, the elasticity of substitution equals unity and the specification is Cobb Douglas. As $\gamma \Rightarrow 1$, the goods tend to be perfect substitutes while as $\gamma \Rightarrow -\infty$, they tend to be perfect complements.

Differentiating the maximisation plan subject to the budget constraint with respect to B_{t+1}, yields to:

$$\beta^{t+1}\lambda_{t+1}(1+r_{t+1}) = \beta^t\lambda_t \Rightarrow \beta U_{ct+1}(1+r_{t+1}) = U_{ct}$$

Defining the stochastic discount factor, $\Lambda_t = \beta\frac{U_{ct}}{U_{ct-1}}$, and the interest rate paid at $t+1$, $R_t = (1+r_{t+1})$, the Euler equation can be written as:

$$R_t\Lambda_{t+1} = 1. \tag{2.12}$$

2.3 Production side

There are identical competitive firms producing the private good. They post vacancies for which they face posting expenses, κ, and hire workers for the production process. The production function is subject to aggregate technology, A, and idiosyncratic productivity, a.

$$y_t = A_t l_t \int_{\widetilde{a}_t} \frac{af(a)}{1-F(\widetilde{a}_t)}da, \tag{2.13}$$

where,

$$\ln A_t = (1-\rho_A)\ln\overline{A} + \rho_A(\ln A_{t-1}) + \varepsilon_{At} \tag{2.14}$$

$$a_t = (1-\rho_a)\ln\overline{a} + \rho_a(\ln a_{t-1}) + \varepsilon_{at}, \tag{2.15}$$

with $\varepsilon_{At} \sim N(0,\sigma_A)$ being aggregate technology shock and $\log\varepsilon_{at} \sim N(\mu_a,\sigma_a)$ being idiosyncratic productivity shocks respectively.[8]

Firms take employment in period t as given and maximise their profit plan by optimally choosing vacancies to post and the cut-off productivity level, subject to the law of motion for employment and the production function. In the expenditure side, they face costs for posting a vacancy and firing taxes (FT) for endogenous separations, along with the labour costs. The maximisation problem of the firms reads as follow:

$$\begin{aligned}\Pi = \max\{&A_t l_t \int_{\widetilde{a}_t} \frac{af(a)}{1-F(\widetilde{a}_t)}da - l_t \int_{\widetilde{a}_t} \frac{w_t(a)f(a)}{1-F(\widetilde{a}_t)}da \;- \kappa v_t - F(\widetilde{a}_t)[(1-s^x)l_{t-1} + q_t v_t]FT + \\ &E_t\Lambda_{t+1}\{A_{t+1}l_{t+1}\int_{\widetilde{a}_{t+1}} \frac{af(a)}{1-F(\widetilde{a}_{t+1})}da - l_{t+1}\int_{\widetilde{a}_{t+1}} \frac{w_{t+1}(a)f(a)}{1-F(\widetilde{a}_{t+1})}da - \kappa v_{t+1} \\ &- F(\widetilde{a}_{t+1})[(1-s^x)l_t + q_{t+1}v_{t+1}]FT + ...\}.\end{aligned} \tag{2.16}$$

In maximising the profit plan, the $f.o.c.$ with respect to v_t yields the associated job creation condition where the cost of posting an additional vacancy equals the expected benefit from filling it,

[8] Variables with bars denote the steady state values.

$$\frac{\kappa}{q_t} = (1 - F(\widetilde{a}_t))[\int_{\widetilde{a}_t} (A_t\alpha - w_t(a))\frac{f(a)}{1 - F(\widetilde{a}_t)}da + (1 - s^x)E_t\Lambda_{t+1}\frac{\kappa}{q_{t+1}}] - F(\widetilde{a}_t)(FT). \tag{2.17}$$

Differentiating the maximization plan with respect to employment, gives the value for an additional job for the firm, V_t^j. An additional job comes with the real marginal product of the worker and a further benefit by not being vacant given the non-separation. Also, the firm gains in terms of firing costs in case of non-separation today but has to consider potential separation in the future and the costs associated with this.

$$\begin{aligned} V_t^j &= \int_{\widetilde{a}_t} (A_t\alpha - w_t(a))\frac{f(a)}{1 - F(\widetilde{a}_t)}da \\ &+ (1 - s^x)E_t\Lambda_{t+1}\{(1 - F(\widetilde{a}_{t+1}))(\int_{\widetilde{a}_t+1} (A_{t+1}\alpha - w_{t+1}(a))\frac{f(a)da}{1 - F(\widetilde{a}_{t+1})} \\ &+ (1 - s^x)E_{t+1}\Lambda_{t+2}\frac{\kappa}{q_{t+2}}) - F(\widetilde{a}_{t+1})(FT)\} \\ &\Rightarrow V_t^j = (A_t\alpha - w_t(a))\frac{f(a)}{1 - F(\widetilde{a}_t)}da + (1 - s^x)E_t\Lambda_{t+1}\frac{\kappa}{q_{t+1}} \end{aligned} \tag{2.18}$$

Firms consider the cut-off productivity that defines the endogenous separation. An expression for the job destruction is given by the following equation, when we evaluate V_t^j at $\widetilde{a}_t$:

$$\begin{aligned} &V_t^j(\widetilde{a}_t) + (FT) = 0 \Rightarrow \\ &\qquad A_t\widetilde{a}_t = w_t(\widetilde{a}_t) - (FT) - (1 - s^x)E_t\Lambda_{t+1}\frac{\kappa}{q_{t+1}}. \end{aligned} \tag{2.19}$$

We can re-arrange the associated job creation condition using the job destruction expression,

$$\begin{aligned} \frac{\kappa}{q_t} + F(\widetilde{a}_t)(FT) &= (1 - F(\widetilde{a}_t))[\int_{\widetilde{a}_t} (A_t\alpha - w_t(a))\frac{f(a)}{1 - F(\widetilde{a}_t)}da + (1 - s^x)E_t\Lambda_{t+1}\frac{\kappa}{q_{t+1}}] \Rightarrow \\ \frac{\kappa}{q_t} + F(\widetilde{a}_t)(FT) &= (1 - F(\widetilde{a}_t))[\int_{\widetilde{a}_t} (A_t\alpha - w_t(a))\frac{f(a)}{1 - F(\widetilde{a}_t)}da - FT - A_t\widetilde{a}_t + w_t(\widetilde{a}_t)] \Rightarrow \\ \frac{\kappa}{q_t} &= \int_{\widetilde{a}_t} [A_t(\alpha - \widetilde{a}_t) - (w_t(a) - w_t(\widetilde{a}_t))]f(a)da - FT. \end{aligned} \tag{2.20}$$

2.4 Wage negotiation

Firms and workers negotiate over the wage solving the Nash plan. The parameter ϕ expresses the bargaining power of the firm and $X_t^f(a_t)$, $X_t^w(a_t)$ are the firm's and worker's surpluses respectively. The solution to the Nash plan yields the following:

$$(1-\phi)X_t^f(a_t) = \phi X_t^w(a_t). \tag{2.21}$$

The firm's and the worker's surpluses, where V_t^w and V_t^u are the values of being working and of being unemployed respectively, are given by:

$$\begin{aligned} X_t^f(a_t) &= (V_t^j(a_t) + FT) = A_t a_t - w_t(a_t) + \\ &(1-s^x)E_t\Lambda_{t+1}[\int\limits_{\widetilde{a}_{t+1}} V_{t+1}^j(a_{t+1})dF(a) - F(\widetilde{a}_{t+1})FT] + FT \end{aligned} \tag{2.22}$$

$$X_t^w(a_t) = (V_t^w(a_t) - V_t^u) = (1-\tau_t^w)w_t(a_t) - (nw)_t + (1-s^x)E_t\Lambda_{t+1}\int\limits_{\widetilde{a}_{t+1}} X_{t+1}^w(a_{t+1})dF(a), \tag{2.23}$$

where $(nw)_t = (V_{ut} + rr_b\overline{w}) + (1-s^x)E_t\Lambda_{t+1}f(\theta_{t+1})\int\limits_{\widetilde{a}_{t+1}} X_{t+1}^w(a_{t+1})dF(a)$ is the outside option value and $rr_b\overline{w}$ is the unemployment benefit. Substituting the surpluses into equation (2.21) and solving for the wage yields the following expression:[9]

$$\begin{aligned} w_t(a_t) = &\frac{(1-\phi)}{(1-\phi\tau_t^w)}\{A_t a_t + [1-(1-s^x)E_t\Lambda_{t+1}(1-f_{t+1}(\theta_{t+1}))](rr_f\overline{w})\} \\ &+ \frac{(1-\phi)}{(1-\phi\tau_t^w)}(1-s^x)E_t\Lambda_{t+1}\kappa\theta_{t+1} + \frac{\phi}{(1-\phi\tau_t^w)}(V_{ut} + rr_b\overline{w}), \end{aligned} \tag{2.24}$$

where rr_f is the replacement rate for firing taxes and $rr_f\overline{w}$ stands for the firing taxes.

2.5 Government

The government collects tax revenues and issues bonds to finance its expenses. Also, the firing contributions are paid by the firms to the government so they add up to tax revenues. Firing costs are not transfer payments to workers but take other forms like bureaucratic expenses and health insurance missed payments, following Zanetti (2011) and Thomas and Zanetti (2009).[10] Thus the government budget constraint is the following:

$$g_t + (1-l_t)rr_b\overline{w} + (1+r_t)B_t = T_t + \tau_t^w l_t \int\limits_{\widetilde{a}_t} \frac{w_t(a)f(a)}{1-F(\widetilde{a}_t)}da + \tau_t^c c_t + B_{t+1} + F(\widetilde{a}_t)[(1-s^x)l_{t-1} + q_t v_t](rr_f\overline{w}). \tag{2.25}$$

The government authority follows rules for government consumption and taxation which are partially autoregressive but also responsive to output. Besides, there is a condition for the lump-sum transfers which balances the budget constraint in case of divergence from the equilibrium debt target, $\frac{\overline{B}}{y}$, as in Bermperoglou, Pappa and Vella (2013).

[9]Details on the derivation are shown in Appendix, section 7.1.

[10]In Mortensen and Pissarides (2003), firing taxes are not payments from the employers to the fired workers because if firing costs take a severance form under the wage bargaining process considered, they do not incur allocation implications.

Thus the following setting characterizes the fiscal behaviour:

$$\ln(\frac{g_t}{\overline{g}}) = \rho_g \ln(\frac{g_{t-1}}{\overline{g}}) + \rho_{gy} \ln(\frac{y_{t-1}}{\overline{y}}) + \varepsilon_{gt} \tag{2.26}$$

$$\ln(\frac{\tau_t^i}{\overline{\tau^i}}) = \rho_{\tau^i} \ln(\frac{\tau_{t-1}^i}{\overline{\tau^i}}) + \rho_{\tau^i y} \ln(\frac{y_{t-1}}{\overline{y}}) + \varepsilon_{\tau^i t} \tag{2.27}$$

$$T_t = \overline{T} \exp\{\zeta_d(\frac{B_t}{y_t} - (\frac{\overline{B}}{y}))\}, \tag{2.28}$$

where ε_{gt} and $\varepsilon_{\tau^i t}$ for $i = w, c$ are zero mean white noise shocks with σ_g and σ_{τ^i} standard deviations, in government consumption and tax rates of labour income (τ_t^w) and consumption (τ_t^c).

2.6 Equilibrium

We now summarize the equilibrium conditions for this economy. The wage can be evaluated at $\widetilde{a}_t$ to substitute out for $w_t(\widetilde{a}_t)$ in the job creation condition in the following way.

$$\begin{aligned} w_t(\widetilde{a}_t) = (1-\phi)\{A_t\widetilde{a}_t + [1 - (1-s^x)E_t\Lambda_{t+1}(1 - f(\theta_{t+1}))](rr_f\overline{w})\} \\ + (1-\phi)(1-s^x)E_t\Lambda_{t+1}\kappa\theta_{t+1} + \phi(V_{ut} + rr_b\overline{w}) \end{aligned}$$

Thus,

$$w_t(a_t) - w_t(\widetilde{a}_t) = (1-\phi)A_t(a_t - \widetilde{a}_t).$$

Substituting out for $w_t(\widetilde{a}_t)$, the job creation and job destruction conditions can be reexpressed as follow:

$$\frac{\kappa}{q(\theta_t)} = \phi A_t \int_{\widetilde{a}_t} (\alpha - \widetilde{a}_t) f(a) da - (rr_f\overline{w}), \tag{2.29}$$

$$\begin{aligned} \phi A_t\widetilde{a}_t = (1-s^x)E_t\Lambda_{t+1}[(1-\phi)\kappa\theta_{t+1} - \frac{\kappa}{q(\theta_{t+1})}] + \phi(V_{ut} + rr_b\overline{w}) \\ -[\phi + (1-\phi)(1-s^x)E_t\Lambda_{t+1}(1 - f(\theta_{t+1}))](rr_f\overline{w}). \end{aligned} \tag{2.30}$$

The total separation rate, the law of motion of employment and of workers searching are given by equations (2.1), (2.2) and (2.3). The Nash bargained wage is given by equation (2.24), and the labour market tightness and production function are given by equations (2.7) and (2.13) respectively. The household's maximization problem is summarized by equations (2.10), (2.11) and (2.12). The government budget constraint, fiscal rules and lump-sum transfer condition are given by expressions (2.25), (2.26), (2.27) and (2.28) respectively. The flows of job creation (jc) and job destruction (jd) can be represented by:

$$jc_t = e\theta_t^{(1-\rho)} u_t \tag{2.31}$$

$$jd_t = s_t l_{t-1} + F(\widetilde{a}_t) jc_t. \tag{2.32}$$

Finally, the resource constraint reads as:

$$y_t = c_t + g_t + \kappa v_t. \tag{2.33}$$

2.7 Calibration

This section provides details about the calibration of the model.[11] It is calibrated to represent an EU economy in quarterly basis. The discount factor (β) is set to 0.99. The equilibrium unemployment rate is 0.1, following Blanchard and Gali (2006) and Thomas and Zanetti (2009), so the employment rate is given by 0.9. The job filling rate (q) is set to 0.7, as in Stähler and Thomas (2012) and the matching efficiency (e) is calibrated to satisfy this. The worker's negotiating power ($1-\phi$) is set to 0.5, equal to the elasticity of the matching function with respect to the unemployed (ρ) to ensure the Hosios requirement. Aggregate technology (A) is normalized to 1 and the government share of GDP is set to 20%. Replacement rates for unemployment insurance and firing costs are chosen as $rr_b = 0.4$ and $rr_f = 0.2$ respectively, following Thomas and Zanetti (2009).

The parameter γ is important in showing how the public and the private goods are related to each other. Since there is not a clear consensus about their relationship, we assume that they are complements setting γ equal to -0.8, following the listing of Fiorito and Kollintzas (2004). Fiorito and Kollintzas (2004) list government goods into "merit" goods and "public" goods, and conclude that "merit" goods complement private goods while "public" goods substitute the private ones. According to their ranking, "merit" goods include education and health care system while "public" goods are about justice, public order and defense. Expecting that spending on "merit" goods has a bigger proportion of government consumption relative to "public" goods, private and government goods are assumed to be complements.[12]

The scale parameter of the public good in the utility function (ζ) is set to 0.05, within the range that Bermperoglou, Pappa and Vella (2013) assume. The persistence coefficients in the shock processes are set equal to 0.8. The response of lump-sum taxes to debt and of government spending to output are $\zeta_d = 2$ and $\rho_{gy} = -0.05$ respectively and the debt proportion of GDP is set to 60%, as in Bermperoglou, Pappa and Vella (2013). Also, the response of tax rates to output is set to $\rho_{\tau^i y} = 0.05$. The steady state tax rate for consumption is $\tau^c = 0.09$ and for labour income is $\tau^w = 0.22$, as in Stähler and Thomas (2012). To solve for the equilibrium separation rates (s, s^n, s^x), we proceed in the following way.

[11] Although my code is different, I would like to thank Francenco Zanetti for kindly guiding with showing some code.

[12] Cases when the elasticity of substitution is larger than one and equal to one were considered. Specifically, for the goods being substitutes γ and ζ were set to 0.8 and 0.5, and for the case of the elasticity of substitution being equal to unity, γ and ζ were set to 0 and 0.2 respectively. The private consumption response to a government consumption cut depends on the assumption about the substitutability between these goods.

$$
\begin{aligned}
qv &= fu, \\
l &= (1 - F(\widetilde{a}))((1 - s^x)l + fu) \Rightarrow \\
l &= \frac{(1 - s^n)f}{s + f(1 - s^n)(1 - s^x)} \Rightarrow l = \frac{(1 - \frac{s}{2})f}{s + f(1 - s)},
\end{aligned}
$$

given that $s = s^x + (1 - s^x)s^n$ and assuming that s^n is the half of s. The expression for l is used to solve for the s, s^n, s^x in the steady state,

$$
\begin{aligned}
s &= \frac{2f(1 - l)}{2l(1 - f) + f}, \\
s^n &= \frac{s}{2}, \\
s^x &= \frac{s - s^n}{1 - s^n}.
\end{aligned}
$$

Total separation rate (s) is equal to 0.026 and s^n, s^x are 0.0132 and 0.0134 respectively. Expressions for the vacancies and workers searching for a job are given by:

$$
\begin{aligned}
v &= \theta u, \\
u &= 1 - l(1 - s^x).
\end{aligned}
$$

For the cut-off productivity in the steady state ($\tilde{a}$), given that idiosyncratic productivity is log-normally distributed, and by setting μ_a equal to zero and σ_a equal to 0.2, following Thomas and Zanetti (2009), it follows that the cut-off and the average idiosyncratic productivity are 0.64 and 1.025 respectively.

$$
\begin{aligned}
F(\widetilde{a}) = s^n &\Rightarrow \widetilde{a} = F^{-1}(s^n; \mu_a, \sigma_a) = 0.64 \\
\overline{a} &= \int_{\widetilde{a}} \frac{af(a)}{1 - F(\widetilde{a})} = 1.025
\end{aligned}
$$

We obtain the equilibrium values of $y = Al\ \overline{a}$, $g = \frac{g}{y}y$ and $B = \frac{B}{y}y$ with $\frac{B}{y}$ set to 60%. Steady state values for wage, market tightness, marginal utility of consumption and consumption along with the cost of posting a vacancy and the gain from unemployment in the utility function respect the model's equilibrium equations.

$$
\frac{\kappa}{q(\theta)} = \phi A \int_{\widetilde{a}} (\alpha - \widetilde{a})f(a)da - (rr_f\overline{w})
$$

$$
\begin{aligned}
\phi A\widetilde{a} = {} & (1 - s^x)\beta(1 - \phi)\kappa\theta - (1 - s^x)\beta\frac{\kappa}{q(\theta)} + \phi(\frac{\chi}{U_c} + (rr_b\overline{w})) - \\
& [\phi + (1 - \phi)(1 - s^x)\beta(1 - f(\theta))](rr_f\overline{w})
\end{aligned}
$$

$$\overline{w} = \frac{(1-\phi)}{(1-\phi\tau^w)}\{A\int_{\widetilde{a}} \frac{af(a)}{1-F(\widetilde{a})} + [1-(1-s^x)\beta(1-f(\theta))](rr_f\overline{w})\} +$$
$$\frac{(1-\phi)}{(1-\phi\tau^w)}(1-s^x)\beta\kappa\theta + \frac{\phi}{(1-\phi\tau^w)}(\frac{\chi}{U_c} + (rr_b\overline{w}))$$

$$U_c = \frac{c^{\gamma-1}}{c^\gamma + \zeta g^\gamma}\frac{1}{(1+\tau^c)}$$

$$c = y - \kappa v - g$$

$$l = (1-F(\widetilde{a}))((1-s^x)l + fu)$$

Also, unemployment benefits and firing costs are given by $UB = rr_b\overline{w}$ and $FT = rr_f\overline{w}$ respectively, and the government budget constraint is satisfied.

3 The effects of contractionary fiscal shocks

This section presents the implications that fiscal austerity shocks have on the main macroeconomic variables of the model, with a focus on unemployment. It also provides unemployment fiscal multipliers and shows how they vary when the labour market is characterised by stronger employment security. The contractionary fiscal innovations that we look at, are a cut in government consumption, an increase in labour income taxation and a consumption tax hike. Shocks are expressed in 0.5% of *GDP*, as in Faia, Lechthaler and Merkl (2013).[13] We first investigate these implications in a baseline economy where the labour market structure is characterised by firing costs of 20% of the average wage. We then perform a simulation in an economy with higher firing costs to explore the impact of stronger employment protection on the fiscal transmission to unemployment. In summary, a government consumption cut affects unemployment in a stronger and more persistent way as compared to tax hikes. A rise in labour income taxation increases unemployment in the first year but its cumulative effect tends towards zero in the third year. The cumulative unemployment multiplier of consumption taxation has the lowest magnitude in the first year but the effect is more persistent in the following years relative to the effect of income taxation. The model's predictions suggest that government consumption cuts are more harmful for employment than tax increases. Among taxation, a labour income tax increase has strong effect on unemployment in the first year while an upsurge in consumption taxation smooths the unemployment response throughout the time horizons. Higher employment protection tends to magnify the effects of the shocks making the unemployment fiscal multipliers bigger.

3.1 A cut in government consumption

A government consumption retrenchment causes a fall in aggregate output, as predicted by DSGE models developed in the related literature (e.g. Bermperoglou, Pappa and Vella (2013) and Stähler and Thomas (2012)). The fall in output and consequently in employment induces a rise in unemployment. We observe a fall in private consumption, for the response of which there is less consent across studies. From a neoclassical point of view, lower government consumption would imply lower taxes in the future so agents would increase private consumption due to their wealth perception. In the current environment, the contractionary government shock induces a fall in private consumption as the pooled income of the households is lower due to higher unemployment. There is a small decrease in the threshold idiosyncratic productivity and a subsequent decrease in the job destruction flows but the job creation flows fall by much more. Thus unemployment is higher and households' income lower. In this set-up the imperfect substitutability between the public and private consumption goods can imply a fall in private consumption following a fall in government consumption. The decrease in private consumption induces an increase in the marginal utility of consumption so the value of the outside option falls which pushes the wage downwards. However, this wage fall is quantitatively small and lasts for a very short period. Thus firms are not prevented from posting fewer vacancies. The cut in government

[13] In the case of tax rate innovations, the shocks are scaled such as the change in the tax revenues to be expressed in 0.5% of *GDP*.

consumption is associated with a fall in public debt. Given the presence of fiscal rules, the tax rates of consumption and labour income are decreased to prevent output from falling further. However, the fiscal rules are assumed to have mild stabilizing power and a high autoregressive component. Figure 2.1 depicts the impulse responses of the model's main variables to a government consumption cut, under the assumption that there is imperfect substitutability between the two goods.[14]

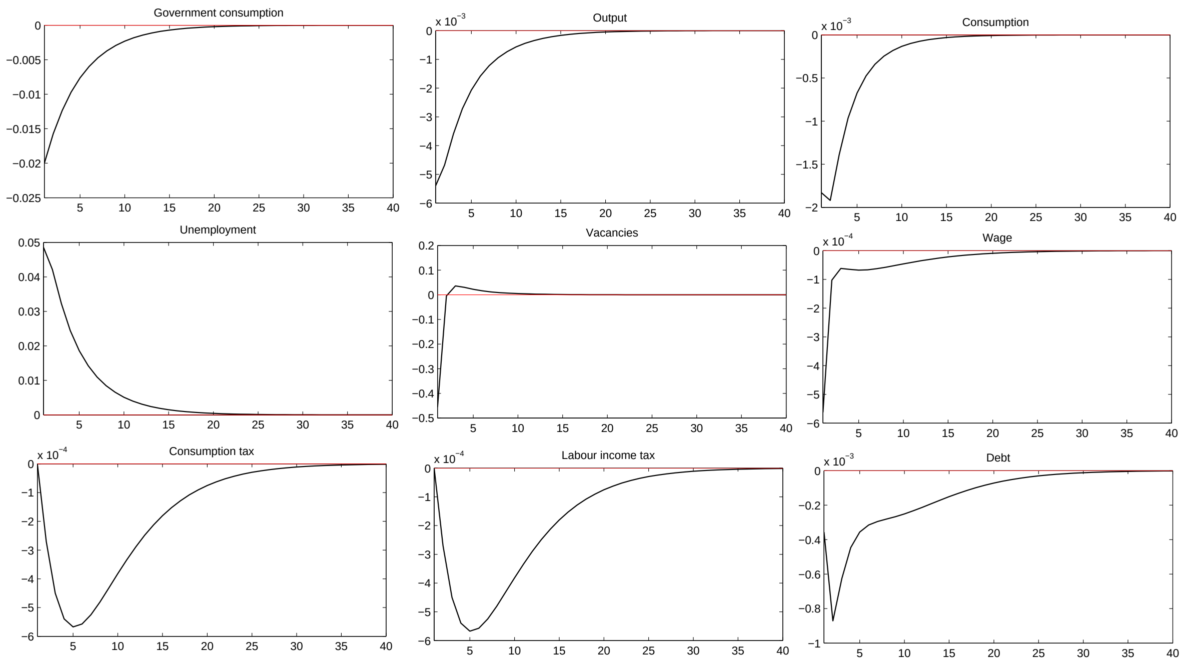

Figure 2.1: Impulse responses to a cut in government consumption. The values on the vertical axes are multiplied by 100 to obtain percentage deviations from the steady state and percentage point deviations for the tax rates.

[14] In a different scenario of the public and private goods being perfect substitutes, the response of private consumption was different, precisely increasing after one year due to a government consumption cut. In that scenario, consumption was negatively affected on impact but it started to increase as it was perfectly substitutable with the public consumption which had fallen.

3.2 A rise in labour income tax rate

An increase in labour income tax rate induces a decrease in output and an increase in unemployment via the wage channel. In the models characterised by search frictions in the labour market, workers face inelastic labour supply but still taxation on income affects the bargaining process of the wage. Higher income tax rates add upward pressure on wages since the value of being employed falls relative to the value of being unemployed. Increased wages induce a rise in labour cost, and the firms' expected benefit of posting a vacancy falls. Thus, more workers are fired, vacancies decline and consequently output falls and unemployment rises. As the pooled financial resources of the households decline, consumption falls. The negative implications on output are slightly mitigated by the mild response of government spending and consumption taxes. Fiscal authorities decrease consumption tax rate and increase government consumption in response to a hike in income tax rate to contain the decrease in output. Debt increases to finance the increased government consumption. The adjustment in lump-sum transfers will be such that to gradually stabilize debt towards the target. Figure 2.2 shows the effects of a rise in labour income tax on the main variables of the model.

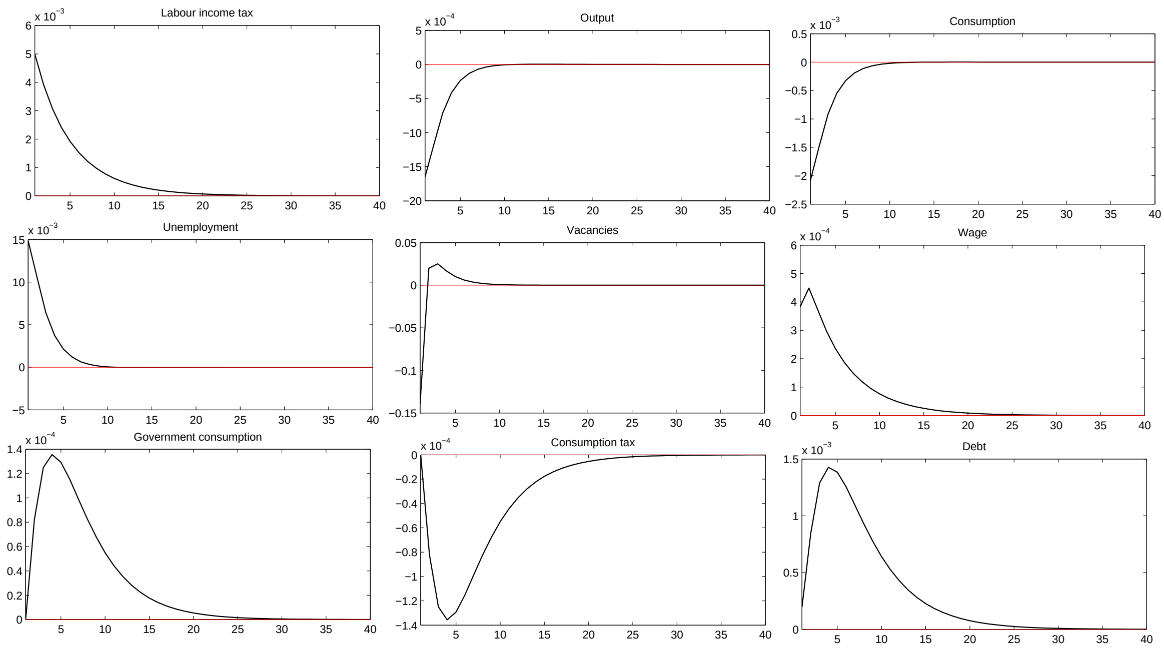

Figure 2.2: Impulse responses to an increase in income tax rate. The values on the vertical axes are multiplied by 100 to obtain percentage deviations from the steady state and percentage point deviations for the tax rates.

3.3 A rise in consumption tax rate

Indirect taxation via an increase in consumption tax rate lowers private consumption and output. The fall in consumption induces an increase in the marginal utility of consumption, thus a decrease in the value of leisure which pushes the wage downwards. However, the wage decrease is so small that cannot significantly affect employers' incentives for vacancy posting. Firms, mostly driven by the decrease in private consumption, post fewer vacancies, therefore unemployment rises and output falls. The response of fiscal stabilization tools takes place through increased government consumption and decreased income labour taxation but their effects are moderate. Public debt rises for the government consumption to be funded and lump-sum taxes will ensure its progressive sustainable restoration. Figure 2.3 outlines the responses of the main model's variables to a rise in consumption tax rate.

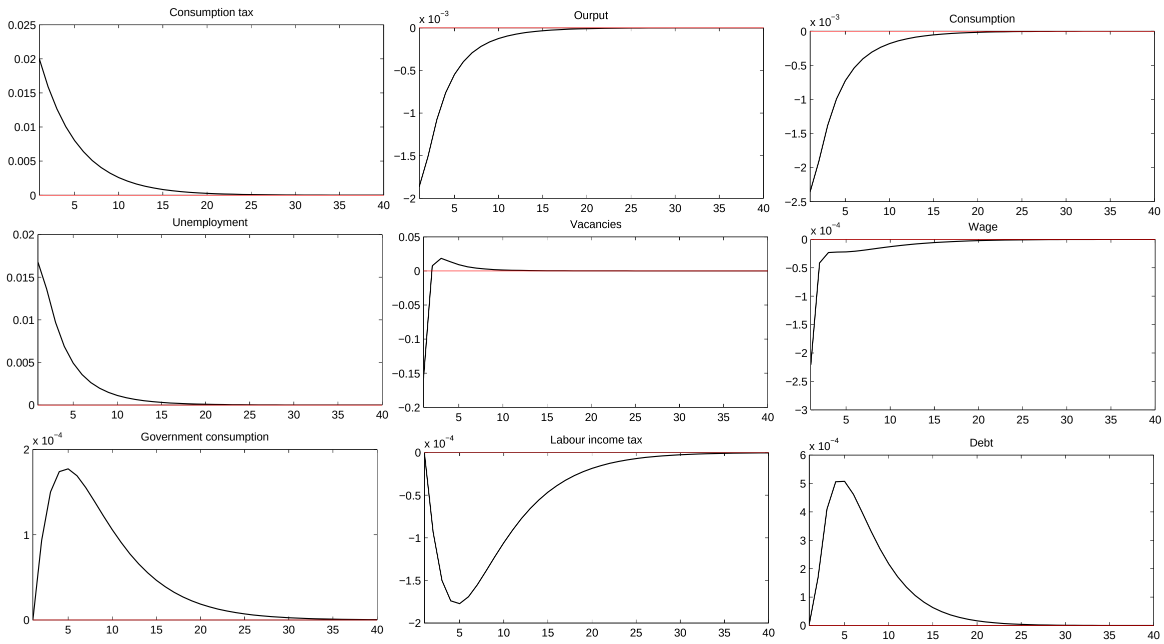

Figure 2.3: Impulse responses to an increase in consumption tax rate. The values on the vertical axes are multiplied by 100 to obtain percentage deviations from the steady state and percentage point deviations for the tax rates.

3.4 Unemployment fiscal multipliers

This sub-section focuses on the cumulative responses of unemployment to the fiscal contractionary shocks considered, by comparing the cumulative unemployment fiscal multipliers for government consumption, labour income taxation and consumption taxation. Apart from looking at the differentiated effects on unemployment depending on the fiscal shock, the focus is also on considering how such unemployment responses can be affected by the degree of employment protection. Towards this direction, cumulative unemployment multipliers are reported for a baseline economy (the unemployment responses of which were presented in sub-sections 3.1, 3.2 and 3.3) and for an alternative scenario in which the representative economy is characterised by higher employment security.

For the case of a government consumption shock, the multiplier measures the cumulative effect of percentage deviations of government consumption on percentage deviations of unemployment from the steady state values for the h time horizon,

$$\text{cumulative multiplier } (h) = \frac{\sum_{t=0}^{h} \Delta u_t}{\sum_{t=0}^{h} \Delta g_t}.$$

The cumulative multiplier for taxation is calculated as,

$$\text{cumulative multiplier } (h) = \frac{\sum_{t=0}^{h} \Delta u_t}{\sum_{t=0}^{h} \Delta TR_t},$$

where TR stand for the tax revenues obtained by the change in the labour income and consumption tax rates considering steady state values for employment, wage and consumption. Table 2.1 provides the unemployment cumulative multipliers for three years, for the baseline economy of firing costs being 20% of the average wage ($rr_f = 0.2$) and for an economy characterised by higher employment protection, proxied by firing costs being 30% of the average wage ($rr_f = 0.3$). Looking at the baseline case, government spending multiplier is of the highest magnitude, larger than 2. Income tax multiplier is larger than one (1.42) in the first year but gets lower then after having negligible effects in the third year. The cumulative multiplier of consumption taxes is of the lowest magnitude in the first year (0.56) but the effects of consumption taxation are more spread out throughout the horizons comparing to the effects of labour income taxation. Considering the economy with higher firing costs, the multipliers of all three fiscal components become larger for the entire time horizon that we look at. When the labour market is characterised by higher employment protection, firms' disincentive to post vacancies after a contractionary shock becomes bigger, thus the increase in unemployment can be higher. In the current framework it is implied that stronger employment security can possibly affect the hiring margin more than the firing one.

Table 2.1: Unemployment cumulative multipliers

rr_f	years	gov. consumption	income taxation	consumption tax
	1	-2.55	1.42	0.56
0.2	2	-2.5	0.4	0.5
	3	-2.4	0.03	0.4
	1	-3.3	1.54	0.68
0.3	2	-3.7	1.8	0.77
	3	-3.9	2	0.8

4 Empirical analysis

4.1 Methodology

A panel hierarchical model estimated using Bayesian techniques, is used to empirically investigate fiscal consolidation effects on unemployment in a number of European countries, and examine the predictions of the theoretical model. The estimation results, which are presented in section 5, support the theoretical predictions. The panel consists of heterogeneous countries and the time span is based on the data availability. Bayesian estimation method implemented in this Chapter, can account for parameter heterogeneity even in a relatively small sample and allow for potential correlations across countries' parameter vectors without imposing restrictions of a classical specification.[15] In estimating the parameters' vector, the hierarchical structure allows us to tie in potential heterogeneous responses of countries due to country-specific labour market features and cross-country correlations as well. As stressed by Rossi, Allenby and McCulloch (2005), unit estimations in a panel may be linked via correlation in the errors or in the parameter vectors where the coefficients can differ across units but are drawn from a common mean distribution. The current set-up follows the latter specification. The model estimates the unobserved heterogeneity between countries' coefficients, the inclusion of which considers error cross correlation as outlined in Hausman and Wise (1978).[16] The panel specification reads as follow:[17]

$$u_{it} = \alpha_i + \beta_{1i}u_{it-1} + \beta_{2i}u_{it-2} + \gamma_{0i}FP_{it} + \gamma_{1i}FP_{it-1} + \varepsilon_{it}, \tag{2.34}$$

where u is the unemployment rate, FP is the fiscal consolidation measure which takes three different types, $i = 1, 2, ..., n$ stands for countries and $t = 1, 2, ..., T$ for time, and ε_{it} are random errors for each country with σ_i^2 error variance. Errors are assumed to be i.i.d. $N(0, \sigma_i^2)$. Thus, $E(\varepsilon_{it}^2) = \sigma_i^2$, $E(\varepsilon_{it}\varepsilon_{js}) = 0$ for $i \neq j$, $t \neq s$. Letting Σ being the matrix of all $\sigma_i^{2\prime}s$, Σ is assumed to be diagonal.

What characterizes this specification is that the countries' coefficient vectors are associated through a common mean in their prior distribution. The parameters' vector is made

[15]The relative gains of using this method are highlighted in Rossi, McCulloch and Allenby (1996).

[16]Another approach of accounting for residual cross correlation would be based on the Common Correlated Effect methodology followed in the first Chapter.

[17]The model is of an autoregressive distributed lag form, chosen based on no serial correlation and significance criteria. As in the first Chapter, the analysis for each country was initially conducted and for the three different types of consolidation, based on Bayesian Information Criterion ensuring no serial correlation. Then, the best fit specification overall for the panel of countries was chosen.

conditional on specific labour market elements and the estimated variation across countries is maintained to describe unobserved heterogeneity. Assuming $\boldsymbol{\beta}_i = [a_i,\ \beta_{1i},\ \beta_{2i},\ \gamma_{0i},\ \gamma_{1i}]'$ being the vector of parameters for country i, $\boldsymbol{\beta}_i$ is expressed as:

$$\boldsymbol{\beta}_i = \Delta' z_i + v_i, \tag{2.35}$$

where z_i is a vector of an intercept and labour market institutions and Δ is the interaction matrix between the z_i elements and the parameters. Errors v_i are i.i.d. $N(0, V_\beta)$ with V_β being the covariance matrix of the $\boldsymbol{\beta}_{i's}$ implying unobserved heterogeneity in the parameters across countries. We can stack the parameter vectors of all countries and express the multivariate specification as:

$$B = Z\Delta + V, \tag{2.36}$$

where B is $n \times k$, Z is $n \times n_z$, Δ is $n_z \times k$ and V is $n \times k$, with n_z being the number of z elements and k the number of parameters. We are interested in the estimates of the interaction matrix Δ which is the common mean, and the across countries unobserved variation which is expressed by the square root of the diagonal of the estimated V_β. These results will provide average estimates for our parameters along with their interrelation with the labour market characteristics, and an estimated dispersion. Consequently individual country estimates can be also retrieved. Estimates of β_1 and β_2 suggest how persistent unemployment rate is and these of γ_0 and γ_1 capture the contemporaneous and lagged total effect of fiscal consolidation on unemployment.[18] The model is estimated via Bayesian method. To obtain posterior mean estimates for $\{\beta_i, \Delta, V_\beta, \sigma^2\}$, we make use of Markov Chain Monte Carlo technique, particularly of Gibbs sampling, where the prior distributions and the likelihood are merged so as to express the conditional posterior densities.

4.2 Bayesian inference

The posterior densities of the parameters to be estimated are given by combining the prior densities and the likelihood function of the data.[19] In what follows for a parameter θ, $\overline{\theta}$ is the posterior estimator and $\underline{\theta}$ is the prior. For $u_{it} \mid X_{it}, \beta_i, \sigma_i^2$ the likelihood is:[20]

$$\begin{aligned} p(u \mid X, \beta, \sigma^2) \propto (\sigma^2)^{-\frac{n-k}{2}} \exp(-\frac{(n-k)((u - X\widehat{\beta})'(u - X\widehat{\beta}))}{2\sigma^2})(\sigma^2)^{-\frac{k}{2}} \\ \times \exp(-\frac{1}{2\sigma^2}(\beta - \widehat{\beta})' X' X)(\beta - \widehat{\beta}). \end{aligned} \tag{2.37}$$

[18]Fiscal policy measures are supposed to be exogenous given the narrative estimates dataset of Devries et al. (2011) which they are based on. The same fiscal dataset as in the first Chapter is used. The estimated fiscal coefficients capture the total effect of the fiscal shock on unemployment taking care of omitted variable bias.

[19]Bayesian inference is based on the Bayes theorem: $p(\beta \mid y) = \frac{p(y|\beta)p(\beta)}{p(y)}$ where $p(\beta \mid y)$ is the posterior density, $p(y \mid \beta)$ is the likelihood and $p(\beta)$ is the prior density.

[20]The following exposition is similar to Rossi, Allenby and McCulloch (2005).

The conjugate prior for σ^2 is Inverse Gamma distribution, $\sigma^2 \mid a, b \sim IG(a, b)$.[21]

$$\sigma^2 \mid a, b \sim IG(a, b) \Longrightarrow p(\sigma^2) \propto (\sigma^2)^{-(a+1)} \exp(-\frac{b}{\sigma^2}), \tag{2.38}$$

where $a = \frac{v}{2}$ and $b = \frac{vS_0^2}{2}$, with v being the degrees of freedom. Combining the likelihood and the prior, we obtain an expression for the conditional posterior density of σ^2:

$$p(\sigma^2 \mid \Theta_{-\sigma^2}, u) \propto (\sigma^2)^{-(\frac{n}{2}+a+1)} \exp\{-\frac{1}{\sigma^2}(\frac{1}{2}\sum_i (u_i - X_i\beta_i)'(u_i - X_i\beta_i) + b)\}, \tag{2.39}$$

where Θ_{-i} stands for all the parameters apart from the parameter i which is estimated. For the estimation of $B = Z\Delta + V$, the likelihood is:

$$\begin{aligned} p(B \mid Z, \Delta, V_\beta) \propto |V_\beta|^{-\frac{n}{2}} \exp\{tr(-\frac{1}{2}(B - Z\widehat{\Delta})'(B - Z\widehat{\Delta})V_\beta^{-1})\} \, |V_\beta|^{-\frac{n}{2}} \\ \times \exp\{tr(-\frac{1}{2}(\Delta - \widehat{\Delta})'Z'Z(\Delta - \widehat{\Delta})V_\beta^{-1})\}. \end{aligned} \tag{2.40}$$

The conjugate priors for V_β^{-1} and for Δ are Wishart distribution, $V_\beta^{-1} \mid v_0, R \sim W(v_0, (v_0R)^{-1})$, and normal conditional on V_β distribution, $\Delta \mid V_\beta \sim N(\underline{\Delta}, A_d)$ respectively,

$$V_\beta^{-1} \mid v_0, R \sim W(v_0, (v_0R)^{-1}) \Longrightarrow p(V_\beta^{-1} \mid v_0, (v_0R)^{-1}) \propto |V_\beta|^{\frac{v_0+k+1}{2}} \exp\{tr(-\frac{1}{2}(v_0R)^{-1}V_\beta)\}, \tag{2.41}$$

$$\Delta \mid V_\beta \sim N(\underline{\Delta}, A_d) \Longrightarrow p(\Delta \mid V_\beta) \propto |V_\beta|^{-\frac{k}{2}} \exp\{tr(-\frac{1}{2}(\Delta - \underline{\Delta})'A_d(\Delta - \underline{\Delta})V_\beta^{-1})\}. \tag{2.42}$$

The matrix Δ can be vectorized in δ,

$$\delta \mid V_\beta, \underline{d}, A_d \Longrightarrow \delta \sim N(\underline{d}, V_\beta \otimes A_d^{-1}). \tag{2.43}$$

The joint posterior is:

$$\begin{aligned} p(V_\beta, \Delta \mid B, Z) \propto |V_\beta|^{-\frac{k}{2}} \exp\{tr(-\frac{1}{2}(\Delta - \overline{\Delta})'(Z'Z + A_d)(\Delta - \overline{\Delta})V_\beta^{-1})\} \, |V_\beta|^{-\frac{v_0+k+1}{2}} \\ \times \exp\{tr(-\frac{1}{2}(v_0R + S)V_\beta^{-1})), \end{aligned} \tag{2.44}$$

where $S = (B - Z\overline{\Delta})'(B - Z\overline{\Delta}) + (\overline{\Delta} - \underline{\Delta})'A_d(\overline{\Delta} - \underline{\Delta})$ and tr stands for the trace. The joint posterior can be re-expressed, using the trace properties, as:

$$\begin{aligned} p(V_\beta, \delta \mid B, Z) \propto |V_\beta|^{-\frac{k}{2}} \exp\{-\frac{1}{2}(\delta - \overline{\delta})'(V_\beta^{-1} \otimes (Z'Z + A_d)(\delta - \overline{\delta}))\} \, |V_\beta|^{-\frac{v_0+k+1}{2}} \\ \times \exp\{-\frac{1}{2}(v_0R + S)V_\beta^{-1})\}, \end{aligned} \tag{2.45}$$

[21] $a = \frac{v}{2}$ and $b = \frac{vS_0^2}{2}$ with v being the degrees of freedom.

where $\overline{\delta}$ is the posterior estimator:

$$\overline{\delta} = (V_\beta^{-1} \otimes (Z'Z + A_d))^{-1}(V_\beta^{-1} \otimes (Z'Z\widehat{\delta} + V_\beta^{-1} \otimes A_d\underline{\delta}). \quad (2.46)$$

The conditional posterior densities for δ and V_β^{-1} (where δ is the vectorized Δ) are given by:

$$\delta \mid B, Z, V_\beta \sim N(\overline{\delta}, V_\beta \otimes (Z'Z + A_d)^{-1}) \quad (2.47)$$

$$V_\beta^{-1} \sim W(n + v_0,\ (\sum_i (\beta_i - \Delta' z_i)(\beta_i - \Delta' z_i)' + v_0 R)^{-1}\ ). \quad (2.48)$$

A summary of the problem reads as follow:

$$u_{it} \mid X_{it,}\beta_{i,}\sigma_i^2$$
$$\beta_i \mid z_i\Delta, V_\beta$$
$$\delta \mid V_\beta, \underline{\delta}, A_d.$$

Natural conjugate priors for the parameters of the multivariate model are chosen, following Zellner (1971). For σ^2 and for V_β^{-1}, Inverse Gamma and Wishart prior densities are respectively imposed to achieve conjugacy. The choice of such distributions is based on what is mostly used in the literature. The prior of V_β^{-1} is proper but still diffuse so as to impose little convergence of V_β to the observed data. Prior densities of σ^2 and δ which are quite diffuse are chosen following Rossi, McCulloch and Allenby (1996, 2005). In particular, for the Inverse Gamma prior of σ^2, a is set to 3 and b is set to 1. For the conditional on V_β normal prior of δ, $\underline{d}$ equals 0 and A_d is $0.01 \times I_d$. Finally, the Wishart prior of V_β^{-1} consists of v_0 being 6 and R being a matrix of zero off-diagonal elements and diagonal of 0.5^2 corresponding to slopes and 1 corresponding to the intercept.[22] The expressed conditional posterior densities are used in the Gibbs sampler for the estimation as explained in the following sub-section.

4.3 Gibbs sampling

This sub-section briefly outlines the Gibbs sampling method, originated by Geman and Geman (1984), using the conditional posterior densities for $\beta_i, \sigma^2, V_\beta^{-1}, \Delta$ to approximate the actual posterior distribution and obtain posterior mean estimates.

In summary the joint posterior density, where Θ stands for all the parameters to be estimated, is the following:

$$p(\Theta \mid u) \propto [\prod_{i=1}^{12} p(u_i \mid X_i, \beta_{i,}\sigma_i^2) p(\beta_i \mid z_i, \Delta, V_\beta^{-1})] p(\Delta \mid V_\beta, \overline{\Delta}, A_d) p(\sigma^2 \mid a, b) p(V_\beta^{-1} \mid v_0, v_0 R) \quad (2.49)$$

In the sampler, initial values are taken for $\sigma_i^2, V_\beta, \Delta$ which are $\sigma_{i(0)}^2, V_{\beta(0)}, \Delta_{(0)}$.

[22] We follow Koops, Poirier and Tobias (2007) who allow for different variability of the parameters. In the location prior matrix R, higher variability is imposed on the intercept as compared to the slopes. We also choose the prior such that the variance to be invertible, as explained in Zellner (1971).

We draw $\beta_{i(1)}$ from its conditional posterior density based on the $\sigma^2_{i(0)}, V_{\beta(0)}, \Delta_{(0)}$:[23]

$$p(\beta_{i(1)} \mid u_i, X_i, \Delta_{(0)}, z_i, \sigma^2_{i(0)}, V_{\beta(0)}).$$

$\sigma^2_{i(1)}$ is drawn from:

$$p(\sigma^2_{i(1)} \mid u_i, X_i, \beta_{i(1)}, v_i, s^2_{0i}).$$

$V_{\beta(1)}$ is drawn from:

$$p(V_{\beta(1)} \mid \beta_{i(1)}, v_0, R, Z, \underline{\Delta}, A_d).$$

And finally $\Delta_{(1)}$ is drawn from:

$$p(\Delta_{(1)} \mid \beta_{i(1)}, V_{\beta(1)}, Z, \underline{\Delta}, A_d).$$

The same routine is done for the second round of draws using the updated values, and the draws continue until the specified number of draws is reached and convergence is achieved. Each of these draws corresponds to a vector of parameters. The sequence of draws is a Markov Chain used to approximate the posterior distribution. Gelfand and Smith (1990) show that with the Gibbs sampler, the real joint posterior distribution is achieved as draws go to infinity. The number of draws is crucial but autocorrelation and convergence tests can direct our decision.

The sampler is run for 10,000 draws and 5% of it is used as burn-in to avoid dependence on initial values. Turning to diagnostics checks about dependence on initial conditions and convergence of the sampler, Raftery and Lewis (1992a) testing did not imply non-convergence issues for the parameter chains of the model for FC. The dependence factor in Raftery and Lewis test was well below the value of 5, that is considered to be a threshold above which autocorrelation issues can lead to concerns about non-convergence of the sampler. For the models of G and T, parameter chains did not exhibit possible non-convergence issues apart from few fiscal parameters. By choosing the burn-in to control for any further dependence on initial values, 10 % and 25 % of the distributions were used to calculate the posterior means for the G and T models respectively, and non-convergence did not appear to be an issue based on the dependence factor. More details about the estimates of this factor for each parameter are provided in the Appendix, section 7.5.

[23]The subscript corresponds to the number of draw. The exposition is related to a more detailed description in Rossi, Allenby and McCulloch (2005).

4.4 Data and the choice of institutional features

As in the first Chapter, the annual sample spans from 1978 to 2009 and consists of 12 European countries; Austria, Belgium, Denmark, Finland, France, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the UK. This is due to availability of the narrative estimates for European discretionary consolidation as percentage of GDP of Devries et al. (2011), which is used in this Chapter as well. Details about this dataset, along with description of the unemployment variables have been already provided in the first Chapter. As a short reminder, there are three identified austerity types; overall fiscal consolidation (FC) when there is an overall fiscal re-balancing coming from spending retrenchment and tax increases, spending oriented austerity (G) and tax based austerity (T), when consolidation is mostly driven by the spending or revenue side respectively. Unemployment rates are collected from the AMECO database of DG ECFIN, and cyclical unemployment rates are used for the benchmark specifications.[24]

With regard to the choice of labour market institutions, the z vector consists of the following elements:

$$z = \begin{bmatrix}1 & ud & ub & epl\end{bmatrix}',$$

where ud is the trade union density (unionised members) as percentage of the labour force, ub is the unemployment benefits as percentage of GDP and epl is the employment protection legislation. The institutional data are obtained from the OECD database.[25] The presence of specific labour market characteristics is seen as departure from the mean values of these elements. Each of the parameters will interact with each of the z elements, as outlined in the section of the estimation results. Thus, when the intercept of z vector interacts with each parameter, it corresponds to the coefficient estimates when the labour market institutions are on average values.

Looking at some facts about labour market institutions across European countries, trade union density is relatively low, up to one third of the labour force, in France, Spain and the Netherlands while is up to 50% of the labour force in Portugal, Italy, Austria, Ireland and the UK. More than 50% of the labour force are unionised members in Belgium, Finland, Denmark and Sweden. Unemployment benefits as percentage of GDP are relatively low in the UK and Italy while the proportion is higher in France, Finland, Denmark, Spain and the Netherlands. Ireland, Austria and Belgium are in the middle scale, with spending on unemployment insurance being around one percent of GDP. Despite the fact that some countries have higher or lower employment protection in permanent contracts

[24] Cyclical unemployment rate is taken by subtracting the NAWRU from the total unemployment rate.

[25] An average value for the institutions of each country is used. In general, variation within country in the data during the period considered is small, and in many cases, values are constant across some or all the years (especially for employment protection). The institutional elements are standardized (demeaned by standard deviation) to be comparable. Instead of ub as percentage of GDP, the unemployment benefit replacement rate could be considered. However, it may not be only the level of insurance but also its eligibility that matters, as also mentioned in Blanchard and Summers (1986). Thus, we alternatively use the ub as expenditure share of GDP. The significance of the gross replacement rate measure of OECD ($GRR = \frac{social\ pre-tax\ social\ insurance}{pre-tax\ wage}$) was checked but its role in affecting the coefficients appeared to be weaker as compared to the ub as percentage of GDP. Employment protection legislation is expressed in indexes of security strictness (scores from zero to six). The benchmark specifications include the index for employment protection legislation of temporary contracts. Estimates based on employment protection legislation of permanent contracts are provided in section 7.4 of the Appendix, for which the response of unemployment is not qualitatively different but the effect is of lower magnitude.

comparing to temporary contracts, there is some clear impression for others. In particular, Ireland and the UK have the lowest employment security indexes for both permanent and temporary contracts while Italy, Spain and Portugal have the highest scores for both. Austria, Finland and Denmark are characterised by medium scores.

The choice of the specific labour market institutions is driven by the high attention focused on exploring their role in affecting equilibrium labour market variables and the transmission of shocks. For instance, there is a number of studies supporting that higher trade union density and coverage can positively affect unemployment.[26] Nickell and Layard (1999) argue that unions along with social benefits account for undesirable implications on employment. Calmfors and Driffill (1988) stress out the importance of the degree of wage setting centralization for real wages, equilibrium unemployment and macroeconomic outcomes, claiming that without centralization or with complete centralization there are better outcomes for employment, but medium degrees of centralization lead to higher pressure on real wages and worse employment outcomes. The literature has also been concerned with how employment protection and unemployment benefits affect labour market outcomes in terms of the steady state and dynamics implications.[27]

[26]See Booth et al. (2000) for a summary.
[27]Related studies include Nickell, Nunziata and Ochel (2005) and Blanchard and Wolfers (2000).

5 Estimation results

The tables in this section display posterior mean estimates for the elements of the interaction matrix, Δ, along with the estimated unobserved heterogeneity of the parameters and 68% credible intervals, as commonly used in Bayesian analysis. A model's fit like ρ^2 is also reported, implying how much of the variability of the parameters across countries is explained by the institutional characteristics under consideration. In particular, ρ^2 is given by subtracting the ratio of variation of unobserved components to total variation of the parameters from one. The second column of the tables, this of the intercepts (*int*) expresses what the average responses of the coefficients are when the labour market features are on average. By considering each of the labour market elements we can see how the coefficients are affected. This effect on average responses is expressed in the third column for the trade union density (*ud*), in the fourth column for the unemployment benefit as *GDP* share (*ub*) and in the fifth column for the contribution of employment protection legislation (*epl*). Cyclical unemployment rates are used for the benchmark estimations. Estimation results for total unemployment rates are provided in Appendix, section 7.2. There are three measures for fiscal re-balancing (*FC* for overall consolidation, *G* for spending based and *T* for tax oriented austerity) thus three different panel estimations. The results are shown in Tables 2.2, 2.3 and 2.4 for *FC*, *G* and *T* specifications respectively. The model is adjusted in the cases of *G* and *T* based austerity in order to ensure that we capture the effects of the policy considered given that the other policy may change as well (i.e. when estimating the effects of spending oriented action we control for potential non-zero action in the taxation side). In particular, these specifications are the following:

$$u_{it} = \alpha_i + \beta_{1i}u_{it-1} + \beta_{2i}u_{it-2} + \gamma_{0i}FP_{it} + \gamma_{1i}FP_{it-1} + \gamma_{2i}RC_{it} + \gamma_{3i}RC_{it-1} + \varepsilon_{it}, \quad (2.50)$$

where $\widehat{\gamma_{0i}}, \widehat{\gamma_{1i}}$ are the estimated contemporaneous and lagged total effects of G based action while $\widehat{\gamma_{2i}}, \widehat{\gamma_{3i}}$ are control estimates for $\gamma_{2i} \neq 0, \gamma_{3i} \neq 0$ with RC expressing the tax revenue component.

$$u_{it} = \alpha_i + \beta_{1i}u_{it-1} + \beta_{2i}u_{it-2} + \gamma_{0i}FP_{it} + \gamma_{1i}FP_{it-1} + \gamma_{2i}EC_{it} + \gamma_{3i}EC_{it-1} + \varepsilon_{it}, \quad (2.51)$$

where $\widehat{\gamma_{0i}}, \widehat{\gamma_{1i}}$ are the estimated contemporaneous and lagged total effects of T based action while $\widehat{\gamma_{2i}}, \widehat{\gamma_{3i}}$ are control estimates for $\gamma_{2i} \neq 0, \gamma_{3i} \neq 0$ with EC standing for the expenditure component.

The overall results suggest that the average unemployment rate significantly increases in response to fiscal austerity shocks.[28] Comparing the consolidating policies of different type, we observe that spending oriented austerity seems to increase cyclical unemployment by more as compared to this of taxation, and unemployment responses are significant on impact and with a lag. Tax based policy is suggested to significantly increase cyclical unemployment in a more moderate way on impact, while having zero lagged implications. Labour market institutions provide information about the persistence of unemployment and fiscal transmission. The estimated interactions are significant for some coefficients but weaker or not significant for others. However, even under weak estimates and given

[28] If the credible interval does not include zero, estimates are treated as significant.

the dispersed Bayesian set-up, we mostly focus on how likely is to obtain a negative or a positive sign when conditioning the parameters on the structural information. This will give us an impression of what is the probability for instance that the unemployment persistence and the unemployment response to consolidation are favoured by the presence of a particular feature. The interaction estimates are in some cases big and the implied most likely signs are the expected ones.

More specifically, if labour market features are on average values, an overall fiscal austerity shock, 1% of $GDP\ FC$, causes an increase in cyclical unemployment rate of 0.86 percentage points (pp) on impact. Labour market institutions moderately affect the fiscal transmission to unemployment, given the uncertainty allowed in the model. For example, the response of cyclical unemployment to a FC innovation is likely to be favoured by 0.19 pp if we consider the employment protection index. Also the lead unemployment rate increases by 0.18 pp for average values of institutional features but most likely it responds by 0.2 pp more when employment protection is taken into account. Employment protection appears to significantly make unemployment persist two years after. Looking at the specific type of fiscal action, cyclical unemployment significantly responds to a spending oriented policy shock, rising by 1.51 pp on impact and by 0.65 with a lag while it increases by 0.62 pp in response to a tax based policy shock on impact. It is implied that employment protection can possibly contribute to higher increases of unemployment responding to either G or T oriented policies. Also, the response of average unemployment rate to fiscal shocks seems to be higher on impact when considering the unemployment benefits as GDP share. It does not seem likely that trade union density has a role on fiscal transmission. Instead, it has a significant interaction with the second lagged coefficient of persistence, this of containing unemployment. Finally, by-product estimated coefficients for the individual countries of the panel are shown in Tables 2.5, 2.6 and 2.7 in section 7.3 of the Appendix. These tables depict the estimated responses of cyclical unemployment to overall fiscal consolidation, spending driven and tax oriented austerity respectively, where we can see that there is a lot of heterogeneity across countries both in terms of unemployment persistence and fiscal policy implications on unemployment.

Table 2.2: Cyclical unemployment and FC

beta	*int*	*ud*	*ub*	*epl*	*Unob.Het.*	ρ^2
α (*cons*)	0.22	0.09	0.05	-0.05	0.78	0.03
	(0 0.44)	(-0.15 0.33)	(-0.18 0.28)	(-0.3 0.18)		
β_1 (u_{t-1})	0.65	0.11	0.1	-0.18	0.87	0.08
	(0.41 0.9)	(-0.16 0.38)	(-0.17 0.36)	(-0.45 0.09)		
β_2 (u_{t-2})	-0.15	-0.19	-0.11	0.19	0.55	0.3
	(-0.32 0.01)	(-0.36 -0.01)	(-0.29 0.06)	(0.01 0.37)		
γ_0 (FC_t)	0.86	0.02	0.22	0.19	1.17	0.07
	(0.53 1.18)	(-0.36 0.38)	(-0.13 0.59)	(-0.19 0.55)		
γ_1 (FC_{t-1})	0.18	-0.07	0.09	0.2	0.66	0.16
	(-0.04 0.4)	(-0.31 0.14)	(-0.12 0.31)	(-0.02 0.43)		

Note: 16th and 84th quantiles in parentheses. Unobserved heterogeneity (*Unob.Het.*) measured as the square root of diagonal elements of the estimated V_β.

Table 2.3: Cyclical unemployment and G

beta	*int*	*ud*	*ub*	*epl*	*Unob.Het.*	ρ^2
α (*cons*)	0.19	0.08	0.06	-0.09	0.87	0.03
	(-0.05 0.45)	(-0.17 0.34)	(-0.20 0.33)	(-0.35 0.18)		
β_1 (u_{t-1})	0.73	0.14	0.13	-0.19	1.01	0.07
	(0.44 1.01)	(-0.17 0.44)	(-0.16 0.41)	(-0.48 0.10)		
β_2 (u_{t-2})	-0.22	-0.21	-0.13	0.2	0.64	0.26
	(-0.40 -0.03)	(-0.41 0)	(-0.33 0.05)	(0.01 0.39)		
γ_0 (G_t)	1.51	0.2	0.4	0.29	2.27	0.05
	(0.67 2.36)	(-0.47 0.83)	(-0.24 1.07)	(-0.35 0.98)		
γ_1 (G_{t-1})	0.95	0.05	0.28	0.29	1.51	0.08
	(0.45 1.43)	(-0.41 0.54)	(-0.20 0.73)	(-0.17 0.75)		
γ_2($control_t$)	-0.85	-0.24	-0.22	-0.09	1.68	0.04
	(-1.58 -0.11)	(-0.72 0.24)	(-0.69 0.24)	(-0.59 0.39)		
γ_3($control_{t-1}$)	-0.96	-0.17	-0.23	-0.14	1.59	0.03
	(-1.51 -0.43)	(-0.7 0.33)	(-0.71 0.27)	(-0.65 0.37)		

Note: 16th and 84th quantiles in parentheses. Unobserved heterogeneity measured as the square root of diagonal elements of the estimated V_β. In order to estimate the effects of G based action we control for potential non-zero tax action taken at the same time. The sampler is based on 10,000 draws, of which 10% was used to calculate the posterior ensuring that all the parameter chains were converged.

Table 2.4: Cyclical unemployment and T

beta	*int*	*ud*	*ub*	*epl*	*Unob.Het.*	ρ^2
α (*cons*)	0.18	0.08	0.06	-0.08	0.87	0.02
	(-0.06 0.42)	(-0.19 0.35)	(-0.21 0.32)	(-0.35 0.18)		
β_1 (u_{t-1})	0.75	0.13	0.12	-0.18	0.99	0.07
	(0.46 1.03)	(-0.16 0.43)	(-0.17 0.41)	(-0.47 0.12)		
β_2 (u_{t-2})	-0.22	-0.2	-0.13	0.19	0.62	0.26
	(-0.4 -0.04)	(-0.39 -0.01)	(-0.32 0.05)	(0 0.38)		
γ_0 (T_t)	0.62	0.01	0.16	0.19	0.95	0.08
	(0.33 0.91)	(-0.28 0.31)	(-0.14 0.46)	(-0.11 0.5)		
γ_1 (T_{t-1})	-0.02	-0.11	0.05	0.17	0.69	0.12
	(-0.26 0.21)	(-0.35 0.11)	(-0.17 0.28)	(-0.06 0.41)		
γ_2($control_t$)	1.24	0.24	0.31	0.22	1.91	0.05
	(0.5 1.93)	(-0.32 0.82)	(-0.26 0.87)	(-0.39 0.83)		
γ_3($control_{t-1}$)	0.94	0.11	0.23	0.24	1.49	0.05
	(0.44 1.42)	(-0.35 0.56)	(-0.21 0.7)	(-0.23 0.73)		

Note: 16th and 84th quantiles in parentheses. Unobserved heterogeneity measured as the square root of diagonal elements of the estimated V_β. In order to estimate the effects of T based action we control for potential non-zero expenditure action taken at the same time. The sampler is based on 10,000 draws, of which 1/4 was used to calculate the posterior ensuring that all the parameter chains were converged.

6 Conclusion

This Chapter studied both theoretically and empirically the effects of fiscal consolidation on labour market and unemployment, and examined the role of labour market structure on the transmission mechanism of fiscal austerity. To disentangle the channels of fiscal transmission to the labour market and explore the role of employment protection, the theoretical underpinning provided a DSGE model with labour market frictions and fiscal policy rules. The purpose was to study the effects of contractionary fiscal shocks and unemployment fiscal multipliers along with their interactions with employment protection. The unemployment multiplier of government consumption was found to be of the highest magnitude (the one year cumulative multiplier is -2.55). Contractionary tax shocks appeared to have smaller effects on unemployment. The one year cumulative unemployment multipliers are 1.42 for the labour income taxation and 0.56 for the consumption taxation. Higher employment protection appeared to induce higher multipliers.

On the empirical side we estimated a hierarchical panel model for a number of European countries using Bayesian analysis, the results of which supported the theoretical predictions. Average unemployment rate was suggested to significantly increase in response to fiscal austerity, with spending retrenchment action having a bigger effect on cyclical unemployment comparing to the effect of tax hike policies. The model also explored whether different labour market institutions across countries can contribute to our understanding of heterogeneous unemployment responses to fiscal consolidation and unemployment persistence. For institutional features, we considered unemployment benefits as GDP share, employment protection legislation and trade union density. Employment protection and unemployment benefits seemed to interact with the fiscal transmission, having the tendency to make the response of unemployment stronger.

This study contributes to the ongoing debate on the effects of fiscal austerity on unemployment and the labour market, and the different unemployment fiscal multipliers depending on the adjustment coming from the expenditure or the revenue side. It further considers the role of labour market structure on fiscal transmission, focusing more on the degree of employment protection. There is a big interest about which austerity measures seem to be more employment friendly and how the labour market structure can affect the propagation of the shocks. This analysis suggested that for government budget re-balancing, tax measures appear to have smaller implications on cyclical unemployment comparing to government consumption cuts, and that the effects on unemployment become larger when the policies are implemented under higher employment protection. Given the need of prioritizing fiscal management and maintaining sustainable government budget balances, the attention is focused on practising specific fiscal instruments along with the consideration of country specific institutional features. Thus, policies can be successful in restoring fiscal balances and mitigating potential negative implications on employment.

7 Appendix

7.1 Wage derivation

$$(1-\phi\tau_t^w)w_t(a_t) = (1-\phi)A_t\alpha_t + (1-\phi)(1-s^x)E_t\Lambda_{t+1}[\int\limits_{\widetilde{a}_{t+1}} V_{t+1}^j(a_{t+1})dF(a) -$$

$$F(\widetilde{a}_{t+1})FT] + (1-\phi)FT + \phi(nw)_t - \phi(1-s^x)E_t\Lambda_{t+1}\int\limits_{\widetilde{a}_{t+1}} \underbrace{X_{t+1}^w(a_{t+1})}_{\frac{(1-\phi)}{\phi}(V_{t+1}^j(a_{t+1})+FT)} dFa$$

$$\Rightarrow (1-\phi\tau_t^w)w_t(a_t) = (1-\phi)[A_t\alpha_t + (1-(1-s^x)E_t\Lambda_{t+1})FT] + \ \phi(V_{ut} + rr_b\overline{w})$$

$$+\phi(1-s^x)E_t\Lambda_{t+1}f(\theta_{t+1})\int\limits_{\widetilde{a}_{t+1}} \underbrace{X_{t+1}^w(a_{t+1})}_{\frac{(1-\phi)}{\phi}(V_{t+1}^j(a_{t+1})+FT)} dF(a)$$

$$\Rightarrow (1-\phi\tau_t^w)w_t(a_t) = (1-\phi)\{A_t\alpha_t + (1-(1-s^x)E_t\Lambda_{t+1}(1-f(\theta_{t+1})))FT\} +$$

$$(1-\phi)(1-s^x)E_t\Lambda_{t+1}\kappa\theta_{t+1} \ + \ \phi(V_{ut} + rr_b\overline{w})$$

(after substituting out $V_{t+1}^j(a_{t+1})$ with $\frac{\kappa}{q(\theta_{t+1})}$)

$$\Rightarrow w_t(a_t) = \frac{(1-\phi)}{(1-\phi\tau_t^w)}\{A_t\alpha_t + (1-(1-s^x)E_t\Lambda_{t+1}(1-f(\theta_{t+1})))FT\} +$$

$$\frac{(1-\phi)}{(1-\phi\tau_t^w)}(1-s^x)E_t\Lambda_{t+1}\kappa\theta_{t+1} \ + \ \frac{\phi}{(1-\phi\tau_t^w)}(V_{ut} + rr_b\overline{w})$$

7.2 Total unemployment estimates

Table 2.5: Total unemployment and FC

beta	*int*	*ud*	*ub*	*epl*	*Unob.Het.*	ρ^2
α (*cons*)	4.23	0.89	0.08	2.21	5.2	0.17
	(2.73 5.72)	(-0.62 2.39)	(-1.54 1.72)	(0.65 3.8)		
β_1 (u_{t-1})	0.38	-0.22	0.05	-0.40	0.86	0.22
	(0.11 0.65)	(-0.49 0.05)	(-0.20 0.31)	(-0.68 -0.12)		
β_2 (u_{t-2})	0.08	-0.03	-0.04	0.17	0.55	0.11
	(-0.12 0.26)	(-0.22 0.16)	(-0.22 0.14)	(-0.02 0.37)		
γ_0 (FC_t)	0.83	0.05	0.14	0.16	1.12	0.04
	(0.42 1.25)	(-0.31 0.4)	(-0.22 0.48)	(-0.20 0.52)		
γ_1 (FC_{t-1})	0.33	0.12	0.07	0.24	0.82	0.1
	(-0.02 0.65)	(-0.17 0.39)	(-0.21 0.35)	(-0.08 0.56)		

Note: 16th and 84th quantiles in parentheses. Unobserved heterogeneity (*Unob.Het.*) measured as the square root of diagonal elements of the estimated V_β.

Table 2.6: Total unemployment and G

beta	*int*	*ud*	*ub*	*epl*	*Unob.Het.*	ρ^2
α (*cons*)	4.46	1.06	0.05	2.42	5.61	0.18
	(2.89 6)	(-0.63 2.72)	(-1.62 1.74)	(0.7 4.13)		
β_1 (u_{t-1})	0.35	-0.26	0.04	-0.44	0.93	0.24
	(0.07 0.62)	(-0.55 0.03)	(-0.24 0.32)	(-0.73 -0.14)		
β_2 (u_{t-2})	0.08	-0.03	-0.04	0.2	0.6	0.11
	(-0.11 0.27)	(-0.22 0.17)	(-0.23 0.15)	(0 0.4)		
γ_0 (G_t)	3.36	0.98	0.21	1.79	4.84	0.14
	(1.34 5.4)	(-0.42 2.4)	(-1 1.49)	(0.17 3.5)		
γ_1 (G_{t-1})	-1.15	-0.42	0.03	-0.78	2.12	0.14
	(-2.11 -0.19)	(-1.1 0.2)	(-0.55 0.6)	(-1.57 -0.01)		
$\gamma_2(control_t)$	-2.71	-0.94	-0.05	-1.76	4.5	0.16
	(-4.78 -0.64)	(-2.3 0.28)	(-1.2 1)	(-3.45 -0.19)		
$\gamma_3(control_{t-1})$	1.73	0.7	0.09	1.27	2.9	0.2
	(0.55 2.9)	(-0.14 1.8)	(-0.71 0.89)	(0.28 2.3)		

Note: 16th and 84th quantiles in parentheses. Unobserved heterogeneity (*Unob.Het.*) measured as the square root of diagonal elements of the estimated V_β. In order to estimate the effects of G based action we control for potential non-zero tax action taken at the same time.

Table 2.7: Total unemployment and T

beta	*int*	*ud*	*ub*	*epl*	*Unob.Het.*	ρ^2
α (*cons*)	4.46	1.06	0.09	2.43	5.62	0.18
	(2.9 6.05)	(-0.64 2.74)	(-1.57 1.76)	(0.69 4.19)		
β_1 (u_{t-1})	0.36	-0.25	0.04	-0.43	0.93	0.23
	(0.08 0.64)	(-0.55 0.03)	(-0.25 0.32)	(-0.73 -0.13)		
β_2 (u_{t-2})	0.06	-0.03	-0.04	0.19	0.6	0.11
	(-0.13 0.26)	(-0.22 0.17)	(-0.23 0.15)	(-0.01 0.39)		
γ_0 (T_t)	0.58	0.00	0.13	0.04	1	0.02
	(0.17 0.98)	(-0.33 0.34)	(-0.19 0.45)	(-0.32 0.41)		
γ_1 (T_{t-1})	0.57	0.24	0.11	0.44	1.17	0.16
	(0.16 1.03)	(-0.14 0.62)	(-0.26 0.47)	(0.04 0.85)		
$\gamma_2(control_t)$	3.49	1.08	0.18	2.01	5.22	0.15
	(1.39 5.62)	(-0.41 2.66)	(-1.17 1.57)	(0.29 3.78)		
$\gamma_3(control_{t-1})$	-1.94	-0.78	-0.06	-1.41	3.23	0.20
	(-3.16 -0.73)	(-1.82 0.19)	(-0.99 0.84)	(-2.52 -0.32)		

Note: 16th and 84th quantiles in parentheses. Unobserved heterogeneity (*Unob.Het.*) measured as the square root of diagonal elements of the estimated V_β. In order to estimate the effects of T based action we control for potential non-zero expenditure action taken at the same time.

7.3 Country specific estimates

Table 2.8: Individual country estimates. Cyclical unemployment and FC

	α $(cons)$	β_1 (u_{t-1})	β_2 (u_{t-2})	γ_0 (FC_t)	γ_1 (FC_{t-1})
Austria	0.19	0.18	0.02	-0.01	0
	(0.01 0.37)	(-0.02 0.38)	(-0.17 0.21)	(-0.4 0.35)	(-0.36 0.36)
Belgium	-0.06	0.5	-0.02	0.85	0.38
	(-0.25 0.12)	(0.3 0.69)	(-0.2 0.17)	(0.47 1.2)	(0.02 0.75)
Denmark	0.31	0.73	-0.71	0.88	0.15
	(0.14 0.49)	(0.52 0.92)	(-0.9 -0.5)	(0.47 1.2)	(-0.21 0.5)
Spain	0.12	1.03	-0.02	2.4	0.82
	(-0.07 0.3)	(0.82 1.24)	(-0.21 0.18)	(2 2.9)	(0.4 1.26)
Finland	0.4	1.45	-0.73	1.1	-0.32
	(0.21 0.59)	(1.2 1.6)	(-0.94 -0.52)	(0.7 1.5)	(-0.73 0.09)
France	0.24	0.39	0.1	0.59	0.04
	(0.05 0.41)	(0.19 0.58)	(-0.09 0.28)	(0.2 0.97)	(-0.29 0.38)
Ireland	0.37	0.85	-0.19	0.32	-0.39
	(0.18 0.56)	(0.64 1)	(-0.38 0)	(-0.07 0.71)	(-0.79 0)
Italy	0.12	-0.08	0.39	0.55	0.51
	(-0.04 0.31)	(-0.3 0.12)	(0.2 0.59)	(0.17 0.95)	(0.13 0.88)
Netherlands	0.3	0.49	-0.18	0.92	0.66
	(0.12 0.48)	(0.29 0.7)	(-0.38 0)	(0.53 1.3)	(0.3 1)
Portugal	-0.04	0.3	0.3	0.62	0.16
	(-0.23 0.13)	(0.1 0.5)	(0.12 0.5)	(0.23 1)	(-0.19 0.51)
Sweden	0.57	0.87	-0.27	1.33	0.28
	(0.39 0.76)	(0.67 1)	(-0.46 -0.08)	(0.94 1.7)	(-0.08 0.65)
UK	0.1	1	-0.54	0.66	-0.15
	(-0.08 0.29)	(0.88 1.3)	(-0.74 -0.33)	(0.25 1)	(-0.5 0.22)

Note: 16th and 84th quantiles in parentheses.

Table 2.9: Individual country estimates. Cyclical unemployment and G

	α (*cons*)	β_1 (u_{t-1})	β_2 (u_{t-2})	γ_0 (G_t)	γ_1 (G_{t-1})	$\gamma_2(control_t)$	$\gamma_3(control_{t-1})$
Austria	0.20 (0.04 0.37)	0.17 (-0.04 0.36)	0.02 (-0.16 0.21)	-0.06 (-0.74 0.61)	-0.03 (-0.59 0.51)	0 (-0.71 0.71)	0.10 (-0.52 0.75)
Belgium	-0.09 (-0.28 0.09)	0.54 (0.34 0.75)	-0.05 (-0.24 0.14)	1.21 (0.43 2.01)	0.89 (0.29 1.49)	-0.45 (-1.26 0.35)	-0.56 (-1.21 0.04)
Denmark	0.3 (0.13 0.46)	0.77 (0.55 0.97)	-0.76 (-0.96 -0.55)	1.27 (0.46 2.08)	0.71 (0.08 1.33)	-0.57 (-1.41 0.28)	-0.60 (-1.24 0.06)
Spain	0.03 (-0.17 0.19)	1.28 (1.06 1.50)	-0.17 (-0.38 0.03)	4.43 (2.67 6.22)	3.09 (2.11 4.09)	-2.26 (-4.22 -0.30)	-2.92 (-4.00 -1.96)
Finland	0.34 (0.15 0.53)	1.73 (1.50 1.95)	-0.94 (-1.15 -0.73)	2.92 (1.48 4.36)	1.43 (0.68 2.16)	-2.24 (-3.82 -0.67)	-2.39 (-3.26 -1.53)
France	0.23 (0.06 0.40)	0.44 (0.24 0.64)	0.07 (-0.12 0.25)	0.92 (0.17 1.70)	0.53 (-0.04 1.11)	-0.42 (-1.21 0.35)	-0.62 (-1.26 0.01)
Ireland	0.37 (0.20 0.55)	0.91 (0.68 1.11)	-0.23 (-0.42 -0.03)	0.55 (-0.19 1.28)	-0.02 (-0.61 0.55)	-0.39 (-1.19 0.36)	-0.54 (-1.18 0.11)
Italy	0.10 (-0.07 0.28)	-0.10 (-0.30 0.11)	0.40 (0.20 0.60)	0.68 (-0.09 1.41)	0.70 (0.12 1.30)	-0.15 (-0.89 0.58)	-0.15 (-0.86 0.52)
Netherlands	0.28 (0.10 0.46)	0.49 (0.29 0.70)	-0.20 (-0.40 0.01)	1.20 (0.35 2.00)	1.11 (0.46 1.71)	-0.48 (-1.35 0.41)	-0.32 (-0.97 0.33)
Portugal	-0.08 (-0.26 0.07)	0.42 (0.21 0.61)	0.24 (0.04 0.44)	1.45 (0.54 2.36)	0.92 (0.32 1.51)	-0.96 (-1.92 -0.01)	-1.06 (-1.73 -0.38)
Sweden	0.50 (0.33 0.68)	1.05 (0.85 1.26)	-0.40 (-0.60 -0.19)	2.81 (1.52 4.12)	1.77 (1.07 2.48)	-1.79 (-3.18 -0.43)	-1.88 (-2.70 -1.07)
UK	0.10 (-0.08 0.27)	1.17 (0.96 1.38)	-0.60 (-0.79 -0.40)	1.05 (0.25 1.88)	0.45 (-0.14 1.08)	-0.62 (-1.46 0.22)	-0.75 (-1.43 -0.08)

Note: 16th and 84th quantiles in parentheses.

Table 2.10: Individual country estimates. Cyclical unemployment and T

	α (*cons*)	β_1 (u_{t-1})	β_2 (u_{t-2})	γ_0 (G_t)	γ_1 (G_{t-1})	$\gamma_2(control_t)$	$\gamma_3(control_{t-1})$
Austria	0.21	0.18	0.01	-0.05	0.02	-0.02	-0.08
	(0.03 0.38)	(-0.02 0.36)	(-0.17 0.2)	(-0.38 0.28)	(-0.35 0.39)	(-0.79 0.72)	(-0.69 0.49)
Belgium	-0.08	0.55	-0.06	0.63	0.25	0.87	0.65
	(-0.25 0.09)	(0.34 0.76)	(-0.25 0.13)	(0.27 1)	(-0.12 0.62)	(0.02 1.74)	(0.02 1.29)
Denmark	0.31	0.79	-0.78	0.62	0.01	0.97	0.62
	(0.13 0.49)	(0.58 0.99)	(-0.98 -0.58)	(0.26 0.97)	(-0.38 0.39)	(0.08 1.87)	(-0.05 1.29)
Spain	-0.01	1.29	-0.19	1.92	0.26	3.33	2.97
	(-0.19 0.17)	(1.08 1.5)	(-0.4 0)	(1.46 2.38)	(-0.21 0.72)	(1.82 4.82)	(1.99 3.97)
Finland	0.32	1.69	-0.92	0.75	-0.8	2.62	1.9
	(0.14 0.5)	(1.47 1.9)	(-1.11 -0.71)	(0.35 1.15)	(-1.27 -0.33)	(1.22 3.99)	(1.05 2.73)
France	0.22	0.44	0.07	0.44	-0.07	0.7	0.61
	(0.05 0.39)	(0.24 0.64)	(-0.11 0.25)	(0.09 0.77)	(-0.45 0.3)	(-0.08 1.46)	(-0.01 1.22)
Ireland	0.38	0.91	-0.23	0.14	-0.52	0.54	0.24
	(0.21 0.56)	(0.71 1.12)	(-0.42 -0.04)	(-0.2 0.5)	(-0.91 -0.13)	(-0.3 1.4)	(-0.4 0.9)
Italy	0.09	-0.08	0.4	0.46	0.49	0.41	0.37
	(-0.08 0.27)	(-0.28 0.11)	(0.2 0.59)	(0.1 0.82)	(0.1 0.88)	(-0.37 1.23)	(-0.26 1)
Netherlands	0.28	0.52	-0.21	0.64	0.61	0.83	0.58
	(0.1 0.45)	(0.32 0.72)	(-0.39 -0.02)	(0.27 0.99)	(0.2 1)	(0 1.78)	(-0.05 1.24)
Portugal	-0.09	0.4	0.25	0.46	-0.03	1.19	0.99
	(-0.27 0.07)	(0.2 0.6)	(0.05 0.44)	(0.11 0.83)	(-0.41 0.34)	(0.31 2.09)	(0.31 1.67)
Sweden	0.49	1.03	-0.39	0.97	-0.06	2.31	1.72
	(0.31 0.66)	(0.82 1.23)	(-0.59 -0.19)	(0.6 1.35)	(-0.46 0.32)	(1.16 3.46)	(0.99 2.46)
UK	0.1	1.18	-0.61	0.41	-0.32	0.89	0.59
	(-0.06 0.26)	(0.97 1.39)	(-0.79 -0.41)	(0.03 0.77)	(-0.71 0.06)	(-0.02 1.79)	(-0.05 1.28)

Note: 16th and 84th quantiles in parentheses.

Table 2.11: Individual country estimates. Total unemployment and FC

	α (*cons*)	β_1 (u_{t-1})	β_2 (u_{t-2})	γ_0 (FC_t)	γ_1 (FC_{t-1})
Austria	3.7	-0.2	0.17	0.17	0.19
	(2.57 4.8)	(-0.49 0.1)	(-0.1 0.45)	(-0.35 0.69)	(-0.3 0.7)
Belgium	5.3	0.43	-0.04	1	0.59
	(4.2 6.4)	(0.12 0.74)	(-0.32 0.24)	(0.43 1.57)	(0.04 1.16)
Denmark	3.15	0.62	-0.25	0.75	0.25
	(2 4.2)	(0.32 0.9)	(-0.53 0.03)	(0.23 1.29)	(-0.27 0.76)
Spain	4.9	0.85	0.4	1.52	0.52
	(3.8 6)	(0.53 1.15)	(0.12 0.7)	(0.89 2.15)	(-0.06 1.1)
Finland	7.2	-0.09	0.19	1.3	0.76
	(6 8.3)	(-0.4 0.22)	(-0.1 0.47)	(0.68 1.9)	(0.16 1.3)
France	6.7	-0.16	0.42	0.76	0.44
	(5.6 7.8)	(-0.4 0.14)	(0.13 0.7)	(0.17 1.3)	(-0.13 1)
Ireland	-2.2	1.7	0	0.45	-0.5
	(-0.34 -1.15)	(1.3 2)	(-0.3 0.3)	(-0.17 1.16)	(-1.23 0.09)
Italy	6	-0.28	0.61	0.88	0.67
	(5 7.2)	(-0.6 0.03)	(0.31 0.9)	(0.29 1.4)	(0.09 1.25)
Netherlands	1.9	0.72	-0.27	0.8	0.48
	(0.79 3)	(0.4 1)	(-0.56 0.01)	(0.26 1.3)	(-0.04 1)
Portugal	5.9	0.19	-0.1	0.64	0.33
	(4.8 7)	(-0.1 0.5)	(-0.38 0.18)	(0.06 1.23)	(-0.23 0.89)
Sweden	6.6	-0.34	0.15	0.82	0.65
	(5.5 7.8)	(-0.65 -0.03)	(-0.13 0.44)	(0.23 1.42)	(0.06 1.24)
UK	1.4	1.1	-0.29	0.64	0
	(0.3 2.5)	(0.7 1.42)	(-0.58 0)	(0.08 1.2)	(-0.53 0.54)

Note: 16th and 84th quantiles in parentheses.

Table 2.12: Individual country estimates. Total unemployment and G

	α (*cons*)	β_1 (u_{t-1})	β_2 (u_{t-2})	γ_0 (G_t)	γ_1 (G_{t-1})	$\gamma_2(control_t)$	$\gamma_3(control_{t-1})$
Austria	4.05	-0.25	0.19	2.16	-1.14	-2.29	1.59
	(2.9 5.19)	(-0.56 0.05)	(-0.09 0.47)	(0.35 4.07)	(-2.12 -0.14)	(-4.32 -0.36)	(0.44 2.73)
Belgium	5.50	0.41	-0.04	3.35	-0.92	-2.48	1.80
	(4.37 6.62)	(0.09 0.72)	(-0.33 0.25)	(1.24 5.6)	(-2.03 0.17)	(-4.96 -0.21)	(0.59 3.04)
Denmark	3.19	0.64	-0.28	1.96	-0.54	-1.22	0.81
	(2 4.35)	(0.32 0.94)	(-0.56 0.01)	(0.47 3.54)	(-1.42 0.32)	(-2.87 -0.33)	(-0.18 1.74)
Spain	5.05	0.80	0.44	3.86	-0.89	-2.27	1.58
	(3.9 6.2)	(0.48 1.12)	(0.14 0.74)	(1.58 6.28)	(-2 0.26)	(-4.86 0.11)	(0.26 2.85)
Finland	8.02	-0.23	0.23	5.80	-2.01	-4.73	3.43
	(6.81 9.22)	(-0.56 0.1)	(-0.08 0.53)	(2.1 10)	(-3.7 -0.23)	(-9.25 -0.69)	(1.44 5.46)
France	7.18	-0.25	0.45	4.24	-1.83	-3.83	2.69
	(5.99 8.33)	(-0.56 0.06)	(0.14 0.74)	(1.35 7.36)	(-3.26 0.41)	(-7.76 -0.72)	(1.09 4.31)
Ireland	-2.79	1.82	-0.04	-1.54	0.84	2.24	-2.05
	(-3.97 -1.58)	(1.46 2.16)	(-0.36 0.29)	(-3.62 0.39)	(-0.35 2)	(0.17 4.47)	(-3.43 -0.69)
Italy	6.41	-0.38	0.67	4.07	-1.39	-3.39	2.56
	(5.24 7.55)	(-0.7 -0.05)	(0.36 0.97)	(1.37 6.92)	(-2.7 -0.07)	(-6.49 -0.51)	(1 4.05)
Netherlands	1.83	0.73	-0.29	1.43	0.12	-0.51	0.52
	(0.69 2.96)	(0.41 1.05)	(-0.58 0)	(0.16 2.75)	(-0.69 0.98)	(-1.89 0.78)	(-0.4 1.47)
Portugal	6.13	0.24	-0.16	3.22	-1.32	-2.90	1.67
	(4.98 7.26)	(-0.01 0.53)	(-0.46 0.14)	(1 5.59)	(-2.48 -0.16)	(-5.52 -0.5)	(0.4 2.95)
Sweden	7.37	-0.47	0.18	4.87	-1.91	-4.34	3.15
	(6.16 8.57)	(-0.7 -0.11)	(-0.12 0.48)	(1.54 3.54)	(-3.5 -0.31)	(-8.29 -0.76)	(1.33 5.02)
UK	1.30	1.17	-0.34	0.74	-0.05	-0.08	-0.12
	(0.16 2.9)	(0.84 1.4)	(-0.64 0)	(-0.46 2)	(-0.88 0.77)	(-1.37 1.16)	(-1 0.83)

Note: 16th and 84th quantiles in parentheses.

Table 2.13: Individual country estimates. Total unemployment and T

	α (*cons*)	β_1 (u_{t-1})	β_2 (u_{t-2})	γ_0 (T_t)	γ_1 (T_{t-1})	$\gamma_2(control_t)$	$\gamma_3(control_{t-1})$
Austria	4.14	-0.27	0.2	-0.06	0.48	3.12	-2.3
	(2.99 5.26)	(-0.58 0.04)	(-0.09 0.47)	(-0.64 0.5)	(-0.1 1.07)	(0.97 5.33)	(-3.66 -0.9)
Belgium	5.49	0.44	-0.07	0.7	0.87	4.05	-2.19
	(4.35 6.63)	(0.13 0.75)	(-0.36 0.21)	(0.09 1.3)	(0.26 1.5)	(1.63 6.53)	(-3.61 -0.75)
Denmark	3.21	0.65	-0.29	0.59	0.34	2.24	-1.08
	(2.1 4.32)	(0.35 0.95)	(-0.58 -0.01)	(0.03 1.12)	(-0.23 0.93)	(0.46 4.08)	(-2.26 0.13)
Spain	5.13	0.83	0.4	1.25	0.77	4.29	-1.97
	(3.95 6.24)	(0.51 1.14)	(0.12 0.7)	(0.06 1.91)	(0.08 1.43)	(1.7 6.95)	(-3.47 -0.45)
Finland	8.28	-0.24	0.19	0.91	1.44	7.62	-4.64
	(7.06 9.44)	(-0.55 0.08)	(-0.11 0.48)	(0.17 1.64)	(0.7 2.16)	(3.25 11.8)	(-6.85 -2.36)
France	7.3	-0.26	0.45	0.37	0.92	5.69	-3.78
	(6.07 8.43)	(-0.56 0.06)	(0.15 0.74)	(-0.29 1.04)	(0.25 1.57)	(2.4 8.82)	(-5.44 -1.97)
Ireland	-2.87	1.82	-0.04	0.56	-0.98	-2.76	2.57
	(-4.04 -1.65)	(1.47 2.16)	(-0.34 0.28)	(-0.15 1.24)	(-1.71 -0.24)	(-5.15 -0.23)	(0.86 4.14)
Italy	6.45	-0.37	0.65	0.55	1.13	5.2	-3.26
	(5.28 7.56)	(-0.7 -0.04)	(0.35 0.94)	(-0.12 1.18)	(0.47 1.8)	(2.2 8.13)	(-4.82 -1.55)
Netherlands	1.78	0.77	-0.32	0.71	0.54	1.36	-0.26
	(0.67 2.96)	(0.45 1.08)	(-0.61 -0.02)	(0.15 1.26)	(-0.04 1.17)	(-0.24 3.13)	(-1.48 0.87)
Portugal	6.07	0.24	-0.17	0.32	0.52	4.16	-2.33
	(4.9 7.23)	(-0.07 0.55)	(-0.46 0.13)	(-0.31 0.94)	(-0.1 1.16)	(1.63 6.68)	(-3.75 -0.88)
Sweden	7.56	-0.48	0.17	0.48	1.24	6.62	-4.34
	(6.39 8.74)	(-0.8 -0.15)	(-0.13 0.46)	(-0.21 1.19)	(0.54 1.92)	(2.78 10.33)	(-6.27 -2.24)
UK	1.26	1.19	-0.36	0.53	-0.09	0.52	0.18
	(0.15 2.42)	(0.86 1.5)	(-0.65 -0.06)	(-0.05 1.09)	(-0.69 0.53)	(-1.02 2.22	(-1.06 1.35)

Note: 16th and 84th quantiles in parentheses.

7.4 Cyclical unemployment estimates (permanent contract protection)

Table 2.14: Cyclical unemployment and FC (permanent *epl*)

beta	*int*	*ud*	*ub*	*epl*	*Unob.Het.*	ρ^2
α (*cons*)	0.22	0.09	0.06	-0.03	0.78	0.022
	(0 0.44)	(-0.14 0.33)	(-0.17 0.3)	(-0.26 0.2)		
β_1 (u_{t-1})	0.65	0.13	0.11	-0.17	0.87	0.07
	(0.4 0.89)	(-0.13 0.39)	(-0.14 0.38)	(-0.42 0.09)		
β_2 (u_{t-2})	-0.15	-0.19	-0.12	0.17	0.55	0.28
	(-0.31 0.01)	(-0.37 -0.02)	(-0.29 0.05)	(0.01 0.34)		
γ_0 (FC_t)	0.86	-0.01	0.24	0.03	1.17	0.05
	(0.51 1.22)	(-0.36 0.34)	(-0.12 0.6)	(-0.31 0.38)		
γ_1 (FC_{t-1})	0.18	-0.1	0.08	0.11	0.66	0.09
	(-0.04 0.4)	(-0.33 0.12)	(-0.13 0.31)	(-0.1 0.32)		

Note: 16th and 84th quantiles in parentheses. Unobserved heterogeneity (*Unob.Het.*) measured as the square root of diagonal elements of the estimated V_β.

Table 2.15: Cyclical unemployment and G (permanent *epl*)

beta	*int*	*ud*	*ub*	*epl*	*Unob.Het.*	ρ^2
α (*cons*)	0.18	0.09	0.05	-0.04	0.87	0.02
	(-0.05 0.43)	(-0.16 0.35)	(-0.21 0.32)	(-0.29 0.21)		
β_1 (u_{t-1})	0.73	0.15	0.13	-0.15	1	0.07
	(0.45 1)	(-0.14 0.46)	(-0.17 0.43)	(-0.44 0.13)		
β_2 (u_{t-2})	-0.21	-0.22	-0.14	0.17	0.63	0.24
	(-0.39 -0.03)	(-0.41 -0.02)	(-0.34 0.05)	(-0.02 0.35)		
γ_0 (G_t)	1.58	0.17	0.4	0.18	2.3	0.04
	(0.76 2.41)	(-0.49 0.82)	(-0.27 1.09)	(-0.47 0.85)		
γ_1 (G_{t-1})	0.93	0	0.27	0.2	1.45	0.07
	(0.45 1.41)	(-0.44 0.45)	(-0.18 0.72)	(-0.23 0.66)		
$\gamma_2(control_t)$	-0.91	-0.22	-0.2	-0.13	1.7	0.03
	(-1.66 -0.16)	(-0.71 0.27)	(-0.71 0.29)	(-0.63 0.34)		
$\gamma_3(control_{t-1})$	-0.94	-0.15	-0.21	-0.13	1.5	0.04
	(-1.46 -0.42)	(-0.62 0.32)	(-0.69 0.26)	(-0.59 0.33)		

Note: 16th and 84th quantiles in parentheses. Unobserved heterogeneity (*Unob.Het.*) measured as the square root of diagonal elements of the estimated V_β. In order to estimate the effects of G based action we control for potential non-zero tax action taken at the same time.

Table 2.16: Cyclical unemployment and T (permanent *epl*)

beta	*int*	*ud*	*ub*	*epl*	$Unob.Het.$	ρ^2
α (*cons*)	0.19	0.09	0.05	-0.05	0.87	0.02
	(-0.06 0.44)	(-0.17 0.36)	(-0.21 0.31)	(-0.3 0.2)		
β_1 (u_{t-1})	0.73	0.14	0.13	-0.15	0.98	0.06
	(0.45 1)	(-0.15 0.44)	(-0.16 0.43)	(-0.44 0.14)		
β_2 (u_{t-2})	-0.22	-0.22	-0.14	0.17	0.63	0.25
	(-0.4 -0.03)	(-0.41 -0.02)	(-0.34 0.04)	(-0.02 0.36)		
γ_0 (T_t)	0.62	-0.02	0.17	0.05	0.96	0.05
	(0.33 0.92)	(-0.32 0.27)	(-0.12 0.47)	(-0.24 0.34)		
γ_1 (T_{t-1})	0	-0.13	0.05	0.08	0.68	0.07
	(-0.23 0.23)	(-0.36 0.1)	(-0.18 0.27)	(-0.14 0.31)		
$\gamma_2(control_t)$	1.18	0.2	0.28	0.15	1.88	0.04
	(0.44 1.94)	(-0.33 0.77)	(-0.27 0.85)	(-0.4 0.69)		
$\gamma_3(control_{t-1})$	0.92	0.07	0.23	0.17	1.47	0.04
	(0.41 1.43)	(-0.38 0.52)	(-0.23 0.69)	(-0.28 0.62)		

Note: 16th and 84th quantiles in parentheses. Unobserved heterogeneity ($Unob.Het.$) measured as the square root of diagonal elements of the estimated V_β. In order to estimate the effects of T based action we control for potential non-zero expenditure action taken at the same time.

7.5 Diagnostics of the Gibbs sampler

Table 2.17: Raftery Lewis diagnostics: dependence factor I

		int	*ud*	*ub*	*epl*
	α	1.03	1.02	1.00	1.00
	β_1	0.98	1.00	1.01	1.02
FC	β_2	1.03	1.04	1.02	0.99
	γ_0	1.00	1.02	1.00	0.99
	γ_1	1.12	1.08	1.00	1.02
	α	1.05	1.06	1.07	1.00
	β_1	1.11	1.08	1.00	1.06
	β_2	1.10	1.08	1.03	1.02
G	γ_0	2.12	0.99	1.11	1.20
	γ_1	1.29	1.08	1.03	1.08
	γ_2	3.03	1.29	1.40	1.31
	γ_3	1.37	1.15	1.10	1.11
	α	0.99	0.99	1.00	0.96
	β_1	1.10	0.98	1.00	1.00
	β_2	1.03	1.09	0.98	1.00
T	γ_0	1.08	1.01	0.97	1.03
	γ_1	1.20	1.05	1.01	1.01
	γ_2	4.59	1.07	1.02	1.18
	γ_3	3.26	0.95	1.01	1.10

Note:. I statistic (dependence factor) is given by the sum of N (iterations proposed) and M (burn-in) divided by N_{min} (iterations if there was no serial correlation). When this factor exceeds 5, autocorrelation is a concerning issue.

Chapter 3

The relationship between fiscal and current account balances in the UK

1 Introduction

A lot of attention has been focused on the implications of fiscal policy shocks on various macroeconomic variables. When considering fiscal economic implications within a small open economy, we are interested, among other variables, in the current account and the real exchange rate movements. Current account movements and their association with the real exchange rate have been the focus of a big strand of the literature. Along these lines, Bussière, Karadimitropoulou and Leòn-Ledesma (2018) examine the effects of temporary and permanent output shocks, preferences shock and external supply shock on the current account of G6 countries and how related the impulse responses of the current account and real exchange rate are; stressing the role of the specific type of shock in explaining the relationship between these two. Lee and Chinn (2006) also focus on the responses of current account and real exchange rate to permanent and temporary shocks for G7 economies. Instead of examining current account dynamics from a more general point of view, the aim of this Chapter is to focus on how current account movements are potentially related to the fiscal stance.

How does the current account respond to changes in the government budget balance? It could be theoretically argued that an increase in government deficit causes a deterioration in the current account and real exchange rate appreciation, as expansionary fiscal policy funded by debt can potentially induce higher interest rate, and by attracting capital inflows, can lead to real exchange rate appreciation and current account deterioration.[1] This behaviour lies behind the "twin deficits" hypothesis, a Keynesian perspective regarding the co-movement between government budget and current account deficits. According to the opposite theoretical argument, this of Ricardian equivalence (following Barro, 1989), an increase in the government budget deficit is not expected to incur a deterioration in the current account, as the private sector increases savings and decreases consumption in expectation of future taxation in order the government debt to be financed. Moreover, New Open Economy Macroeconomics models give justification on how higher public spending permanently can lead to an improvement in the net foreign investment position, as outlined by Obstfeld and Rogoff (1995) and Betts and Devereux (2000a). Such arguments can be intuitively framed by the basic current account identity, representing the total foreign wealth holdings. Following Krugman and Obstfeld (ch.12, 2009), the current account identity can be expressed as follow:

$$\begin{aligned} CA &= EX - IMP \\ S &= Y - C - G + CA \Rightarrow \\ S &= I + CA \Rightarrow \\ (S^p + S^g) &= (Y - T - C) + (T - G) = I + CA \Rightarrow \\ CA &= (S^p - I) + (T - G), \end{aligned} \tag{I1}$$

where CA, EX, IMP, I, Y, C and $(T - G)$ stand for current account, exports, imports, investment, output, consumption and government budget balance respectively. S represents national saving which breaks down into public saving, S^g, and private saving, S^p.

[1] This mechanism is explained by among others, Obstfeld and Rogoff (1996).

The identity implies that the relationship between current account and government budget balance depends on the adjustment of private saving.

Empirical findings on the relationship between government budget and current account balances have not been converged to the same direction. For instance, Roubini (1988) and Normandin (1999) have argued that a worsening position in the US trade balance has been caused by fiscal deficits. Further evidence on a positive relationship between budget and current account balances can be found in Bluedorn and Leigh (2011) by implementing their analysis on a panel of 17 OECD countries, Beetsma, Giuliodori and Klaassen (2008) by employing a panel VAR model of 14 EU countries, and Papadogonas and Stournaras (2006) by conducting a Johansen's cointegration analysis for 15 EU countries. A less clear positive relationship is implied by Khalid and Guan (1999) who outline that the "twin deficits" behaviour is relevant for the developing but not the developed countries. Along similar lines, Evans (1988) and Bussière, Fratzscher and Müller (2010) show that current account has only a moderate response to the deterioration of the government budget balance. Erceg, Guerrieri and Gust (2005), by employing a dynamic general equilibrium model, indicate that an increase in government budget deficit can only moderately affect the US trade balance, emphasizing that the drivers of trade balance deficits do not find their roots in government budget deficits but other factors (e.g. rise in productivity, moderate worldwide growth and investors who switch to US assets). Using a panel of countries, Badinger, Clairfontaine and Reuter (2016) show that current account positively responds to government budget balance, but such a relationship is conditional on country specific fiscal rules, i.e. the presence of strict rules can decrease or even suppress this impact. Moreover, Kim and Roubini (2008), by focusing on whether the "twin deficits" argument is supported for the US, show that not only does this hypothesis not hold but also that higher fiscal deficit is associated with an improvement in the current account and real exchange rate depreciation during some periods and especially in the recent times. They attribute this diverging relationship between the government budget and current account balances mostly to output shocks. Current account could be improved after a deterioration in government savings if agents, by adopting Ricardian-type behaviour, increase private savings to counterbalance for the higher public spending. Thus, consumption and private investment can fall and current account may experience an improvement. Also, Antonakakis et al. (2016) disentangle the long-run relationship between fiscal and trade balance deficits in the US for a very long period, highlighting the importance of non-linearities in this relationship.

Given that the link between these balances is still not clear, this Chapter is concerned with the question of how relevant the "twin deficits" hypothesis is for the UK economy, which has indicated both fiscal and current account deficits over times. The implications of contractionary fiscal shocks on a number of macroeconomic variables are investigated within an open-economy set-up, with the attention focused on the responses of the current account and the real exchange rate. To this end, we aim to explore whether fiscal consolidation shocks are associated with an improved position in the current account, as the "twin deficits" hypothesis would imply. More specifically, the effects of a positive shock in the government budget balance are examined, by employing a SVAR model with short-run identifying restrictions, i.e. imposing a recursive scheme following Sims (1980); an approach close to the one followed by Kim and Roubini (2008) for the case of the US. Besides, an alternative method for shock identification is adopted, as proposed by Stock and Watson (2012) and Mertens and Ravn (2014), namely the "proxy SVAR" model, in order to recover structural tax revenue shocks and explore their implications in an open-economy framework. According to this method, the "true" or structural tax revenue shocks can be recovered within a SVAR model by using a tax instrument which comes from narrative estimates of unanticipated tax changes. Regarding this approach, Mertens and Ravn (2014) study the effects of tax revenue shocks in the US within a closed economy environment, using the narrative tax estimates of Romer and Romer (2009). In a very recent study, Mumtaz and Petrova (2018, 2019) propose a time-varying parameter "proxy SVAR" and explore tax shocks implications on the US and UK output growth using narrative estimates of Mertens and Ravn (2012) and Cloyne (2013). However, based on my knowledge, an open-economy analysis for the UK with a focus on investigating the relationship between the government budget stance and the current account, has not been developed yet. One of the contributions of this Chapter is to employ the "proxy SVAR" approach in order to identify tax revenue shocks in the UK within an open-economy framework, using the narrative estimates for changes of tax revenues constructed by Cloyne (2013).

This Chapter first examines the responses of output, current account, real interest rate and real exchange rate to a government budget balance shock which implies an improvement in public savings, by imposing short-run identifying restrictions (recursive scheme) in a SVAR model. We are particularly interested in figuring out how shocks in the government budget balance affect the current account balance and the real exchange rate. Second, the focus turns into the responses of these variables to an increase in tax revenues using the "proxy SVAR" methodology, in order to examine the implied relationship between the change in taxation and current account and real exchange rate.

Based on the recursive identification scheme, a positive shock in the primary government budget balance causes real exchange rate appreciation but the current account does not seem to significantly respond. It is likely that output increases in response to an improvement in the government budget balance in the first year, which implies that private agents behave in a Ricardian manner, but the significance of its response is sensitive to the ordering of the variables. Based on the "proxy SVAR" estimates, an increase in tax revenues causes a significant decrease in output growth. Real exchange rate significantly appreciates in the long-run, which is also consistent with the results of the SVAR model based on the recursive identification scheme. The response of current account to an increase of one per cent of GDP tax revenues is not found to be statistically significant. Overall, the findings of this Chapter do not provide support to the "twin deficits" argument for the UK, for the time period under consideration, implying that private agents seem to adopt a Ricardian type of behaviour as a response to fluctuations in government budget balance.

What composes the rest of the Chapter is outlined as follow. Section 2 reviews some existing relevant empirical literature for the UK. Section 3 presents the empirical methodology implemented and the estimation results. More specifically, sub-section 3.1 outlines a SVAR model, in which short-run identifying restrictions are imposed in order to investigate the effects of a government budget balance shock on the current account and real exchange rate. Sub-section 3.2 employs the narrative identification approach in a SVAR setup to explore the implications of a tax revenue shock, and its implied relationship with the country's net foreign investment position. Finally, Section 4 concludes.

2 Empirical literature for the UK

There is relatively limited but fast growing research on the effects of fiscal shocks in the UK. Barro (1987), based on a long time span analysis since 1700s to World War I, has shown that a government spending shock leads to an increase in the long-run interest rate. More recently, Perotti (2005), by exploring the effects of fiscal shocks for a number of OECD countries, supports that in the UK, output, interest rate and inflation rise in response to a positive government spending shock; and output and inflation rise, and interest rate moderately increases on impact due to a tax cut shock. Cloyne (2013) constructs a dataset for tax revenues shocks in the UK using a narrative approach in order to explore the effects of these tax changes on macroeconomic variables. Cloyne finds that a tax cut leads to an increase in output, consumption, investment, real wages and imports. Mumtaz and Petrova (2019), by implementing a time-varying parameter "proxy SVAR", show that the effect of tax shocks on UK output growth has been reduced over time.

With regard to the literature focusing on the responses of current account and real exchange rate to fiscal shocks, Monacelli and Perotti (2010) find that a positive government spending shock causes real exchange rate depreciation and worsening in the trade balance. Ravn, Schmitt-Groh and Urib (2007), by using a panel VAR model and considering deep habits, suggest that in the UK, a positive government spending innovation leads to higher consumption and output, trade balance worsening and real exchange rate depreciation.

Alonso and Sousa (2009), by employing a Bayesian SVAR model with recursive identification structure, claim that a positive spending shock leaves consumption almost unaffected while decreases investment, money supply growth and housing and stock prices, but increases productivity and real wage, and depreciates the real exchange rate. Kamal (2010), by studying the effects of UK fiscal shocks using sign restrictions, following Mountford and Uhlig (2009), shows that after a positive financed by deficit spending shock, output, investment, consumption and real wage respond positively but moderately, real exchange rate depreciates and trade balance improves. Kamal (2010) also finds that after a financed by deficit tax cut, output, consumption and investment rise, real wage falls, real exchange rate appreciates and trade balance improves.

More specifically about the correlation between fiscal and current account deficits, Xie and Chen (2014) do not find a positive relationship among them for the UK, when applying panel Granger causality testing. Also, Daly and Siddiki (2009), by using cointegration analysis for 23 OECD nations, find that in some countries including the UK, private agents respond in a Ricardian way to fiscal deficits.

3 Empirical methodology and results

3.1 A SVAR model with short-run restrictions

We are interested in recovering structural shocks of UK government budget balance and examine its effects on real output, current account, real interest rate and real effective exchange rate, based on SVAR analysis. We focus on the relationship between government budget and current account balances. Figure 3.1 provides the pattern of these figures. Current account and government budget balance do not appear to have a clear correlation, while we notice periods of divergence especially when comparing the current account with the primary government budget balance.

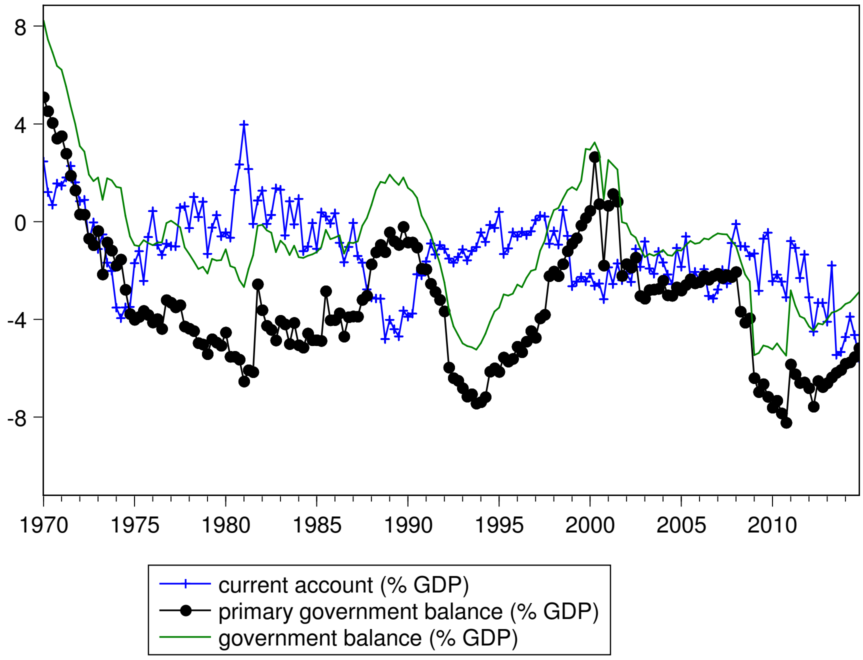

Figure 3.1: Current account and (primary) government budget balance, 1970-2014. The figures are expressed in percentage of GDP.

The system of structural equations we estimate is characterised by the following SVAR specification:

$$A_0 X_t = \sum_{i=1}^{p} A_i X_{t-i} + \varepsilon_t,$$

where $E(\varepsilon\varepsilon') = \Omega$, with $\varepsilon's$ structural innovations assumed to be orthogonal. The SVAR model cannot be directly estimated unless the A_0 matrix is diagonal. The model's reduced form representation can be expressed by the following unrestricted VAR model:

$$X_t = \sum_{i=1}^{p} B_i X_{t-i} + e_t,$$

where $B_i = A_0^{-1} A_i$, $e_t = A_0^{-1}\varepsilon_t$ and $E(ee') = A_0^{-1}\Omega A_0^{-1\prime}$; a system that can be estimated. The matrix B has k^2 elements to be estimated for k parameters, and the variance co-variance matrix of the reduced form errors has $\frac{k(k+1)}{2}$ parameters that can be estimated, thus overall $(k^2 + \frac{k(k+1)}{2})$ parameters can be informative for the estimation of the SVAR model. However the SVAR specification entails $(k^2 - k)$ parameters of the A_0 matrix after normalization of the system, k^2 parameters of the A_i matrix and k variances of the structural innovations, so in total $2k^2$ parameters have to be estimated. The information coming from the VAR model is only for $(k^2 + \frac{k(k+1)}{2})$ parameters though, thus $(\frac{k(k-1)}{2})$ restrictions have to be imposed on the SVAR model in order to recover the structural shocks of the system. Consequently, short-run identifying restrictions are imposed in the structural matrix A_0. Such a type of identification approach is based on the recursive scheme proposed by Sims (1980), in which by assuming that the A_0 matrix is triangular and given that Ω is diagonal, the orthogonalization of the reduced form errors is achieved by Cholesky decomposition.

The model to be estimated consists of five variables, and the methodology followed is similar to this of Kim and Roubini (2008) in their relevant study for the US. Primary government budget balance, real GDP, current account, real interest rate and real effective exchange rate are included in the specification. The data are collected from the OECD (Main Economic Indicators), the IMF (International Financial Statistics), and the Office for National Statistics (ONS). The analysis covers a period since the first quarter of 1970 until the fourth quarter of 2014. Further explanation about the data is provided in Appendix, section 5.1. More specifically, the variables are expressed as *pgov* for primary government budget balance as percentage of GDP, y for the log of real GDP, *ca* for the current account as percentage of GDP, *rir* for the real interest rate and *reer* for the log of real effective exchange rate. Augmented Dickey Fuller testing for unit roots (Dickey and Said, 1984) suggested that *pgov* and *ca* are stationary while the unit root hypothesis could not be rejected for y, *rir* and *reer*. The variables are used in levels and ratios even if evidence for unit roots were suggested.[2] This treatment follows Gospodinov, Herrera and Pesavento (2013) who conclude that when using short-run identifying restrictions, the impulse responses are similar for both a VAR in levels and a VAR controlled for unit roots and vector error corrections terms.

[2] A stationary VAR model, where y, *rir* and *reer* are included in first differences, is also estimated, the impulse response functions of which are depicted in Appendix, section 5.3.

The ordering of the variables plays an important role in terms of addressing endogeneity concerns. More specifically, the exogenous variables are initially ordered and the real variables are ordered before the financial ones treated as simultaneously exogenous to them, following Kim and Roubini (2008). It is first assumed that government budget balance movements are exogenous to contemporaneous economic conditions due to sluggish fiscal policy which takes some time to respond to changes in current activity, thus primary government budget balance is ordered first, assuming that it responds only to the lagged variables of the system. Once we impose the recursive identification scheme (Cholesky decomposition) on the SVAR model, we can estimate the system equation by equation using Ordinary Least Squares method. The lower triangular A_0 matrix is:

$$A_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -\alpha_{pgov}^{y} & 1 & 0 & 0 & 0 \\ -\alpha_{pgov}^{ca} & -\alpha_{y}^{ca} & 1 & 0 & 0 \\ -\alpha_{pgov}^{rir} & -\alpha_{y}^{rir} & -\alpha_{ca}^{rir} & 1 & 0 \\ -\alpha_{pgov}^{reer} & -\alpha_{y}^{reer} & -\alpha_{ca}^{reer} & -\alpha_{rir}^{reer} & 1 \end{bmatrix},$$

and the system of equations is expressed as:

$$pgov_t = \sum_{i=1}^{p} A_i X_{t-i} + \varepsilon_t^{pgov} \tag{3.1}$$

$$y_t = \alpha_g^{y} pgov_t + \sum_{i=1}^{p} A_i X_{t-i} + \varepsilon_t^{y} \tag{3.2}$$

$$ca_t = \alpha_g^{ca} pgov_t + \alpha_y^{ca} y_t + \sum_{i=1}^{p} A_i X_{t-i} + \varepsilon_t^{ca} \tag{3.3}$$

$$rir_t = \alpha_g^{rir} pgov_t + \alpha_y^{rir} y_t + \alpha_{ca}^{rir} ca_t + \sum_{i=1}^{p} A_i X_{t-i} + \varepsilon_t^{rir} \tag{3.4}$$

$$reer_t = \alpha_g^{reer} pgov_t + \alpha_y^{reer} y_t + \alpha_{ca}^{reer} ca_t + \alpha_{rir}^{reer} rir_t + \sum_{i=1}^{p} A_i X_{t-i} + \varepsilon_t^{reer}. \tag{3.5}$$

Once we estimate the A_0 matrix, we can recover the structural shocks by using the relationship between the reduced form errors and the structural innovations, $e_t = A_0^{-1}\ \varepsilon_t$, and obtain the impulse responses of our variables to the structural shocks. A constant and four lags are included in the VAR model. In particular, the Akaike information criterion suggested two lags, however four lags are included to deal with the presence of serial correlation in the VAR residuals. It is common that the dynamics in a quarterly VAR are framed by four lags, given that the number of observations allows for. Diagnostics VAR tests are included in Appendix, section 5.2. From equation 3.1, we see that the estimated residuals correspond to the "true" structural shocks. We can sequentially estimate the system, i.e. using $pgov_t$ to the other equations in order to estimate $\alpha_g^{y}, \alpha_g^{ca}, \alpha_g^{rir}$ and α_g^{reer} which partly compose A_0, and express the contemporaneous responses of each variable to a standard deviation government budget balance shock. Once we obtain the A_0 matrix, we map from the reduced form residuals into the structural shocks using $e_t = A_0^{-1}\varepsilon_t$, and eventually extract the impulse response functions to each shock.

Figure 3.2 depicts the impulse responses of all variables to each one standard deviation shock over a five year horizon. It is shown that in response to a positive one standard deviation shock in the primary government budget balance, real exchange rate appreciates but current account and real interest rate do not appear to significantly respond. Output increases in the first year but its response becomes insignificant then after. These responses could imply that as government improves its fiscal stance, private agents save less in expectation of lower future taxation and, by consuming more, increase the demand for money, thus real exchange rate appreciates. Such a type of behaviour is consistent with the Ricardian equivalence hypothesis and the assumption used in the New Open Macroeconomics models about money demand being led by consumption (Obstfeld and Rogoff, 1995). These results do not give rise to the "twin deficits" hypothesis, as current account does not show a significant response to a positive shock in the primary government budget balance. This is consistent with the findings of Kim and Roubini (2008) for the US, implying that fiscal and current account deficits can move to different directions during some periods, partially due to the argument of the Ricardian equivalence. To this end, it is implied that after an improvement in the government budget balance, when it is caused by a decrease in public spending, people expect lower taxes in the future, so private saving falls. If private saving decreases after an increase in public saving, then the current account might remain unaffected. Also, a decrease in private saving implies higher consumption which can moderately drive output upwards. The impulse responses obtained are consistent with these theoretical suggestions.

One could expect that larger fiscal deficit, when associated with higher real interest rate, suppresses investment thus demand according to the "crowding-out" factor, as explained by among others Spencer and Yohe (1970). In our case, real exchange rate appreciates as a response to an improvement in primary government budget balance but real interest rate appears to be unaffected. Within the robustness checks, when a positive shock in government budget balance (including net interest rate payments) is considered, real interest rate seems to increase in early horizons. A possible explanation behind this could be that agents, by decreasing private savings as government saves more, can induce an increase in the real interest rate. Also private consumption would rise, causing real exchange rate appreciation (if it is assumed that money demand is driven by consumption demand, as supported in the New Open Economy Macroeconomics models, e.g. Obstfeld and Rogoff, 1995). The impulse responses of the SVAR model including government budget balance (instead of primary government budget balance) are provided in Appendix, section 5.4.

Focusing on the effects of primary government balance shocks, the results presented here are compared with those of Monacelli and Perotti (2010) who apply SVAR methodology to study the implications of fiscal shocks in a number of countries, including the UK. They show that increasing government spending causes real exchange rate depreciation and deterioration in the trade balance. Our findings are consistent with their findings in terms of the real exchange rate, as in our case an improvement in government savings induces real exchange rate appreciation. However, we do not obtain significant responses of the current account, which could be explained by agents adopting a Ricardian-type behaviour.

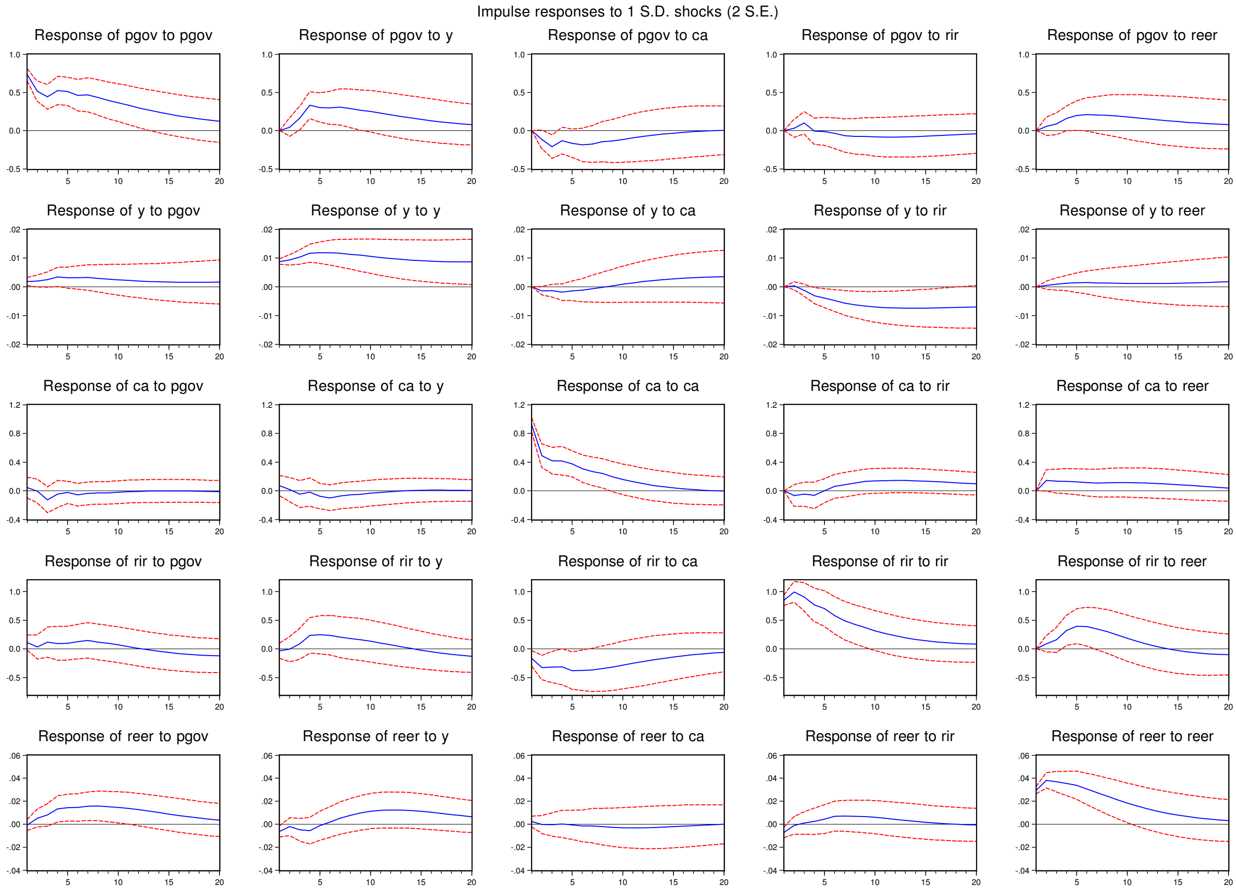

Figure 3.2: Recursive identification (ordering primary government budget balance first), 1970Q1-2014Q4. Impulse responses to structural one standard deviation innovations with two standard error bands for the horizon of five years. Standard errors are based on 10,000 Monte Carlo repetitions.

In response to a positive shock in output, primary government budget balance seems to be improved. The reason why is that economies while experiencing booms or recessions, deal with conditions of either fiscal contraction or fiscal expansion respectively, due to the automatic stabilizing role of the government budget's components, as outlined among others by Fatas (2009). With regard to current account, it does not generally exhibit a significant response to output fluctuations. When the government budget balance (including net interest rate payments) is alternatively used (Appendix, section 5.4), current account might deteriorate in the longer horizons. As also highlighted by Kim and Roubini (2008), when positive movements of productivity drive output changes, investment rises so current account deteriorates which is consistent with the identity (I1),

$$CA = (S^p - I) + (T - G).$$

Thus, output shocks could direct current account and government budget balances in opposite directions. Real exchange rate is found to appreciate in response to a positive shock in output, which is consistent with the findings of Kim and Roubini (2008) for the US. Looking at a positive shock in the current account, primary government budget balance deteriorates on impact, implying a diverging relationship between these balances. Real interest rate falls in response to an improvement in the current account in the first two years. An exogenous improvement in the current account could induce a fiscal relaxation. Also, as lower private savings could be maintained, real interest rate could remain unattractive and low. A positive shock in the real interest rate, which can be seen as a proxy for monetary policy intervention, appears to have contractionary effect on output as expected. Current account exhibits moderate improvement in longer horizons, as the fall in output and demand induces a decline in imported goods as well. Finally, a positive innovation in the real exchange rate (appreciation) causes an increase in real interest rate in the first year, and an improvement in the current account but only on impact. The response of the current account then after is insignificant. An appreciated domestic currency could potentially make the value of imported goods lower, thus improving the external position in the beginning. However, as the quantities of the imported and exported goods start to adjust, we would expect a deterioration in the current account due to currency appreciation. Primary government budget balance seems to improve in the short-run in response to real exchange rate appreciation. As real interest rate is higher and government borrowing becomes more costly, the primary fiscal stance is improved.

In order to explore further the contribution of each shock to the variables' movements, Table 3.1 presents the forecast error variance decomposition of the model's variables. Shocks in the primary government budget balance account for almost 83% of its own movements after a year, while have less but still important contribution as the time horizon expands up to five years. Shocks in output contribute to primary government balance movements, having a maximum impact of almost 20% in the fifth year. Approximately 5% and 8% of the primary budget movements are attributed to current account and real exchange rate innovations respectively, while the contribution of real interest rate is very low. Shocks in output appear to mainly drive output movements in the short-run horizons (e.g. 90% in the first year), but shocks in real interest rate become important for output movements after some quarters as well (e.g. 25% in the fifth year), implying the effectiveness of monetary policy intervention. On the other hand, fluctuations in primary government budget balance do not importantly account for output movements (their maximum contribution is almost 6% in the second year). Movements in the current account are mostly driven by its own innovations, while budget balance shocks correspond to slightly higher than 1% of its evolution. Fluctuations in real interest rate and real exchange rate seem to contribute to current account changes by approximately 10% and 8% respectively after five years.

According to the variables' ordering in the benchmark specification, primary government budget balance is constrained to be contemporaneously exogenous to all variables including output as well. However, it is likely that budget balance movements are associated with current output, as for instance one expects lower tax revenues during recessionary periods. To this end, Blanchard and Perotti (2002) provide evidence with respect to output having an impact on taxes in the same period. For a robust analysis, a different ordering of variables is implemented, in which primary budget balance movements are allowed to be endogenous to current output but contemporaneously exogenous to the other current variables, as in Kim and Roubini (2008). The model specification is similar to this of alternative ordering of variables, including a constant and four lags. Figure 3.3 shows the impulse responses of all variables to each one standard deviation shock.

Table 3.1: Forecast error variance decomposition

Horizon	***S.E.***	***pgov***	***y***	***ca***	***rir***	***reer***
			pgov			
4	1.24	82.92	9.08	4.86	0.74	2.41
		(6.14)	(4.78)	(3.63)	(1.49)	(2.52)
8	1.75	70.25	16.26	6.12	0.73	6.65
		(9.49)	(8.16)	(5.58)	(2.19)	(6.02)
12	2.00	66.40	18.34	5.87	1.22	8.16
		(10.89)	(9.71)	(6.82)	(3.69)	(8.05)
16	2.10	65.14	18.94	5.49	1.60	8.83
		(11.55)	(10.32)	(7.49)	(4.79)	(9.18)
20	2.13	64.68	19.06	5.29	1.76	9.20
		(11.96)	(10.51)	(7.95)	(5.41)	(9.84)
			y			
4	0.02	5.62	89.72	1.59	2.48	0.59
		(4.65)	(5.77)	(2.20)	(2.25)	(1.48)
8	0.03	5.58	82.18	0.97	10.36	0.91
		(5.40)	(9.19)	(2.77)	(6.71)	(3.03)
12	0.04	4.75	75.93	0.94	17.50	0.88
		(5.43)	(11.67)	(3.69)	(10.07)	(4.13)
16	0.05	4.05	70.98	1.86	22.20	0.91
		(5.41)	(13.56)	(5.52)	(12.27)	(5.16)
20	0.05	3.63	67.53	3.01	24.77	1.07
		(5.55)	(14.86)	(7.26)	(13.68)	(6.11)
			ca			
4	1.23	1.33	0.51	93.72	0.73	3.70
		(2.27)	(1.83)	(4.64)	(1.89)	(3.37)
8	1.41	1.32	1.63	89.96	1.66	5.43
		(2.86)	(3.43)	(7.31)	(2.42)	(5.63)
12	1.49	1.27	1.66	85.03	4.91	7.14
		(3.24)	(4.09)	(9.39)	(4.75)	(7.17)
16	1.53	-1.20	1.58	81.24	7.83	8.14
		(3.53)	(4.33)	(10.81)	(6.41)	(8.06)
20	1.54	1.19	1.55	79.24	9.61	8.41
		(3.82)	(4.52)	(11.65)	(7.29)	(8.48)

Table 3.1: Forecast error variance decomposition

Horizon	***S.E.***	***pgov***	***y***	***ca***	***rir***	***reer***
				rir		
4	1.92	0.99	1.75	9.02	84.50	3.74
		(2.36)	(2.73)	(5.94)	(7.21)	(3.26)
8	2.50	1.58	4.10	13.88	69.91	10.53
		(3.51)	(5.43)	-(8.80)	(11.43)	(7.56)
12	2.67	1.62	4.44	16.35	66.68	10.91
		(3.99)	(6.33)	(10.77)	(12.99)	(8.63)
16	2.71	1.74	4.37	17.19	66.05	10.65
		(4.15)	(6.40)	(11.58)	(13.39)	(8.59)
20	2.74	2.35	4.85	17.12	64.89	10.80
		(4.47)	(6.35)	(11.73)	(13.48)	(8.53)
				reer		
4	0.07	5.01	1.87	0.09	1.08	91.94
		(4.38)	(2.86)	(1.65)	(1.68)	(5.49)
8	0.10	-11.86	1.95	0.15	2.25	83.80
		(7.47)	(2.97)	(2.89)	(3.72)	(8.83)
12	0.11	15.63	5.65	0.40	2.75	75.57
		(8.71)	(5.55)	(4.39)	(4.77)	(11.90)
16	0.12	16.86	8.89	0.53	2.66	71.07
		(9.07)	(7.42)	(5.61)	(5.07)	(13.51)
20	0.12	17.05	10.41	0.53	2.58	69.43
		(9.11)	(8.23)	(6.36)	(5.25)	(14.19)

Note: Standard errors based on 10,000 Monte Carlo repetitions in parentheses.

Changing the order of variables to allow for endogenous movements of the primary government budget balance to current output, does not generally contradict the impulse responses obtained from the initial variable ordering. Based on this alternative model, output does not respond to a primary government budget balance shock. However, in order to further examine how important the shocks are for the variables' movements, Table 3.2 provides forecast error variance decomposition of the variables based on this different specification. Output fluctuations account for a big proportion of the variation in primary budget government balance, while most of the variance of output comes from its own innovations. These results highlight the importance of examining the specification of ordering output first in the SVAR model to account for endogenous responses of the government budget balance to current economic conditions, proxied by current output (y). More specifically, by ordering y first, we see that around 30% of the movements of primary government budget balance is attributed to output shocks. Changes in current account and real exchange rate contribute to fiscal variation by approximately 5.5% and 9% respectively after four years. With respect to output evolution, real interest rate accounts for almost 25% of it after five years, while fluctuations in the primary budget balance appear to explain very little of its variance.

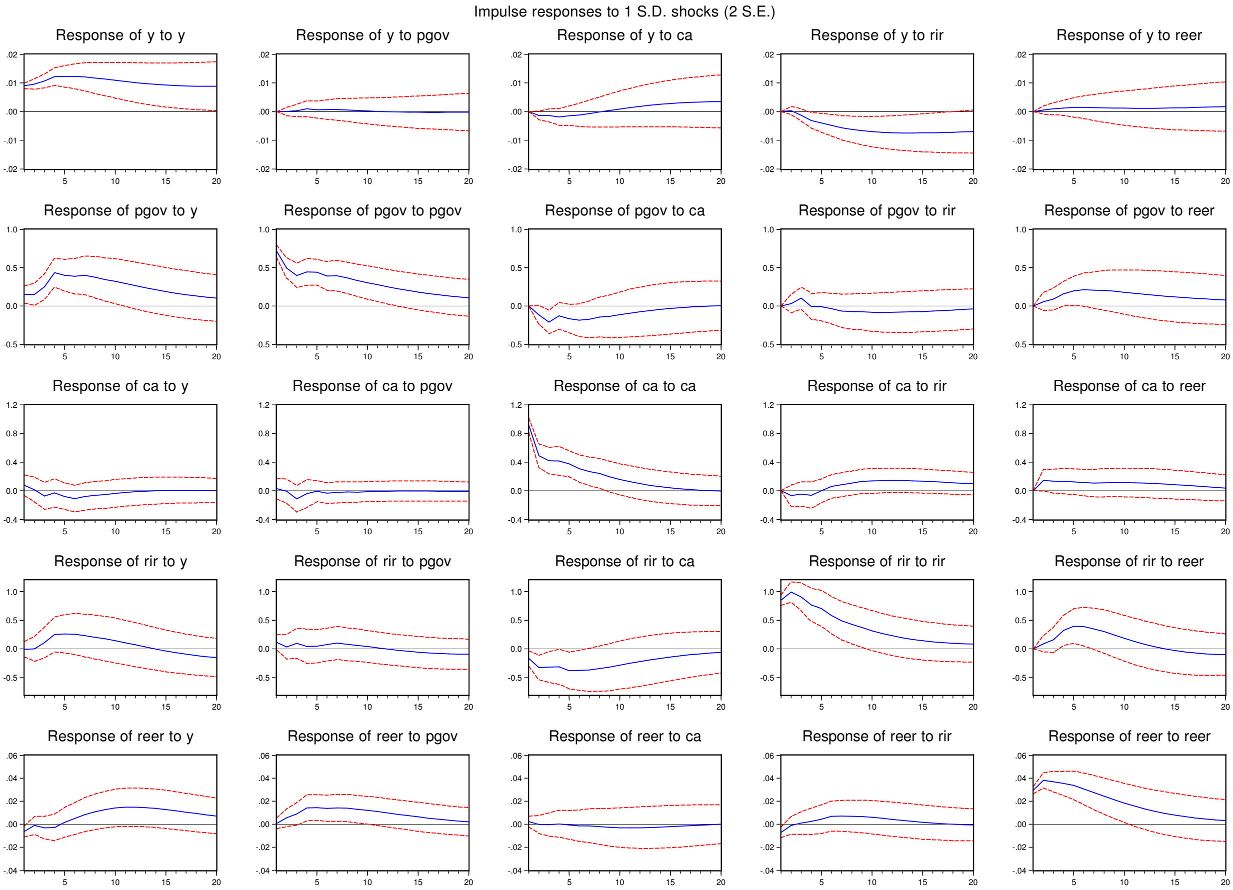

Figure 3.3: Recursive identification (ordering output first), 1970Q1-2014Q4. Impulse responses to structural one standard deviation innovations with two standard error bands for the horizon of five years. Standard errors are based on 10,000 Monte Carlo repetitions.

Table 3.2: Forecast error variance decomposition

Horizon	***S.E.***	***y***	***pgov***	***ca***	***rir***	***reer***
			y			
4	0.02	95.11	0.22	1.59	2.48	0.59
		(3.70)	(1.11)	(2.18)	(2.27)	(1.45)
8	0.03	87.53	0.24	0.97	10.36	0.91
		(7.98)	(1.76)	(2.73)	(6.71)	(3.00)
12	0.04	80.52	0.16	0.94	17.50	0.88
		(11.25)	(2.13)	(3.63)	(10.05)	(4.08)
16	0.05	74.91	0.13	1.86	22.20	0.91
		(13.62)	(2.55)	(5.49)	(12.25)	(5.08)
20	0.05	71.04	0.11	3.01	24.77	1.07
		(15.17)	(2.99)	(7.26)	(13.66)	(6.03)
			pgov			
4	1.24	19.32	72.67	4.86	0.74	2.41
		(7.29)	(7.76)	(3.66)	(1.43)	(2.52)
8	1.75	29.51	56.99	6.12	0.73	6.65
		(10.51)	(10.31)	(5.61)	(2.08)	(5.87)
12	2.00	32.24	52.50	5.87	1.22	8.16

Table 3.2: Forecast error variance decomposition

Horizon	***S.E.***	***y***	***pgov***	***ca***	***rir***	***reer***
		(12.11)	(11.24)	(6.82)	(3.54)	(7.85)
16	2.10	33.01	51.07	5.49	1.60	8.83
		(12.76)	(11.62)	(7.49)	(4.66)	(8.99)
20	2.13	33.17	50.57	5.29	1.76	9.20
		(12.97)	(11.83)	(7.95)	(5.29)	(9.66)
				ca		
4	1.23	0.81	1.03	93.72	0.73	3.70
		(1.88)	(2.16)	(4.59)	(1.87)	(3.32)
8	1.41	2.06	0.89	89.96	1.66	5.43
		(3.77)	(2.41)	(7.12)	(2.41)	(5.54)
12	1.49	2.09	0.83	85.03	4.91	7.14
		(4.56)	(2.61)	(9.19)	(4.68)	(7.18)
16	1.53	1.99	0.79	81.24	7.83	8.14
		(4.92)	(2.82)	(10.63)	(6.34)	(8.09)
20	1.54	1.95	0.79	79.24	9.61	8.41
		(5.21)	(3.05)	(11.47)	(7.24)	(8.50)
				rir		
4	1.92	2.04	0.70	9.02	84.50	3.74
		(2.93)	(2.10)	(5.89)	(7.15)	(3.22)
8	2.50	4.87	0.81	13.88	69.91	10.53
		(5.98)	(2.76)	(8.79)	(11.38)	(7.49)
12	2.67	5.26	0.80	16.35	66.68	10.91
		(7.02)	(3.10)	(10.83)	(12.99)	(8.64)
16	2.71	5.20	0.92	17.19	66.05	10.65
		(7.09)	(3.26)	(11.69)	(13.44)	(8.63)
20	2.74	5.90	1.29	17.12	64.89	10.80
		(7.11)	(3.52)	(11.86)	(13.53)	(8.58)
				reer		
4	0.07	1.08	5.81	0.09	1.08	91.94
		(2.22)	(4.72)	(1.63)	(1.68)	(5.52)
8	0.10	2.74	11.07	0.15	2.25	83.80
		(3.78)	(7.13)	(2.81)	(3.70)	(8.92)
12	0.11	8.39	12.88	0.40	2.75	75.57
		(7.42)	(7.73)	(4.32)	(4.74)	(11.99)
16	0.12	12.60	13.15	0.53	2.66	71.07
		(9.57)	(7.75)	(5.57)	(5.04)	(13.61)
20	0.12	14.41	13.05	0.53	2.58	69.43
		(10.43)	(7.66)	(6.34)	(5.26)	(14.29)

Note: Standard errors based on 10,000 Monte Carlo repetitions in parentheses.

3.2 A SVAR model based on narrative estimates

This section focuses specifically on a component of the UK government budget, this of tax revenues. The effects of tax revenue shocks are examined based on an identification method that uses narrative estimates as an instrumental variable for structural tax innovations. It is known in the literature as "proxy SVAR", as initiated by Mertens and Ravn (2014, 2013) and Stock and Watson (2012). Since its early implementation for the identification of tax innovations, this approach has been gaining ground in the SVAR literature, as addressing concerns about measurement error which can potentially distort the estimated effects of an innovation. To this end, Carriero et al.(2015) show that the estimated impact of uncertainty shocks is higher and lasts for longer as compared to the estimates obtained from a SVAR model with a Cholesky type of identification. Large macroeconomic effects of uncertainty innovations are also found by Piffer and Podstawski (2017) who identify uncertainty shocks by applying the gold's price as a proxy for the identification. With regard to news shocks, Hachula and Nautz (2017) follow this approach to explore their implications on inflation expectations. Also, from the monetary point of view, Caldara and Herbst (2016) identify monetary policy shocks in a Bayesian "proxy SVAR" framework using high frequency data. Recent extension of this methodology consists in Mumtaz and Petrova (2018) who explore tax implications on output growth by accounting for time variation of parameters in a Bayesian proxy SVAR model.

In order to identify the structural tax shocks, this method incorporates estimates for changes in tax revenues from a narrative approach into a SVAR model, treating them as endogenous to tax fluctuations but exogenous to the rest "true" or structural shocks of the system. Mertens and Ravn (2014) suggest that the differences observed in tax multipliers subject to different identification schemes, have to do with the elasticity of tax revenues with respect to output that is used. An outline of this narrative method is provided below, following Stock and Watson (2008). Assuming of being aware of one of the structural shocks, we would express the vector of variables (Y) as a function of the variable the innovation of which is known (τ) and collect all the other variables into X,

$$Y_t = \begin{bmatrix} \tau_t \\ X_t \end{bmatrix}$$

Allowing for the reduced form errors to be u_t^{τ} and u_t^X, and the structural innovations to be ε_t^{τ} and ε_t^X, the relationship between the reduced form residuals and the structural shocks can be expressed as follow:

$$Ru_t = \varepsilon_t \Rightarrow \begin{bmatrix} R_{\tau\tau} & R_{\tau X} \\ R_{X\tau} & R_{XX} \end{bmatrix} \begin{bmatrix} u_t^{\tau} \\ u_t^X \end{bmatrix} = \begin{bmatrix} \varepsilon_t^{\tau} \\ \varepsilon_t^X \end{bmatrix} \Rightarrow \begin{aligned} u_t^{\tau} &= -R_{\tau\tau}^{-1} R_{\tau X} u_t^X + R_{\tau\tau}^{-1} \varepsilon_t^{\tau} \\ u_t^X &= -R_{XX}^{-1} R_{X\tau} u_t^{\tau} + R_{XX}^{-1} \varepsilon_t^X. \end{aligned}$$

This system cannot be recovered due to endogeneity. However, we can follow an instrumental variable approach to address the endogeneity issues and consequently estimate the system. More specifically, the structural shock ε_t^{τ} can be recovered using an instrumental variable m_t which respects the following conditions:

$$E(\varepsilon_t^{\tau} m_t) = a$$
$$E(\varepsilon_t^{X} m_t) = 0.$$

This means that the instrument, m_t, is expected to be correlated with the shock we want to recover but uncorrelated with all the other structural innovations of the system. More specifically on this approach, u_t^X is regressed on m_t to estimate $-R_{XX}^{-1}R_{X\tau}$, and $\widehat{\overline{\varepsilon_t^X}} = u_t^X + \widehat{R_{XX}^{-1}R_{X\tau}}u_t^{\tau}$ is obtained where $\overline{\varepsilon_t^X} = R_{XX}^{-1}\varepsilon_t^X$. Consequently, $\widehat{\overline{\varepsilon_t^X}}$ is used as an instrument in order to estimate $-R_{\tau\tau}^{-1}R_{\tau X}$ and obtain $\widehat{\overline{\varepsilon_t^{\tau}}} = u_t^{\tau}\varepsilon_t^{\tau} = R_{\tau\tau}^{-1}\varepsilon_t^{\tau}$. The scaled $\widehat{\overline{\varepsilon_t^{\tau}}}$ will be the structural shock of interest, for the occurrence of which, we can obtain the impulse responses of the system's variables, given that the structural innovations are not correlated. This is achieved by regressing our variables on the current and lagged values of $\widehat{\overline{\varepsilon_t^{\tau}}}$.

Mertens and Ravn (2014) apply this method to US data, using the narrative estimates constructed by Romer and Romer (2009) as an instrument for tax changes. They measure the elasticity of tax revenues with respect to output to be larger as compared to the one used by Blanchard and Perotti (2002), which eventually leads to larger tax multipliers. They also suggest that this method is superior to conventional narrative procedures in terms of accounting for measurement error. Comparing to other narrative methods, they do not treat the narrative estimates as the "true" shocks but as instruments, and they do not measure tax multipliers after a tax shock based on the forecasted tax liabilities but on the real tax receipts.

Motivated by the purpose of additional exploration of the international implications of austerity actions and the advantages of adopting "proxy SVAR" methodology, the aim is to examine the effects of tax revenue shocks in the UK, in an open-economy model, using narrative estimates for tax fluctuations developed by Cloyne (2013), as an instrument for the identification of these shocks. Those estimates correspond to "exogenous" as called by Cloyne (2013) and Romer and Romer (2010), shocks in taxes, since such changes are independent of the current economic activity, but they are driven by political deliberation and incentives for achieving future horizon goals related to public finance. Cloyne (2013) constructs such an "exogenous" series of tax fluctuations as percentage of GDP for the UK, and eventually studies its effect on output:

$$\Delta y_t = \mu + \sum_{j=0}^{\infty} \gamma_j m_{t-j} + v_t,$$

where γ_j reflects the impact of these tax fluctuations on output growth. It is assumed that $E(m_t ... m_{t-j}, v_t) = 0$, meaning that the current and past observations of this tax variable are on impact exogenous to other fluctuations of the system. The tax series is depicted in Figure 3.4.[3] It is suggested that they are not subject to substantial anticipation effects, i.e. when announcement for a tax change precedes the change itself, economic variables may start to react before the change actually occurs. This follows the decomposition

[3]This series corresponds to Cloyne (2013) baseline classification for exogenous narrative measures (the data set can be accessed at his website: https://sites.google.com/site/jamescloyne/research).

between anticipated and unanticipated tax changes in Cloyne (2013), in which the majority of tax changes were seen as unanticipated, in the sense that they were announced and implemented in the same quarter as defined in Mertens and Ravn (2012).

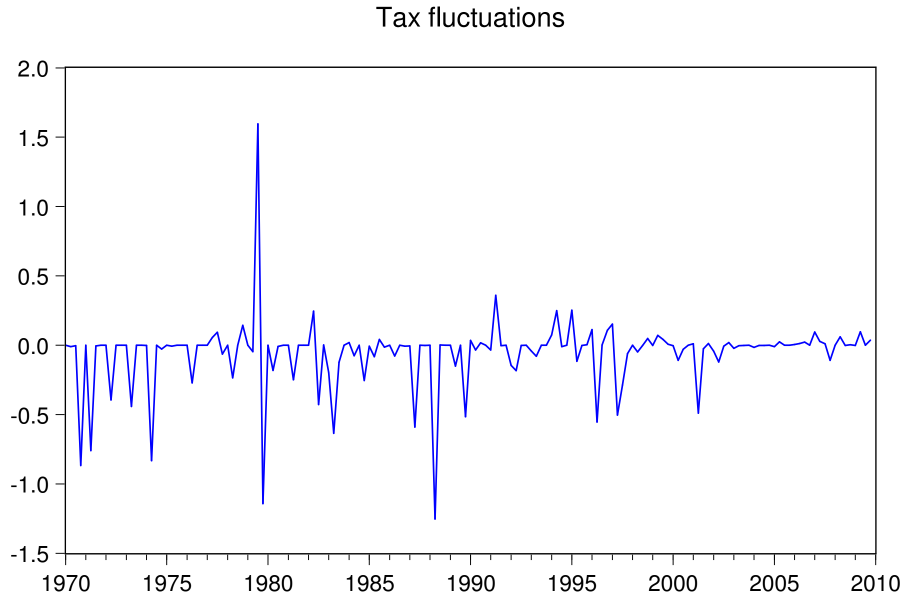

Figure 3.4: Exogenous tax fluctuations as percentage of GDP. Source Cloyne (2013).

Differently from the study of Cloyne (2013), in which output growth is directly regressed on the narrative estimates for tax changes ($\sum_{j=0}^{\infty} \gamma_j m_{t-j}$), we examine the effects of tax revenue shocks within an open-economy SVAR framework, by using these narrative tax estimates as an instrument for identification of the "true" tax fluctuations. Adopting the instrumental variable procedure as previously outlined following Stock and Watson (2008), we first estimate a VAR model covering the period since the first quarter of 1970 until the fourth quarter of 2009:[4]

$$\begin{bmatrix} \tau_t \\ g_t \\ y_t \\ ca_t \\ rir_t \\ reer_t \end{bmatrix} = \begin{bmatrix} b_{11} & . & . & . & . & b_{16} \\ . & . & & & & . \\ . & & . & & & . \\ . & & & . & & . \\ . & & & & . & . \\ b_{61} & . & . & . & . & b_{66} \end{bmatrix} \begin{bmatrix} \tau_{t-1} & . & . & . & . & \tau_{t-p} \\ . & & . & & & . \\ . & & & . & & . \\ . & & & & . & . \\ . & & & & & . \\ reer_{t-1} & . & . & . & . & reer_{t-p} \end{bmatrix} + \begin{bmatrix} u_t^{\tau} \\ u_t^{g} \\ u_t^{y} \\ u_t^{ca} \\ u_t^{rir} \\ u_t^{reer} \end{bmatrix},$$

where τ_t stands for the net tax revenues as percentage of GDP, g_t is the government expenditure as percentage of GDP, y_t is the growth rate of real GDP and the rest of the variables are the same as in the previous section.[5]

Details on how τ_t and g_t are constructed are provided in the data description in Appendix, section 5.1. The model consists of a constant and two lags following the Akaike information criterion, and given that the VAR residuals do not exhibit serial correlation.

[4]The analysis spans until 2009 since there is availability of the narrative estimates dataset until that time.

[5]Net tax revenues are defined as tax revenues minus transfers and interest and dividends payments. More details are provided in Appendix, section 5.1.

Letting the relationship between the reduced form errors u_t and the structural shocks ε_t be $Ru_t = \varepsilon_t$, where R is a 6 by 6 matrix, and imposing the restrictions coming from the conditions for the instrumental variable, m_t, on the covariance matrix of the residuals (i.e. m_t is correlated with u_t^τ but uncorrelated with all the other structural shocks), the system can be expressed as follow:

$$u_t^\tau = -R_{\tau\tau}^{-1}R_{\tau g}u_t^g - R_{\tau\tau}^{-1}R_{\tau y}u_t^y - R_{\tau\tau}^{-1}R_{\tau ca}u_t^{ca} - R_{\tau\tau}^{-1}R_{\tau rir}u_t^{rir} - R_{\tau\tau}^{-1}R_{\tau reer}u_t^{reer} \quad (3.6)$$
$$+ R_{\tau\tau}^{-1}\varepsilon_t^\tau \quad (3.7)$$
$$u_t^g = -R_{gg}^{-1}R_{g\tau}u_t^\tau + R_{gg}^{-1}\varepsilon_t^g \quad (3.8)$$
$$u_t^y = -R_{yy}^{-1}R_{y\tau}u_t^\tau + R_{yy}^{-1}\varepsilon_t^y \quad (3.9)$$
$$u_t^{ca} = -R_{caca}^{-1}R_{ca\tau}u_t^\tau + R_{caca}^{-1}\varepsilon_t^{ca} \quad (3.10)$$
$$u_t^{rir} = -R_{rirrir}^{-1}R_{rir\tau}u_t^\tau + R_{rirrir}^{-1}\varepsilon_t^{rir} \quad (3.11)$$
$$u_t^{reer} = -R_{reerreer}^{-1}R_{reer\tau}u_t^\tau + R_{reerreer}^{-1}\varepsilon_t^{reer}. \quad (3.12)$$

Thus, we recover the shock in tax revenues (ε_t^τ), by first regressing each of the residuals $u_t^g, u_t^y, u_t^{ca}, u_t^{rir}$ and u_t^{reer} on m_t to estimate $-R_{gg}^{-1}R_{g\tau}$,$-R_{yy}^{-1}R_{y\tau}$,$-R_{caca}^{-1}R_{ca\tau}$,$-R_{rirrir}^{-1}R_{rir\tau}$ and $-R_{reerreer}^{-1}R_{reer\tau}$ respectively. Then, for each of these equations we obtain:

$$\widehat{\overline{\varepsilon_t^i}} = u_t^i + \widehat{R_{ii}^{-1}R_{i\tau}}u_t^\tau, \quad (3.13)$$

for $i = g, y, ca, rir, reer$, and

$$\overline{\varepsilon_t^i} = R_{ii}^{-1}\varepsilon_t^i. \quad (3.14)$$

We then use the estimated $\widehat{\overline{\varepsilon_t^i}}$ as instruments for each of the u_t^i in equation 3.6, in order to estimate $-R_{\tau\tau}^{-1}R_{\tau g}$,$-R_{\tau\tau}^{-1}R_{\tau y}$,$-R_{\tau\tau}^{-1}R_{\tau ca}$,$-R_{\tau\tau}^{-1}R_{\tau rir}$,$-R_{\tau\tau}^{-1}R_{\tau reer}$, and we can eventually obtain:

$$\widehat{\overline{\varepsilon_t^\tau}} = u_t^\tau + \widehat{R_{\tau\tau}^{-1}R_{\tau g}}u_t^g + \widehat{R_{\tau\tau}^{-1}R_{\tau y}}u_t^y + \widehat{R_{\tau\tau}^{-1}R_{\tau ca}}u_t^{ca} + \widehat{R_{\tau\tau}^{-1}R_{\tau rir}}u_t^{rir} + \widehat{R_{\tau\tau}^{-1}R_{\tau reer}}u_t^{reer}, \quad (3.15)$$

where $\overline{\varepsilon_t^\tau} = R_{\tau\tau}^{-1}\varepsilon_t^\tau$.

As we can estimate the scaled tax revenue shocks $\overline{\varepsilon_t^\tau}$, impulse responses of the system's variables are provided by running the regressions of each of the variables on current and lagged values of $\widehat{\overline{\varepsilon_t^\tau}}$. The responses of government spending, growth rate, current account, real exchange rate and real interest rate to one percent of GDP increase in tax revenues are shown in Figure 3.5.

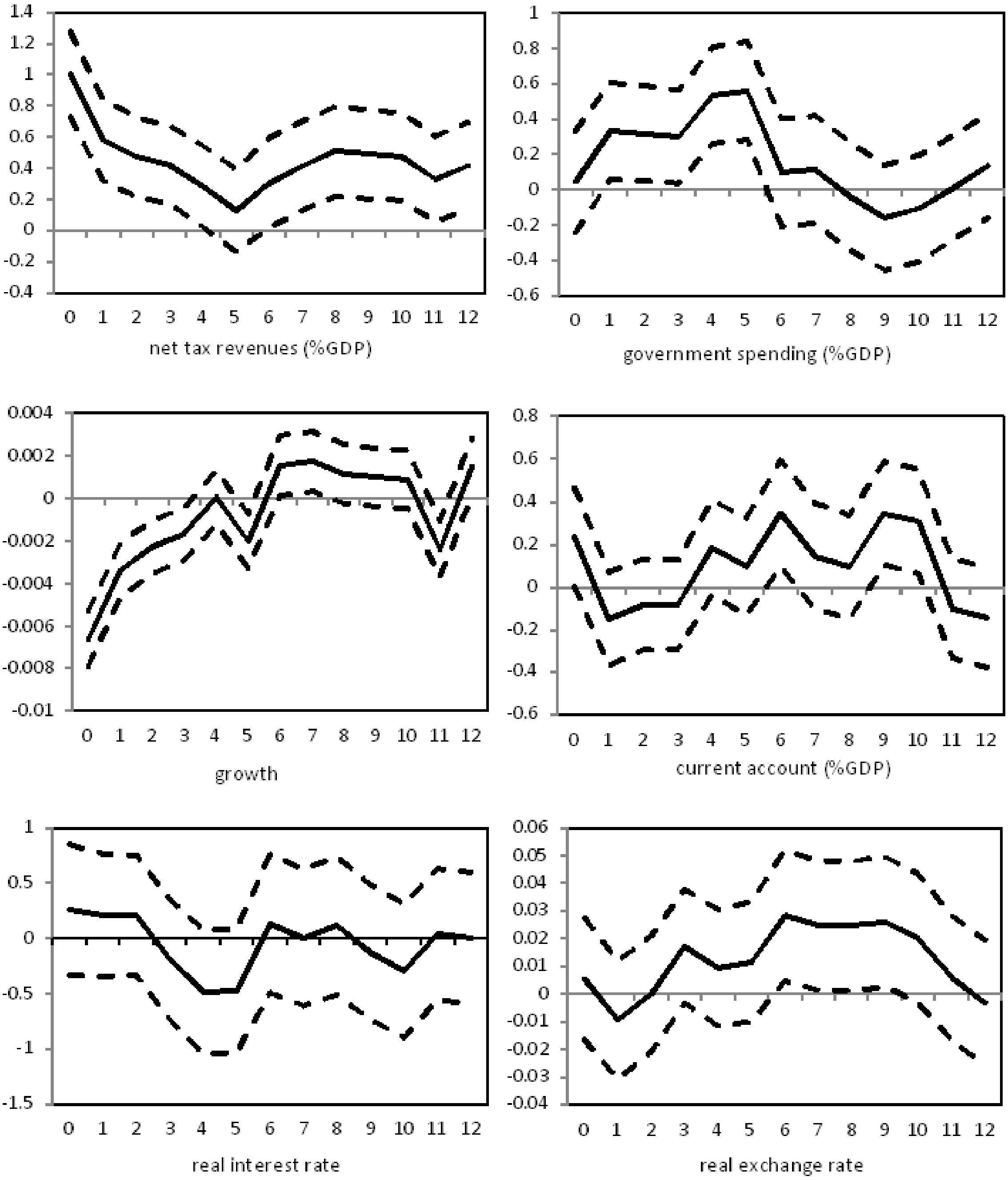

Figure 3.5: Impulse responses to 1% of GDP tax increase, along with one standard error bands (bootstrapped standard errors based on 10,000 draws), for the horizon of three years.

It is suggested that in response to one per cent of GDP increase in taxation, output growth shrinks by almost 0.7 per cent on impact and the negative effect on growth continues for the first quarters (about the first year). This is consistent with the findings of Mertens and Ravn (2014) for the US, who estimate big tax multipliers. The impact and short-run horizon effects on output growth appear to be large and significant. Comparing to the estimates of Cloyne (2013) for the effect of taxation on output growth in the UK, our result is very close to this finding regarding the impact implication of taxation. However, by using the tax narrative estimates as an instrumental variable to recover the tax shock within the open-economy SVAR setup, we do not find persistent effects of taxation on output growth as provided by Cloyne (2013).

Government spending increases in response to higher taxation for almost one year and a half. Real exchange rate appreciates due to one per cent of GDP tax increase, but its response is significant in longer horizons with an increase (appreciation) of approximately 3 per cent after 6 quarters. The response of real exchange rate to tax revenues changes is similar to its response to an improvement in the primary government budget balance, as shown in Section 3.1. Current account does not seem to follow a clear pattern, with its overall response to tax increase not being statistically different from zero.

4 Conclusion

This Chapter explored the implications of fiscal shocks in the UK in an open-economy set-up, and the implied relationship between the government budget and current account balances, using SVAR modelling. The results suggested that, under the period of consideration, the "twin deficits" hypothesis does not appear to be relevant for the UK, implying that fiscal re-balancing may not be expected to be correlated with an improved position in the current account. It is also implied that the private sector could have been adopting a Ricardian type of response to changes in public savings reflected in government budget balance changes.

Two identification methods were followed to identify the structural shocks of the systems. First, short-run identifying restrictions were imposed in a SVAR model to recover a positive shock in the primary government budget balance, meaning an improvement in public savings. Besides, the "proxy SVAR" methodology, which uses an instrumental variable based on narrative estimates to identify the structural shocks within a SVAR set-up, was implemented in order to recover tax revenue innovations.

Based on the short-run identification scheme, it is shown that in response to a positive shock in the primary government budget balance, output increases in the first year, real exchange rate appreciates but current account remains overall unaffected. Output shocks significantly contribute to movements in the primary government budget balance, which implies endogeneity of the government budget balance to the current economic activity, being associated with the stabilizing role of the fiscal variables responding to current output. Following the findings from the narrative identification method, a positive shock in tax revenues induces a decrease in output growth in the short-run and real exchange rate appreciation especially in the long-run. Current account does not seem to significantly respond.

5 Appendix

5.1 Data Description

The analysis covers the period since the first quarter of 1970 until the fourth quarter of 2014 (this is due to the fact that data for real effective exchange rate are available since 1970). Many data series are available after seasonal adjustment (s.a.). However, for the series related to the government budget balance, government expenditure and tax revenues were not seasonally adjusted, and the TRAMO-SEATS approach (an ARIMA model based approach for seasonal adjustment) was used to seasonally transform them.[6] GDP is adjusted for inflation using GDP deflator index and it is used in log specification in the VAR model, (y). Current account (ca) and primary government budget balance ($pgov$) are used as percentages of GDP. Also the real effective exchange rate ($reer$) is used in log specification. Data sources are the following:

1) GDP: OECD (National Accounts, GDP by Expenditure, Current Prices, Gross Domestic Product, Total [Level, s.a.]).

2) GDP Deflator: OECD (National Accounts, National Accounts Deflators, Gross Domestic Product, GDP Deflator [base year 2010, s.a.]).

3) CA: OECD (Balance of Payments, Current Account Balance, Total, Total [National currency, sum over component sub-periods s.a]).

4) $REER$: OECD/Main Economic Indicators, retrieved from FRED, Federal Reserve Bank of St. Louis (Real effective exchange rates, Manufacturing, ULC [base year 2010]). Following the definition of the OECD, the REER is a competitiveness measure, weighted relative consumer prices and labour costs for the economy in $ terms. An increase in the index reflects a real effective appreciation and a corresponding deterioration of the competitive position.

5) Treasury Bill Rate and real interest rate (rir): The source for the Treasury bill rate is the IMF IFS series 11260CS.ZF, retrieved from FRED, Federal Reserve Bank of St. Louis. This is the short term nominal interest rate. The short term real interest rate, as the difference between the nominal interest rate and inflation rate, is used in the VAR model analysis. The inflation rate is given by $\pi_t = \log(P_t) - \log(P_{t-1})$, and it is calculated based on the same quarter of the previous year. For the price index, the GDP deflator is used.

6) Current government budget balance (gov): ONS (series ANMU). The current government budget balance consists of the primary budget balance and the net receipts, interest rate receipts (ANSC, GG) minus interest rate payments (NMYX, GG). In the benchmark VAR specification, the primary budget balance is used ($pgov$).

7) Government Consumption (G): This series is constructed by using the sum of the following series from the ONS, ANSE (Gross fixed capital formation, GG) and GZSN (Current expenditure on goods and services, GG).

[6] The adjustment was done in E-Views software using X-13 ARIMA SEATS method.

8) Tax Revenues net transfers and interest and dividends payments, i.e. net tax revenues (T): This variable is constructed by using the following series from the ONS, NMYE (taxes on production, GG) plus NMZJ (taxes on income and wealth, GG) plus NMGI (capital taxes, GG) plus MJBC (other current taxes, GG) minus NMRL (subsidies, GG) minus GZSL (net social benefits, GG) minus NMYX (interest and dividends payments, GG).

5.2 VAR Tests

Table 3.3: VAR stability condition

Root		***Modulus***
0.998062		0.998062
0.913487	- 0.042970i	0.914497
0.913487	+ 0.042970i	0.914497
0.838574	- 0.141491i	0.850427
0.838574	+ 0.141491i	0.850427
0.745747	- 0.131889i	0.75732
0.745747	+ 0.131889i	0.75732
-0.186775	+ 0.585500i	0.614569
-0.186775	- 0.585500i	0.614569
0.001208	- 0.582083i	0.582084
0.001208	+ 0.582083i	0.582084
-0.318182	- 0.458581i	0.558154
-0.318182	+ 0.458581i	0.558154
-0.550582		0.550582
0.348321	+ 0.405594i	0.534634
0.348321	- 0.405594i	0.534634
-0.372587		0.372587
0.36775		0.36775
-0.178085	+ 0.260452i	0.315514
-0.178085	- 0.260452i	0.315514

Note: Stability test for VAR model of Section 3.1. No root lies outside the unit circle, the VAR is stable.

Table 3.4: VAR residuals autocorrelation

Lags	***LM-Stat***	***Prob***
1	30.14	0.22
2	37.67	0.05
3	32.35	0.15
4	31.85	0.16

Note: Multivariate LM test for VAR model of Section 3.1. No autocorrelation is suggested, taking jointly the lags (Null hypothesis: No autocorrelation).

Table 3.5: VAR residuals normality

Component	***Skewness***	***Chi-sq***	***df***	***Prob.***
1	-0.11835	0.410848	1	0.5215
2	0.284333	2.371461	1	0.1236
3	-0.19863	1.157281	1	0.282
4	0.280062	2.300759	1	0.1293
5	-0.48529	6.90824	1	0.0086
Joint		13.14859	5	0.022

Component	***Kurtosis***	***Chi-sq***	***df***	***Prob.***
1	6.625494	96.39086	1	0
2	7.678925	160.5438	1	0
3	3.223992	0.36793	1	0.5441
4	5.952723	63.93619	1	0
5	5.255811	37.317	1	0
Joint		358.5558	5	0

Component	***Jarque-Bera***	***df***	***Prob.***
1	96.8017	2	0
2	162.9153	2	0
3	1.525212	2	0.4664
4	66.23695	2	0
5	44.22524	2	0
Joint	371.7044	10	0

Note: Normality tests for VAR model of Section 3.1. Jarque-Bera test statistics for skewness and kurtosis of the data implies non-normality (Null hypothesis: data is normally distributed).

5.3 Stationary SVAR model

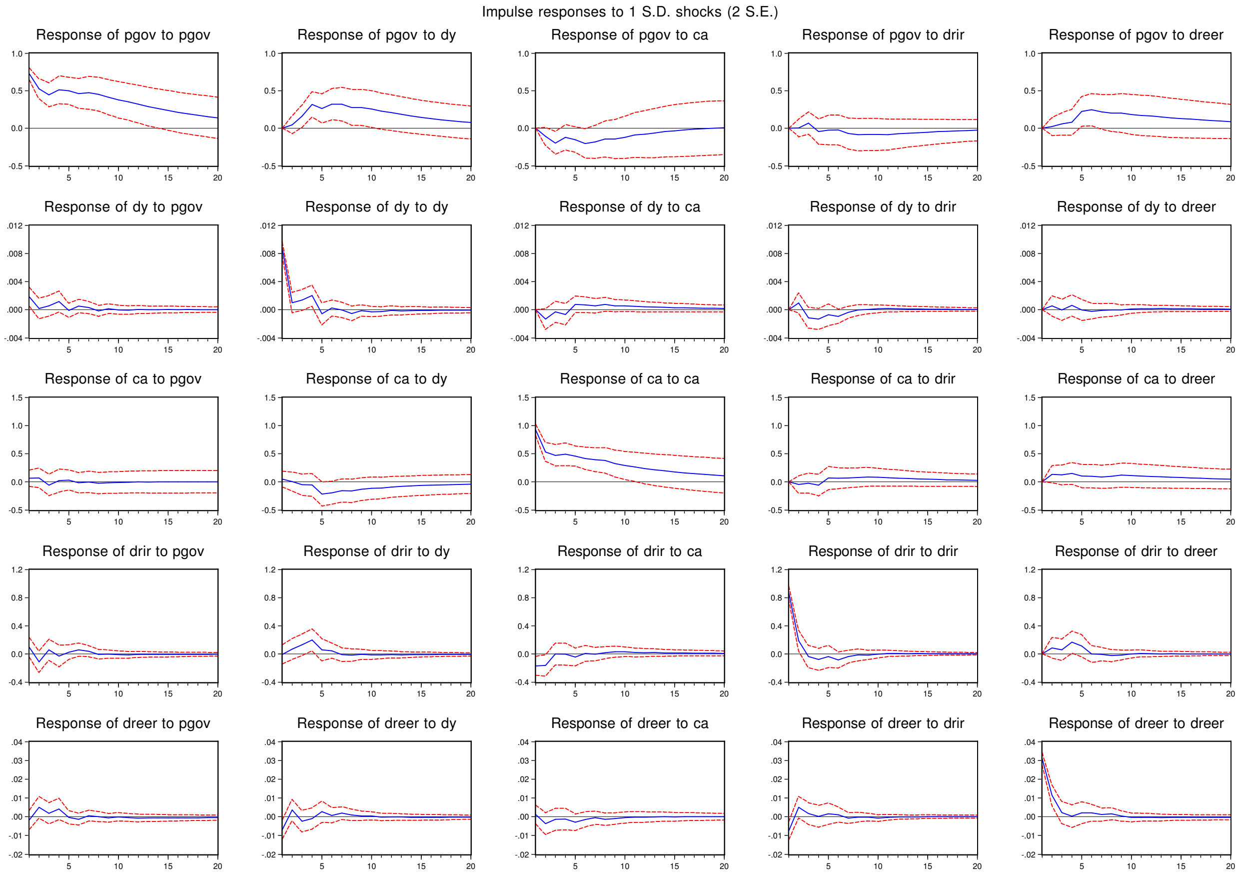

Figure 3.6: Recursive identification (ordering primary government budget balance first), 1970Q1-2014Q4. Stationary SVAR specification (y, rir, $reer$ included in first differences, constant, four lags). Impulse responses to structural one standard deviation innovations with two standard error bands for the horizon of five years. Standard errors are based on 10,000 Monte Carlo repetitions.

5.4 SVAR model including government budget balance

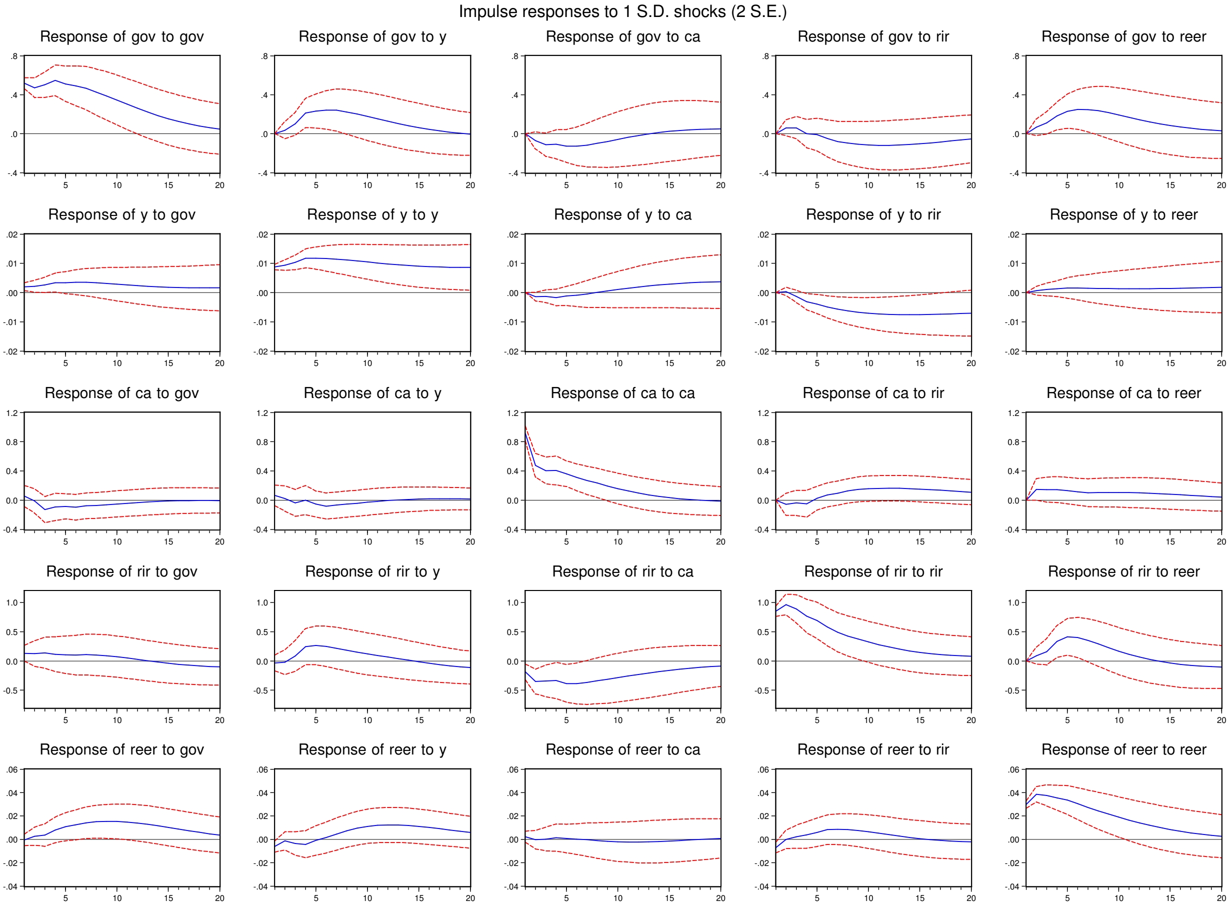

Figure 3.7: Recursive identification (ordering government budget balance first), 1970Q1-2014Q4. Impulse responses to structural one standard deviation innovations with two standard error bands for the horizon of five years. Standard errors are based on 10,000 Monte Carlo repetitions.

Concluding remarks

This Thesis has contributed to the literature of fiscal austerity with a particular focus on its labour market effects and implications for international economic components, with the development of both empirical and theoretical analyses.

The First Chapter provided empirical evidence from a cross-sectional dependence panel of twelve European countries on the responses of unemployment and other variables of the labour market to overall fiscal consolidation, and more specifically to spending versus tax oriented austerity. Fiscal adjustment appeared to significantly increase both cyclical and total unemployment in the short-run and long-run. Looking at specific components of the government budget balance, expenditure focused austerity appeared to increase cyclical and total unemployment in the short-run, whereas cyclical unemployment did not significantly respond to tax oriented austerity. Total unemployment however seemed to increase in the long-run due to tax elevation. Spending based adjustment was found to negatively affect labour force participation. Real wage appeared to decrease (although not significantly) in the long-run due to tax increases.

In the Second Chapter, we investigated the heterogeneous responses of unemployment across European countries to fiscal consolidation measures, attributing part of the responses to distinct labour market institutions. The analysis implemented was based on a DSGE model with frictional labour market and a hierarchical Bayesian panel model. Cutting expenditure was found to increase cyclical unemployment by more as compared to increasing taxation. Labour market characteristics provided information on the transmission of fiscal policy to the labour market. In particular, higher degree of employment security was found to induce a bigger response of unemployment to fiscal consolidation.

The Third Chapter contributes to the literature on international implications of fiscal austerity, by investigating the relationship between government budget and current account balances. The aim was to explore the effect of fiscal consolidating actions in the UK, and the analysis was based on SVAR models. The findings showed that an improvement in government budget balance was not related to a current account improvement. In response to a positive shock in government budget balance (reflecting an increase in public savings), real exchange rate was found to appreciate. In addition, a tax increase was found to decrease output growth, and induce real exchange rate appreciation in the long-run. The recommendations of this analysis did not support the twin deficits hypothesis for the UK under the time period considered.

For the assessment of fiscal effects on real economic activity, different approaches have been followed in the literature. An extensive strand of empirical work is based on SVAR identification methods, for instance techniques followed by Blanchard and Perotti (2002) and Mountford and Uhlig (2009). The SVAR approach has been criticized for not incorporating important information about agents decision making, i.e. its incompetence in capturing non-fundamental shocks (see Alessi et al., 2011, for a review of non-fundamentalness in SVAR models). To overcome this shortcoming by encompassing the relevant knowledge, factor-augmented VAR (see Forni and Gambetti, 2010) and Bayesian VAR models (see Ellahie & Ricco, 2017, for a study of fiscal shocks) have been developed to manage large scale information, associated with complications in structural identification though. In effect, Sims (2012) shows that non-fundamentalness in SVAR set-up may not entail to importantly biased impulse responses. To such a degree, Beaundry et al. (2016) outline the quantitative triviality of the non-fundamentalness issue for news shocks. Within such a type of foresight concerns, Ramey (2011b) generates a variable to proxy news related to fiscal innovations and includes this information into a VAR model (Expectational VAR). An alternative approach, this of the local projection method initiated by Jorda (2005), has been used to estimate output responses to fiscal shocks, characterised by the advantage of being a flexible technique to capture non-linear effects.

Another considerable thread of the literature is based on the narrative approach (e.g. Romer and Romer, 2010) which comes with the advantage of identifying exogenous shocks unaffected by potential responses to expected economic circumstances, by absorbing to some extent information about anticipations of private agents. Narrative measures have been also used as an instrument in order to recover structural innovations in SVAR models (e.g. Stock and Watson, 2012). Focused on the merits of this methodology, the empirical analysis of this Thesis was mainly based on narrative records for the identification of fiscal innovations (First and Second Chapters), in addition to the proxy SVAR approach which incorporates the narrative measures into the SVAR analysis (Third Chapter).

A subsequent issue for further discussion is concerned with the degree of exogeneity of the narrative estimates used in the analysis. In particular, the First and Second Chapters were based on the narrative fiscal dataset constructed by Devries et al. (2011) for the period from 1978 to 2009. This dataset motivated a lot of research since its development, but also created contradictory views about the degree of exogeneity of the innovations. To this end, Alesina et al. (2015), by building on these records, provide an extension of measures framed as fiscal plans able to capture anticipation effects; and support that spending cuts are less costly for output than tax increases, due to consumers' confidence being more responsive to tax changes. Another concern about these estimates is raised by Jorda and Taylor (2013) who refer to their predictability from past fiscal events, debt and growth, using dummy transformation of the fiscal episodes and propensity score method. This issue however may not appear to undermine the exogenous nature of fiscal plans based on the narrative approach, as outlined by Alesina et al. (2015). In particular, to examine the likelihood of predictability from past growth, Alesina et al. (2015), by using different method than this of Jorda and Taylor (2013), do not generally provide regression based evidence of the fiscal events being foreseen by lagged output. On the other hand, de Cos and Moral-Benito (2013), by using a dummy variable to define fiscal re-balancing realizations, assume that fiscal consolidation is weakly exogenous allowing for feedback from the lagged value of output; and show that expenditure cuts have contractionary output effects in the short-run, which leads to a diverging direction from the result of

Alesina and Ardagna (1998, 2010) regarding the idea of expansionary spending oriented austerity.

In association with these concerns, the hierarchical Bayesian model we implement in the Second Chapter allows for unobserved heterogeneity, thus to some extent deals with potential endogeneity issues. It would be fruitful to develop a future analysis using the fiscal plans of Alesina et al. (2015), and examine whether fiscal changes are predictable from past unemployment rates based on different approaches.

Further open questions arising from this Thesis are related to the differences we observed between the responses of cyclical and total unemployment rates to tax driven adjustment. In particular, while cyclical unemployment was not found to significantly respond to tax hikes, total unemployment instead appeared to increase. Such a type of outcome induces further interest on investigating the effects of tax changes on structural unemployment, and consequently on potential output, such that to additionally contribute to the relative trade-offs of different types of fiscal adjustment and their implications for long-run economic capabilities. Also, after highlighting the interplay between labour market institutions and austerity measures, an interesting research extension would encompass the analysis of labour market responses to the co-action of fiscal re-balancing and labour market reforms.

To conclude, the implementation of fiscal consolidation remains a topic of dispute due to its complications with regard to issues like the composition of fiscal adjustment, the economic cycle, the stance of monetary policy and the structural characteristics of the country practising such a type of policies. Contributing to the debate, this Thesis was focused on the differentiated effects of austerity on the labour market, originated from not only the different components of the government budget balance, but also from the distinct labour market features across countries. Moreover, it provided further evidence on the international implications of austerity, by investigating the link between government budget and current account balances. Further stimulating inquires for future analysis have emerged from the data perspective and the substance of findings. Within the data context, the modified fiscal episodes of Alesina et al. (2015) could be used to provide an alternative evaluation of fiscal labour market implications, along with the exploration of feedback effects from past unemployment rate. Also, motivated by the empirical findings about total unemployment being more responsive to tax increases as compared to cyclical unemployment, it is worth exploring how the composition of tax programmes affects structural unemployment.

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