European University Institute

DEPARTMENT OF ECONOMICS

Fiscal Policy in the Great Recession

Romanos Priftis

Thesis submitted for assessment with a view to obtaining the degree of Doctor of Economics of the European University Institute

Florence, 22 May 2015

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Στους γονείς μου

Abstract

This thesis investigates three questions on fiscal policy that have gained importance in the recent turbulent times of general economic decline, labelled as the Great Recession.

The first chapter examines how government spending multipliers can vary depending on the location of the debt holder. Empirically, we find that fiscal multipliers are larger when government purchases are financed by issuing debt to non-resident foreign investors, than to resident home investors. Using a theoretical model we then show how the location of the government debt holder produces these differential responses through the extent that investment is crowded out in each case. Increasing international capital mobility of the resident private sector can attenuate the difference between the two types of financing.

The second chapter contributes to the current debate on fiscal sustainability and fiscal co-ordination in currency unions. It does so using a large-scale New-Keynesian DSGE model calibrated to the EA South and EA North, and fed with a particular fiscal policy scenario identified using the guidelines of the Stability and Growth Pact. The results suggest that when monetary policy is constrained by the zero-lower bound an expansion in the EA North offsets a consolidation in the EA South leading to a union-wide increase in output.

The third chapter studies the effects of fiscal policy in a setting where crisis shocks propagate through the real exchange rate to generate distortions in labour and financial markets. The joint presence of labour market and financial frictions, modelled as downward nominal rigid wages and a collateral constraint on private borrowing, endogenously generate unemployment and persistently high debt levels. Fiscal policies aiming to stimulate or consolidate the economy affect the movement of the real exchange rate in such a way so as to generate it toothless in the face of a 'debt-unemployment' trade-off.

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Preface

This thesis investigates three questions on fiscal policy that have gained importance in the recent turbulent times of general economic decline, labelled as the Great Recession. The first chapter (co-authored with S. Zimic) and entitled *'Sources of Borrowing and Fiscal Multipliers'* examines how government spending multipliers can vary depending on the location of the debt holder. In a sample of 59 countries we find that government spending multipliers are larger when government purchases are financed by issuing debt to foreign investors (non-residents), compared to the case when government purchases are financed by issuing debt to home investors (residents). In a theoretical model we show that the location of the government debt holder produces these differential responses through the extent that investment is crowded out in each case. Increasing international capital mobility of the resident private sector decreases the difference between two types of financing, a prediction, which is also confirmed by the data. The share of rule-of-thumb workers, as well as the strength of the public good in the utility function also play key roles in quantitatively explaining the results obtained in the data.

The second chapter entitled *'Fiscal Policy Coordination under the Zero Lower Bound'* investigates the effects of coordinating fiscal policy in a currency union. It constructs a large-scale New-Keynesian DSGE model with nominal frictions in prices and wages, a distinction of households into liquidity-constrained and Ricardian, and an expanded fiscal sector with a role for productive government investment. The model is then calibrated to the EU South and EU North and fed with a particular fiscal policy scenario identified using the guidelines of the Stability and Growth Pact, which assigns a fiscal expansion to the EU North and a fiscal consolidation to the EU South. The results suggest that when monetary policy is constrained by the zero-lower bound the expansion in the EA North offsets the consolidation in the EA South leading to a union-wide increase in output. Under active monetary policy the regional spillovers are dampened and the expansion in the EA North triggers an increase in the real interest rate leading to an appreciation of the Euro. The paper provides a theoretical contribution to understand the current debate on fiscal sustainability and coordination in currency unions.

The third chapter entitled *'Fiscal Policy under Labor Market and Financial Frictions'* investigates the effects of fiscal policy in a setting, which captures the relevant features to hindering the process of recovery from a financial crisis in a currency union: high unemployment and a slow private sector deleveraging process. Crisis conditions arise due to a joint presence of labor market and financial frictions modeled as downward nominal rigid wages and a collateral constraint on private sector borrowing. The two frictions interact through the real exchange rate to spill over crisis shocks from the financial sector of the model into the labor market. Fiscal policies aiming to stimulate or consolidate the economy affect the movement of the real exchange rate in such a way so as to generate it toothless in the face of a 'debt-unemployment' trade-off. Welfare multipliers are largest for a negative shock to government investment.

The thesis is structured as follows. In order to facilitate reading, figures have not been included in the main text but have been introduced in an appendix at the end of each chapter. All reference material is to be found at the end of the document.

Chapter 1

Sources of Borrowing and Fiscal Multipliers

with Srecko Zimic (European University Institute)

1.1 Introduction

Several European economies are currently undertaking significant measures to reduce government spending with the view of lightening their debt burdens and achieving healthy signs in their growth paths. During this ongoing process, a number of the leading actors in the European crisis have prescribed policies, which have triggered a heated economic debate with regards to countries' prospects for economic recovery. The particular focus of attention since the first quarter of 2013 has been the size of fiscal multipliers. This debate was revitalized at the same time where statistics of progress were published for countries like Greece, Italy and Spain, which had failed to show positive signs in their economic activity. The key actor responsible for prescribing fiscal policy in several of these European countries, the International Monetary Fund (IMF) itself, had also revived its attention on fiscal multipliers with Blanchard and Leigh (2013, pp.3) questioning "whether forecasters have underestimated fiscal multipliers[?]"

The question we attempt to answer in this paper is whether the transmission mechanism of a fiscal shock can differ depending on whether government spending is financed via government debt issued to home investors (residents), or government debt issued to foreign investors (non-residents). Economic theory, but also our empirical investigation, suggests that government spending shocks have differential effects on the real economy depending on the location that government debt is held. As such, the magnitude of fiscal multipliers is dependent on the source of borrowing for the government and in particular are larger when government spending is financed via debt issued abroad rather than at home.

We approach the question in a twofold way. First, we study the responses of endogenous variables such as output, consumption and investment to debt-financed government spending shocks in a structural vector-autoregression (SVAR), whereby we propose a novel way to identify the different types of shocks in the data. This novel conceptual framework of identification is necessary primarily because of the reduced availability of data on both domestic and foreign public debt for a large number of economies. Empirically, we are able to distinguish between the two shocks by extending the conventional sign restrictions approach of Canova and de Nicolo (2003) and Canova and Pappa (2005) to include magnitude restrictions in the spirit of Kilian and Murphy (2012). Sign restrictions work by limiting the responses of endogenous variables to the shocks in a way that is theoretically robust to a large class of economic models, which do not necessarily share the same microfoundations. In addition, they also avoid problems that may arise with endogeneity and the predictability of movements in the endogenous variables of the model. Magnitude restrictions complement this approach by combining restrictions on the signs of endogenous variables with further empirically accepted bounds on their magnitude.[1]We derive the magnitude restrictions by imposing relatively minor assumptions on the movements of the unobserved components of total public debt and total public external debt and find that fiscal multipliers are larger when government spending is financed with debt held abroad. We confirm our proposed identification methodology by estimating the same SVAR on US data, for which the disaggregated debt components of interest are available.

Armed with this empirical evidence, we then propose a theoretical model, which allows us to think of a setting in which such effects are present. The fundamentals of the mechanism arise due to the specification of the economy's resource constraint, that is how credit-constrained the private sector is in borrowing from abroad. The composition of the resource constraint influences the extent of crowding out of private investment, which is the main feature driving the differential responses on fiscal multipliers depending on the location of borrowing. In addition, we also show how a standard wealth effect that is active in most Keynesian models also affects fiscal multipliers differentially. By allowing the private sector in the economy to accommodate government increases in foreign debt, which is implemented by altering the levels of the household's credit-constraint through the debt-elasticity of the interest rate, we show how these differential responses on output can be dampened. We conclude that these factors are important to understand why fiscal multipliers are different for the two cases of government financing. In addition, we augment the model with utility-enhancing government expenditure and show that under plausible parametrizations we are able to quantitatively replicate the fiscal multipliers identified in the data.

Our work ties in with several branches of the fiscal policy literature, in particular those emphasizing the response of private investment following a fiscal shock. On the em-

[1]For example, Kilian and Murphy (2012) implement these on the short-run oil supply elasticity and on the impact response of real activity. In this way, they are able to reduce the set of admissible model solutions to a small number of qualitatively similar estimates.

pirical side, work relying on the SVAR methodology includes studies by Blanchard and Perotti (1999); Fatas and Mihov (2001); Perotti (2005) among others, which identify fiscal shocks by assuming that fiscal variables do not contemporaneously react to changes in economic conditions. Using this specification the conclusions generally suggest that private consumption, output, employment and the real wage increase with the fiscal shock, features which are all consistent with the results obtained in this paper. Using quarterly data for Canada, Japan, UK and the US, Pappa (2009) finds that increases in government spending increases private consumption contemporaneously and employment with some lag, but responses of investment are mixed. More evidence on the responses to investment in the US is provided by Mountford and Uhlig (2009) and Leeper et al. (2010), who find that investment falls in response to a a government spending increase.

However, most of these studies do not allow for a flexible specification of how the government spending shock is financed. At best, Mountford and Uhlig (2009) analyze three policy scenarios: deficit-spending, deficit-financed tax cuts and a balanced budget spending expansion. Bermperoglou et al. (2013) in turn look at how different government outlays affect output and unemployment, by studying the effects of shocks to government consumption, government investment and government employment. Nevertheless, there is no existing study, which differentiates between debt-financed government spending shocks where the location of debt holding is assessed. This gap in the literature presumably arises because of the difficulty in obtaining detailed data on debt components. Data on public debt from the World Bank for example only reports 'central government debt'[2] and 'external debt stocks'.[3] In this paper, we fill precisely this gap. By proposing an identification strategy, which relies on movements of the

[2]Indicator code: GC.DOD.TOTL.GD.ZS
[3]Indicator code: DT.DOD.DECT.GN.ZS

components of government debt, and by imposing relatively insignificant assumptions on them, we are able to isolate the effects of fiscal shocks that are financed via debt held at home or debt held abroad. We also show how our methodology is validated by estimating the same system on US data where the disaggregated data of interest is available.

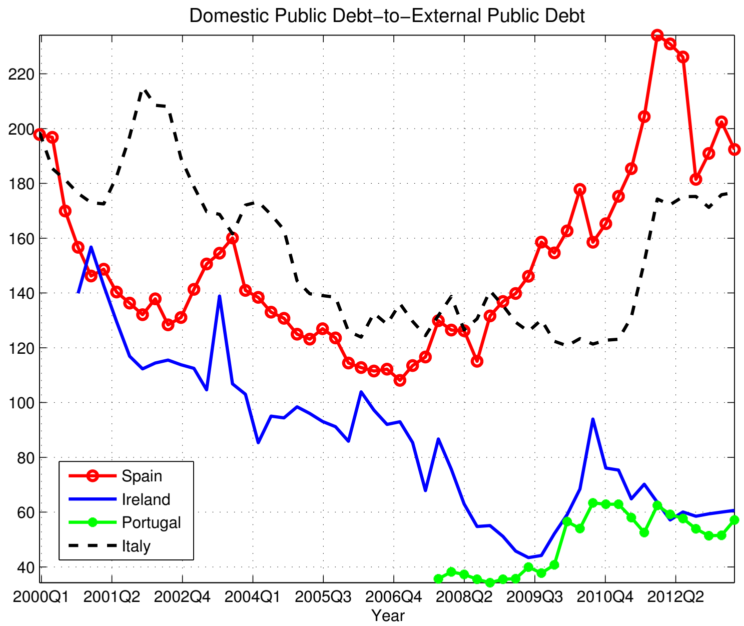
On the theoretical side, there is little work analyzing the heterogeneous effects of fiscal shocks on the real economy, where the location of debt-financed government spending matters. Although the transmission mechanism arises naturally, as will be seen in Section 3.2 most work has paid little attention to this distinction. The closest study to ours is recent work by Shen and Yang (2013). They analyze the effects of government spending in an environment specific to developing countries with limited international capital mobility, noting an exchange rate channel, which can mitigate the responses of output following a government spending shock. As such, to the best of our knowledge, this paper forms the first attempt at studying the heterogeneous effects of different types of debt-financed government spending shocks on the economy.

Our work can also be seen as providing an empirical validation, and complementary theoretical interpretation to Broner et al. (2014), which study the incentives of creditor discrimination in times of sovereign risk. In that paper, during periods where the probability of default on sovereign debt is large, creditor discrimination arises because sovereign debt offers a larger expected return to domestic creditors rather than foreign creditors (following from the assumption that domestic debt is less likely to be defaulted on). Given financial frictions in private borrowing, which prevent the private sector to finance their domestic debt from abroad, domestic purchases of sovereign debt lead to a crowding out of productive investment. In our paper, we interpret debt purchases by domestic and foreign creditors as financing government spending, thereby allowing us to study the effects of domestically- and foreign-debt financed fiscal policy shocks.

Finally, our work is also related to Werning and Farhi (2012), who allude to the heterogeneous effects caused by domestic and foreign government borrowing. They show that when changes in government spending are financed with transfers from abroad the associated fiscal multipliers may be substantially larger than one. The reason for this is that a closed economy under autarky is considered to be operating as an incomplete market, whereby no insurance to income shocks can be made. As a result, residents have to adjust their consumption and investment to buffer any changes in a government spending shock. However, in an open economy, it is nonresident foreigners that finance the government spending through transfers.

On the policy front our analysis has implications for the effects of fiscal consolidations in several countries. In particular, the effect of a fiscal consolidation, or more generally any change in a government's fiscal instruments, will be influenced by the composition of its debt, that is whether it is held abroad or domestically. Since Foreign debt-financed government shocks have higher multipliers this implies that in countries such as Greece, where most of the debt is externally held, government expenditure cuts will bring deeper than intended recessions; or rather deeper recessions than where the reduction in government expenditures were to be accompanied by a purchase of domestically held debt. Interestingly enough, the composition of public debt alone plays a role in determining the business cycle absent any changes in fiscal policy. Since the fiscal multiplier on output is greater for a Foreign debt-financed than a Home debt-financed government spending shock, shifting the mixture of the government's debt portfolio from home to abroad (but keeping the total level constant) can trigger a recession. Conversely, a change in the composition from where the majority of public debt is held abroad to being held at home can trigger an expansion, ceteris paribus. As can be seen in Figure (1.1.1) this issue is mostly relevant for the Eurozone's debt-distressed economies where the composition of public debt shifted from largely being held domestically to being held externally since the 2000s. The reliance on external debt rather than domestic debt after the onset of the financial crisis could thus lead to a fiscal multiplier that turns negative without any changes in government expenditures.

Figure 1.1.1: The Composition of Public Debt in the Eurozone Periphery



Such a conclusion may have important consequences for the fiscal consolidation packages proposed by the European Central Bank (ECB) and the IMF for distressed economies during the ongoing European debt crisis. It may also have important consequences on the prospects of economic recovery as avoiding to consider the location of financing of government consumption may erroneously lead to poorly-prescribed policies that actually deepen the recession in these economies when asked to cut back on their government expenditures.

The remainder of the paper is organized as follows: In Section 1.2 we describe the empirical strategy used to estimate the SVAR and present the results of the estimation. In Section 3.2 we build a theoretical model and in Section 3.3 we use it to illustrate the mechanism and the results of our quantitative analysis. In Section 1.5 we report fiscal multipliers and perform a sensitivity analysis on the model's key features. In Section 1.6 we focus on the issue of imperfect capital mobility for the private sector and investigate the important country characteristics that drive the model's results. Finally, in Section 3.4 we conclude.

1.2 Empirical Investigation

We study the effects of a government spending shock financed via public debt and propose a strategy for identifying fiscal shocks financed with debt held by residents within the domestic economy (Home-financed government spending shock), or held by nonresidents abroad (Foreign-financed government spending shock). Our empirical procedure consists of estimating an SVAR for 59 countries, for which data availability on the location of debt holdings is not readily available. We proceed by proposing a conceptual framework derived from theoretical foundations, which allows us to identify the two types of government spending shocks based on two conventional assumptions.

1.2.1 Theoretical Background on SVARs

A Structural Vector Autoregression model (SVAR) can be written as:

$$A_0 y_{n,t} = \alpha_i + A_1 y_{n,t-1} + A_2 y_{n,t-1} + ... + A_N y_{n,t-N} + B\varepsilon_{n,t} \tag{1.2.1}$$

where $y_{n,t}$ is a $k \times 1$ vector of endogenous variables, α_i are fixed effects, and where the structural errors are assumed to be white noise $\mathcal{N}(0, I_{\mathrm{k}})$. It is assumed that the true model can be represented via a finite lag VAR with lag $p \in [1, 2, ..., N]$. The model in

(1.2.1) then implies the following structural moving average representation:

$$y_{n,t} = B(L)\varepsilon_{n,t}$$

where $B(L)$ is the impulse response function. However, the system in (1.2.1) cannot be directly estimated, so we need to transform it into a reduced form representaion:

$$y_{n,t} = a_i^* + A_1^* y_{n,t-1} + A_2^* y_{n,t-1} + ... + A_N^* y_{n,t-N} + \upsilon_{n,t} \tag{1.2.2}$$

where $\upsilon_{n,t} = A_0^{-1}B\varepsilon_{n,t}$ and $A_p^* = A_0^{-1}A_p$ for $p \in [1, 2, ..., N]$. We then choose to estimate the reduced form model (1.2.2) using a first difference estimator which eliminates possible fixed effects and transforms the data into stationary series. [4]

In addition, (1.2.1) also implies the following structural moving average representation:

$$y_{n,t} = C(L)\upsilon_{n,t} \tag{1.2.3}$$

where $C(L)$ is the non-structural impulse response function and is related to the structural impulse responses as $C(L) = A_0^{-1}B(L)$. By defining $S = A_0^{-1}B$ and given the assumed distribution of errors $\sum_\varepsilon = I$, then the impact matrix must satisfy:

$$\sum_\upsilon = SS' \tag{1.2.4}$$

where $\sum_\upsilon$ is the variance-covariance matrix of the reduced form errors. However, the structural decomposition in (1.2.4) is not unique and the way this decomposition is

[4] As explained in Anderson and Hsiao (1982) the first difference estimator is not consistent for T fixed and they instead propose to instrument lagged dependent variables by their second lags, Δy_{t-2}. We experimented with an IV estimation, but the results were imprecise due to weak instruments. We therefore opted for OLS estimation, as IV point estimates also contained explosive roots. We have also estimated the model assuming fixed effects in the differenced model - the results do not change quantitatively in this case.

chosen will affect the identification of the impact matrix in the model. For example, for some arbitrary orthogonalization, $\tilde{S}$ (e.g. a Choleski decomposition), the alternative structural decomposition can be obtained by randomly choosing a matrix H with $HH' = I$ and post-multiplying H by $\tilde{S}$. It is then immediate that $\tilde{S}H(\tilde{S}H)' = \tilde{S}\tilde{S}'$ and therefore the condition in (1.2.4) is satisfied. Therefore, the entire set of permissible impact matrices is infinite and the impact matrix cannot be identified from the data.

1.2.2 Identification of Shocks

To obtain a unique structural decomposition, the econometrician needs to assume $k(k-1)/2$ restrictions. In the present paper, rather than imposing restrictions to obtain a unique identification we obtain the distribution of impulse response functions by retaining only those that satisfy prior constraints. These constraints are derived from economic theory predicted by the model we propose in Section (3.2) and also replicate the results of a number of studies studying the effects of fiscal shocks (see e.g. Pappa (2009); Mountford and Uhlig (2009)). These conditions rely on restricting the sign as well as the magnitude of the responses of endogenous variable to the shocks being identified.

Decomposition of Debt Variables

Since our main question of interest is whether the source of financing of government debt is able to differentially affect the endogenous variables in our model (e.g. consumption, output and investment), as a first step we illustrate the problematic nature of the data at our disposal.

The debt data available is obtained from Reinhart and Rogoff (2011), which report '*total gross central government debt*' and *'total gross external debt'*. But, we do not have their disaggregated components *'total home public debt'* and *'total external public debt'*, which would be of direct relevance for our empirical investigation. For example, looking at equation (1.2.5), if data on *'total home public debt'* were available then it would be straightforward to identify the two types of shocks of interest, that is a Home-debt financed government spending shock and a Foreign-debt financed government spending shock.

$$\frac{\textbf{Total public debt}}{\textbf{Total external debt}} = \frac{\text{Public home debt} + \text{Public external debt}}{\text{Public external debt} + \text{Private external debt}} \tag{1.2.5}$$

However, since we do not have such variables for the whole sample we choose to rely on, we proceed by proposing two assumptions that will enable us to identify the location of debt holdings from the data. We then use these assumptions to restrict the signs and magnitudes of the responses of the endogenous variables. Notably, our identifying assumptions are later validated by estimating the same SVAR on US data (see Section (1.2.4) a sample for which these disaggregated components are available.[5]

Assumptions

Before presenting the assumptions needed, we note that fiscal shocks in this study are considered to be increases in government spending financed by public debt. That is, we do not assume the government budget constraint to follow a balanced path in each period. Notably, the assuptions are valid for debt issued by the government both at home and abroad.

Assumption (1) states that:

[5] It is important to clarify here that we abstract from issues such as the location of debt issuance, the currency denomination of debt, the jurisdiction of issuance, the maturity of the assets, and other features such as which is the issuing government agency. What we are solely interested in exploring is whether debt-financed government policy produces differential results on other macroeconomic aggregates depending on whether the holder of debt resides within or outside the economy.

1. *A government spending shock increases external debt via an increase in the current account deficit*

We label Assumption (1) as the *indirect effect* of government spending. The indirect effect states that any increase in government spending due to debt issuance, be it held domestically or abroad, will lead to an increase in external debt via a deterioration in the current account. This will be This effect is validated in numerous studies that investigate the effects of government spending shocks on the trade balance (see e.g. Beetsma et al. (2008) for the EU, or Monacelli and Perotti (2006) for the US, UK, Canada and Australia) and is also a mechanism present in the model proposed in Section (3.2).[6] Assumption (1) implies that the majority of the proceeds from the issuance of debt by the government will be allocated to improve the import position of the domestic economy. At the same time, this effect is also present via an analogous mechanism that is active on the side of the private sector. If the private sector is not fully credit-constrained then private borrowing abroad will also increase the external debt of the economy. The extent of this increase will depend on how perfect access is to financial markets from the side of the private sector. This consideration is important in analyzing the differential effects of fiscal shocks on fiscal multipliers and the response of private investment, as will be explained in Section (3.2).

Assumption (2) states that:

2. *The increase in external debt (due to the indirect effect) is smaller than the increase in public debt*

Our consideration of the fiscal shock as debt-financed implies that total public debt increases following a government spending increase, while Assumption (1) guarantees

[6] Kim and Roubini (2008)and Corsetti and Muller (2006) find that a shock to the budget deficit-to-GDP ratio in the US leads to an improvement in the current account-to-GDP ratio. We conjecture that these contrasting results stem from the alternate specification and identification methods used in these studies.

that there is also an increase in external debt. Without any further restrictions on the magnitude of these increases it is impossible to achieve identification on whether the debt-financed government spending shock is Home-financed or Foreign-financed. To distinguish between the two, we therefore need to introduce Assumption (2).

Assumption (2) implies that although a deterioration in the current account occurs, this does not fully compensate for the increase in public debt. Since a deterioration in the current account implies an increasing surplus in the capital account, the increased consumption of imports should not be equal to the increase in public debt. It is straightforward to expect that a current account deterioration occurs, but that some of the raised public debt will also be used to boost the domestic export sector, thus limiting the increase in capital outflows.

Magnitude Restrictions

The Assumptions above propose movements on the responses of the debt components following any type of government financed debt shock. The next step is to translate these assumptions in the analogous magnitude restrictions that will enable us to differentiate between the two types of shocks of interest, that is a Home-debt financed government spending shock and a Foreign-debt financed government spending shock.

Restriction 1: Home-debt financed government spending shock

By the consideration of the fiscal shock as debt-financed the increase in government spending increases total public debt, and by Assumption (1) it also increases total external debt. By Assumption (2) the increase in total external debt is lower than the increase in total public debt, leading to the restriction that the increase in total public debt must be greater than the increase in total external debt. This is shown in equation (1.2.6).

$$\Psi_{n,t+h}\left(public\ \ debt\right) >= \Psi_{n,t+h}\left(external\ \ debt\right) \tag{1.2.6}$$

where $\Psi_{n,t+h}\left(public\ \ debt\right)$ and $\Psi_{n,t+h}\left(external\ \ debt\right)$ are the impulse responses of the corresponding debt components to the identified shock. Restriction 1 thus says that the increase in public debt is at least as large as the increase in external debt.[7]

Restriction 2: Foreign-debt financed government spending shock

By the consideration of the fiscal shock as debt-financed the increase in government spending increases public debt, and by Assumption (1) it also increases external debt. Assumption (2) implies that the increase in external debt is smaller than the increase in public debt. However, in contrast to the Home-debt financed government spending shock there is an additional over-and-above increase in external debt via the *direct effect* of external debt. This comes from the increase in external debt itself to finance government spending and the subsequent current account deterioration. This implies that the increase in external debt is a one-for-one increase in public debt, and follows immediately from the definition of the variable, hence the terminology. Therefore, the increase in external debt due to the direct and indirect effect combined is now larger than the increase in public debt. Intuitively, the external debt multiplier on government spending is larger for a Foreign-debt financed government spending shock. As a result, external debt increases more than public debt, which leads to the second magnitude

[7]Note that this condition does not hold with a strict inequality as it is still theoretically possible, but empirically implausible, that the current account deterioration triggered by the Home-financed government spending shock only occurs through an increase in imports.

restriction in equation (1.2.7).

$$\Psi_{n,t+h}\,(public\ \ debt) < \Psi_{n,t+h}\,(external\ \ debt) \tag{1.2.7}$$

where again $\Psi_{n,t+h}\,(public\ \ debt)$ and $\Psi_{n,t+h}\,(external\ \ debt)$ are the impulse responses of the corresponding debt components to the identified shock. Restriction 2 states that the increase in public debt is strictly smaller than the increase in external debt.[8]

Sign Restrictions

In the baseline specification of the empirical model the vector of endogenous variables y_t contains the variables: *government spending, output, household consumption, investment, total public debt* and *total external debt*, collected at annual frequency from 1980 - 2010. For information on the data and sources see section (1.7) in the Appendix. All series are transformed in log differences and are set in per capita terms.[9] Both types of debt are also in real terms. We employ 2 lags of the endogenous variables as proposed by the HQ criterion.

[8]We also include additional restrictions on the size of the multiplier on public debt and on the size of the multiplier on external debt. The reason is that a number of models consistent with our baseline restrictions produced high multipliers on public and external debt, although according to our definition public debt multipliers they should be equal to one. There may be several reasons why this may not hold empirically, but two obvious cases are: i) our measure of government expenditures consists of general government final consumption expenditures, which represents only a share of total government expenditures. ii) our measures of government expenditures, public debt and external debt may be contaminated due to large measurement errors. Nevertheless, in order to achieve consistency within our emprical investigation we restrict the size of the multiplier on public debt to be less than 7.5, and the size of the multiplier on external debt to a Foreign-financed shock to be less than 15 - this approximately corresponds to the lowest 10-th percentile of accepted models without this additional constraint. Dropping this restriction does not particularly affect the qualitative results, but only causes fiscal multipliers to become larger - we show unrestricted impulse responses in subsection (1.2.4).

[9]Outliers are identified as values differing from the mean of each time series by 6-times the interquartile range of their time series. Identified outliers are then replaced with the corresponding maximum value - in the case of a positive value, they are replaced by the mean plus 6-times the interquartile range, and in case of a negative value, they are replaced with the mean minus 6-times the interquartile range.

Building on the magnitude restrictions above we then propose the following identification restrictions on the endogenous variables of the model in order to disentangle the government spending shocks from a business cycle shock. In contrast to the restrictions employed in the literature, which are to a large extent conventional, we propose identification restrictions, which are mostly theory based. The reason is that those employed in other studies are hard to justify with the low frequency data at our disposal. For example, assuming that it takes more than a period for government spending to respond to unexpected output movements is unappealing in annual data because of the presence of automatic stabilizers.[10] Our proposed restrictions are found in Table (1.1).[11]

Table 1.1: Identification Restrictions

	G	Y	C	I	Public Debt	External Debt
Home	+	+			+	+
Foreign	+	+			+	+
Business Cycle		+	+	+	-	

Combining the sign restrictions in Table (1.1) with the magnitude restrictions (1.2.6) and (1.2.7) we are then able to separately identify a Home-debt financed government spending shock, a Foreign-debt financed government spending shock, and a business cycle shock.

Finally, following the literature on fiscal multipliers we calculate the cumulative mul-

[10] We impose these restrictions to hold for 3 periods in our baseline estimation, but also experimented with shorter horizons.

[11] Matching the empirical results with the theoretical predictions in Section (3.2) would necessitate additional restrictions on the responses of government consumption and public debt. Namely, we would need to impose that public debt increases one-for-one with government consumption. Forcing such a restriction however, results in no accepted draws, as public debt tends to increase disproportionally more than government consumption when no restrictions are used. The restriction we therefore impose is to allow public debt to increase less than five times more than government consumption. This suggests that our estimates of absolute multipliers may be upwardly biased, however the relative difference between the two types of shocks remains unaffected.

tiplier as:

$$m_{t+s} = \frac{\sum_{q=t}^{t+s} \Delta \ln(X_q)}{\sum_{q=t}^{t+s} \Delta \ln(G_s)} \left(\frac{\bar{X}}{G} \right)$$

where X corresponds to the endogenous variable of interest (output Y, consumption C and investment I) and G is government consumption. $\left(\frac{\bar{X}}{G}\right)$ is the steady state of the endogenous variable over government consumption and serves to translate the growth rate into absolute values. We use the mean values of variables in our sample to calculate the steady states.[12]

1.2.3 Results

We estimate the SVAR using a Pooled Ordinary Least Squares Estimator.[13]

As can be seen from Figures (1.7.1) and (1.7.2) by distinguishing the government spending shock as Home debt-financed and Foreign debt-financed we obtain a differential response on the main variables of interest, investment. For a Home-debt financed government spending shock the responses is negative whilst for a Foreign-financed government spending shock it is positive. Government spending, private consumption, public debt and external debt increase by assumption for both shocks and output too increases in both cases, but at different magnitudes.

Moreover, from Figures (1.7.3) and (1.7.4) we can see that the magnitude of the output multiplier is much smaller for a Home-financed government spending shock. The impact multipliers are approximately 1 for the Home-financed shock and approximately 3 for

[12]Owyang et al. (2013) show that calculating multipliers in this ex post fashion may lead to upwardly biased estimates. They instead follow Hall (2009) and Barro and Redlick (2011) and convert GDP and government spending changes to the same units *before* the estimation. However, their framework is based on the Jorda decomposition and is thus not possible to use this transformation in a standard VAR specification, since here all variables must be of the same form. Nevertheless, even if the values we report further on are upwardly biased, the result we want to emphasize is the relative difference of multipliers between the two types of shocks, which remains unaffected.

[13]For details on the estimation algorithm see Section 1.7 in the Appendix.

the Foreign-financed shock. The biggest difference is in the investment multiplier, which is negative for a Home-financed shock (-1.3), but positive and large for the Foreign-financed shock (3). Moreover, we find that in 99 percent of the accepted draws the investment multiplier is higher for a Foreign-financed shock. For output this is at 86 percent and for consumption at 80 percent of the cases.

1.2.4 Robustness Checks

By changing the assumptions, sample used, or the econometric strategy we are able to verify the robustness of our results. Notably, although in some cases our results are weakened, it is important to mention that at least some evidence is always present in favor of our baseline results and the economic intuition we obtain through the model. Thus, we are never able to generate the reverse result of home-financed government spending generating larger multipliers.

US Data

In the case of the US we have available a full decomposition of the variables of interest - we have the exact data that comprise the following ratio: public external debt-to-public domestic debt. This allows us to test the validity of our identification strategy by simply including this ratio in the system and checking if the response of the ratio is as expected, without restricting it a priori. We choose to include the ratio itself rather than public debt and external debt in order to economize on degrees of freedom. The expectation is that the ratio will decrease following a Home-debt financed government spending shock and increase following a Foreign-debt financed government spending shock. As can be seen in Figures (1.7.5) and (1.7.6) the ratio follows the anticipated pattern. This verifies our expectations and hence lends validity to our initial identification and estimation across the whole sample.

Alternative Estimation Procedures

Here, we proceed by relaxing one of the assumptions in our original shock identification, namely that output increases following a shock to government expenditures. In order to make the shocks mutually exclusive, we assume external debt increases after the business cycle shock. As can be seen from Figures (1.7.7), (1.7.8), (1.7.9) and (1.7.10) the results are similar to our baseline specification with the output multiplier being larger in the case of a Foreign-financed shock.

In Figures (1.7.11), (1.7.12), (1.7.13), and (1.7.14) we relax the assumption of constraining the size of the debt multiplier. Whilst in Figures (1.7.15), (1.7.16), (1.7.17), and (1.7.18) we re-estimate our model using fixed effects in growth rates.

1.3 Model Environment

Consider a small open economy populated by a continuum of households $h \in [0, 1]$, of which a fraction s are rule-of-thumb workers (w) and the remaining fraction $1 - s$ are saver capitalists (k). The economy also includes perfectly competitive firms and a government. Both types of households supply labor, and capitalists supply capital to competitive firms for the production of a final output, which is consumed domestically.[14]Fiscal policy in the economy is determined by the government, which finances unproductive public expenditures via lump-sum taxes, debt issued to the resident households in the form of one-period non-contingent bonds, and debt issued to

[14]Having two types of households (workers and capitalists) is not essential in qualitatively obtaining our central result that government spending shocks have differential effects on the real economy depending on their source of debt financing. However, once we allow for this we are able to also quantitatively replicate the magnitudes of fiscal multipliers following the two types of debt-financed government spending shock.

nonresident foreign investors in the form of one-period non-contingent bonds. That is, the government finances its public expenditures by issuing *two* types of bonds, which differ in the location of the holder, one is at home and the other is abroad. Foreign investors are unmodelled and as such it is is simply assumed that the interest rate on foreign-issued debt follows an exogenous debt-elastic rule. The government chooses the mixture of expenditure-financing by minimizing the cost of financing its deficit. This implies that the mixture of public debt will be endogenously determined through a no-arbitrage condition equalizing the returns on home and foreign debt and be to a large extent affected by the degree of openness of the economy.

1.3.1 Preferences

Households are indexed by $j \in \{w, k\}$. In order to lighten the notation, we drop the index j from the parameters, but note that these can still be different across types of households as will become the case when we calibrate the model.

Since households differ only in the composition of their budget constraints, for both types of households j preferences are given by equation (3.2.1). They consume a CES basket C_t^j and supply labor n_t^j. The CES basket in (1.3.2) aggregates over the private consumption good c_t^j and the public consumption good G_t.

$$U_t = E_t \sum_{t=0}^{\infty} \beta^t \left\{ \frac{\left(C_t^j - \psi \left(n_t^j \right)^{\varphi} \right)^{1-\gamma} - 1}{1-\gamma} \right\} \tag{1.3.1}$$

$$C_t^j = \left(\eta^{\frac{1}{\zeta}} \left(c_t^j \right)^{\frac{(\zeta-1)}{\zeta}} + (1-\eta)^{\frac{1}{\zeta}} \left(G_t \right)^{\frac{(\zeta-1)}{\zeta}} \right)^{\frac{\zeta}{(\zeta-1)}} \tag{1.3.2}$$

The period utility function $U(.)$ is assumed to be strictly increasing, strictly concave and twice continuously differentiable. $E_t[.]$ is the expectation operator conditional on information available at time t and β is the subjective discount factor assumed to satisfy $0 < \beta < 1$. ψ denotes the share of labor in the utility function and γ is the intertemporal elasticity of substitution. We assume that $\psi > 0$ and $\gamma > 0$. C_t^j in turn aggregates consumption of the private good c_t^j and the public good G_t. The parameter ζ governs the elasticity of substitution between consumption of the private good and consumption of the public good, such that when $\zeta \to \infty$, c_t^j and G_t are perfect substitutes and when $\zeta \to 0$ they are perfect complements. The parameter η determines the share of the two consumption goods in the basket.

Rule-of-Thumb Workers

Workers are assumed to behave in a rule-of-thumb fashion and thus in every period consume all of their disposable income earned from supplying labor to competitive firms. Expressed in terms of the private consumption good they face the budget constraint

$$c_t^w = W_t n_t^w - \tau_t^w \tag{1.3.3}$$

The left-hand side represents their expenditures where c_t^w is total worker consumption and the right-hand side represents their labor income $W_t n_t^w$ minus any lump-sum taxes τ_t^w levied from the government (transfers if < 0). The representative worker on the interval $h \in [0, s]$ faces the simple optimization problem of choosing c_t^w and n_t^w to maximize (3.2.1) subject to (1.3.3) taking the price W_t as given.

Capitalists

Capitalists in turn supply labor and capital to firms and have the ability to borrow from the government as well as external financial markets. Their budget constraint in terms of the private consumption good is given by

$$c_t^k + i_t - b_{f,t}^k + b_{h,t} = W_t n_t^k + r_t k_{t-1} + R_{h,t-1} b_{h,t-1} - R_{f,k}^k b_{f,t-1}^k - \tau_t^k \qquad (1.3.4)$$

The left-hand side represents expenditures where c_t^k is consumption of the private consumption good, i_t is investment in productive capital and $b_{f,t}^k$ and $b_{h,t}$ denote the purchase of debt made by capitalists at time t from external financial markets and the domestic government respectively. If $b_{f,t}^k > 0$ and $b_{h,t} > 0$ the capitalist is a borrower. The right-hand side represents the capitalist's income. $W_t n_t^k$ is their labor income, $r_t k_{t-1}$ is the rent from capital, and $R_{h,t-1} b_{h,t-1}$ and $R_{f,t-1}^k b_{f,t-1}^k$ denote the gross returns from the two types of debt decisions made at time $t-1$. $\tau_t^k > 0$ are again lump-sum taxes (transfers if < 0) from the government.

Domestic bonds are supplied by the government, so the domestic bond interest rate is determined in equilibrium. This will imply domestic bonds will be in zero net supply and their price will be determined through the capitalists' Euler equation. To determine private foreign debt we follow **?** and specify a debt-elastic interest rate rule, which depends on the household's own debt position $b_{f,t}^k$. This ensures stationarity of private foreign debt and closes the model accordingly.

$$R_{ft}^k = \Psi(b_{f,t}^k) = r^* + \nu \left(\exp(b_{f,t}^k - \bar{b_f^k}) - 1 \right) \qquad (1.3.5)$$

The internal debt-elastic interest rate faced by the household assumes that the interest rate is a sum of the world interest rate, r^*, and a convex function of deviations of their individual debt position, $b_{f,t}^k$, from the steady state value of private foreign debt, $\bar{b_f^k}$. As a result, capitalists will determine their optimal expenditures by considering the effect that a change in their debt position has on the marginal cost of funds. [15] The parameter $\nu \geq 0$ represents a proxy for external financial market openness and is further discussed below, when describing the determination of fiscal policy.

The representative capitalist on the interval $h \in [1-s, 1]$ chooses consumption c_t^k, labor supply n_t^k, as well as positions on domestic bonds $b_{h,t}$ and foreign bonds $b_{f,t}^k$ to maximize utility (3.2.1) subject to the budget constraint (1.3.4) taking prices W_t, r_t, $R_{f,t}^k$ and $R_{h,t}$ as given.

1.3.2 Firms

On the production side output is produced using a Cobb-Douglas production function over capital and total labor.

$$F(k_{t-1}, N_t) = z_t k_{t-1}^{\alpha} N_t^{1-\alpha} \tag{1.3.6}$$

where α determines the share of capital in production. z_t is an exogenous shock and follows an AR(1) process with autocorrelation coefficient $\rho < 1$.

$$\ln(z_t) = \rho \ln(z_{t-1}) + \varepsilon_t \tag{1.3.7}$$

Firms choose k_{t-1} and N_t to maximize profits taking prices as given.

1.3.3 Fiscal Policy

Public spending G_t is financed via debt issued to domestic households $b_{h,t}$, which is then repaid in a lump-sum fashion through government transfers T_t, and to unmodelled

[15] We impose a steady state value of foreign debt $\bar{b_f^k} = 0$, which implies that the equation admits the solution $b_{f,t}^k = \bar{b_f^k}$.

foreign investors $b^g_{f,t}$. The government's budget constraint is given by

$$G_t - T_t = b_{h,t} - R_{h,t-1}b_{h,t-1} + b^g_{f,t} - R^g_{f,t-1}b^g_{f,t-1} \tag{1.3.8}$$

which implies that the budget deficit $G_t - T_t$ can be financed from two sources of debt; domestic debt $\left(b_{h,t} - R_{h,t-1}b_{h,t-1}\right)$ and foreign debt $\left(b^g_{f,t} - R^g_{f,t-1}b^g_{f,t-1}\right)$. The utility-enhancing public expenditures are determined according to a fiscal rule, where current government spending G_t depends on its past realization G_{t-1} as well as a shock ε^g_t. We allow for a constant term in the fiscal rule, such that the steady-state level of government spending is positive ($\kappa^g > 0$).

$$G_t = \kappa^g + \rho_g G_{t-1} + \varepsilon^g_t \tag{1.3.9}$$

In turn, taxes also follow a predetermined rule, whereby they depend on the share of total debt relative to its steady state value $\bar{B}$

$$T_t = \kappa \left(\frac{B_{t-1}}{\bar{B}}\right)^{\xi} \tag{1.3.10}$$

where $\kappa, \xi \geq 0$ and B_t is the sum of foreign and domestic debt

$$b_{f,t} + b_{h,t} = B_t$$

As in the case of the private sector, foreign public debt is determined by a debt-elastic interest rate rule, but in which this case depends on the amount of foreign government debt $b^g_{f,t}$ issued.

$$R^g_{f,t} = \Psi(b^g_{f,t}) = r^* + \bar{\nu}\left(\exp(b^g_{f,t} - \bar{b^g}) - 1\right) \tag{1.3.11}$$

The parameter $\bar{\nu} \geq 0$ this time analogously represents a proxy for the openness of external financial markets from the perspective of the government. If $\bar{\nu} = 0$ it implies that the government has perfect access and as such can issue debt abroad at the world interest rate $R_{f,t} = r^*$. As $\bar{\nu}$ increases external capital becomes more limited and the interest rate the government faces increases with the size of debt issued in an exponential fashion.[16]

Finally, we need to specify how the mixture of debt is determined. This will enable us to pinpoint the location of debt holdings, which in turn will tell us from which type of debt (Home or Foreign) government spending is financed. In order to do this we momentarily introduce the parameter λ into the government budget constraint for illustrative purposes in the following way

$$G_t - T_t = \lambda \left(b_{h,t} - R_{h,t-1} b_{h,t-1}\right) + (1 - \lambda)\left(b^g_{f,t} - R^g_{f,t-1} b^g_{f,t-1}\right) \tag{1.3.12}$$

Recall that our empirical model identifies the two uncontaminated cases of a fully Home-debt financed and a fully Foreign-debt financed government spending shock. Here, by allowing λ to reflect the proportion of government debt that is issued *domestically* we are able to nest the cases we study empirically in our theoretical model. As such, when $\lambda = 0$ it implies that total government debt is is issued to nonresidents, whereas when $\lambda = 1$ total government debt is only composed of debt issued domestically to resident households. As such, a government spending shock when $\lambda = 0$ will only transmit itself by issuing debt domestically and when $\lambda = 1$ it will only transmit itself by issuing debt abroad. In an endogenous setting where λ is determined in equilibrium it involves a problem where the government minimizes its costs of financing

[16]Possible reasons as to why access to external financial markets may not be perfect from the perspective of the sovereign include the risk of default, a history of crises, political instability, among others reasons.

subject to its budget constraint up until the no-arbitrage condition of $R^g_{f,t} = R_{h,t}$ is met. This endogenous government problem is simple to implement, and the mixture of Home and Foreign debt that is issued is this setting would be to a large extent determined by the degree of openness of external financial markets from the perspective of the government, that is by the parameter $\bar{\nu}$. [17]

1.3.4 Aggregation and Identities

Denote the aggregate quantity of a variable z_t by Z_t. Then,

$$Z_t = \int_0^1 z_t(h)dh = s z_t^w + (1-s) z_t^k \quad , \quad z \in \{c, n\}$$

Given that we assume that only capitalists have access to capital and asset markets then aggregate investment, aggregate capital and aggregate debt are given by

$$Z_t = \int_0^1 z_t(h)dh = (1-s) z_t^k \quad , \quad z \in \left\{i, k, b_{h,t}, b^k_{f,t}\right\}$$

Lump-sum transfers are assumed to be identical for both workers and capitalists

$$Z_t = \int_0^1 z_t(h)dh = z_t \quad , \quad z \in \{\tau_t\}$$

The current account CA_t is defined as the sum of the trade balance TB_t, and net

[17] Notice that if $\bar{\nu} \to \infty$ then access to external financial markets for the government is completely blocked and is equivalent to the case where $\lambda = 0$. However, since in practice we can only experiment with finite values of $\bar{\nu}$, even if $\bar{\nu}$ is large, there will still be some movement in domestic debt (in particular savings) in order to finance the issuance of debt abroad. Although qualitatively our results remain unaffected in this endogenous setting, we opt for the former approach where the government behaves as an automaton and the mixture of debt is determined by changing λ. This allows us to perfectly capture the uncontaminated cases of a fully Home-debt or Foreign-debt financed government spending shocks as in the empirical exercise.

investment income on the country's net foreign asset position.

$$TB_t = Y_t - C_t - I_t - G_t \tag{1.3.13}$$

$$CA_t = TB_t - R^g_{f,t-1}B^g_{f,t-1} \tag{1.3.14}$$

Finally, the resource constraint of the economy is given by aggregating the budget constraints of the households (1.3.4, (1.3.3) and that of the government (1.3.8).

$$C_t + I_t + G_t = F(K_{t-1}, N_t) + B_{f,t} - R_{f,t-1}B_{f,t-1} + B^k_{f,t} - R^k_{f,t-1}B^k_{f,t-1} \tag{1.3.15}$$

Note that an alternative way to model the financial friction for private borrowers would be to include portfolio adjustment costs for capitalists. As mentioned above however, we opt for specifying an internal debt-elastic interest rate for private foreign debt, which increases exponentially by altering the parameter ν. As $\nu \to \infty$ then private foreign borrowing would be completely prevented and the final two terms in the resource constraint would drop out.

1.4 Quantitative Analysis

This section serves to illustrate the principal mechanism at work, and provide a robust theoretical explanation for the results we observe in the data. As will be shown, the crucial features that drive the differential effects of a government spending shock are the extent that private investment is crowded in, or out. This is a direct consequence of whether the private sector has (im)perfect access to external financial markets at the time that the government spending shock hits the economy.

1.4.1 No Private Access to External Financial Markets

In what follows we assume that private access to external markets by capitalists is completely prevented. Although in theory this is achieved when $\nu \to \infty$ we experiment with several values for ν and conclude that a value of $\nu = 50$ is enough to block all private foreign debt holdings. With regards to the other parameters we choose them illustratively and leave a more motivated assignment of values to Section (1.5) where we report fiscal multipliers.[18] Note that we perform the following exercise by setting $\eta^w = \eta^k = 1$. That is, we do not allow for the consumption of the public good to enter the consumption baskets of neither workers nor capitalists. We opt for this since, as will be shown further down, the introduction of government spending in the utility function can alter the responses of consumption and confound the explanation in our baseline example.

In order to explain the results of the uncontaminated Home-debt financed and Foreign-debt financed government spending shocks that we find in the data, we exogenously determine the mixture of debt by imposing values for the parameter λ, which governs the location of deficit financing for the government.. The budget deficit is fully financed domestically when $\lambda = 1$ and fully abroad when $\lambda = 0$. These results can be considered as the extreme cases, which do not mirror optimal debt management decisions of a government, but can explain the two shocks that we disentangle and uniquely identify in the empirical investigation. The impulse responses of the model are shown in Figure (1.7.19). As in the empirical section, the key feature, which drives the differential changes in output is the movement in investment. For the Foreign-debt financed government spending shock investment increases, whereas for the Home-debt

[18] Even so, we experimented with several values for parameters $\{s, \eta^j, \zeta^j\}$ in a close range and found that our results remained qualitatively unaffected.

Table 1.2: Parameter Values for Household j

Parameter Name	Label	Value
Discount factor	β	0.99
World interest rate	r^*	$\frac{1}{\beta}$
Capital share	α	0.33
Share of consumption in CES consumption basket	η^j	1
Elasticity of substitution in CES consumption basket	ζ^j	2
Inverse of Frisch elasticity of labor supply	φ^j	1.5
Share of workers	s	0.5
Depreciation rate	δ	0.025
Output persistence	ρ	0.9
Output standard deviation	σ	0.01
Relative risk aversion	γ^j	2
Share of labor supply	ψ^j	1
Debt-elastic interest rate coefficient (household)	ν	$[0, \infty)$
Government spending constant	κ^g	0.05
Government spending autocorrelation coefficient	ρ_g	0.9
Debt-elastic interest rate coefficient (government)	$\bar{\nu}$	$[0,\infty)$
Tax rate parameter	κ	0.5
Tax rate exponent	ξ	0.3

financed government spending shock investment decreases.

The mechanism that brings about these results can be understood by comparing the capitalist's budget constraint (1.4.1) with the resource constraint of the economy (1.4.2).

$$c_t^k + i_t + b_{h,t} = W_t n_t^k + r_t k_{t-1} + R_{h,t-1} b_{h,t-1} - \tau_t^k \tag{1.4.1}$$

$$C_t + I_t + G_t = F(K_{t-1}, N_t) + B_{f,t} - R_{f,t-1} B_{f,t-1} \tag{1.4.2}$$

Clearly, since we do not allow capitalists to borrow from abroad, but only from the domestic government the resource constraint will only contain foreign public bonds. This implies that when a government spending shock hits the economy (whether it is Home- or Foreign-debt financed) some components of the resource constraint will need to adjust in order to absorb the increase in government expenditures. If the shock is

Home-debt financed, which occurs when households are buying bonds from the government, then to meet the resource constraint they will need to reduce consumption and/or investment, assuming that labor remains fixed. Due to a motivation for consumption smoothing, which derives from the curvature of the utility function, it will be investment that is required to adjust the most. If the government spending shock is Foreign-debt financed however then a shock to government expenditures implies that foreign bonds can be used to buffer this shock, and hence we should not observe such a decline in consumption and/or investment, ceteris paribus. Thus, a Foreign-debt financed government spending shock should not lead to such large levels of crowding out of private investment as a Home-debt financed government spending shock.

However, at the same time there is also a wealth effect operating (of different magnitude for each shock), leading to a further heterogeneous response (of all variables) to the two shocks. The wealth effect comes about due to the expected increases of future taxation making agents feeling poorer and increasing their labor supply to both shocks. First, in the case of a Foreign-debt financed government spending shock households feel poorer as they do not receive the interest rate payments that they would otherwise receive under a Home-debt financed government debt shock. That is, the interest paid on foreign bonds is simply wasted when private external borrowing is completely blocked. This effect implies that agents provide more labor in response to a Foreign-debt financed government spending shock. On the other hand, the wealth effect induces a second differentiation across the two shocks, this time deriving from the endogenous response of economy in each case. Agents recognize that their consumption and/or investment has to decline when the government finances the deficit by issuing domestic public debt making them feel poorer and hence leading them to increase their labor relatively more for a Home-debt financed shock than a Foreign-debt financed shock. In equilibrium, we see that the second effect dominates. implying that a utility specification, which could potentially feature lower wealth effects would lead to a larger difference in the responses to the two shocks.[19]

Furthermore, since investment increases when the Foreign-debt financed government spending shock hits, and capital takes time to build, we observe a further rise in labor for the Foreign-debt financed government spending shock in the second period. This is because the marginal product of labor increases due to the increase in investment, thus incentivizing households to further increase their labor in the subsequent period. Another feature, which we observe is the deterioration of the current account, which occurs for either type of government spending shock. This result lends validity to the assumptions we have imposed in the empirical section.

Finally, at this stage we do not stress the quantitative response of any of the endogenous variables and the translation of the responses to fiscal multipliers. Although it is evident that following a Foreign-debt financed government spending shock the response of output is greater in magnitude, which would hence imply a larger multiplier, we leave the quantitative exploration of multipliers to Section (1.5).

1.4.2 Private Access to External Financial Markets

The results presented above rely on the fact that households did not have access to foreign financial markets. In this section we reverse this condition and assume that there is full *private* access to external financing. We do this by setting $\nu = 0.0007$. Figure (1.7.20) plots the impulse responses for the endogenous variables following a Foreign-debt financed ($\lambda = 0$) and Home-debt financed ($\lambda = 1$) government spending shock. The main difference, is that now the response of investment is increasing follow-

[19] An extension of interest (not reported here) allowed for a Jaimovich-Rebelo-type utility specification (Jaimovich and Rebelo, 2009), where the strength of wealth effects could be altered. We observed that weaker wealth effects led to a larger difference in the output responses to the two shocks.

ing both types of shocks. The reason for this increase is that in both cases capitalist households can themselves now buffer the government spending shock by engaging in private foreign borrowing, something which was ruled out before.

1.4.3 Varying the Debt-Elasticity of the Foreign Interest Rate for the Private Sector

In order to reconcile the two cases where the private sector does, or does not have access to foreign financial markets we experiment with the value of the private debt-elastic parameter within the range $0 \leq \nu < 0.03$. Figure (1.7.21) plots the responses of investment following a Home-debt financed or Foreign-debt financed government spending shock for different values of the parameter governing the debt-elasticity of the interest rate for households.

As agents increase their labor supply in response to both fiscal shocks because of a wealth effect, the marginal return to capital increases and agents would like to increase their investment. When the shock is financed by issuing debt to foreign holders investment therefore always increases. On the other hand, for a domestically financed shock the response of investment depends on the private sector's access to foreign financial markets. When access is high (i.e. the interest rate elasticity is low) agents borrow externally to finance their investment and take advantage of their increased labor supply. However, when access is low (i.e. the interest rate elasticity is high) external borrowing is too costly and investment actually decreases as agents are obliged to spend a large share of their income to purchase government bonds.

1.5 Fiscal Multipliers

As there are several ways to measure fiscal multipliers, we follow the definition used in the empirical investigation presented above. That is, the change in real GDP caused by a one-unit increase in the government spending. Following Ilzetzki et al. (2013), as multipliers may depend on the forecast horizon, we concentrate on reporting two different fiscal multipliers. An impact multiplier defined as

$$Impact\ muliplier = \frac{\Delta y_o}{\Delta g_o}\left(\frac{\bar{Y}}{\bar{G}}\right)$$

, which measures the ratio of the change in output to the change in government spending at the same time the government spending innovation occurs, scaled by the share of steady-state government spending to steady-state output. Furthermore, we also present the cumulative multiplier at time T, which is defined as:

$$Cumulative\ muliplier = \frac{\sum_{t=0}^{T}\Delta y_t}{\sum_{t=0}^{T}\Delta g_t}\left(\frac{\bar{Y}}{\bar{G}}\right)$$

, which measures the cumulative change in output per unit of additional government spending, from the time the government spending innovation occurs until time T, scaled by the share of steady-state government spending to steady-state output.

1.5.1 Matching Impulse Responses

Since our intention is to test the model's predictions in confronting the data-reported fiscal multipliers, we proceed in the spirit of Canova (2002) and examine whether implications from the theory and the SVAR can be matched in dimensions of interest. As such, we categorize the set of parameters $\theta = (\theta_1, \theta_2)$, where θ_1 represents the parameters, which we keep fixed and θ_2 are parameters, which we have identified to play a role in significantly altering the quantitative responses of the endogenous variables in the model and thus experiment with values for them in a close range (see table 1.3).

For θ_1 we set the discount factor to 0.99 in order to achieve an interest rate of 1%, which is the average quarterly interest rate on a 3-month US treasury bill. Following conventional parameterisation in the macroeconomic literature we set the coefficient of relative risk aversion (for both workers and capitalists) to 2, the share of capital in production to 0.33, the inverse of the Frisch elasticity of labor supply (for both workers and capitalists) to 1.5, the share of labor supply in the utility function (for both workers and capitalists) to 1, and the depreciation rate to 0.025 (see Mendoza, 1991).[20] θ_2 includes the share of the government consumption good in the aggregate consumption basket (for both workers and capitalists), the strength of complementarity between private and public consumption in the CES aggregator (for both workers and capitalists), and the share of rule-of-thumb workers in the aggregation of households.

In order to avoid indeterminacies, when simulating a home-debt financed government spending shock ($\lambda = 1$), we set the debt-elastic interest rate for the government to 50 (no external access), whilst when simulating a foreign-debt financed government spending shock ($\lambda = 0$), we set the debt-elastic interest rate for the government to 0 (perfect external access). Finally, since we are interested in capturing the magnitudes of fiscal multipliers reported in the data, which represent an upper bound, we set the debt-elastic interest rate for capitalists to 50 in each simulation.

[20]In sensitivity analysis (not reported here, but available upon request) we experiment with several other plausible values of θ_1-type parameters and conclude that our results remain unaffected.

Table 1.3: Parameter values for matching impulse responses

θ_1		
Discount factor	β	0.99
World interest rate	r^*	$\frac{1}{\beta}$
Capital share	α	0.33
Inverse of Frisch elasticity of labor supply (workers)	φ^w	1.5
Inverse of Frisch elasticity of labor supply (capitalists)	φ^k	1.5
Depreciation rate	δ	0.025
Relative risk aversion (workers)	γ^w	2
Relative risk aversion(capitalists)	γ^k	2
Share of labor supply (workers)	ψ^w	1
Share of labor supply (capitalists)	ψ^k	1
Debt-elastic interest rate coefficient (capitalists)	ν	50
Debt-elastic interest rate coefficient (government)	$\bar{\nu}$	(0,50)
θ_2		
Share of consumption in CES consumption basket (workers)	η^w	(0.1, 0.3, 0.5, 0.7, 0.9)
Share of consumption in CES consumption basket (capitalists)	η^k	(0.1, 0.3, 0.5, 0.7, 0.9)
Elasticity of substitution in CES consumption basket (workers)	ζ^w	(1.2, 1.4, 1.6, 1.8, 2)
Elasticity of substitution in CES consumption basket (capitalists)	ζ^k	(1.2, 1.4, 1.6, 1.8, 2)
Share of workers	s	(0.2, 0.4, 0.6, 0.8, 0.1)

We then simulate the model for the 5^5 parameter combinations and make a formal comparison of impact impulse response coefficients by choosing the set of parameters that gives the best match of simulated data responses to those generated by the data. Formally, we minimize the sum of squared differences between the impact responses of the model- and data-generated impulse response functions.

$$D = \left(\left(IRF_{model}^{home} - IRF_{data}^{home} \right)^2 - \left(IRF_{model}^{foreign} - IRF_{data}^{foreign} \right)^2 \right)^2 \tag{1.5.1}$$

Figures(1.7.22) and (1.7.23) plot the various responses of investment for the full set of parameter combinations. It is evident that for the vast majority of cases the response of investment is as expected, positive for a home-debt financed government shock and negative otherwise. Figure (1.7.24) plots the associated impact multipliers on output for the two government spending shocks as well as the difference between the two. It is evident that in a great number of cases the foreign-debt financed government spending shock leads to higher output impact multipliers than a home-debt financed government spending shock. Finally, Figures (1.7.25), (1.7.26) and (1.7.27) plot the cumulative and impact multipliers on output, investment and consumption respectively for the parameter combination that minimizes the distance matrix in (1.5.1). The impact multiplier on output is 2.47 for a Foreign-shock and 1.64 for a Home-shock. For the case of a Foreign-shock the model slightly underestimates the impact multiplier (3 in the data), whilst for the case of the Home-shock it slightly overestimates it (1 in the data). In similar fashion, the impact multiplier for investment for a Foreign-shock is 0.19 (3 in the data) and -1.1 for a Home-shock (-1.3 in the data), whilst is 0.84 for consumption (3.1 in the data) and 0.42 (0 in the data) respectively for a Foreign- and Home-shock. Notably, the parameter combinations, which achieve these results are $s = 0.4$, $\zeta^k = 1.4$, $\eta^k = 0.1$ $\zeta^w = 1.6$ and $\eta^w = 0.9$.

1.5.2 Sensitivity Analysis

Here, we perform a further decomposition of the sensitivity analysis implemented above by altering each time subsets of θ_2, whilst keeping the remaining θ_2 fixed either at the baseline calibration in table (3.1) or at the values minimizing (1.5.1). This allows us to better understand the effects of specific features of the model.

Utility-enhancing Government Spending

The parameter η^k determines the weight of the public consumption good in the consumption basket for capitalists, whereas the parameter ζ^k governs the strength of the complementarity between capitalist consumption of the private consumption good and capitalist consumption of the public good. Figure (1.7.28) plots the difference in the output multiplier following the two types of government spending shock for different levels of these parameters. The left panel assumes no access to external financial markets by the private sector $\nu = 50$, whereas the right panel assumes a case of perfect access $\nu = 0$.

When external market access is perfect (right panel), the greatest difference in output impact multipliers (higher for the foreign-debt financed government shock), although only marginally, is generated when the share of government spending in the consumption basket is high and complementarity is high. The reason for this is straightforward. An increase in government consumption leads to a complementary increase in the private consumption good, boosting output. However, interestingly, when there is no access to external financial markets (left panel), there is nonmonotonicity displayed whereby the largest difference in impact output multipliers is generated when the share of government consumption is large, but the strength of complementarity is either very low, or very high.

Share of Rule-of-Thumb households

Figure (1.7.29) plots impact and cumulative output multipliers following the two types of government spending shock for different shares of rule-of-thumb behavior in the aggregation of worker households. The remaining parameters are fixed at their distance-minimizing values. Overall, we observe that Foreign-debt financed shocks lead to higher output multipliers across all simulations. However, increasing the share of rule-of-thumb households decreases both multipliers and even reduces them to 0 for extreme values ($s = 1$). This is because as capitalists are depleted from the aggregation, although consumption may be increasing due to the high share of rule-of-thumb-workers, productive investment is displaced leading to lower output responses.

1.6 Country Characteristics

In this section we attempt to better reconcile the empirical results with the theoretical model. It is evident that the key mechanism through which the theoretical results are obtained are due to crowding out of private investment and the extent to which both the private sector and the government have access to external financial markets. In Figure (1.7.30) we present impact multipliers on output, consumption and investment following the two types of government spending shocks by splitting the sample of countries according to three proxies for access to external financial markets in the spirit of Ilzetzki et al. (2013). These proxies are i) the share of loans from non-resident banks to GDP, ii) the number of crisis events, and iii) the variance of output. For the first proxy we postulate that a higher share of non-resident bank loans for a country implies a better access to foreign markets. Recent studies that make use of this measure, especially for cases of developing countries are Bandyopadhyay et al. (2012) among others. The other two proxies suggest that the more numerous the number of crises and the higher the variance of output then countries will have lower access to foreign markets.

For all endogenous variables and across all proxies, the results suggest that for countries with higher access to external markets the difference in the multipliers (especially for output and investment) across the two types of shocks are smaller than for countries with lower access. For example, for countries with a high variance of output, the impact multiplier on output following a Home-debt financed shock is 2.51, whereas following a Foreign-debt financed shock it is 5.23. For the countries with a low variance of output the respective impact multipliers are 0.77 and 5.71. As the relative difference in multipliers is smaller for the low output variance subsamples, we conclude that this verifies our theoretical predictions that a country's ability to borrow from abroad is a crucial feature in generating asymmetries. The share of accepted models where the output multiplier is larger for a foreign shock over a home shock is 98 percent for countries with high access and 70 percent for countries with low access.

1.7 Conclusion

In this paper we have asked the question: how do fiscal multipliers differ if a fiscal shock is financed via home debt, or foreign debt. To answer this question we have estimated an SVAR identified by placing conventional sign restrictions on the movement of endogenous variables and by complementing them with magnitude restrictions on the movement of government debt. For several specifications of the SVAR we find that fiscal multipliers are larger when government spending is financed by debt that is held in a foreign economy.

We validate our econometric methodology by building a model that can account for these asymmetries. The fundamental mechanism that brings about this differential effect of government spending financing is the extent to which private investment is crowded in, or out following the two types of government spending shocks. When the private sector can have access to foreign borrowing then investment tends to be crowded in for both types of government spending shock and the output multipliers are qualitatively similar. When private access to foreign borrowing is completely limited then the difference on the effect of fiscal shocks is most emphasized. The specification of preferences of households, and in particular the extent to which government consumption can become utility enhancing drives a further quantitative difference between the effects of the two fiscal shocks. Policy prescriptions in the ongoing crisis in the Eurozone should take these differential effects into account as requiring a government to decrease its expenditures could potentially result in deeper than intended recessions if the location of public debt holdings is not considered.

Appendix

Data and variables

Unless stated otherwise nominal values are converted to real values using the price deflator for private consumption expenditures. Data are in constant 2000 U.S. dollars.

Public Debt. The sum of total domestic and total external gross central government debt-to-GDP. Whenever central government debt is not available we replace it with general government debt. *Source*: Reinhart and Rogoff (2011)

External Debt. The sum of total public and total private gross external debt-to-GDP. *Source*: Reinhart and Rogoff (2011)

Output. Y_t is gross domestic product. *Source*: World Bank

Government Expenditures. G_t is general government final consumption expenditure. *Source*: World Bank

Consumption. $C_t$is final consumption expenditure. *Source*: World Bank

Investment. I_t is gross fixed capital formation. *Source*: World Bank

List of Countries in sample: Algeria, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Germany, Ghana, Greece, Guatemala, Honduras, Hungary, Iceland, India, Indonesia, Ireland, Italy, Ivory Coast, Japan, Kenya, Korea, Malaysia, Mexico, Netherlands, New Zealand, Nicaragua, Norway, Panama, Paraguay, Philippines, Poland, Portugal, Romania, Russia, Singapore, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Tunisia, United Kingdom, USA, Venezuela, Zambia.

Estimation algorithm

The estimation procedure consists of three steps. In the first step, we estimate the reduced form VAR model. In the second step, we identify the structural shocks and take into account identification uncertainty. The third step serves to take into account estimation uncertainty. The steps are:

1. **Estimate reduced form VAR:** Given the number of lags proposed by Hannan-Quinn (HQ) or Bayesian Information criterion (BIC), $\widehat{p}$, $VAR(\widehat{p})$ is estimated by Ordinary Least Squares (OLS) with fixed effects to obtain an estimate of autoregressive coefficients and the variance-covariance of reduced form errors, $\widehat{\Sigma_u}$.

2. **Identification restrictions:** non-structural impulse responses function, $C(L)$, is related to the structural impulse responses function as $B(L) = A_0^{-1}C(L)$ and reduced form errors, u_t, are related to structural errors as $u_t = A_0^{-1}B\varepsilon_t$. Impact matrix, $S = A_0^{-1}B$, must satisfy"

$$\Sigma_u = SS' \tag{1.7.1}$$

   The estimate of impact matrix, $\widehat{S}$, is obtained by Cholesky decomposition of estimated variance-covariance of reduced form errors, $\widehat{S} = chol(\widehat{\Sigma_u})$. We use non-uniqueness of the representation in (1.7.1) to derive the distribution of impulse response functions by sign restrictions:

- First, the $k \times k$ matrix P is constructed with draws from a standard normal distribution, $\mathcal{N}(0, 1)$.
- The QR decomposition of P is derived, such that $P = QR$ and $QQ' = I$.
- The new impact matrix is constructed as $\widehat{D} = \widehat{S}Q$, and the corresponding impulse responses function is retained whenever it satisfies sign restrictions.
- The steps 2-2 are repeated 1000 times. The IRF's distribution is obtained by retaining the impulse responses functions that satisfy sign restrictions.

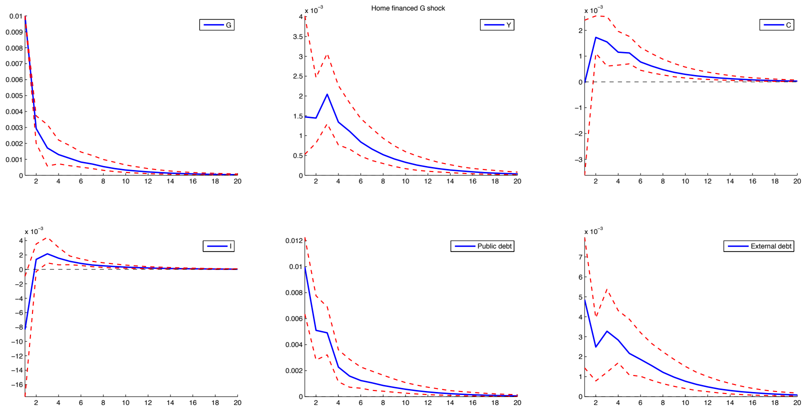
3. **Estimation uncertainty:** to account for estimation uncertainty, we repeat steps 1-2 1000 times, each time with a new artificially constructed data sample, Y^*. To construct data samples, we use block bootstrap, where blocks are individual countries. The countries are selected by random drawing with replacement from the pool of countries in original data set. The length of new data sample, n, is the same as length of original data set.

The IRF's point estimates and the related confidence bands are constructed by retaining the median along with the relevant percentiles of the distribution of retained IRFs.

Baseline results (section 1.2.3)

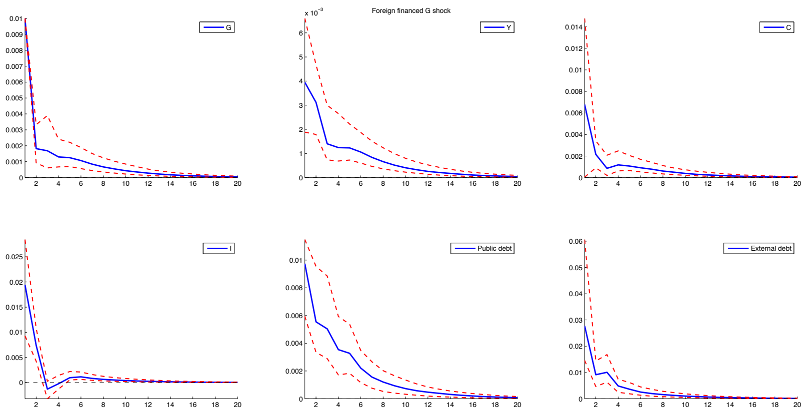
Estimates

Figure 1.7.1: IRFs to the government spending shock financed with home debt - baseline estimates



The IRFs are presented for the baseline case with variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

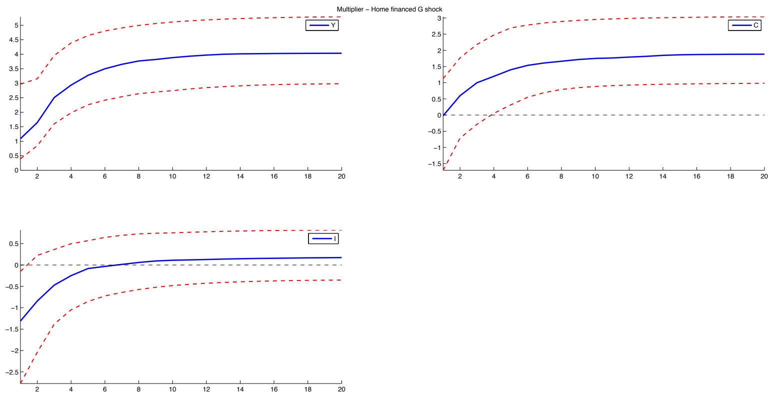
Figure 1.7.2: IRFs to the government spending shock financed with foreign debt - baseline estimates



The IRFs are presented for the baseline case with variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

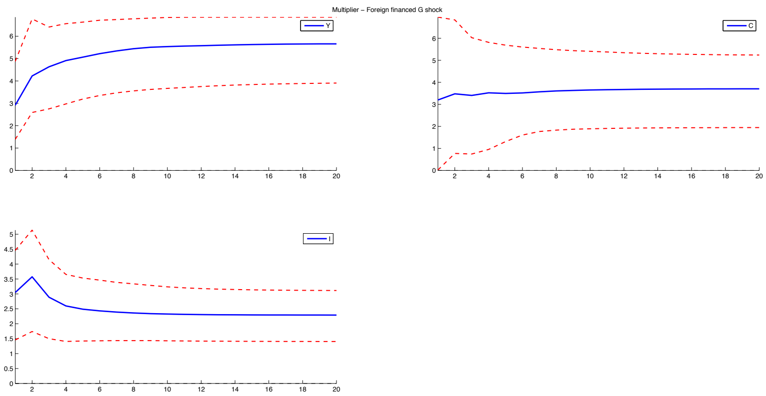
Multipliers

Figure 1.7.3: Cumulative multipliers to the government spending shock financed with home debt - baseline estimates



The cumulative multiplier is defined as the ratio between the accumulated response of the log difference of variable of interest over the log difference of government consumption. The figure presents the cumulative multiplier for output, consumption and investment.

Figure 1.7.4: Cumulative multipliers to the government spending shock financed with foreign debt - baseline estimates

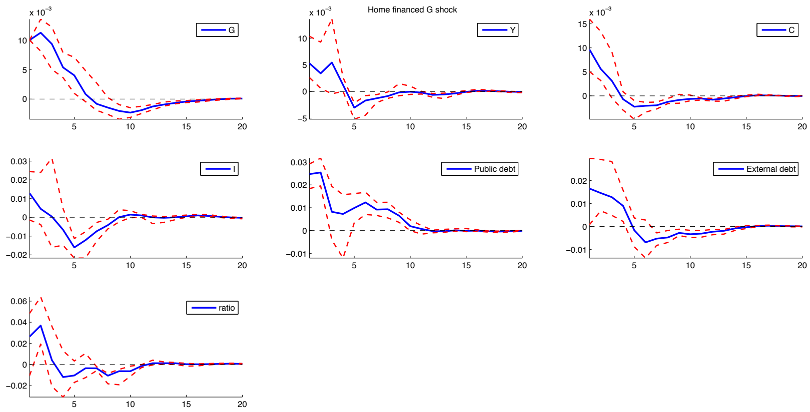


The cumulative multiplier is defined as the ratio between the accumulated response of the log difference of variable of interest over the log difference of government consumption. The figure presents the cumulative multiplier for output, consumption and investment.

Robustness checks: US (section 1.2.4)

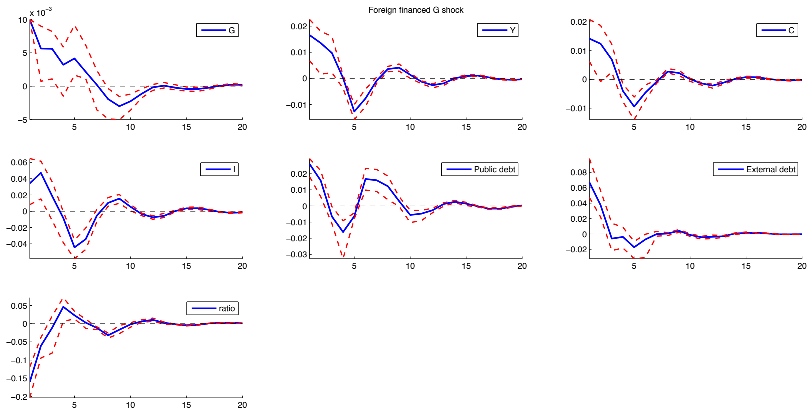
Estimates

Figure 1.7.5: IRFs to the government spending shock financed with home debt - baseline estimates



The IRFs are presented for the US with variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

Figure 1.7.6: IRFs to the government spending shock financed with foreign debt - baseline estimates

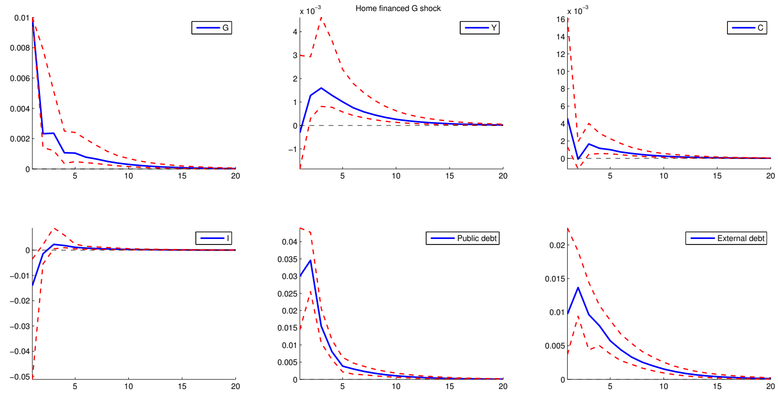


The IRFs are presented for the US with variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

Robustness checks: no restrictions on output (section 1.2.4)

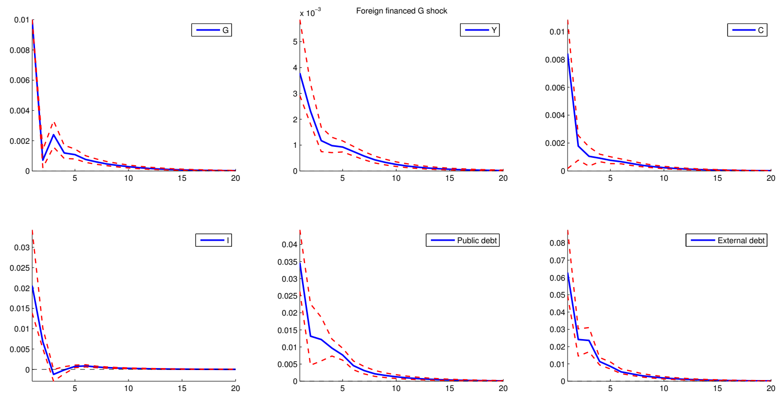
Estimates

Figure 1.7.7: IRFs to a government spending shock financed with home debt



The IRFs are presented for the variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

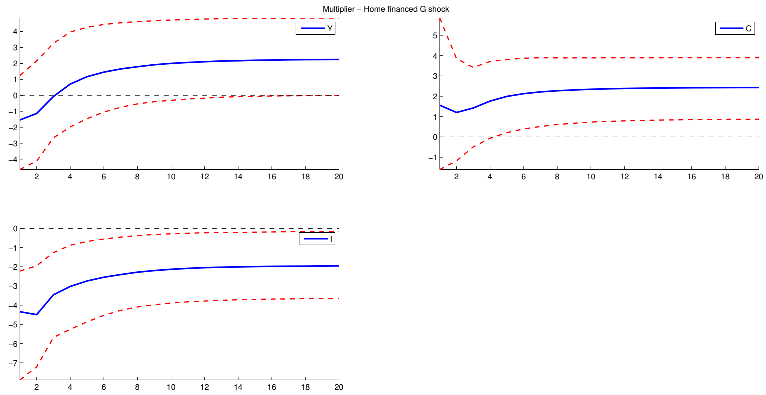
Figure 1.7.8: IRFs to a government spending shock financed with foreign debt.



The IRFs are presented for the variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

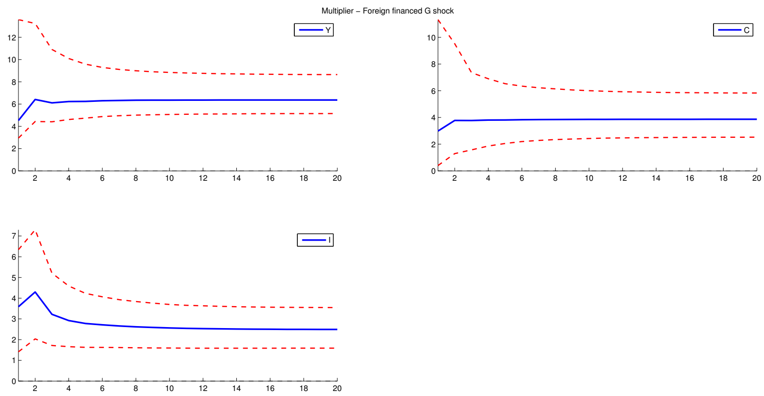
Multipliers

Figure 1.7.9: Cumulative multipliers to the government spending shock financed with home debt



The cumulative multiplier is defined as the ratio between the accumulated response of the log difference of variable of interest over the log difference of government consumption. The figure presents the cumulative multiplier for output, consumption and investment.

Figure 1.7.10: Cumulative multipliers to the government spending shock financed with foreign debt

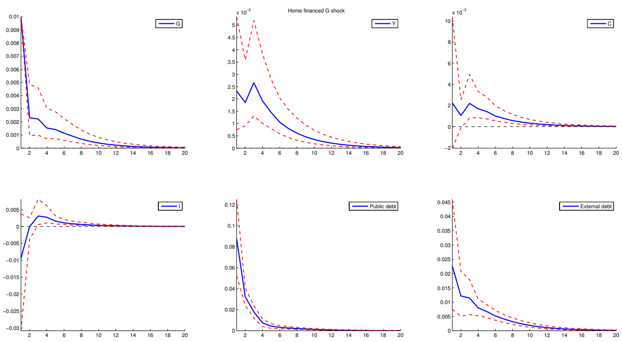


The cumulative multiplier is defined as the ratio between the accumulated response of the log difference of variable of interest over the log difference of government consumption. The figure presents the cumulative multiplier for output, consumption and investment.

Robustness checks: no restrictions on debt multipliers (section 1.2.4)

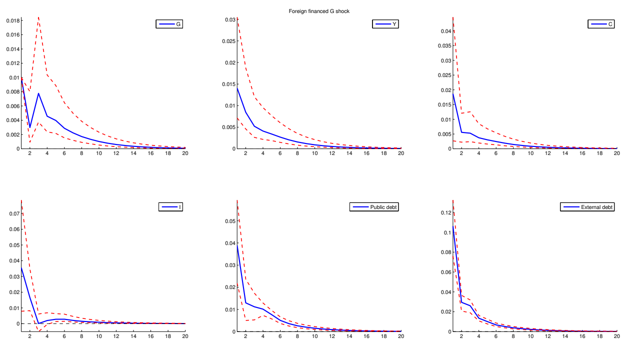
Estimates

Figure 1.7.11: IRFs to a government spending shock financed with home debt



The IRFs are presented for the variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

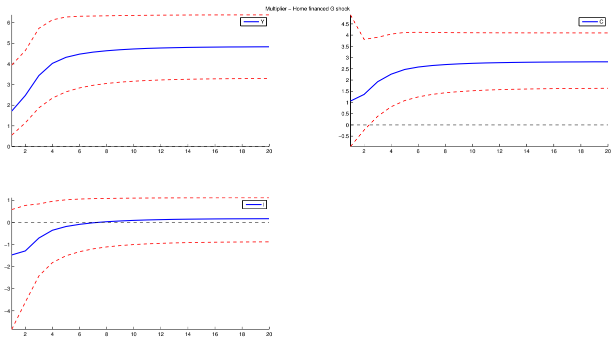
Figure 1.7.12: IRFs to a government spending shock financed with foreign debt.



The IRFs are presented for the variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

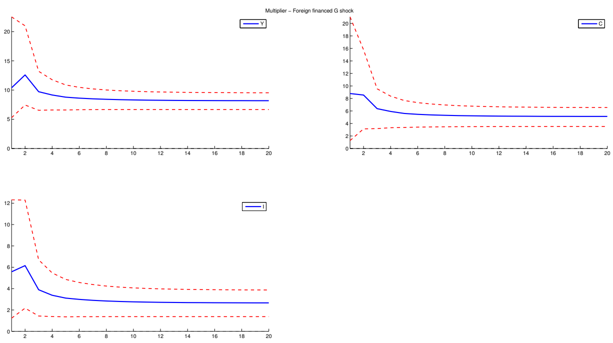
Multipliers

Figure 1.7.13: Cumulative multipliers to the government spending shock financed with home debt



The cumulative multiplier is defined as the ratio between the accumulated response of the log difference of variable of interest over the log difference of government consumption. The figure presents the cumulative multiplier for output, consumption and investment.

Figure 1.7.14: Cumulative multipliers to the government spending shock financed with foreign debt

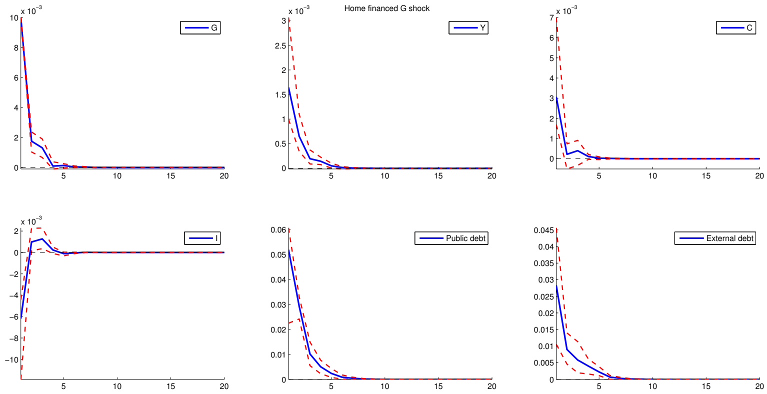


The cumulative multiplier is defined as the ratio between the accumulated response of the log difference of variable of interest over the log difference of government consumption. The figure presents the cumulative multiplier for output, consumption and investment.

Robustness checks: estimation with fixed effects (section 1.2.4)

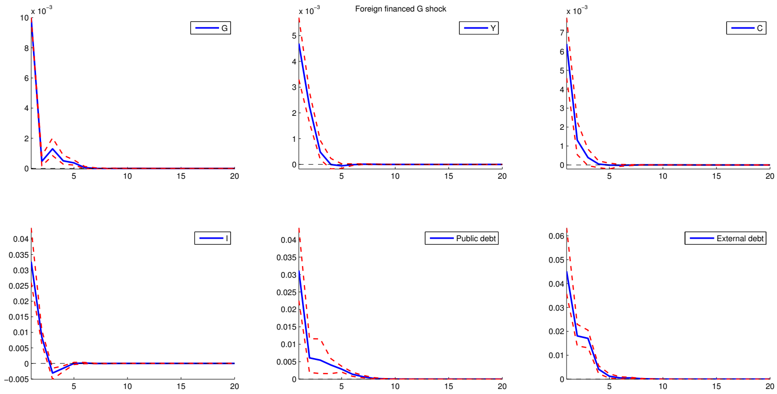
Estimates

Figure 1.7.15: IRFs to a government spending shock financed with home debt



The IRFs are presented for the variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

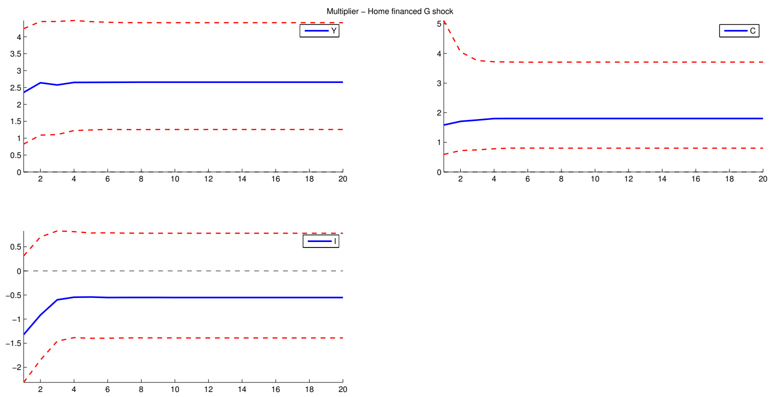
Figure 1.7.16: IRFs to a government spending shock financed with foreign debt.



The IRFs are presented for the variables: government consumption, real output, real household final consumption, real investment, public debt and external debt. The dashed lines correspond to identification and parameter uncertainty of one-standard deviation.

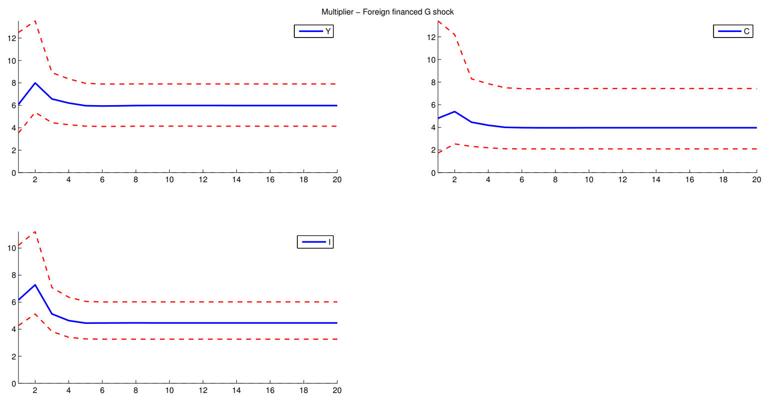
Multipliers

Figure 1.7.17: Cumulative multipliers to the government spending shock financed with home debt



The cumulative multiplier is defined as the ratio between the accumulated response of the log difference of variable of interest over the log difference of government consumption. The figure presents the cumulative multiplier for output, consumption and investment.

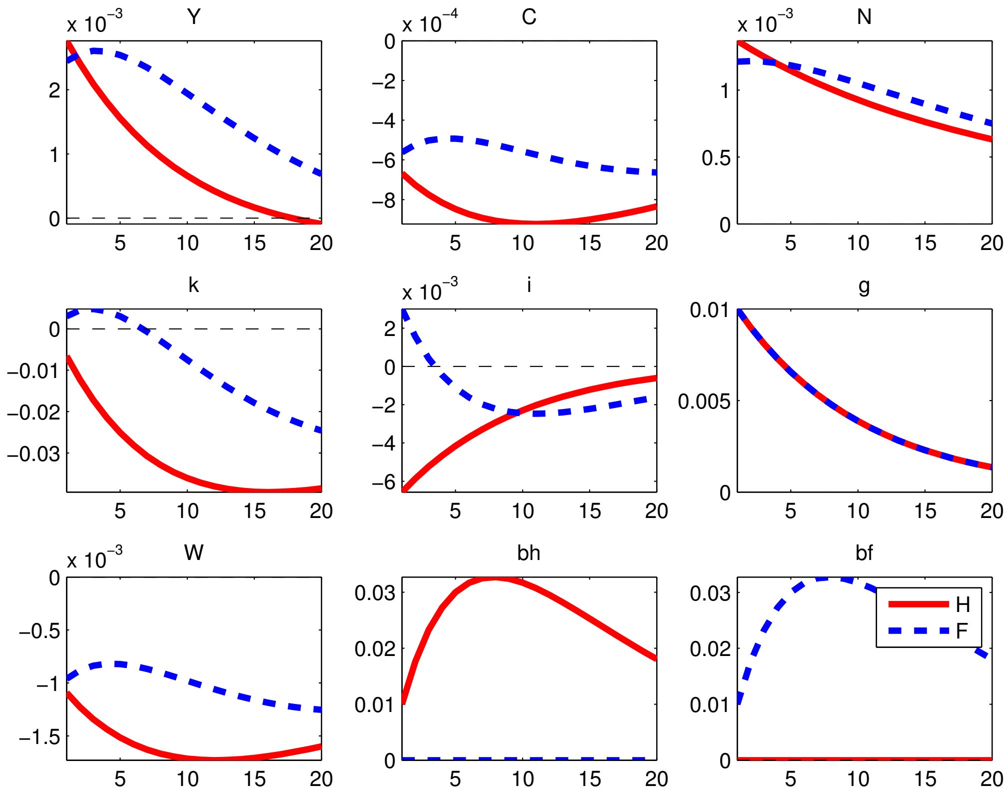
Figure 1.7.18: Cumulative multipliers to the government spending shock financed with foreign debt



The cumulative multiplier is defined as the ratio between the accumulated response of the log difference of variable of interest over the log difference of government consumption. The figure presents the cumulative multiplier for output, consumption and investment.

No private access to external financial markets (section 1.4.1)

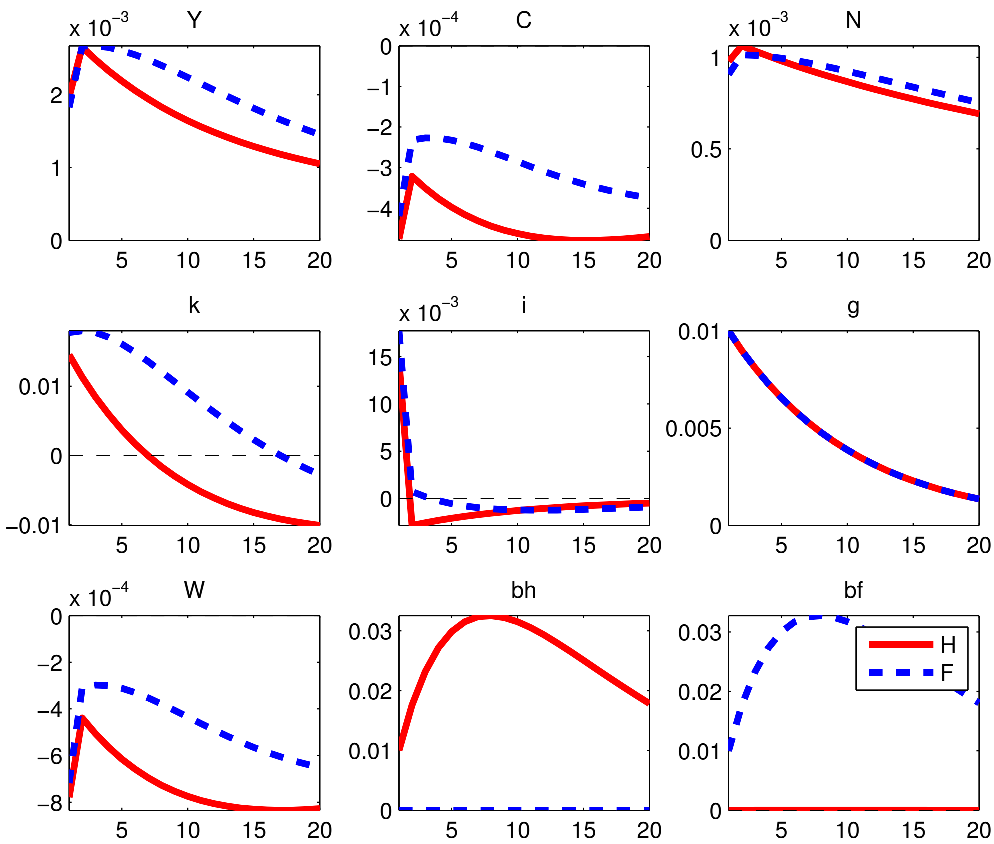
Figure 1.7.19: Impulse response functions following a home-debt financed and foreign-debt financed government spending shock



100% home-financed shock, $\lambda = 1$ (dashed red line), 100% foreign-financed shock, $\lambda = 0$ (solid blue line). **No private access to external financial markets** ($\nu = 50$)

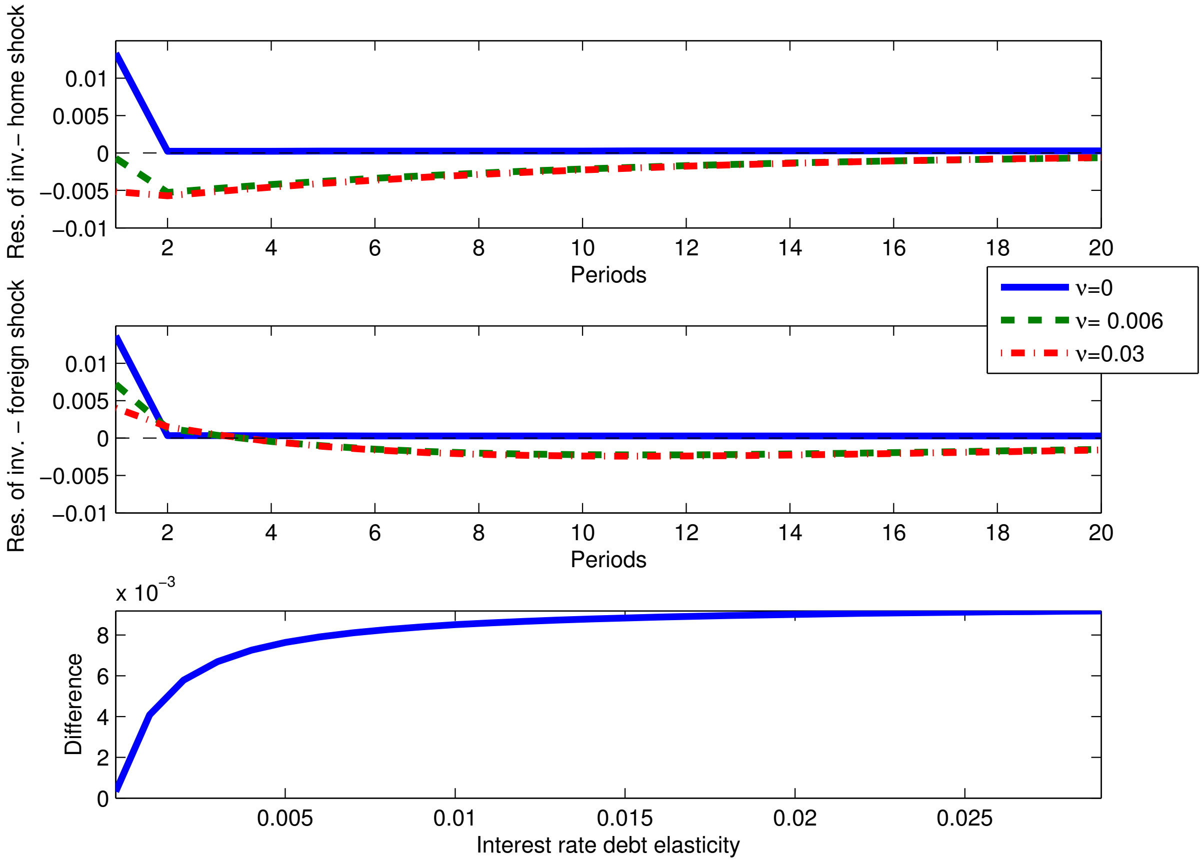
Private access to external financial markets(section 1.4.2)

Figure 1.7.20: Impulse response functions following a home-debt financed and foreign-debt financed government spending shock



100% home-financed shock, $\lambda = 1$ (dashed red line), 100% foreign-financed shock, $\lambda = 0$ (solid blue line). **Full private access to external financial markets** ($\nu = 0.0007$)

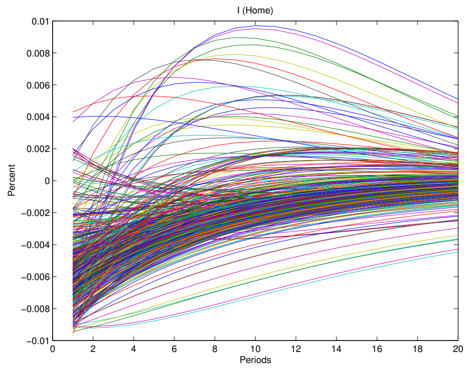
Figure 1.7.21: Difference in the responses of investment following a home-debt financed and a foreign-debt financed shock to government spending



The top panel plots the difference in the responses of investment following a home-debt financed government spending shock, $\lambda = 1$. The middle panel plots the difference in the responses of investment following a foreign-debt financed government spending shock , $\lambda = 0$. For both cases the private interest rate debt-elasticity varies between $\nu = 0$ (blue solid line), $\nu = 0.006$ (green dashed line), $\nu = 0.03$ (red dashed line). The bottom panel denotes the differences in the two responses of investment for a range of the private interest rate debt-elasticity.

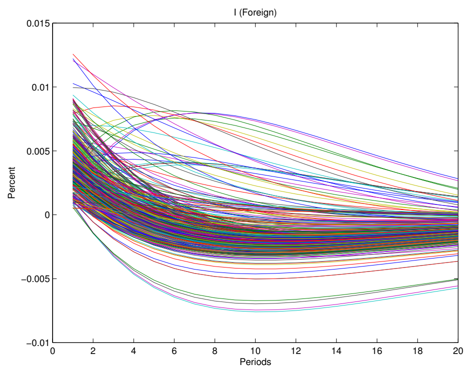
Matching impulse responses (section 1.5.1)

Figure 1.7.22: Investment multipliers to a government spending shock financed with home debt $\lambda = 1$



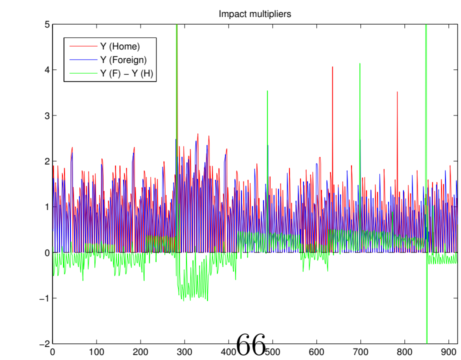
Multipliers are presented for different parameter combinations

Figure 1.7.23: Investment multipliers to a government spending shock financed with foreign debt $\lambda = 0$



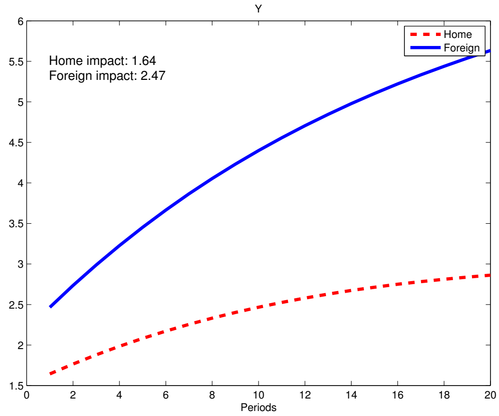
Multipliers are presented for different parameter combinations

Figure 1.7.24: Impact output multipliers to a government spending shock financed with home $\lambda = 1$ or foreign $\lambda = 0$ debt $\lambda = 0$



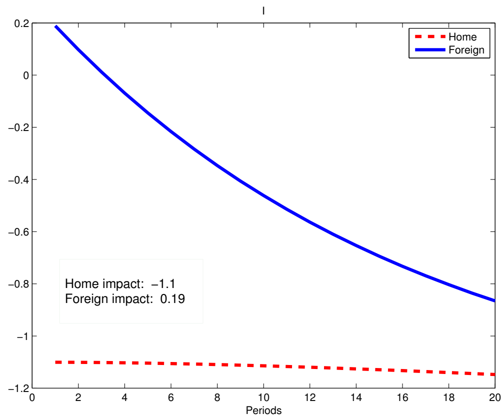
Impact multipliers are presented for the full set of parameter combinations. Green line shows the difference in the impact multiplier between a foreign-financed and a home-financed government spending shock

Figure 1.7.25: Cumulative multipliers for output to a government spending shock financed with home $\lambda = 1$ or foreign debt $\lambda = 0$



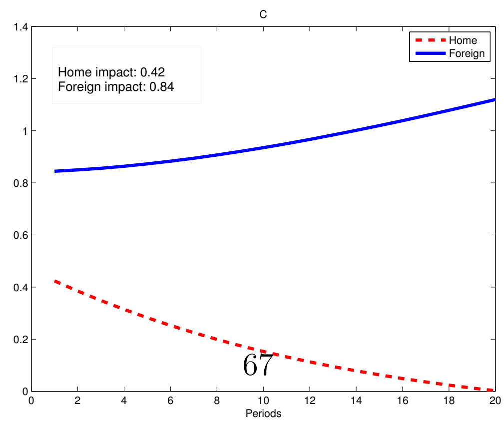
$$s = 0.4, \quad \zeta^k = 1.4, \quad \eta^k = 0.1, \quad \zeta^w = 1.6, \quad \eta^w = 0.9$$

Figure 1.7.26: Cumulative multipliers for investment to a government spending shock financed with home $\lambda = 1$ or foreign debt $\lambda = 0$



$$s = 0.4, \quad \zeta^k = 1.4, \quad \eta^k = 0.1, \quad \zeta^w = 1.6, \quad \eta^w = 0.9$$

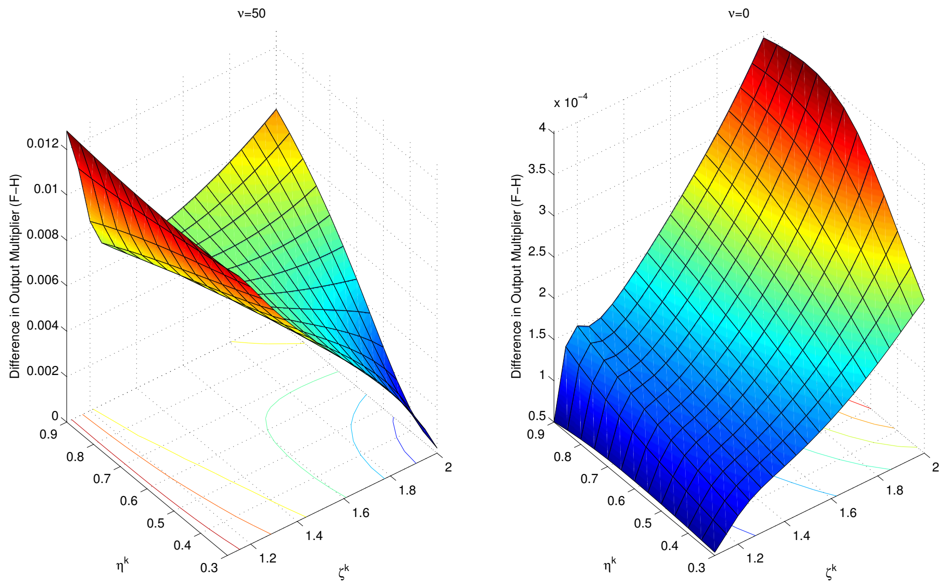
Figure 1.7.27: Cumulative multipliers for consumption to a government spending shock financed with Home $\lambda = 1$ or foreign debt $\lambda = 0$



$$s = 0.4, \quad \zeta^k = 1.4, \quad \eta^k = 0.1, \quad \zeta^w = 1.6, \quad \eta^w = 0.9$$

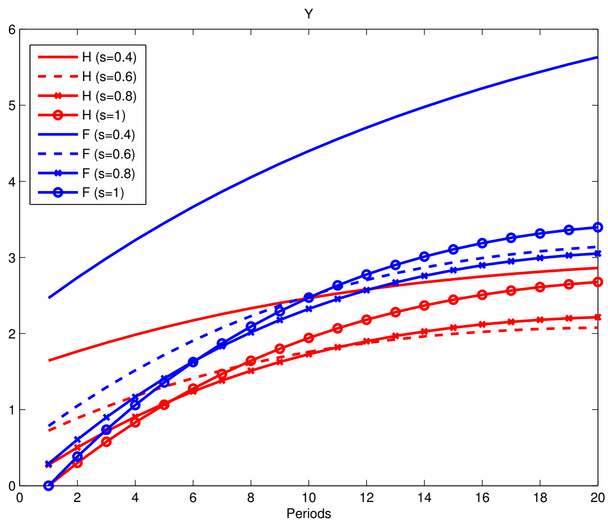
Sensitivity analysis (section 1.5.2)

Figure 1.7.28: Difference in impact output multipliers to a government spending shock financed with home $\lambda = 1$ or foreign debt $\lambda = 0$



Impact multipliers are presented for different levels of private sector access to external financial markets (left panel no access $\bar{\nu} = 50$, right panel complete access $\bar{\nu} = 0$). Remaining parameters are set at baseline calibration (see table 3.1)

Figure 1.7.29: Cumulative multipliers to a government spending shock financed with home $\lambda = 1$ or foreign debt $\lambda = 0$



Cumulative multipliers are presented for different shares of rule-of-thumb consumers $s = \{0.40.6, 0.8, 1\}$. Remaining parameters are fixed at $\bar{\nu} = 50, \quad \zeta^k = 1.4, \quad \eta^k = 0.1, \quad \zeta^w = 1.6, \quad \eta^w = 0.9$

Country characteristics (section 1.6)

Figure 1.7.30: Impact Multipliers based on Different Country Characteristics - Access to Financial Markets Proxies

Variable	Access	Variance of output		Loans from non-resident banks to GDP		Number of crisis	
		H-financed	*F-financed*	*H-financed*	*F-financed*	*H-financed*	*F-financed*
Output	High	**0.77** 0.21 2.00	**5.71** 3.05 8.48	**0.71** 0.16 1.31	**3.62** 2.22 5.59	**0.89** 0.20 2.34	**4.92** 2.68 8.86
	Low	**2.51** 1.28 4.04	**5.23** 2.39 7.59	**1.50** 0.18 2.38	**8.44** 4.63 10.88	**1.11** 0.48 2.26	**3.97** 2.19 5.56
Consumption	High	**0.83** 0.08 4.81	**5.95** -0.53 9.69	**0.13** -1.55 1.53	**3.75** 0.29 6.01	**-0.69** -1.66 -0.06	**3.77** 2.58 7.38
	Low	**0.27** -0.61 1.89	**5.07** 2.15 7.03	**1.75** -0.89 3.91	**6.75** 5.17 13.92	**0.40** -0.67 2.16	**3.28** 0.45 5.98
Investment	High	**-1.59** -3.44 1.28	**4.37** 0.13 7.24	**-1.13** -2.89 0.02	**2.98** 1.39 4.53	**-2.44** -4.83 0.52	**3.87** 0.94 5.64
	Low	**-0.67** -1.72 1.76	**3.21** 0.68 4.88	**-1.92** -2.51 -1.34	**7.34** 4.39 8.97	**-1.40** -2.93 -0.20	**3.69** 2.22 5.13
External Debt	High	**2.76** 0.94 4.51	**11.78** 9.20 14.06	**2.08** 0.60 3.82	**9.44** 6.42 12.60	**2.57** 1.00 3.96	**10.50** 7.77 13.70
	Low	**3.99** 1.48 6.44	**12.83** 9.67 14.40	**3.81** 2.06 5.24	**11.67** 8.65 13.68	**2.79** 1.07 4.85	**12.33** 9.75 14.14

The Figure presents the impact multipliers on output, consumption and investment following a government spending shock financed 100% at Home (Home-financed) and 100% externally (Foreign-financed). High and Low Access differentiates the sample according to whether the country belongs above, or below the mean of the sample for each proxy.

Chapter 2

Fiscal Coordination under the Zero Lower Bound[1]

2.1 Introduction

> "Our fiscal stance is not based on a single budget voted for by a single parliament, but on the aggregation of eighteen national budgets and the EU budget. Stronger coordination among the different national fiscal stances should in principle allow us to achieve a more growth-friendly overall fiscal stance for the euro area."
>
> *Mario Draghi, Annual central bank symposium in Jackson Hole (22.8.2014)*

In the context of the ongoing European debt crisis, a topical debate is taking part in European policymaking circles involving the importance of fiscal sustainability and

[1] The views expressed in this chapter are those of the author and should not be taken to necessarily represent the views of the European Commission. All analysis in the paper is a consequence of the author's calculations based on published and freely available material.

fiscal coordination. On the one hand, debt-to-GDP ratios are substantial, calling for sizable fiscal adjustments. On the other hand, several voices observing the slow recovery of the Eurozone are calling for a more moderate and back-loaded fiscal adjustment with a focus on growth-friendly outcomes. At the same time, weak inflation dynamics have curbed the European Central Bank's (ECB) ability to lower nominal interest rates in order to offer monetary stimuli to the Eurozone.

In his classic study on fiscal federalism, Oates (1999) argues that government policy at the local level cannot use stabilization tools effectively, and ultimately resorts on beggar-thy-neighbour policies, which are likely to lead to suboptimal outcomes. Instead, it should be the role of the central government to undertake fiscal policy programs to achieve a wider economic stabilization. More recently, and in the context of the European Union (EU), the Stability and Growth Pact (SGP) was introduced with the objective of creating a set of rules that ensures countries in the EU will maintain economically sound public finances and coordinate their fiscal policies.

The aim of this paper is to construct a model, through which we can study strategies of fiscal coordination across regions of the Eurozone. The paper contributes to these debates by offering a theoretical understanding of the merits of asymmetric fiscal adjustments in the North and South Eurozone under two different monetary policy arrangements. One where the nominal interest is able to endogenously adjust to economic outcomes, and one where it is constrained to be at the zero-lower bound (ZLB), as in the current environment in the Eurozone. Thus, the question it seeks to answer is 'are there gains from fiscal coordination?'

We approach this issue by building a two-region, two-sector (tradable-nontradable) dynamic stochastic general equilibrium (DSGE) model with nominal rigidities, of the class that has now become the standard vehicle for macroeconomic analysis in central banks and policy institutions. The model closely follows Ratto et al. (2009) and Vogel (2014), but is similar in spirit to the now standard international macroeconomic models of Stockman and Tesar (1995), Benigno and Thoenissen (2008), and Erceg and Linde (2013). The model features nominal rigidities in prices and wages, a distinction of households into Ricardian and liquidity-constrained as in Gali et al. (2007), a relatively rich fiscal sector with productive government investment, and a Taylor-type rule on monetary policy. We then calibrate the model to the EU South and EU North and analyze a particular fiscal policy scenario where the EU North undertakes a fiscal expansion, and the EU South undertakes a fiscal consolidation. This scenario is constructed on the basis of identifying from the data the extent to which these two regions have a positive, or negative fiscal gap (that is, whether their fiscal adjustment implies an expansion, or consolidation in their structural balance). Since the academic and policy literature offers a number of complementary methods to assess fiscal sustainability, we opt for evaluating the aggregate fiscal stance of the regions in the model by exploiting data from the European Commission's Winter Forecast 2015 (ECFIN (2015a)) and the guidelines on fiscal adjustment laid out by the Stability and Growth Pact. This scenario then informs a number of simulations to study the effects of a coordinated fiscal policy in the Eurozone.

The results suggest that when monetary policy is constrained by the zero-lower bound the EA South benefits from the expansion in the EA North, although it is in itself undertaking a fiscal consolidation. The reason is that in this setting the spillovers from the North's expansion become more sizable. Empirical evidence in the literature widely confirms the statistical and quantitative significance of local fiscal policy spillovers (e.g. Beetsma and Giuliodori (2011); Auerbach and Gorodnichenko (2013); Hebous and Zimmermann (2012); Carlino and Inman (2013), among others), lending validity to our theoretical predictions. The key difference between a ZLB and an active monetary arrangement following a Taylor rule targeting inflation and the output gap, is the presence of an interest rate effect, which is under operation only in the latter case. Under an active monetary policy the North's expansion (which has a high share in Euro-area GDP) triggers a nominal interest rate increase leading to an increase in the real interest rate. As a result, the Euro appreciates leading to a loss in competitiveness. In contrast, under a ZLB, fiscal policy actions lead to an overall increase in Euro inflation causing the real interest rate to drop. This then implies an outflow of capital from the EA causing a depreciation of the exchange rate, and hence a loss in output. Interestingly, the ZLB acts as a monetary policy expansion when accompanied by an aggregate fiscal expansion.

To my knowledge this is the first paper studying the coordination of fiscal policies in a large-scale quantitative model, and calibrated to a pertinent scenario identified from the data. An important paper in the field is by Gali and Monacelli (2008), which offers though a normative analysis on the topic showing that inflation should be stabilized at the aggregate level, whereas fiscal policy has a country-specific stabilization role. Our paper differs from theirs in the richness, and hence size of the model, as well as to the particular scenario simulated, which is arguably a good approximation of the policies that Eurozone countries are called to undertake in the current juncture. Recent work by in 't Veld (2013) uses a multi-country model similar to the one in this paper to study the effects of fiscal consolidations in seven Eurozone economies during the crisis years of 2011-2013. Our work, emphasizes the importance of contrasting fiscal adjustments in Eurozone countries, and how these can stabilize the overall Euro area, in the face of different monetary policy assumptions. This paper is also related to Beetsma and Jensen (2005), who explore the welfare consequences of coordinating simple fiscal policy rules in the context of a monetary union. Other, studies investigating the effects of fiscal and monetary policy coordination in this setting include Forlati (2006); Gnocchi

(2007); Flotho (2012), as well as recent work by the International Monetary Fund (IMF) and described in Benes et al. (2013), among others. In the context of a fiscal union, Werning and Farhi (2012) emphasize the role that emerges for government intervention in insuring against aggregate shocks.

The remainder of the paper is structured as follows: In Section (3.2) we outline the model in question. In Section (3.3) we perform a quantitative exploration by first describing the identification of fiscal gaps, which then inform a number of policy-relevant simulations. Finally, in Section (3.4) we hint at possible interesting extension of the current analysis and conclude.

2.2 Model

The model consists of a world comprised of three regions $k \in \{SOEA, NOEA, ROW\}$ and calibrated to the Eurozone South ($SOEA$), the Eurozone North ($SOEA$), and a rest-of-the-world aggregate (ROW). Each region is populated by households, firms and a benevolent government. There is a union-wide monetary authority. Households are distinguished into liquidity constrained, thus only consuming their disposable income, or Ricardian, by having perfect access to financial markets. Domestic and foreign firms produce a continuum of differentiated goods, consumed in the domestic economy or abroad.[2]

2.2.1 Production

In each region there are monopolistically competitive final good producers indexed by j operating on the tradable (t) and non-tradable sector (nt) sector. They produce a

[2]The exposition of the model closely follows Vogel (2014), who describes an environment to study the effects of structural reforms under the zero lower bound on the nominal interest rate.

variety of the tradable and non-tradable good, which is an imperfect substitute for varieties produced by other final good producers. Gross output in each sector is given by O_t^J with $J \in \{T, NT\}$ and is a CES aggregate of varieties O_t^j produced by individual final good producers j

$$O_t^J \equiv \left[\int_0^1 \left(O_t^j \right)^{(\sigma_j - 1)/\sigma_j} dj \right]^{\sigma_j/(\sigma_j - 1)}$$

where σ_j reflects the elasticity of substitution between varieties j within sector J. We allow for the elasticity of substitution between the tradable and nontradable sectors to be different in order to reflect sector specific price mark-ups. The demand function that a firm j faces for its output O^j is then given by

$$O_t^j = (P_t^j / P_t^J)^{-\sigma_j} O_t^J \tag{2.2.1}$$

Firms in the tradable sector sell consumption and investment goods to domestic and foreign households; intermediate inputs to domestic and foreign firms; and consumption and investment goods to domestic and foreign governments. In turn, firms in the non-tradable sector sell consumption goods to domestic households; intermediate inputs to domestic firms; and consumption and investment goods to the domestic government. All private investment in physical capital therefore consists of tradable goods whereas all government consumption consists of nontradable goods.

Each individual firm j produces output O_t^j by combining value-added (Y_t^j) and intermediate inputs (N_t^j) using a CES technology. in turn, value-added is produced using a Cobb-Douglas production function with capital (K_t^j), labor (L_t^j) and public infrastructure capital (K_t^G)

$$O_t^j = \left[(1 - s^j)^{1/\sigma_N} (Y_t^j)^{(\sigma_N - 1)/\sigma_N} + (s^j)^{1/\sigma_N} (N_t^j)^{(\sigma_N - 1)/\sigma_N} \right]^{\sigma_N/(\sigma_N - 1)} \tag{2.2.2}$$

$$Y_t^j = A_t^j \left(u_t^j K_t^j\right)^{1-\alpha} \left(L_t^j\right)^{\alpha} \left(K_t^G\right)^{\alpha_g} \tag{2.2.3}$$

where s^j is the steady-state share of intermediate inputs in output and σ_N is the elasticity of substitution between intermediate inputs and value-added. A_t^j denotes total factor productivity, and u_t^j denotes capacity utilization.

Labor L_t^j is a CES aggregate of labour services supplied by individual households i and is given by

$$L_t^j \equiv \left[\int_0^1 (L_t^{i,j})^{(\theta-1)\theta} di\right]^{\theta/(\theta-1)}$$

where θ is the degree of substitutability between different types of labour i.

Ricardian households (to be elaborated upon below) own the firm and receive real profits given by

$$\Pi_t^j = p_t^j O_t^j - p_t^{N,j} N_t^j - w_t L_t^j - r_t^j p_t^I K_t^j - adj_t^{p,j} - adj_t^{u,j} \tag{2.2.4}$$

where w_t is the real wage, r_t^j is the rental rate of capital, $p_t^{N,j}$ is the price of intermediate inputs, and p_t^I denotes the price of capital.[3] We also assume that firms face constraints in their capacity to adjust the price of output, as well as their capacity utilization. Arguably, these adjustment costs can be the result of technological, administrative or regulatory constraints on production. They are given by the following convex functional form

$$adj_t^{P,j} \equiv \frac{\gamma^{p,j}}{2}(\pi_t^j)^2 Y_t^j \qquad \text{, where} \quad \pi_t^j \equiv \frac{P_t^j}{P_{t-1}^j} - 1 \tag{2.2.5}$$

$$adj_t^{u,j} \equiv p_t^I K_t^j \left(\frac{\gamma_{u1}}{2}\left(ucap_t^j - 1\right) + \frac{\gamma_{u2}}{2}\left(ucap_t^j - 1\right)^2\right) \tag{2.2.6}$$

Firms choose labour, capital, capacity utilization, the price and volume of output j,

[3] Note that lower case letters denote ratios. For example $p_t^j \equiv P_t^j / P_t$ is the price of final good j relative to the GDP deflator.

to maximize profits (3.2.15) subject to their demand function (2.2.1), production technology (2.2.2) and(2.2.3), and price and capacity utilization adjustment costs (2.2.5) - (2.2.6).

The price mark-up is defined from the FOC with respect to the volume of output.

$$O_t^j: \qquad \eta_t^j = 1 - \frac{1}{\sigma^j} - \gamma^{p,j}\left(\beta \mathrm{E}_t \frac{\lambda_{t+1}^r}{\lambda_t^r}\pi_{t+1}^j - \pi_t^j\right) \tag{2.2.7}$$

where η_t^j is the Lagrange multiplier associated with the production technology and λ_t^r is the Lagrange multiplier associated with the budget constraint of the Ricardian households (to be explained below). As can be seen, equation (2.2.7) defines the price mark-up as a function of the elasticity of substitution between varieties of goods of sector j and price adjustment costs.

Following the empirical literature, which supports price setting behavior of a backward-looking nature we assume that a fraction $1-\varepsilon$ of firms index prices to past inflation. This assumption then implies the following redefinition of the price mark-up equation

$$\eta_t^j = 1 - \frac{1}{\sigma^j} - \gamma^{p,j}\left(\beta \mathrm{E}_t \frac{\lambda_{t+1}^r}{\lambda_t^r}\left(\varepsilon \mathrm{E}_t \pi_{t+1}^j + (1-\varepsilon)\pi_{t-1}^j\right) - \pi_t^j\right) \qquad \text{, where} \quad 0 \leq \varepsilon \leq 1 \tag{2.2.8}$$

Notably, given a symmetry of objective functions and constraints across firms j in sector J, the superscript j for individual firms can be dropped to obtain aggregate equations for the tradable and nontradable sectors.

2.2.2 Households

Each region is populated by a continuum of households $i \in [0,1]$. A share $0 \leq s^l \leq 1$ of these households are assumed to be liquidity-constrained and thus behave in a rule-of-thumb fashion. They cannot make investment decisions, nor purchase/sell assets in financial markets. In each period they consume their disposable income. A share $s^r = 1 - s^l$ of households is Ricardian, have full access to asset markets and optimize intertemporally. Period utility is identical for both household types and additively separable in consumption (C_t^i) and leisure ($1 - L_t^i$) with habit persistence in consumption (h):

$$U(C_t^i, 1 - L_t^i) = \frac{1}{1+\sigma^C}\left(C_t^i - hC_{t-1}\right)^{1+\sigma^C} + \frac{\vartheta}{1-\kappa}\left(1 - L_t^i\right)^{1-\kappa} \tag{2.2.9}$$

where ϑ is the weight of leisure in utility and κ is the inverse of the labour supply elasticity.

Ricardian Households

Ricardian households have full access to financial markets. They hold one-period non-contingent domestic government bonds and one-period non-contingent foreign bonds. They also hold the real capital stock of the tradable and non-tradable sectors. Ricardian households receive labour income, returns on financial assets, rental income from renting capital to firms, and the profits from domestic firm ownership in both the tradable and nontradable sectors. Their budget constraint is given by

$$\begin{aligned}
&(1+\tau_t^C)p_t^C C_t^r + \sum_J p_t^{I,J} I_t^J + \frac{B_t^G}{P_t} + e_t\frac{B_t^F}{P_t} \\
&= (1+i_{t-1})\frac{B_{t-1}^G}{P_t} + \left(1 + i_{t-1}^F + r_t^p\right) e_t \frac{B_{t-1}^F}{P_t} \\
&+ \sum_J \left(\left(1-\tau_t^K\right) r_{t-1}^J + \tau_t^K \delta^{K,J}\right) p_{t-1}^{I,J} K_{t-1}^J \\
&+ (1-\tau_t^W) w_t L_t^r + \sum_J \Pi_t^J - \frac{T_t^r}{P_t} \\
&- adj_t^W
\end{aligned} \tag{2.2.10}$$

where $J \in \{T, NT\}$. B_t^G are nominal domestic government bonds carrying the nominal interest rate i_t and B_t^F are nominal foreign bonds carrying a nominal interest rate i_t^F. We assume that these foreign bonds are traded in asset markets located outside the currency union. We assume that the interest rate on foreign bonds is subject to a risk premium r_t^p, which depends on the volume of debt issued. e_t is the nominal exchange rate defined as the price of domestic currency in foreign currency. In turn, K_t^J is the real capital stock in sector J, I_t^J is the corresponding investment, r_t^J is the rental rate of capital, and $\delta^{K,J}$ denotes the sector specific depreciation rate. In addition, we allow for a number of fiscal policy instruments and assume that wage income is taxed at the rate τ^W, corporate income at the rate τ^K and consumption at the rateτ^C. $T_t^r < 0$ denotes lump-sum taxes (transfers if > 0). Price deflators for the consumption and investment good are given by p_t^C and $p_t^{I,J}$.

We also introduce wage adjustment costs in order to reflect the empirically plausible feature of symmetric nominal wage rigidity

$$adj_t^W \equiv \frac{\gamma^w}{2} \left(\pi_t^W\right)^2 L_t$$

The law of motion for capital in sector J is given by

$$K_t^J = I_t^J + (1 - \delta^{K,J}) K_{t-1}^J \tag{2.2.11}$$

Ricardian households choose consumption, positions on domestic and foreign bonds, investment, and labor to maximize their utility (3.2.1) subject to their budget constraint (2.2.10) and the law of motion for capital (2.2.11). From the first order condition on foreign bonds we can derive the uncovered interest rate parity (UIP) condition given by

$$i_t = i_t^F + \mathrm{E}_t \frac{\Delta e_{t+1}}{e_t} + r_t^p \tag{2.2.12}$$

The UIP determines the nominal exchange rate of the euro vis-à-vis the ROW currency. Since members of the Eurozone share the common currency, this implies a fixed nominal exchange rate between the SOEA and NOEA aggregate. As a result of the risk premia which arise this causes interest rate differentials within the Euro Area. Finally, the real interest rate is defined as the nominal interest rate minus the expected percent change in the GDP deflator

$$R_t = i_t - \mathrm{E}_t \pi_{t+1}$$

Liquidity-constrained Households

Liquidity-constrained households behave in a rule-of-thumb fashion and do not face an intertemporal decision problem. They thus simply consume their entire disposable income in each period. Real consumption of household l is hence given by the net wage income minus the lump-sum tax

$$(1 + \tau_t^C) p_t^C C_t^l = (1 - \tau_t^W) w_t L_t^l - T_t^l$$

Similar to Ricardian households, the liquidity-constrained provide differentiated labour services with an elasticity of substitution between different varieties given by θ.

Wage-setting

Wage-setting is governed by a trade union acting on behalf of both types of household, which maximizes a joint utility function for each type of labour i. We assume that this joint utility function is a population-weighted average over Ricardian and liquidity-constrained households' individual utilities (given by equation (3.2.1)). The wage rule is then obtained by equating a weighted average of the marginal utility of leisure to a weighted average of the marginal utility of consumption of both household types multiplied by their real wage and adjusted for a wage mark-up (η_t^W). This wage rule is given by

$$\frac{(1-\omega)U^r_{1-L,t} + \omega U^l_{1-L,t}}{(1-\omega)U^r_{C,t} + \omega U^l_{C,t}} = \frac{(1-\tau_t^W)w_t}{(1+\tau_t^C)p_t^C}\eta_t^W$$

where $U^i_{1-L,t}$ denotes the marginal utility with respect to leisure and $U^i_{C,t}$ denotes the marginal utility with respect to consumption for each household type i.

The wage mark-up can then be defined as

$$\eta_t^W = 1 - \frac{1}{\theta} - \frac{\beta\gamma^w}{\theta}\mathrm{E}_t\left[\frac{\lambda^r_{t+1}}{\lambda^r_t}\left(\pi^W_{t+1} - \pi_t\right) - \left(\pi_t^W - \pi_{t-1}\right)\right]$$

and depends on the inverse of the elasticity of substitution between varieties of labor $(1/\theta)$. Fluctuations of the wage mark-up around $(1/\theta)$ arise from the assumption of wage stickiness. In the presence of wage stickiness, the fraction $1-\varepsilon^w$ of workers $(0 \leq \varepsilon^w \leq 1)$ index wage growth π_t^W to wage inflation in the previous period leading to the following specification the wage mark-up

$$\eta_t^W = 1 - \frac{1}{\theta} - \frac{\beta\gamma^w}{\theta}\mathrm{E}_t\left[\frac{\lambda^r_{t+1}}{\lambda^r_t}\left(\pi^W_{t+1} - (1-\varepsilon^w)\pi_t\right) - \left(\pi_t^W - (1-\varepsilon^w)\pi_{t-1}\right)\right]$$

where λ_t^r denotes the Lagrange multiplier of the Ricardian household associated to their budget constraint.

Aggregation

If X_t^i is the per-capita term of household-specific variables (where $X_t^i \in \{C_t^i, L_t^i, T^i\}$) then we define their aggregate aggregate counterpart as $X_t \equiv \int_0^1 X_t^i di = (1-s^l)X_t^r +$

$s^l X_t^l$. Thus aggregate consumption is given by

$$C_t = (1 - s^l)C_t^r + s^l C_t^l$$

and aggregate labor by

$$L_t = (1 - s^l)L_t^r + s^l L_t^l \qquad , \text{ with } \quad L_t^r = L_t^l$$

2.2.3 Fiscal Policy

Government expenditures consist of consumption and investment purchases. Income consists of revenues from consumption taxes, labour taxes, corporate taxes and a lump-sum levy. The government deficit is defined as

$$DF_t = p_t^C(G_t + I_t^G) + \tau_t^C p_t^C C_t + \sum_J \tau_t^W w_t L_t^J + \sum_J \tau_t^K \left[P_t^J O_t^J - P_t^{N,J} N_t^J - w_t L_t^J - \delta^{K,J} r_t^J p_t^{I,J} K_{t-1}^J \right] - T_t$$

and the government's budget constraint is then given by

$$DF_t + B_t^G = (1 + i_{t-1})B_{t-1}^G$$

We assume that real government expenditures (G_t) and investment (I_t^G) are kept constant in real terms. The stock of public infrastructure that enters the production function of private firms (equation 2.2.3) has the following law of motion

$$K_t^G = I_t^G + (1 - \delta^G)K_{t-1}^G$$

We assume that consumption, corporate income, and lump-sum taxes are exogenous.[4]

[4]Their definitions will be provided below.

To ensure determinacy of the equilibrium and a non-explosive solution for debt, we follow Leeper (1991) and assume that the labour tax is used to stabilize the debt-to-GDP ratio. It targets deviations in government debt-to-GDP from a target level of government debt-to GDP $\left(\frac{B_t}{P_t Y_t}^*\right)$, and in order to prevent large oscialltions it also targets changes in government debt-to-GDP itself with weight τ^{def}.

$$\Delta\tau_t^W = \tau^b \left(\frac{B_t^G}{P_t Y_t} - \frac{B_t^G}{P_t Y_t}^*\right) + \tau^{def}\Delta\left(\frac{B_t^G}{P_t}\right)$$

2.2.4 Monetary Policy

Monetary policy is modeled using a Taylor rule that allows for a smoothing of the interest rate responses to region-wide inflation Π_t^c and the region-wide output gap $\hat{Y}_t$.

$$i_t = \rho_i i_{t-1} + (1-\rho_i)\left(\overline{r} + \pi^* + \psi_\pi(\Pi_t^C - \pi^*) + \psi_y \hat{Y}_t\right)$$

The union central bank can therefore adjust its policy rate i_t in response to deviations of union-wide average CPI inflation from a constant inflation target π^* as well as to the output gap. The weights placed on the two objectives are given by ψ_π and ψ_y.

Following standard practice of output gap calculations in the fiscal and monetary policy surveillance literature we derive the output gap from a production function framework. We thus do not opt for a definition of the output gap as being calculated as the difference between actual and efficient output. More specifically, the output gap is defined as deviations of factor utilization from its long-run trend:

$$\hat{Y}_t \equiv \alpha \ln(L_t/L_t^{ss}) + (1-\alpha)\ln(u_t/u_t^{ss})$$

The variables L_t^{ss} and u_t^{ss} are not steady-state values but moving average specifications of labor and the capacity utilization rate

$$L_t^{ss} = \rho_L L_{t-1}^{ss} + (1 - \rho_L) L_t$$

$$u_t^{ss} = \rho_u u_{t-1}^{ss} + (1 - \rho_u) u_t^J$$

2.2.5 International Linkages

Let $Z_t \in \{C, G, I^G\}$ be the demand by private households and the government for private consumption, government consumption and government investment. In order to facilitate aggregation, we assume that both the private and public sector have identical preferences across tradable and nontradable goods, and are given by the following CES aggregator

$$Z_t = \left[(1 - s_{tnt})^{1/\sigma_{tnt}} \left(Z_t^{NT} \right)^{(\sigma_{tnt}-1)/\sigma_{tnt}} + s_{tnt}^{1/\sigma_{tnt}} \left(Z_t^{TT} \right)^{(\sigma_{tnt}-1)/\sigma_{tnt}} \right]^{\sigma_{tnt}/(\sigma_{tnt}-1)} \quad (2.2.13)$$

where Z^{NT} is an index of demand for the nontradable varieties, whereas Z^{TT} is a bundle of domestically produced (Z^T) and imported (Z^M) tradable goods

$$Z_t^{TT} = \left[(1 - s_M)^{1/\sigma_M} \left(Z_t^{T} \right)^{(\sigma_M-1)/\sigma_M} + s_M^{1/\sigma_M} \left(Z_t^{M} \right)^{(\sigma_M-1)/\sigma_M} \right]^{\sigma_M/(\sigma_M-1)} \quad (2.2.14)$$

The elasticity of substitution between the bundles of non-tradable and tradable goods is σ_{tnt}. The elasticity of substitution between the bundles of domestically produced and imported tradable goods is σ_m. The steady-state shares of tradable goods in Z and of imports Z^{TT} are s_{tnt} and s_m, respectively. All investment in physical capital in the tradable and non-tradable sectors consists of tradable goods.

The CES aggregate (2.2.13) combining tradable and nontradable goods then implies the following demand functions

$$Z_t^T = s_{tnt} \left(\frac{P_t^T}{P_t^C} \right)^{-\sigma_{tnt}} \left(C_t + G_t + I_t^G \right) \tag{2.2.15}$$

$$Z_t^{NT} = (1 - s_{tnt}) \left(\frac{P_t^{NT}}{P_t^C} \right)^{-\sigma_{tnt}} \left(C_t + G_t + I_t^G \right) \tag{2.2.16}$$

The intermediate inputs in sector $J \in \{T, NT\}$ are also composites of tradable and non-tradable inouts analogously to equations (2.2.13) and (2.2.14) with tradable intermediate inputs either domestically produced or imported:

$$N_t^{T,J} = \left[(1 - s_{tnt}^J)^{1/\sigma_{tnt}} \left(N_t^{NT,J} \right)^{(\sigma_{tnt}-1)/\sigma_{tnt}} + \left(s_{tnt}^J \right)^{1/\sigma_{tnt}} \left(N_t^{TT,J} \right)^{(\sigma_{tnt}-1)/\sigma_{tnt}} \right]^{\sigma_{tnt}/(\sigma_{tnt}-1)} \tag{2.2.17}$$

$$N_t^{TT,J} = \left[(1 - s_M)^{1/\sigma_M} \left(N_t^T \right)^{(\sigma_M-1)/\sigma_M} + s_M^{1/\sigma_M} \left(N_t^M \right)^{(\sigma_M-1)/\sigma_M} \right]^{\sigma_M/(\sigma_M-1)} \tag{2.2.18}$$

This gives demand functions for tradable and non-tradable intermediates analogously to (2.2.15) and (2.2.16):

$$N_t^{T,J} = s_{tnt}^J \left(\frac{P_t^T}{P_t^{N,J}} \right)^{-\sigma_{tnt}} N_t^J \tag{2.2.19}$$

$$N_t^{NT,J} = (1 - s_{tnt}^J) \left(\frac{P_t^{NT}}{P_t^{N,J}} \right)^{-\sigma_{tnt}} N_t^J \tag{2.2.20}$$

Combining the demand functions corresponding to (2.2.14) and (2.2.18) gives the import demand equation

$$M_t = s_M \left(\frac{e_t P_t^M}{P_t^T} \right)^{-\sigma_M} \left(Z_t^T + \sum_J I_t^J + \sum_J N_t^{T,J} \right)$$

Import prices are given by

$$p_t^M = \left[\sum_{f=1}^{F} \left(s_m^f \frac{e_t^f P_t^{T,f}}{P_t^x} \right)^{1-\sigma_f} \right]^{1/(1-\sigma_f)}$$

where s_m^f is the share of the country of origin f in domestic imports and $p_t^{T,f}$ is the price of tradables set by producers in country f. Notably, since there are three regions in the model, from the perspective of region SOEA, $f \in \{NOEA, ROW\}$.

Bilateral imports from the individual model regions (f), which are foreign regions from the perspective of the domestic economy, are given by

$$M_t^f = s^f \left(\frac{e_t^f P_t^{T,f}}{e_t P_t^M} \right)^{-\sigma_f} M_t$$

Exports of the domestic economy (X_t) equal the sum of bilateral imports of foreign regions, which implies that the trade balance of the domestic economy is denoted as

$$TB_t \equiv p_t^T X_t - e_t p_t^M M_t$$

The current account is then given as the sum of the trade balance and interest income on the net foreign asset position (NFA)

$$CA_t \equiv i_{t-1}^F e_t B_{t-1}^F + p_t^T X_t - e_t p_t^M M_t$$

The law of motion for the (NFA) position is denoted as

$$e_t B_t^F = (1 + i_{t-1}^F) e_t B_{t-1}^F + p_t^T X_t - e_t p_t^M M_t$$

Finally, in order to ensure stability of the NFA position we assume a closure rule that relates the external risk premium in (2.2.12) to the NFA position of the domestic economy relative to a baseline (target) position equal to $\bar{B}^*$ (as in Schmitt-Grohe and Uribe (2003)).

$$r_t^p = -\bar{r}\left(\frac{e_t B_t^F}{P_t Y_t} - \bar{B}^*\right)$$

An increase (decrease) in the NFA position of the domestic economy increases (decreases) the risk on foreign bonds relative to domestic bonds. A decrease (increase) in the relative risk of domestic assets in response to a rise (fall) in the domestic NFA position increase (decreases) domestic consumption and investment demand, which deteriorates the trade balance and stabilizes the NFA position.

2.3 Quantitative Analysis

In this section we describe the parameterisation of the model, emphasizing the differences across the three regions of the model, and then proceed with presenting the quantitative exercise.

2.3.1 Calibration

Recall that the model consists of a symmetric three-region world, a Southern Euro area aggregate (SOEA), a Northern Euro area aggregate (NOEA), as well as a rest-of-the-world block (ROW).[5] SOEA corresponds to 28.8% of Euro area GDP and NOEA accounts for 71.2% of Euro area GDP. We can distinguish between three types of parameters in the model. First, those pertaining to the model's steady state in the long-run, and which are assumed to be common to all three regions. Second, those

[5]The South is comprised of: ES, IT, PT, MT. The North is comprised of: BE, DE, EE, IE, FR, NL, AT, FI, SK, LV, LT, LU, SI. We exclude GR and CY as they are currently under an economic adjustment program.

affecting the model's short-to-medium run dynamics, but common to all regions. And a third category of parameters, which serve to explicitly differentiate each region in the model, and as will be described affect both the model's dynamics and convergence in the long run.

The parameterisation of the model's steady state in the long run is obtained using the AMECO database, public finance statistics and input-output tables. For parameters, which affect the model's dynamics in the short-medium run (strength of substitution elasticities, nominal and real frictions, habits in consumption, fiscal and monetary policy response parameters) we assume the values based on the estimation of a richer model variant by Ratto et al. (2009) and Kollmann et al. (2014). The model outlined here, is a nested version of the ones found in these studies and thus includes common model features. We assume that such model parameters are common to all regions as the option to calibrate them to the corresponding Euro area countries would be prohibitive given the model's size. Finally, parameters that are region-specific include the long run debt-to-GDP ratios, as well as the share of liquidity-constrained households. For the debt-to-GDP ratio we employ the AMECO database, which results in 66.6% for NOEA and 106.8% in SOEA. Since there is empirical disagreement in appropriate values for such shares in the data, we assume that this share is higher in SOEA (0.5) than in NOEA (0.3). Arguably, this is a good approximation of the current environment in these regions. Table (2.1) reports the calibrated parameter values and targeted ratios.

2.3.2 Identifying Fiscal Gaps

There are several ways to identify the required fiscal adjustment for the two regions in the model. Most methods in the literature rely in normative calculations of a country's level of fiscal sustainability. As such, assessing whether a current fiscal stance is sustainable turns out to be both a problematic, as well as a controversial exercise. At a fundamental level, a government's fiscal stance should be deemed sustainable if the government's budget constraint is satisfied. However, since the government budget constraint is intertemporal and forward-looking this does not seem to solve the problem in practice.

Approaches in the Literature

Here, we briefly describe the main methods proposed in the literature, emphasizing the ones, which are similar in spirit to the one opted for in this paper. For a full overview of approaches assessing fiscal sustainability see Chalk and Hemming (2000), who also describe how these approaches have been used in IMF work. Buiter (1995) also surveys a range of empirically implementable indicators of fiscal sustainability including: the public debt-to-GDP ratio, the one-period primary gap, the permanent primary gap, discounted public debt, as well as the long-run inflation rate implied by the specific fiscal plan.

Polito and Wickens (2011) propose an index of fiscal sustainability derived from the government's inter-temporal budget constraint. The index is constructed by measuring the distance of the existing level of government debt from a forecast of the present value of current and future deficits derived from a VAR forecasting model of the economy.

Carnot (2014) proposes a simple 'rule-of-thumb' for evaluating the effectiveness of fiscal policies. This rule links fiscal policy to a balancing between a long-run debt objective and summary measure of output stabilization. More specifically, the rule proposes that the targeted fiscal effort (E_t) positively depends on the sum of the primary gap (P_t) and an aggregate score of macroeconomic conditions (S_t). The primary gap should then reflect the distance to a path of debt at a specified 'moderate' level, whereas the score is represents views about the business cycle.

The Fiscal Sustainability Report (2012) of the European Commission (ECFIN (2012)) has proposed a medium-term sustainability indicator (S1 indicator), to evaluate the budgetary adjustment change required with a view of steadily improving the structural primary balance by 2020 to bring debt ratios back to 60% of GDP. This 60% debt-to-GDP ratio is the debt threshold implied by the Maastricht Treaty. This budgetary effort should then be kept constant until 2030, but should also include the financing of any additional costs arising from an ageing population.

A Fiscal Stance scenario[6]

In this paper, we identify the required fiscal adjustment for each country by choosing the middle ground from the approaches described above. Our analysis focuses on the guidelines laid out by the European Commission's Stability and Growth Pact (SGP). The SGP "is a set of rules designed to ensure that countries in the European Union pursue sound public finances and coordinate their fiscal policies." (European Commission, 2015[7]) In order to translate these rules into meaningful measures of fiscal adjustment, and in particular, to quantify the changes in government expenditures in the model we proceed in the following way:

First, we refer to the European Commission's 'Flexibility Communication' (ECFIN (2015b)) and the associated 'fiscal adjustment matrix', which specifies fiscal adjustment requirements for countries in the EU, based on their performance along two dimensions: their debt-to-GDP ratio (whether it is below, or above 60%), and their output gap

[6]This scenario is only illustrative and should not be seen as prejudging the ability, or willingness of the European Commission, or countries to recommend, or implement fiscal adjustments.

[7]http://ec.europa.eu/economy_finance/economic_governance/sgp/index_en.htm. Last accessed: 4/4/2015.

(see Figure (2.4.1)). As can be seen, the matrix specifies larger fiscal adjustments under good economic conditions (low debt-to-GDP; positive output gap) and smaller fiscal adjustments during negative economic conditions (high debt-to-GDP; output gap < -4). Notably, the purpose of these guidelines was to specify to member states under the preventive arm of the SGP a straightforward way in achieving their medium-term objectives (MTO).

Second, in order to assign to countries the recommended fiscal adjustment, we refer to the European Economic Forecast: Winter 2015 (ECFIN (2015a)) and in particular to the forecast of the expected fiscal stance in 2014 and 2015. Figure (2.4.2) plots the average change in the structural balance in 2014 - 2015 against the debt-to-GDP ratio (top panel) and the output gap (bottom panel) for countries in the EU. In this context, it is straightforward to read from Figure (2.4.2) each country's economic conditions and assign them values of fiscal adjustment based on the matrix in Figure (2.4.1).

The final step is to take the difference from the forecasted change in the structural balance and the value assigned based on the flexibility matrix guidelines. The forecasted change in the structural balance can be seen directly from Figure (2.4.2), or the country-specific sections in the European Economic Forecast: Winter 2015.

However, the flexibility matrix only provides guidelines to countries under the preventive arm of the SGP that have not yet achieved their MTOs (these include: BE, EE, IT, LT, NL, AT, SK and FI), leaving two more categories of countries with an unassigned fiscal adjustment value. The first of these is countries under the corrective arm of the SGP (that is countries under the Excessive Deficit Procedure: MT, PT, SI, FR, IE and ES). For these we make the assumption that their yearly fiscal adjustment is equal to a fiscal consolidation of 0.5 percentage points of GDP. This assumption is based on debt sustainability guidelines specified in ECFIN (2014). For countries that are at, or above their MTOs (based on our calculations, these include: DE, LV and LU) we assume that they take progressive measures to come back to their MTOs. The resulting values for fiscal adjustment can be see in Figure (2.4.3). Notably, Germany, Italy, Latvia and Slovenia, which are all part of NOEA, undertake a fiscal expansion, whereas all other countries undertake a fiscal consolidation.

2.3.3 Simulations

Given the calculation of the fiscal stance at the country level, we then aggregate country-specific fiscal adjustments, weighted by their real GDP in 2015 to arrive at an aggregate fiscal stance for NOEA and SOEA. The implied fiscal stance for NOEA is 0.26% of GDP, whilst for SOEA it stands at -0.09% of GDP. We start the simulation in 2015, and assume that the two adjustments for NOEA and SOEA take place contemporaneously and last four quarters. Since one period in the model corresponds to one quarter, we then average the results at a yearly frequency. Thus, all the results from the simulations can be viewed as impulse response functions, whereby the fiscal shock takes place in period 1, and is zero thereafter.

Moreover, as in Gali and Monacelli (2008) we assume that the only fiscal instrument, which is affected are government purchases. Thus, all other remaining fiscal instruments (taxes on consumption, labor, corporate profits, lump-sum) remain constant at their calibrated levels. Notably, throughout the simulations we assume that the RoW model block remains unchanged. This is done to prevent confounding of the spillover effects from an adjustment within the EA. The purpose in incorporating such a RoW block in the model is to therefore allow studying the transmission channels of fiscal policy that operate through the nominal exchange rate (that is changes in the euro vis-a-vis the foreign currency). Furthermore, the debt-target in the model is left unchanged, and the tax rule on labor income is switched off until the year 2030, which implies that any effects on the endogenous variables of the model will not occur through endogenous changes in the labor tax rate. Finally, given its large size, the model is solved using deterministic simulations, and thus we implicitly assume that agents in the environment have perfect foresight. This is not such a stringent assumption, since the fiscal shock under consideration is only relevant on impact.

Below we present simulations in which monetary policy is not constrained by the zero bound (i.e. an environment where the ZLB never binds). In Section (2.3.3), we relax this assumption and compare the transmission of the fiscal shocks in an environment where the ZLB is binding for twenty consecutive quarters following the fiscal shock. The latter specification is arguably a more realistic representation of the current environment in the Eurozone.

Domestic Effects and International Spillovers

Figure (2.4.4) plots the domestic effects of a SOEA fiscal consolidation on SOEA, and at the same time a NOEA fiscal expansion on NOEA. Due to the consolidation, the South experiences a crowding out of private consumption and investment, but not strong enough to revert the fall in GDP of approximately 0.05%. On the other hand, the expansion in the North leads to opposite results leading to an increase in GDP by approximately 0.2%. Figure (2.4.5) decomposes the total effect on SOEA into domestic effects from the consolidation and into international spillovers arising from the NOEA expansion. Figure (2.4.6) plots the respective effects on NOEA. It is clear that when the North and the South regions are expanding and consolidating respectively, the spillover effect coming from the North mitigate the effects on the South's real GDP, which is consolidating. On the contrary, the total effect on NOEA is still positive since the size of the expansion is in absolute terms greater than the consolidation in the South, which is not large enough to offset the North's fiscal expansion.

Gains from Fiscal Coordination

Figure (2.4.7) plots the domestic and spillover effects on SOEA and NOEA, as well as what these imply for the whole EA. Naturally, the effects from the spillovers are smaller than the domestic effects of fiscal policy on real GDP. However, given the asymmetric shock sizes and the larger relative size of NOEA, this leads to an increase in overall EA GDP. Thus, there are gains from coordination, both from the perspective of the South (where real GDP falls less on impact), but also from the perspective of the Euro area as a whole (where real GDP increase by approximately 0.9% on impact).

Active Monetary Policy vs a Zero-Lower Bound

Figures (2.4.8), (2.4.9) contrast the total effects on NOEA and SOEA under active monetary policy or when the zero bound constraint is assumed to be binding for 5 years.

First, we observe that under a ZLB on nominal interest rates the South benefits from the expansion in the North. That is, the expansion in the North overcompensates for the fiscal consolidation in the South. This is because under a ZLB the spillovers from the North are positive and more sizable. The transmission mechanism for this result can be attributed to three channels:

Income effect: The increase in government purchases in the North leads to a rise in the quantity of net exports in the South (imports of the North). Since North imports and domestically produced goods are imperfect substitutes this leads to a rise in economic activity in the South.

Internal competitiveness effect: The increase in government purchases in the North leads to a rise in the price of exports in the South (imports of the North) and an increase in South competitiveness relative to the North (due to the increase in inflation of the North).

External competitiveness (exchange rate) effect: The Euro area exchange rate depreciates with respect to the rest of the world generating an increase in competitiveness and hence an increase in domestic demand in the North. This happens because when the nominal interest rate is kept constant at zero, fiscal policy actions lead to an overall increase in Euro inflation causing the real interest rate to drop. This then implies that there is an outflow of capital causing a depreciation of the exchange rate. Interestingly, the ZLB acts as a monetary policy expansion when accompanied by an aggregate fiscal expansion.

In the baseline case, where the nominal interest rate was free to respond to changes in inflation and the output gap there was an additional effect, which overturned the result on South GDP on impact.

Interest rate effect: Due to the North's expansion (which has a high share in Euro-area GDP) the nominal interest rate increases leading to an increase in the real interest rate. This is because prices in the North are increasing (due to the positive demand effect and positive internal competitiveness effect) leading to higher inflation. As a result, the Euro appreciates leading to a loss in competitiveness.

Furthermore, the interest rate channel also operates to affect domestic demand. Since the real interest rate is increasing this implies a reduction in investment and the consumption of Ricardian households.

Finally, Figure (2.4.10) plots the total effects on the EA under a ZLB and under active monetary policy. From the discussion above, it follows that under a ZLB the effects on EA real GDP on impact become more positive. Thus, under the current juncture in the Eurozone, the gains from fiscal coordination are even greater.

2.4 Conclusion

This paper has constructed a model along the lines of Ratto et al. (2009) and Vogel (2014), which allows to study strategies of fiscal coordination across regions of the Eurozone. The paper contributes to the current debate on the merits of fiscal coordination, by offering a theoretical understanding of fiscal adjustments in the North and South Eurozone under two different monetary policy arrangements.

The model is particularly suitable in investigating this question as it consists of a two-region world, with several features that have been identified in the literature as important in replicating empirical stylized facts in quantitative macroeconomics: nominal frictions in prices and wages, a distinction of households into liquidity-constrained and optimizing, an expanded fiscal sector with a role for productive government investment, and a Taylor-type nominal interest rate rule for monetary policy. The model is then calibrated to the EU South and EU North and fed with a particular fiscal policy scenario where the EU North undertakes a fiscal expansion, and the EU South undertakes a fiscal consolidation. This scenario has been constructed by collecting data from the European Commission's Winter Forecast 2015 and the guidelines on fiscal adjustment laid out by the Stability and Growth Pact.

The results suggest that when monetary policy is constrained by the zero-lower bound the EA South benefits from the expansion in the EA North, although it is in itself undertaking a fiscal consolidation. This occurs when monetary policy is constrained under the ZLB, as in this setting the spillovers from the North's expansion are larger. Empirical evidence in the fiscal policy literature confirms the importance of fiscal shock spillovers. The key difference between a ZLB and an active monetary arrangement, is the presence of an interest rate effect, which is under operation only in the latter case. Under an active monetary policy the North's expansion triggers a nominal interest rate increase leading to an increase in the real interest rate. As a result, the Euro appreciates leading to a loss in competitiveness. In contrast, under a ZLB, fiscal policy actions imply an overall increase in Euro inflation causing the real interest rate to drop. This then results in an outflow of capital from the EA causing a depreciation of the exchange rate, and hence a loss in output.

The results in the paper are of particular relevance for policymakers in the US and the Eurozone in the current environment of a slow recovery from the Great Recession. An important next step on the policy front would thus be to design programs and institutions that can implement and accommodate this coordination.

Potential extensions to this paper could include a more accurate regional differentiation in the model, with a distinctive calibration across a greater number of dimensions (e.g. steady shares of consumption-to-GDP, investment-to-GDP, etc). Furthermore, although the paper has emphasized a particular policy scenario, it would be interesting to expand the availability of policy instruments responsible for the fiscal adjustment (consumption taxes, income taxes, corporate taxes, government investment). A welfare analysis would then become appropriate, and lead to further insight. Finally, it would also be relevant to study the timing of the fiscal adjustment (e.g. frontloaded vs. backloaded), and in this way be able to contribute to the debate on the efficacy of growth-friendly fiscal consolidations.

Appendix

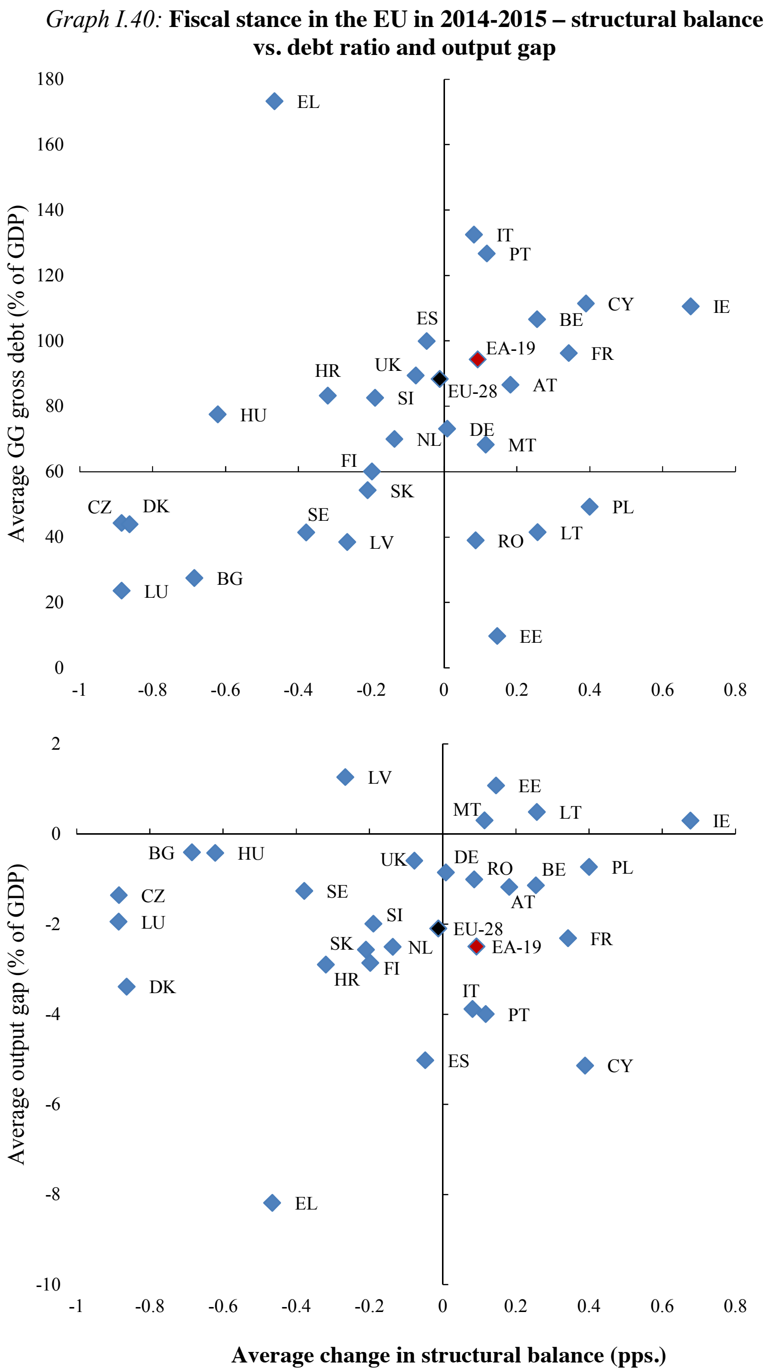
Figure 2.4.1: Fiscal Adjustment Matrix

		Required annual fiscal adjustment*	
	Condition	Debt below 60 % and no sustainability risk	Debt above 60 % or sustainability risk
Exceptionally bad times	Real growth <0 or output gap <-4	No adjustment needed	
Very bad times	-4 ≤ output gap <-3	0	0.25
Bad times	-3 ≤ output gap < -1.5	0 if growth below potential, 0.25 if growth above potential	0.25 if growth below potential, 0.5 if growth above potential
Normal times	-1.5 ≤ output gap < 1.5	0.5	> 0.5
Good times	output gap ≥ 1.5 %	> 0.5 if growth below potential, ≥ 0.75 if growth above potential	≥ 0.75 if growth below potential, ≥ 1 if growth above potential

* all figures are in percentage points of GDP

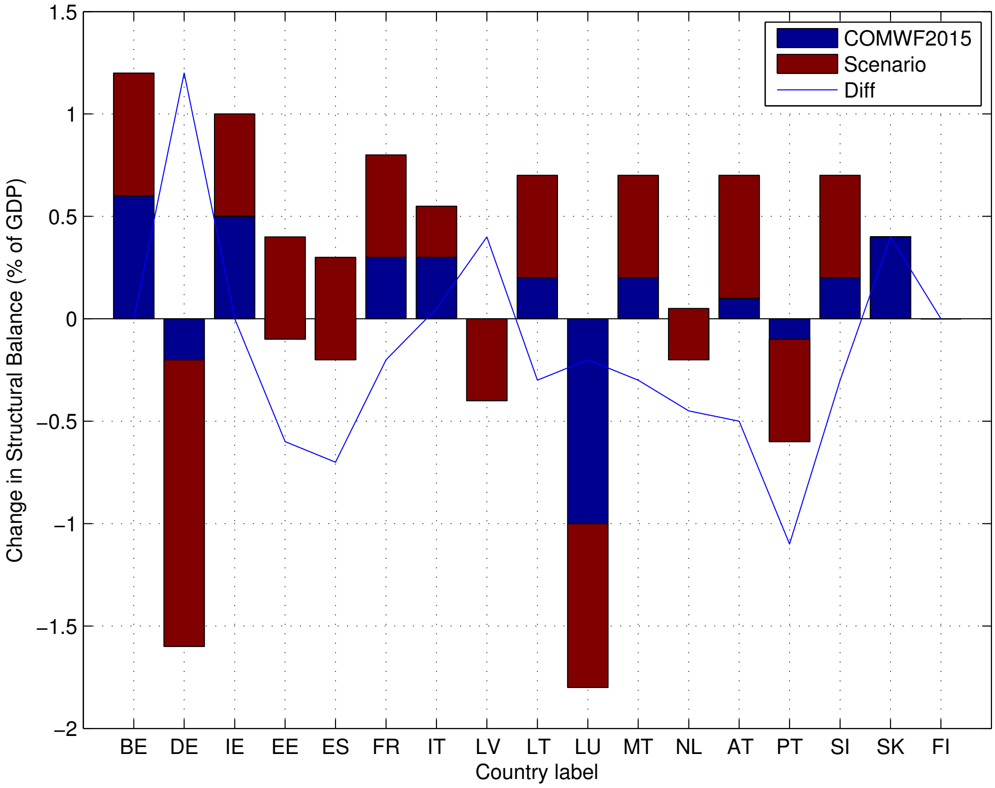
Source: European Commission, Communication: Making the Best Use of the Flexibility within the Existing Rules of the Stability and Growth Pact. Strasbourg, 13/1/2015, page 20, Annex 2.

Figure 2.4.2: Fiscal Gaps for EA



Source: European Commission, European Economic Forecast: Winter 2015, page 42, graph I.40

Figure 2.4.3: Fiscal Gaps for EA

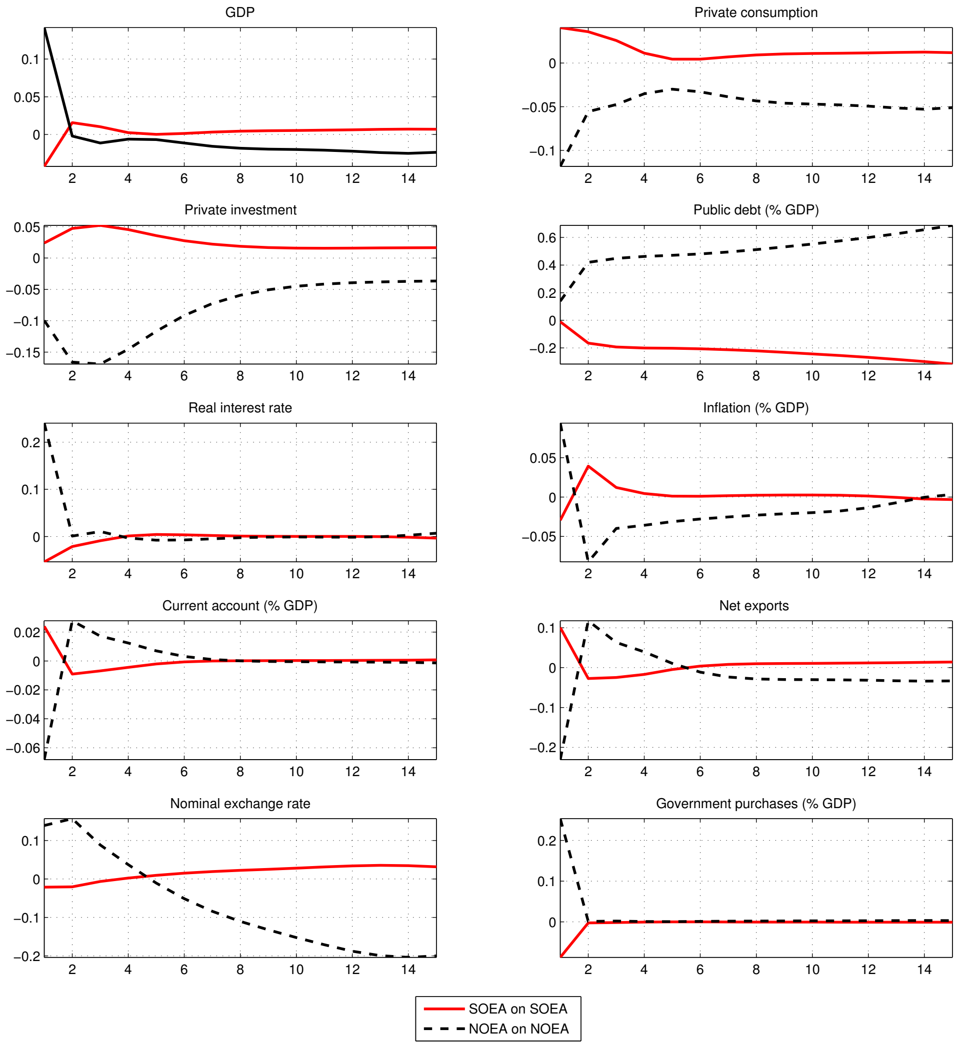


Blue bars denote the forecasted change in the structural balance (as a % of GDP) in 2014-2015. Red bars denote the fiscal stance scenario implied by the 'Flexibility matrix'. Solid blue line denotes the difference in the forecasted change in the structural balance and the fiscal stance scenario. The source for the blue bars is: European Commission, European Economic Forecast: Winter 2015

Table 2.1: Parameter Values

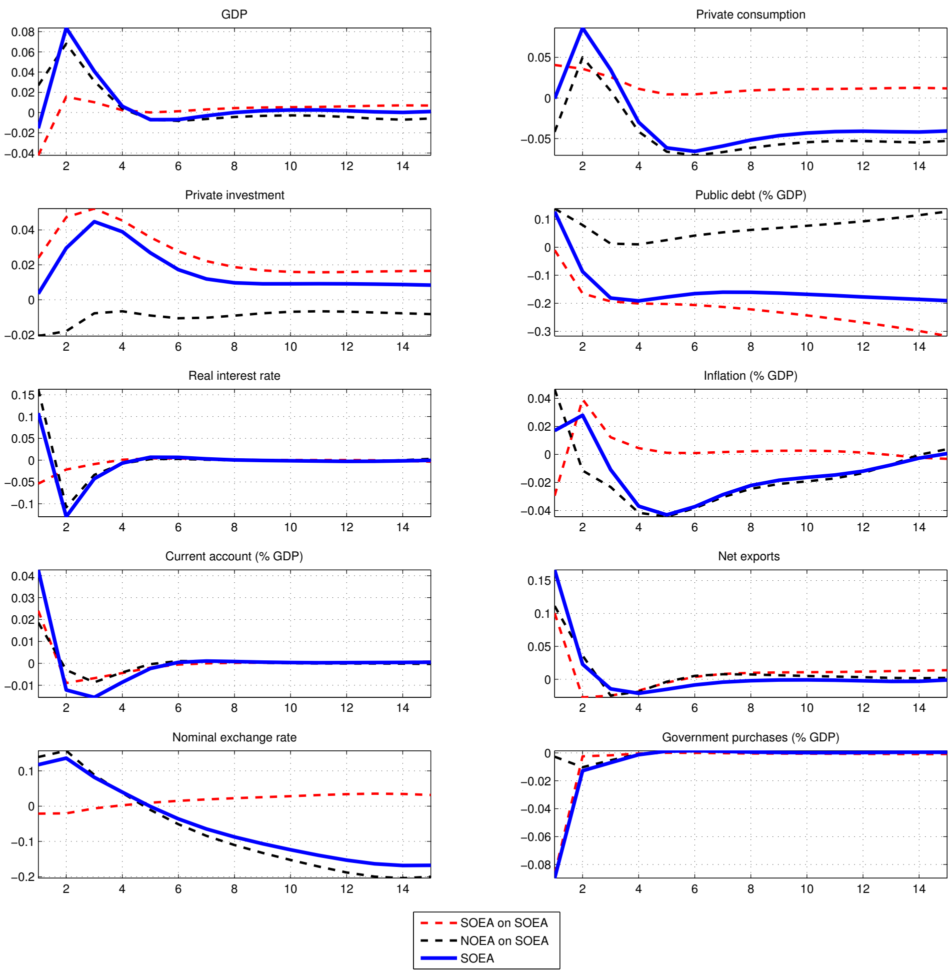
Parameter	Value	Description	Parameter	Value	Description
Preferences			Frictions		
β	0.997	Discount factor	$\gamma_{u,1}$	0.04	Capacity utilization adjustment cost (linear)
h	0.7	Habit persistence	$\gamma_{u,2}$	0.05	Capacity utilization adjustment cost (quadratic)
κ	-5	Inverse elasticity of labor supply	ε	0.9	Share of forward-looking price setters
ϑ	0.001	Weight of leisure in utility	ε^w	0.9	Share of forward-looking wage setters
σ_T	8.3	Elasticity of substitution T varieties	-	5	*Duration of prices (average, quarters)*
σ_{NT}	5	Elasticity of substitution NT varieties	-	3	*Duration of wages (average, quarters)*
σ_{tnt}	0.5	Elasticity of substitution T-NT	Fiscal Policy		
σ_M	1.5	Elasticity of substitution T-M	τ^C	0.17	Consumption tax
σ_f	0.99	Elasticity of substitution between import sources	τ^W	0.25	Labor income tax
s_{tnt}	0.41	Steady-state consumption share of T	τ^K	0.28	Corporate profit tax
s_M	0.41	Steady-state consumption share of imports	τ^b	0.01	Labor tax debt-to-GDP stabilization parameter (debt target)
L	0.66	Steady-state employment to population	τ^{def}	0.1	Labor tax debt-to-GDP stabilization parameter (debt)
s^l	0.5	Share of LC households (SOEA)	$\bar{r}$	0.0025	Risk premium
s^l	0.3	Share of LC households (NOEA)	National accounts		
Production			C	0.67	Private consumption (share of GDP)
a	0.65	Share of labor in value-added	I	0.1	Private investment (share of GDP)
a_g	0.09	Share of public capital in value-added	G	0.19	Government expenditures (share of GDP)
σ_N	0.5	Elast. of subst. between value added and N	IG	0.04	Government investment (share of GDP)
s^T	0.74	Steady-state intermediate share T	M	0.46	Imports (share of GDP)
s^N	0.44	Steady-state intermediate share NT	B^G	0.66	Government debt (share of GDP) - SOEA
s_N^T	0.61	Steady-state T intermediate share in T	B^G	1.07	Government debt (share of GDP) - NOEA
s_N^{NT}	0.43	Steady-state T intermediate share in NT			
θ	6.5	Elasticity of substitution between types of labour			
$\delta^{K,T}$	0.02	Depreciation rate capital T			
$\delta^{K,NT}$	0.01	Depreciation rate capital NT			
δ^G	0.01	Depreciation rate public capital			
ρ_L	0.95	Persistence of potential labor			
ρ_u	0.99	Persistence of potential capacity utilization			

Figure 2.4.4: Domestic Effects on SOEA and NOEA



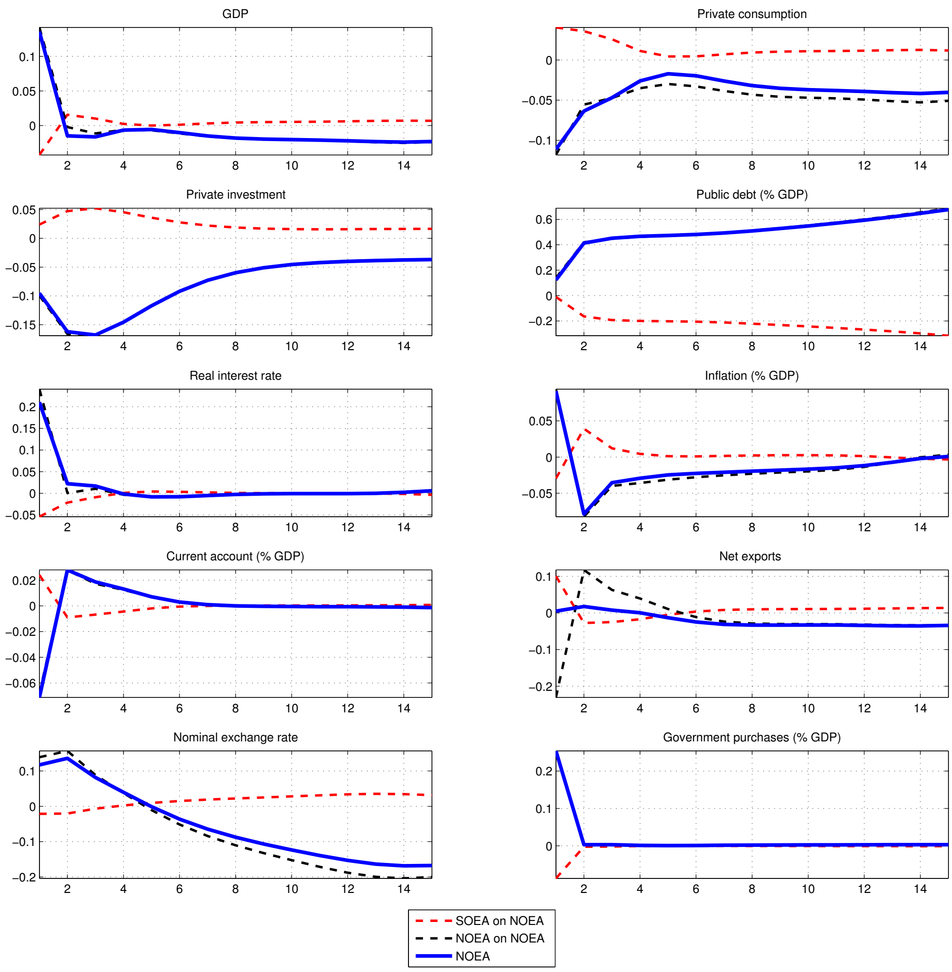
The IRFs are presented for the baseline case of **active monetary policy**. The variables plotted are: GDP, private consumption, private investment, public debt (as a % of GDP), the real interest rate, inflation (as a % of GDP), the current account (as a % of GDP), net exports, the nominal exchange rate and government purchases (as a % of GDP). Solid red lines correspond to the effects of a SOEA fiscal consolidation on SOEA. Dashed black lines correspond to the effects of a NOEA fiscal expansion on NOEA.

Figure 2.4.5: Domestic Effects and International Spillovers on SOEA



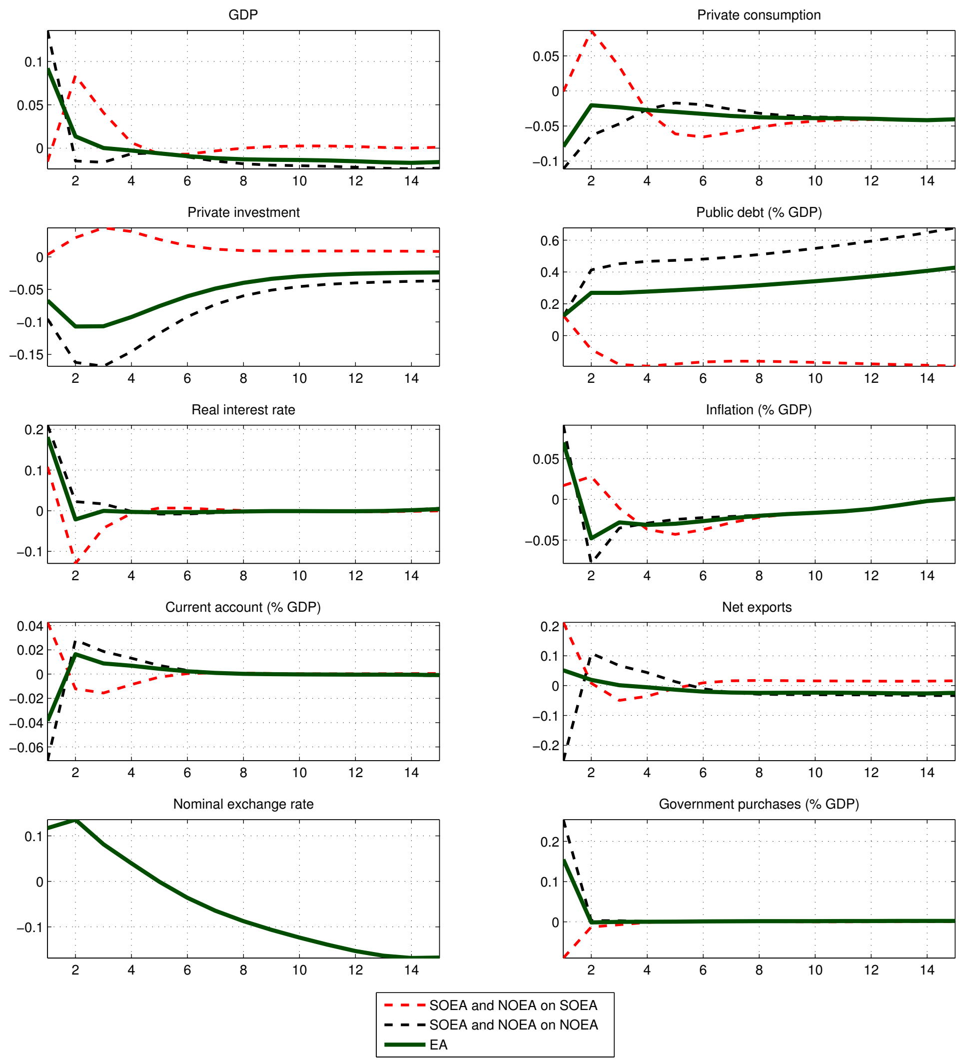
The IRFs are presented for the baseline case of **active monetary policy**. The variables plotted are: GDP, private consumption, private investment, public debt (as a % of GDP), the real interest rate, inflation (as a % of GDP), the current account (as a % of GDP), net exports, the nominal exchange rate and government purchases (as a % of GDP). Dashed red lines correspond to the effects of a SOEA fiscal consolidation on SOEA. Dashed black lines correspond to the effects of a NOEA fiscal expansion on SOEA. Solid blue lines correspond to the GDP-weighted total effects on SOEA.

Figure 2.4.6: Domestic Effects and International Spillovers on NOEA



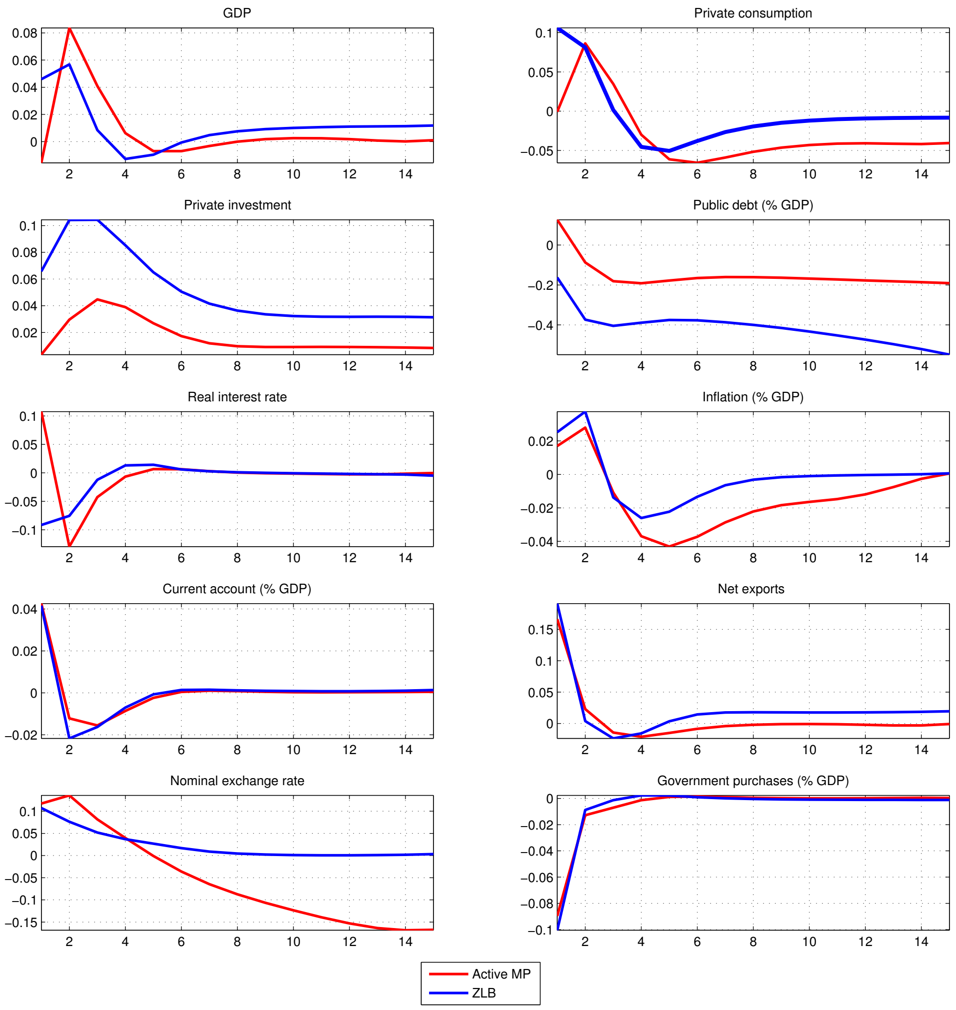
The IRFs are presented for the baseline case of **active monetary policy**. The variables plotted are: GDP, private consumption, private investment, public debt (as a % of GDP), the real interest rate, inflation (as a % of GDP), the current account (as a % of GDP), net exports, the nominal exchange rate and government purchases (as a % of GDP). Dashed red lines correspond to the effects of a SOEA fiscal consolidation on NOEA. Dashed black lines correspond to the effects of a NOEA fiscal expansion on NOEA. Solid blue lines correspond to the GDP-weighted total effects on NOEA.

Figure 2.4.7: Fiscal Coordination



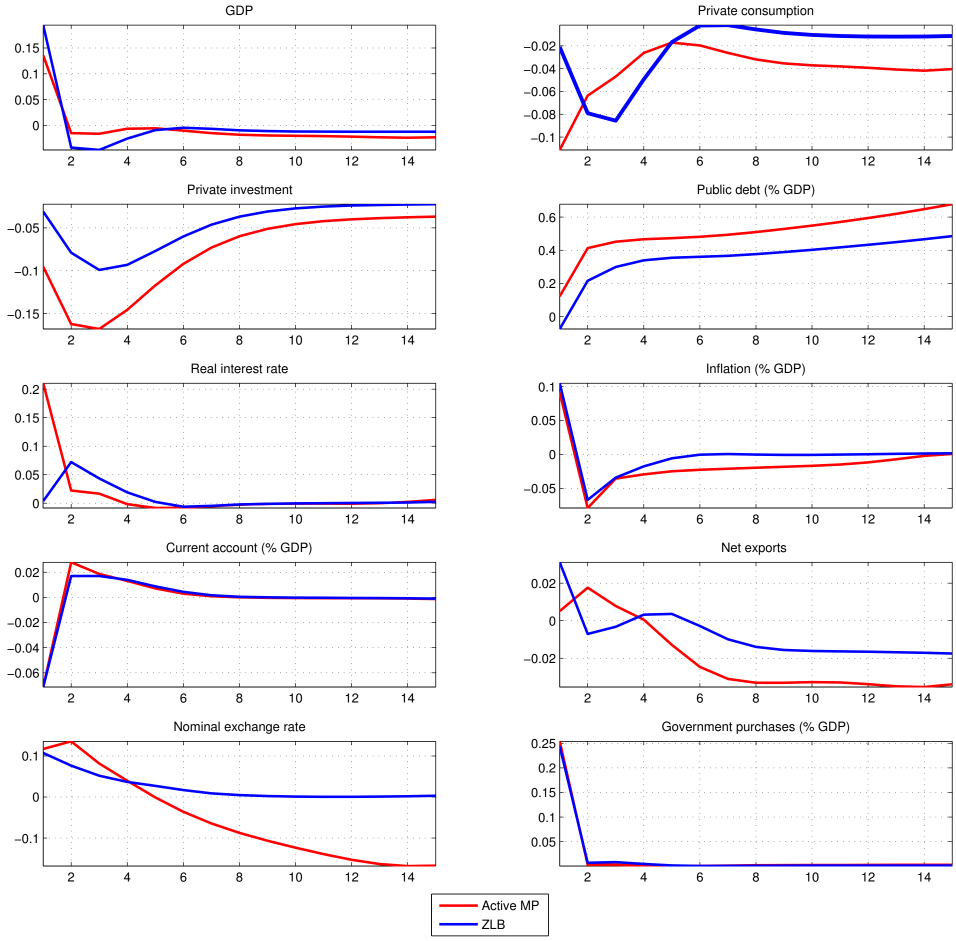
The IRFs are presented for the baseline case of **active monetary policy**. The variables plotted are: GDP, private consumption, private investment, public debt (as a % of GDP), the real interest rate, inflation (as a % of GDP), the current account (as a % of GDP), net exports, the nominal exchange rate and government purchases (as a % of GDP). Dashed red lines correspond to the effects of a SOEA fiscal consolidation on NOEA. Dashed red lines correspond to the effects of a SOEA fiscal consolidation and a NOEA fiscal expansion on SOEA. Dashed black lines correspond to the effects of a SOEA fiscal consolidation and a NOEA fiscal expansion on NOEA. Solid green lines correspond to the effects of a GDP-weighted SOEA fiscal consolidation and a GDP weighted NOEA fiscal expansion on EA.

Figure 2.4.8: Fiscal Coordination in SOEA under Active Monetary Policy vs a Zero Lower Bound



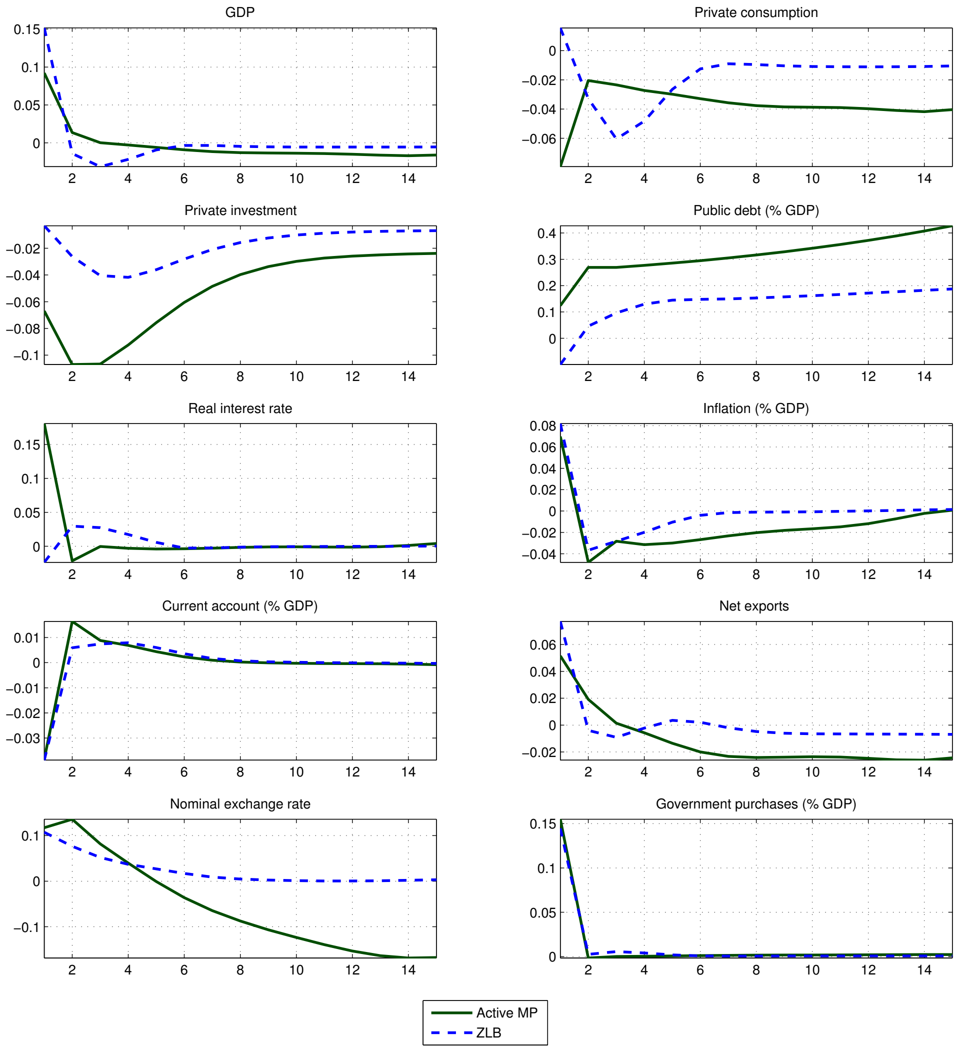
The variables plotted are: GDP, private consumption, private investment, public debt (as a % of GDP), the real interest rate, inflation (as a % of GDP), the current account (as a % of GDP), net exports, the nominal exchange rate and government purchases (as a % of GDP). Solid red lines correspond to the effects of a SOEA fiscal consolidation and a NOEA fiscal expansion on SOEA under active monetary policy. Solid blue lines correspond to the effects of a SOEA fiscal consolidation and a NOEA fiscal expansion on SOEA under a zero lower bound.

Figure 2.4.9: Fiscal Coordination in NOEA under Active Monetary Policy vs a Zero Lower Bound



The variables plotted are: GDP, private consumption, private investment, public debt (as a % of GDP), the real interest rate, inflation (as a % of GDP), the current account (as a % of GDP), net exports, the nominal exchange rate and government purchases (as a % of GDP). Solid red lines correspond to the effects of a SOEA fiscal consolidation and a NOEA fiscal expansion on NOEA under active monetary policy. Solid blue lines correspond to the effects of a SOEA fiscal consolidation and aNOEA fiscal expansion on NOEA under a zero lower bound.

Figure 2.4.10: Fiscal Coordination in EA under Active Monetary Policy vs a Zero Lower Bound



The variables plotted are: GDP, private consumption, private investment, public debt (as a % of GDP), the real interest rate, inflation (as a % of GDP), the current account (as a % of GDP), net exports, the nominal exchange rate and government purchases (as a % of GDP). Solid green lines correspond to the effects of a GDP-weighted SOEA fiscal consolidation and a GDP weighted NOEA fiscal expansion on EA under active monetary policy. Dashed blue lines correspond to the effects of a GDP-weighted SOEA fiscal consolidation and a GDP weighted NOEA fiscal expansion on EA under a zero lower bound.

Chapter 3

Fiscal Policy under Labor Market and Financial Frictions

3.1 Introduction

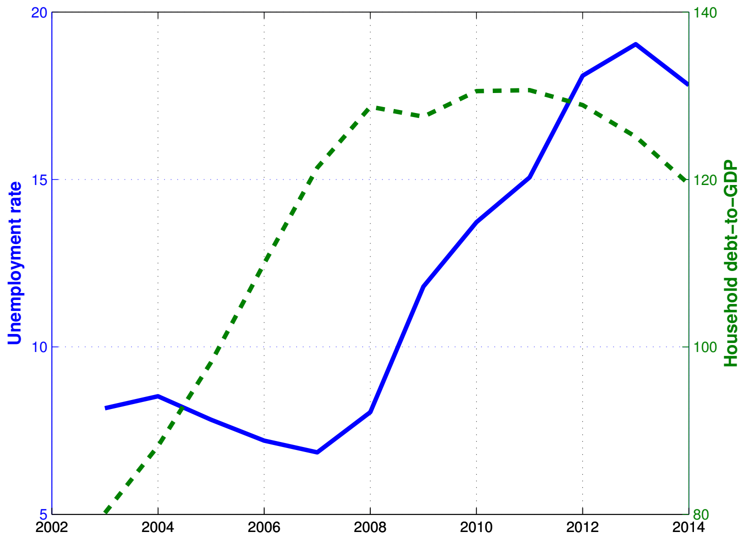
Since the onset of the Great Recession in 2007 many European economies are facing problems of growing government debt and unemployment. This is occurring against the backdrop of deleveraging pressures to households caused by a combination of restricted access to credit from the financial sector and subdued growth. Given these concerns many countries have responded by undertaking massive fiscal consolidation measures, a process labelled as an internal devaluation in the Eurozone periphery. However, these measures largely seem to be failing and emphasis has been placed on the inability of Eurozone members to pursue an independent monetary policy in order to tackle the distortions. The inefficacy of austerity measures has recently launched a debate on the effectiveness of fiscal instruments to offset the distortions amplified by the crisis with the European Economic Recovery Plan in particular giving rise to a new academic and policy literature on the economic effects of fiscal devaluations. The views on the effectiveness of fiscal consolidations do not generally reach a consensus, but a typical argument suggests that the effects of government spending on output are smaller when a country is constrained by a currency peg, as in the European Monetary Union, as potential nominal interest rate decreases and currency depreciations are no longer available instruments to dampen the negative impacts on aggregate demand.

As can be seen in the left panel of Figure (3.1.1) the unemployment rate in Europe's periphery surged following the onset of the crisis in the final quarter of 2007 reaching approximately 18%. One plausible feature that has been put forth to cause this disequilibrium in the labor market is downward nominal rigidity of wages. This regularity has been empirically documented in several studies (e.g. Knoppik and Beissinger (2001); Dickens et al. (2006); Babecky et al. (2010); Benigno and Ricci (2011); Kim and Ruge-Murcia (2011)) and as can be seen in Figure (3.1.2), nominal wages for most of the high-unemployment countries in the sample display this feature.[1] At the same time as this increase in unemployment, the private sector's access to credit has become ever more restricted and the first quarter of 2008 found households in Eurozone's periphery to be forced into a mild deleveraging by cutting down on their net borrowing. However, as observed both in Figure (3.1.1) as well as documented in several empirical studies (Justiniano et al. (2013); Cuerpo et al. (2013); Buttiglione et al. (2014)), the speed of household deleveraging in Europe is still slow. Arguably, the continued high unemployment rates and the slow movement of the net lending-to-net borrowing ratio is acting as a burden on economic recovery from the crisis. Moreover, they empirically appear to be occurring simultaneously.

This paper investigates the effects of fiscal policy in an environment, which captures the salient features that have become relevant to hindering the process of recovery from a

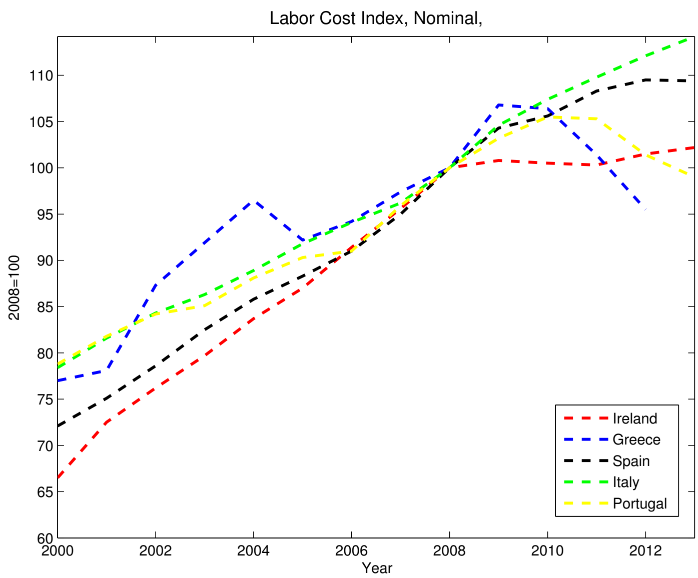
[1] The exceptions are Greece and Portugal from 2010 onwards, but on average the labor cost index across the whole EU periphery is increasing.

Figure 3.1.1: Distortions in the Eurozone Periphery



Mean of Greece, Ireland, Italy, Spain and Portugal. Sample period: 2000-2012. Shaded area corresponds to Great Recession (2008 to 2009). Unemployment is plotted on the left axis. Household debt-to-GDP is plotted on the right axis. Sources: World Bank, Eurostat

Figure 3.1.2: Nominal Labor Cost Index



The nominal unit labour cost is defined as the ratio of total compensation of employees, in millions of national currency per total number of employees in persons divided by the ratio of GDP in market prices in millions, chain-linked volumes, reference year 2005 (CLV05), at 2005 exchange rates in national currency per total number of persons employed in persons. Source: Eurostat financial crisis in a currency union - labor market and financial frictions in an economy operating under a fixed exchange rate regime. The paper proposes a mechanism where "crisis shocks" to the financial sector of the model gives rise to the two distortions jointly, by spilling over from the financial side of the model into the labor market. The frictions responsible in generating these distortions are modeled as downward nominal rigid wages and a collateral constraint on private sector borrowing. Following the bust, which triggers a financial crisis leads to a tightening of household borrowing constraints and an increase in unemployment. These two distortions arise jointly and interact to replicate the stylized fact observed in Figure (3.1.1).

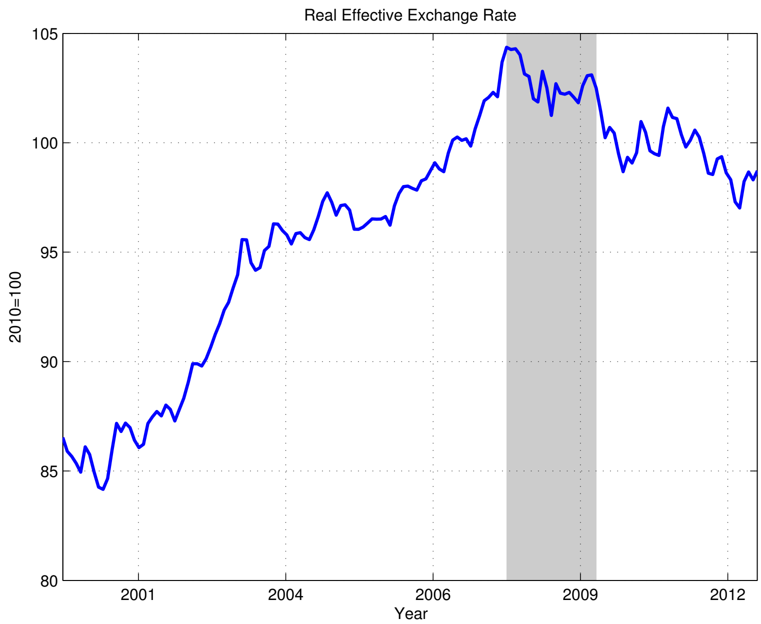
The class of models where unemployment manifests itself in disequilibrium caused by asymmetric wage rigidity is due to Schmitt-Grohe and Uribe (2011, 2012, 2013). In contrast to the standard New Keynesian models of nominal wage rigidity where employment is always demand determined, in this setting employment remains demand determined during contractions, but supply and demand determined during booms. As a result, unemployment arises during contractions, but full employment is reached during booms. The important features that causes real wages to become downwardly rigid is the combination of nominal wage rigidity (document empirically in Figure (3.1.2)) and a fixed exchange rate - a currency peg as in the Eurozone. During a contraction, wages cannot adjust downwards because of their rigidity, requiring a nominal exchange rate depreciation to bring about their indirect deflation. If this instrument is not available due to an economy's pegging of its currency then unemployment arises. We view this approach as a natural way to motivate the increase in unemployment in a recession. Furthermore, it provides an interesting platform to analyze the joint determination of debt and unemployment in the model.

The first contribution of this paper is to enrich the framework where unemployment manifests itself in disequilibrium by incorporating a financial friction found in the works of Mendoza (2010); Bianchi (2011) and Benigno et al. (2012) among others. It then proposes a mechanism for the propagation of crisis shocks in the economy. This friction takes the form of an occasionally binding collateral constraint that is introduced on the side of the private sector whereby the volume of debt issued is limited by the value of collateral leveraged on tradable and non-tradable income. As a result, changes in the value of collateral will affect the tightness of the constraint and hence the ability of the private sector to borrow.

There are several recent attempts to synthesize these distortions. Other papers, which consider the combination of these two distortions in variably different settings include Fornaro (2012); Ottonello (2014) and Zhu (2014). The focus of their work however is on debt relief policies , optimal exchange rate policy, and optimal capital flow management and respectively.

The second objective of this paper is to study the response of fiscal policy in this distortive environment and investigate whether a fiscal consolidation, or expansion is preferable in mitigating, or offsetting these inefficiencies. The results suggests that active fiscal policy cannot tackle both of these issues simultaneously, thereby generating an 'debt-unemployment' trade-off. Following a fiscal consolidation through cuts in government consumption the private sector is induced into a deleveraging, however at a cost of rising unemployment. In contrast, following a fiscal expansion through expenditure increases, labor demand increases to offset unemployment, but at the same time leads to a relaxation of borrowing constraints resulting in higher private debt. The results suggest that in order to understand the appropriate policy targeted at offsetting the distortions amplified by the crisis requires a richer modeling of the fiscal sector, with more explicit roles for the fiscal instruments than the ones commonly found in previous studies. In this paper we allow for fiscal policy to transmit its effects through changes in government consumption, investment and a capital control tax on

Figure 3.1.3: Real Effective Exchange Rate



Mean of Greece, Ireland, Italy, Spain and Portugal. Sample period: 2000-2013. Shaded area corresponds to Great Recession (12-2007 to 06-2009). Source: BIS

private debt.

The key element that affects the extent of deleveraging and unemployment following changes in fiscal policy is the movement of the real exchange rate, an issue, which is still debated in the empirical literature.

Several studies find that following positive government spending shocks the real exchange rate appreciates (Erceg et al. (2008); Galstyan and Lane (2009); Beetsma and Giuliodori (2011)), whereas other work finds the contrasting effect, namely that a positive government spending shock leads to a real exchange rate depreciation (Monacelli and Perotti (2010); Ravn et al. (2012)). This apparent inconsistency can be conjectured to stem from the different methodological approaches and samples in question among other factors that distinguish the relevant papers. As can be seen in Figure (3.1.3) the real effective exchange rate followed a downward trend since the onset of the crisis in 2007, a period, which was marked by large-scale fiscal consolidations in most of the European periphery. This could imply a positive correlation between government spending shocks and real exchange rate depreciations, but further empirical work is needed to fully disentangle this relationship.

On the policy front, the model sheds light on the debate of the merits and disadvantages of fiscal consolidations that have become so commonly implemented in countries like Greece, Portugal and Spain. The fact that fiscal policy is rendered toothless in the presence of high unemployment and private sector debt, also sets a pessimist tone on the optimality of the monetary union, whereby monetary policy at the national level is absent.

The remainder of the paper is structured as follows. Section (3.2) describes the model environment by synthesizing the work on labor market and financial frictions. Section (3.3) in turn proposes a mechanism for the propagation of a financial shock through the economy and performs a quantitative analysis of the model to analyze the effects of fiscal policy in this setting. Finally, section (3.4) concludes.

3.2 Model

The purpose of this section is to describe the main elements of the model, and in particular how the different crisis shocks endogenously generate distortions in labor and financial markets. As such, in what follows we abstract from a fiscal policy block, and only introduce this in Section (3.3.3).

The model features a small open economy populated by a representative household that consumes an aggregate basket (C_t) of tradable goods $\left(c_t^T\right)$ and non-tradable goods $\left(c_t^N\right)$. The tradable good is endowed, whereas the non-tradable good is produced using labor (N_t). Labor is ineslatically supplied by workers to firms operating in a perfectly competitive non-tradable goods market in return for a real wage (w_t). The nominal wage (W_t) however is assumed to be downwardly rigid. The household can also borrow/lend from international credit markets by selling/purchasing one-period non-contingent debt (d_t) subject to an endogenous limit, which links the volume of debt to the value of collateralizable income from both the tradable and the non-tradable sectors. The real interest rate (R_t) on debt is exogenously given and stochastic. Aggregate fluctuations in the economy are driven by stochastic movements in the value of the tradable good (y_t) , the real interest rate (R_t) and in the tightness of the collateral constraint.

3.2.1 Households

Households have preferences over a consumption basket (C_t), which comprises of tradable consumption $\left(c_t^T\right)$ and non-tradable consumption $\left(c_t^N\right)$. Preferences of the representative household are given by the period utility function

$$E_0 \sum_{t=0}^{\infty} \beta_t \frac{C_t^{1-\sigma} - 1}{1-\sigma} \tag{3.2.1}$$

where E_0 denotes the expectations operator conditional upon information known at time t. The parameters $0 < \beta < 1$ and σ denote the subjective discount factor and the inverse of the intertemporal elasticity of consumption respectively.

Tradable c_t^T and non-tradable consumption c_t^N is aggregated using the CES function

$$C_t = A\left(c_t^T, c_t^N\right) = \left[\eta\left(c_t^T\right) + (1-\eta)\left(c_t^N\right)^{\frac{\zeta-1}{\zeta}}\right]^{\frac{\zeta}{\zeta-1}} \tag{3.2.2}$$

where the parameter ζ measures the elasticity of intratemporal substitution between the two consumption goods, and η denotes the relative weight of the tradable consumption good in the basket. Consequently, the aggregate price index is given by

$$P_t = \left[\eta^{\zeta} P_t^{T^{1-\zeta}} + (1-\eta)^{\zeta} P_t^{N^{1-\zeta}}\right]^{\frac{1}{1-\zeta}} \tag{3.2.3}$$

In each period, the representative household is endowed with y_t^T units of the tradable good and one unit of labor. It inelastically supplies labor N_t to the labor market in return for the real wage w_t. Furthermore, it also has the possibility to borrow from financial markets in the form of a one-period non-state-contingent bond by assuming debt d_t denominated in tradable goods. Notably, if $d_t > 0$ the household is a net borrower. Debt faces a household-specific real interest rate R_t, which is exogenously determined. The budget constraint is denominated in units of the tradable good and is given by

$$c_t^T + p_t c_t^N + d_t = d_{t-1}R_{t-1} + y_t^T + w_t N_t + \Pi_t^N \tag{3.2.4}$$

where expenditures consist of real consumption of tradable goods $\left(c_t^T\right)$, real consumption of non-tradable goods $\left(c_t^N\right)$ and real debt d_t. Revenues of the household include real wage income $w_t N_t$, the endowment of the tradable good y_t^T, the real return on debt $d_{t-1}R_{t-1}$, as well as real profits from ownership of the nontradable firms Π_t^N. $p_t \equiv \frac{P_t^N}{P_t^T}$ corresponds to the price of nontradable goods in terms of tradables, and is labelled as the real exchange rate.

Debt issued by the household is subject to an endogenous collateral constraint, which binds in some periods but not all. This is the specification of the financial friction in the model. The constraint depends on current profits and wage income, both influenced by the stochastic realizations in the economy and the wage rigidity imposed. Although debt is denominated in units of tradables, the collateral side consists of income from both the tradable and nontradable sectors, thus capturing the effects of liability dollarization. We assume that it is imposed from the side of external lenders and the motivation for its structure rests on the assumption that debt repayment cannot be perfectly enforced. Households may decide to not honor their debt repayments in every period, in which case with a stochastic time-varying probability κ_t the collateralized assets would be seized and liquidated by lenders. Variation in this probability corresponds to a financial shock in the model, inducing a tightening of the borrowing constraint.[2] This specification of the collateral constraint was first introduced by Mendoza (2002), to study the effects of currency mismatch on external credit-market access. Notably, the constraint generates a pecuniary externality, which arises from the fact that individual agents fail to internalize the aggregate impact of their borrowing decisions on the relative price of non-tradable goods. This in turn affects the value of collateral. Its form is given by

$$d_t \leq \kappa_t \left(y_t^T + w_t N_t + \Pi_t^N \right) \tag{3.2.5}$$

To close the model and determine private debt we follow Schmitt-Grohe and Uribe (2012) and specify an exogenously given real interest rate, which we assume it follows an AR(1) process

$$R_t = \rho_r R_{t-1} + \varepsilon_t^r \tag{3.2.6}$$

Note that an alternative specification of the interest rate could allow it to be elastic in the volume of debt that the household assumes. Shocks to real interest rate represent a sudden increase in risk premia from the perspective of households, thus incentivizing a deleveraging.

In turn, the endowment of the tradable good y_t^T is assumed to be stochastic and follow

[2]For further details on the renegotiation process from which the borrowing constraint arises see: Jermann and Quadrini (2012), or Korinek (2011) among others.

the AR(1) process

$$y_t^T = \rho_y y_{t-1}^T + \varepsilon_t^y \tag{3.2.7}$$

Variations to the tradable endowment y_t^T correspond to shocks to the terms of trade , or in an alternative interpretation, to productivity. Notably, introducing a tradable sector in production, where households provide labor to tradable firms in return for wage income and profits would be an equivalent specification. Shocks to the tradable sector's productivity could then drive aggregate fluctuations.

Finally, a no-Ponzi game condition is also imposed

$$d_t \leq \bar{d} \tag{3.2.8}$$

and following Aiyagari (1994) specified as a natural debt limit $\bar{d} = \frac{\bar{R}}{\bar{R}-1}\underline{y}^T$, where $\underline{y}^T$ corresponds to the lowest possible realization of the tradable endowment shock, and $\bar{R}$ to the highest possible realization of the interest rate shock. The limit determines the maximum amount of debt the household can repay almost surely for any shock realization and assuming that it never consumes any tradable goods ($c_t^T = 0, \text{ for all } t$).

Household First Order Conditions

Households choose state-contingent plans $\left\{c_t^T, c_t^N, d_t\right\}$ to maximize (3.2.1) subject to (3.2.2), (3.2.4), (3.2.5), and (3.2.8). If λ_t, μ_t and η_t are the Lagrange multipliers on equations (3.2.4), (3.2.5) and (3.2.8) respectively then the optimality conditions are given by

$$c_t^T : \quad \eta \left(C_t\right)^{-\frac{\sigma}{\zeta-1}} \left(c_t^T\right)^{-\frac{1}{\zeta}} = \lambda_t \tag{3.2.9}$$

$$c_t^N : \quad (1-\eta) \left(C_t\right)^{-\frac{\sigma}{\zeta-1}} \left(c_t^N\right)^{-\frac{1}{\zeta}} = p_t \lambda_t \tag{3.2.10}$$

$$d_t : \quad \lambda_t = \beta E_t \lambda_{t+1} R_t + \mu_t + \eta_t \tag{3.2.11}$$

along with the complementary slackness conditions

$$\mu_t \left(\kappa_t \left(y_t^T + w_t N_t + \Pi_t^N \right) - d_t \right) = 0 \tag{3.2.12}$$

$$\eta_t \left(\bar{d} - d_t \right) = 0 \tag{3.2.13}$$

Three remarks are in order. First, note that by substituting equation (3.2.9) inside (3.2.10) we can derive the relative consumption of nontradable goods to tradable goods

$$p_t = \left(\frac{1-\eta}{\eta} \right) \left(\frac{c_t^N}{c_t^T} \right)^{\frac{-1}{\zeta}}$$

, which can also be interpreted as the demand schedule for nontradables. Second, recall that labor is inelastically supplied and hence no optimization over labor supply is undertaken by the household. As will be shown further below, labor is exogenously determined in the model and implied by the pricing equation for wages. Because of the presence of downwardly rigid nominal wages the labor market will in general not clear (during contractions) and instead involuntary unemployment equal to $\bar{n} - N_t$ will arise. Further explanations are provided in the description of the labor market below. Third, note that if $\sigma = \frac{1}{\zeta}$ then utility becomes additively separable in the consumption of tradables and nontradables. Thus, the marginal utility of one type of consumption does not depend on the marginal utility of the other, implying that the activity in the non-tradable sector does not affect the activity in the tradable sector.

3.2.2 Firms

Nontradable goods in the economy are produced by firms using hired labor from households

$$Y_t^N = F(N_t) = \delta N_t^{\xi} \tag{3.2.14}$$

Nontradable production is assumed to be an increasing and concave function of labor, in order to capture diminishing marginal returns, where $\xi, \delta > 0$. The parameter δ helps prevent negative realizations of nontradable consumption c_t^N when government spending is introduced in the model (and assumed to consume a share of the non-tradable consumption good).

Profits of the firm are in turn given by

$$\Pi_t^N = p_t Y_t^N - w_t N_t \tag{3.2.15}$$

Firm First Order Conditions

Firms produce Y_t^N by choosing N_t to maximize (3.2.15) given prices p_t and w_t

$$w_t = \delta \xi p_t N_t^{\xi-1} \tag{3.2.16}$$

leading to the determination of the real wage. Re-arranging equation (3.2.16) leads to

$$p_t = \frac{w_t}{\xi N_t^{\xi-1}}$$

which corresponds to the supply schedule of nontradables.

3.2.3 Labor Market

An important feature of the model is the assumption of downwardly nominal rigid wages. We follow Schmitt-Grohe and Uribe (2012) and assume that the present nominal wage W_t has to be a fraction γ greater than nominal wage in the previous period W_{t-1}.

$$W_t \geq \gamma W_{t-1} \tag{3.2.17}$$

For $\gamma \geq 1$ current wages are absolutely downwardly rigid, and for $\gamma = 0$ they are perfectly flexible. In turn, for values of $0 < \gamma < 1$ then the current wage adjusts sluggishly at the rate $(1 - \gamma)$. Assuming the law of one price holds for tradables, $P_t^T = P_t^{T*} E_t$ where E_t is the nominal exchange rate and letting $P_t^{T*} = 1$ we can write the real wage in terms of tradables as

$$w_t = \frac{W_t}{E_t}$$

and by substituting into equation (3.2.17) we obtain

$$w_t \geq \gamma \frac{w_{t-1}}{\epsilon_t}$$

Here, $\epsilon_t \equiv \frac{E_t}{E_{t-1}}$ defines the gross devaluation rate of the nominal exchange rate and is exogenously given. We retain the assumption that the economy described is part of a currency union and has no independent exchange rate authority. This implies that the gross devaluation rate is constant and hence $\epsilon_t = 1$. The latter result can be understood as a currency peg. interstingly, the combination of the two nominal rigidities (downwardly nominal rigid wages and a constant devaluation rate) gives rise to real wages becoming donwardly rigid.

Furthermore, in order to guarantee uniqueness of the equilibrium we impose the following constraint on hours worked

$$N_t \leq \bar{n}$$

, which states that labor (inelastically) supplied to the market N_t may not exceed an exogenously given limit. $\bar{n}$ can be viewed as the maximum number of hours worked and is set in the calibration to be equal to the full employment level ($\bar{n} = 1$). The constraint on hours also implies that demand for labor cannot exceed supply in the labor market. Furthermore, from a theoretical perspective, the constraint becomes necessary as without it an infinite number of solutions can arise when the wage constraint (3.2.17) is non-binding.

Finally, the combination of the constraint on hours with downwardly nominal real wages implies that at any point in time wages and labor demanded must satisfy the following slackness condition

$$(\bar{n} - N_t)\left(w_t - \gamma\frac{w_{t-1}}{\epsilon_t}\right) = 0 \tag{3.2.18}$$

The condition states that periods where the wage constraint is binding, must be accompanied by unemployment ($n_t < \bar{n}$). Typically, as will be explained below this will occur during recessions, whereby the real wage cannot fall to clear the labor market. In contrast, when the wage constraint is not binding, the economy must be in full employment ($\bar{n} = N_t$).

3.2.4 Market Clearing

Market clearing for the nontradable sector is given by

$$F(N_t) = y_t^N = c_t^N \tag{3.2.19}$$

Finally, the current account (CA_t) is obtained by substituting firms' profits (3.2.15) and the market clearing condition for nontradables (3.2.19) into the household's budget constraint (3.2.4)

$$CA_t \equiv y_t^T - c_t^T - d_t + d_{t-1}R_{t-1} \tag{3.2.20}$$

3.2.5 General Equilibrium

Here we provide a definition for the general equilibrium of the economy. Given an exchange rate policy $\epsilon_t = 1$, initial values for the exogenous states $s_0^x = (y_0, E_0, \kappa_0)$ and endogenous states $s_0^e = (d_0, w_{-1})$, equations (3.2.2), (3.2.4), (3.2.9), (3.2.10), (3.2.11), (3.2.12), (3.2.13), (3.2.14), (3.2.15), (3.2.16), (3.2.18), and (3.2.19) comprise an equilibrium in the variables:

$\left\{C_t, c_t^T, c_t^N, p_t, d_t, N_t, y_t^N, w_t, \Pi_t^N, , \lambda_t, \mu_t, \eta_t\right\}$

(3.2.2) : $\quad C = A\left(c_t^T, c_t^N\right) = \left[\alpha\left(c_t^T\right)^{\frac{\zeta-1}{\zeta}} + (1-\alpha)\left(c_t^N\right)^{\frac{\zeta-1}{\zeta}}\right]^{\frac{\zeta}{\zeta-1}}$

(3.2.4) : $\quad c_t^T + p_t c_t^N + d_t = d_{t-1}R_{t-1} + y_t^T + w_t N_t + \Pi_t^N$

(3.2.9) : $\quad \eta\left(C_t\right)^{-\frac{\sigma}{\zeta-1}}\left(c_t^T\right)^{-\frac{1}{\zeta}} = \lambda_t$

(3.2.10) : $\quad (1-\eta)\left(C_t\right)^{-\frac{\sigma}{\zeta-1}}\left(c_t^N\right)^{-\frac{1}{\zeta}} = p_t\lambda_t$

(3.2.11) : $\quad \lambda_t = \beta\left(R_t\right)E_t\lambda_{t+1} + \mu_t + \eta_t$

(3.2.12) : $\quad \mu_t\left(\kappa_t\left(y_t^T + w_t N_t + \Pi_t^N\right) - d_t\right) = 0$

(3.2.13) : $\quad \eta_t\left(\bar{d} - d_t\right) = 0$

(3.2.14) : $\quad Y_t^N = \delta N_t^{\xi}$

(3.2.15) : $\quad \Pi_t^N = p_t Y_t^N - w_t N_t$

(3.2.16) : $\quad w_t = \delta\xi p_t N_t^{\xi-1}$

(3.2.18) : $\quad (\bar{n} - N_t)\left(w_t - \gamma\frac{w_{t-1}}{\epsilon_t}\right) = 0$

(3.2.19) : $\quad Y_t^N = c_t^N$

3.3 Quantitative Analysis

This section undertakes a quantitative analysis of the model in order to illustrate the basic mechanisms. It does so by studying the response of the economy to external shocks that mimic the effects of the financial crisis of 2008 in the Eurozone periphery. As such we proceed by simulating three scenarios. The first consists of a negative shock to the tradable endowment y_t^T. This case can be interpreted as a collapse in the domestic production of tradable goods, or a shock to the terms of trade, arising from external factors. The second case consists of a positive shock to the real interest rate faced by households R_t. The increase in the real interest rate can be viewed as an increase in risk premia, resulting in reduced international capital mobility. The third scenario consists of a shock to the collateral constraint of households and the borrowing limit κ_t, inducing a tightening of borrowing constraints. This has been frequently referred to as a financial shock in the financial frictions literature (see e.g. Jermann and Quadrini, 2012).

3.3.1 Parameterisation and Numerical Solution

The parameters for the quantitative analysis can be seen in Table (3.1). They have been illustratively set to standard values in the literature (see e.g. Schmitt-Grohe and Uribe (2012)), who calibrate a similar environment to Argentina. The shock processes are also assumed to share a common parameterisation.

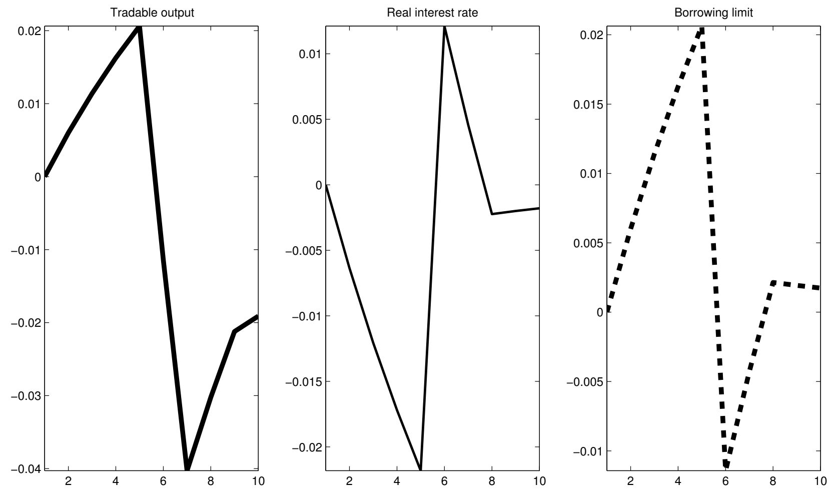
Since the model features two sources of nonlinearities, namely the endogenously binding collateral constraint and asymmetric wage rigidity, a linear analytical closed-form solution cannot be obtained. We proceed to numerically solve the model using the piecewise linear algorithm proposed by Guerrieri and Iacoviello (2015). Applied to the

Table 3.1: Parameter Values

Parameter	Label	Value
σ	Risk aversion	2
ζ	Intratemporal elasticity of substitution between T and NT	0.45
η	Share of Tradables	0.3
β	Discount factor	0.945
ξ	Labor share in NT sector	0.75
γ	Degree of wage rigidity	0.997
$\bar{n}$	Labor endowment	1
Shock processes		
ρ_y, ρ_r, ρ_k	Autocorrelation coefficients	0.9
$\sigma_y, \sigma_r, \sigma_k$	Standard deviation	0.05

current setting, the main novelty behind this solution method invokes the fact that the model can be characterized by at most four regimes: two where the collateral constraint is binding and the wage constraint is binding or slack, and another two where the collateral constraint is slack and the wage constraint is binding or slack. In the (non-stochastic) steady-state the collateral constraint is binding, but the wage constraint is slack guaranteeing full employment. In this way, the model can accommodate values of the wage rigidity parameter γ, which are different from 1. Whenever a shock hits the economy leading the collateral constraint to become slack (or the wage constraint to bind), then there is a regime shift. However, in the long run, the solution is expected to revert to the (non-stochastic) steady state regime. Moreover, within a given regime the solution is linear, which gives rise to in total four different linear policy rules, one for each regime. Within a given regime, policy rules are computed using a first-order approximation. Guerrieri and Iacoviello (2015) show that this approach compares accurately to a global solution method such as value function iteration, and saves on computational time.

Figure 3.3.1: Dynamics of a Crisis



3.3.2 Different Sources of a Crisis

To characterize the behavior of the model under the three crisis environments, for each type of shock we simulate a path, which generates a mild boom followed by an extraordinary contraction in total output. In each scenario, the source for the boom and eventual bust in output will be different. More specifically, we define this cycle as a situation where either three of the following cases hold: i) tradable output is increasing by one standard deviation for two periods, and then contracts sharply by one standard deviation for four periods, ii) the real interest rate decreases by one standard deviation for two periods, and then increases by one standard deviation for four periods, iii) the borrowing limit relaxes by one standard deviation for two periods, and then abruptly tightens by one standard deviation for four periods. The resulting shocks, which we feed into the model can be seen in Figure (3.3.1).

For each shock, we then analyze the unconditional behavior of the model by assuming that the other two remain at their steady-state levels. We relax this assumption in

Section (3.3.4). Figure (3.4.1) plots the impulse responses following a shock, which induces a drop in tradable output (solid black line), an increase in the real interest rate (red line), and a tightening of the collateral constraint of households (dotted black line). Overall, we see that despite the heterogeneous source of the crisis shock, the effects on the variables of the economy are similar.

The crisis induces a moderate deleveraging, whereby households cut down on their private debt. Since the real interest rate remains unchanged (or is exogenously set to increase), the economy is forced to improve its current account by reducing total consumption or increasing the production of the nontradable good. Given that the income effect dominates, there is an increase in the desire to save from the part of the households and a fall in a desire to consume. In addition, given that nominal wages are downwardly rigid and cannot adjust to a lower level on impact, the only way such a deflation could come about would be through a nominal exchange rate depreciation. However, this is prevented since the economy is operating under a fixed exchange rate. As a result, the improvement in the current account can only come about by a reduction in the consumption of the nontradable good. The drop in the consumption of the nontradable good in turn should generate a real exchange rate depreciation but since the nominal exchange rate is fixed, under a terms of trade shock this translates to a fall in the price of nontradables. Given the fixed nominal wages, employing further labor into the nontradable sector thus becomes less profitable and firms are pushed to reduce their labor demand and lower their production of the nontradable good. Although labor demand declines, at the same time the supply schedule does not shift. This is because the combination of a currency peg and downward rigidity of nominal wages prevents the real wage from adjusting downward. At this point, firms are on their labor demand schedule, but households are off their labor supply schedule generating unemployment. The fall in labor demand translates to an increase in unemployment in disequilibrium and the fall in the production of the nontradable goods leads to a recession in the economy.

As we have seen, crisis shocks lead to the two distortions to move hand in hand, thereby generating the stylized fact presented in Figure (3.1.1). Unemployment increases and household debt-to-GDP ratios do not fall as sharply, given the negative growth rate of output.

3.3.3 Introducing Active Fiscal Policy

In what follows, we augment the model to study the effects of active fiscal policy in mitigating, or offsetting the two distortions generated by the crisis shocks. We view this application as an exercise in financial crisis management. In order to allow fiscal policy to have a meaningful role in the environment, we introduce a government that can issue debt to households and raise distortionary taxes to finance its expenditures in consumption and productive investment. Furthermore, we stipulate that the fiscal instruments respond to changes in deviations of the government debt-to-GDP ratio from a stochastic target in the spirit of Erceg and Linde (2013). In order to connect the fiscal block with the labor market we also assume that a share of the nontradable good is used by the government for both consumption and investment. In this way, fiscal shocks will be able to propagate themselves through the nontradable production sector to affect labor supply and demand decisions. The changes we make to the model can be summarized as follows:

1. Introduction of government debt. Households can now purchase one-period non-contingent bonds d_t^g from the government paying an interest rate R_t^g.

2. The government can raise revenues from distortionary taxes on households' private debt (a capital control) and through lump-sum taxes.

3. The government uses the revenues from taxation and the issuance of debt to finance (wasteful) consumption and productive investment. The latter complements labor supply as an input of production in the nontradable sector.

4. The nontradable good is in part consumed by the government, and used for investment purposes.

5. Fiscal policy instruments are exogenously given and have a rule-based stabilizing role.

With these additions to the model, the equations that change are the following:

$$c_t^T + p_t c_t^N + d_t\left(1-\tau_t^d\right) + d_t^g = d_{t-1}^g R_{t-1}^g + d_{t-1}R_{t-1} + y_t^T + w_t N_t + \Pi_t^N - T_t \quad (3.3.1)$$

$$\lambda_t\left(1-\tau_t^d\right) = \beta\left(R_t^f\right) E_t\lambda_{t+1} + \mu_t + \eta_t \quad (3.3.2)$$

$$p_t\left(G_t + i_t\right) = d_t^g + d_{t-1}^g R_{t-1}^g + \tau_t^d d_t + T_t \quad (3.3.3)$$

$$Y_t^N = F\left(N_t\right) = \delta N_t^{\xi}\left(K_{t+1}^g\right)^{\psi} \quad (3.3.4)$$

$$K_{t+1} = \left(1-\delta^g\right) K_t + i_t \quad (3.3.5)$$

$$F\left(N_t\right) = y_t^N = c_t^N + G_t + i_t \quad (3.3.6)$$

$$w_t = \delta\xi p_t N_t^{\xi-1}\left(K_{t+1}^g\right) \quad (3.3.7)$$

Equation (3.3.1) is the new household budget constraint whereby households now also have the ability to purchase/sell one-period non-contingent bonds from to the government (d_t^g) at an interest rate R_t^g. Private debt (d_t) is now taxed by the government at rate τ_t^d, alluding to a capital control tax. We do not allow for labor income taxation as labor is inelastically supplied. Households are also subject to a non-distortionary lump-sum tax T_t (transfer if $T_t > 0$). Equation (3.3.2) is thus the redefined Euler equation of households for private debt, which is now taxed at rate τ_t^d.

Equation (3.3.3) specifies the government budget constraint, whereby government expenditures consist of consumption (G_t) and investment (i_t) of the nontradable good (y_t^N). The nontradable good is now produced jointly with household labor (N_t) by investing in public capital K_t. We assume that labor and public capital are aggregated using the technology in (3.3.4). The law of motion for public capital is given by equation (3.3.5). (3.3.6) thus defines the new market clearing condition for the nontradable sector. Nontradable firms produce Y_t^N by choosing N_t but the introduction of public capital, will now also affect the price for labor demanded (equation (3.3.7)).

In addition, due to the introduction of government debt to the model, two new equations arise:

$$\lambda_t = \beta \left(R_t^g \right) E_t \lambda_{t+1} \tag{3.3.8}$$

$$T_t = \chi \left(\frac{d_t^g}{GDP_t} \right)^{\phi} \tag{3.3.9}$$

Equation (3.3.8) is the households' Euler equation for government assets, whilst equation (3.3.9) is a tax rule targeting the government debt-to-GDP, ratio and required to close the model.

Finally, following Erceg and Linde (2013), we assume that fiscal consolidations and expansions are undertaken through changes of the fiscal instruments $\Psi \in \left\{G, i, \tau^d\right\}$ in the following way

$$\Psi_t = \rho_{\Psi 0} \Psi_{t-1} + (1 - \rho_{\Psi 0}) \left(\frac{d_t^g}{GDP_t} - \frac{d_t^g}{GDP_t}^* \right)$$

where $\frac{d_t^g}{GDP_t}^*$ is an exogenous stochastic target for the government debt-to-GDP ratio, and which follows an AR(1) process given by

$$\frac{d_t^g}{GDP_t}^* = \rho_{dg} \frac{d_{t-1}^g}{GDP_{t-1}}^* + \varepsilon_t^{dg} \tag{3.3.10}$$

where $\rho_{\psi_0} \geq 0$ and $\rho_{dg} < 1$. For the instruments G_t and i_t^g, positive (negative) shocks to the government debt-to-GDP target will generate a fiscal consolidation (expansion). The rest of the model equations remain as they are.

3.3.4 Financial Crisis Management

We are primarily interested in investigating how the two distortions implied by the crisis react in response to fiscal shocks. For this reason, we are prevented from analyzing the effects of fiscal shocks in the steady state. Instead, we resort to calculating the marginal effects of fiscal policy by dictating a transition from a boom-type regime to a bust-type regime throughout the whole impulse response horizon. We do so in the following way. First, we specify a joint path for the three crisis shocks that lead total output to expand by one standard deviation for two periods and subsequently contract for four periods. In the remaining horizon, we allow these shocks to decay at the rate specified by their autoregressive coefficients. We then record the responses of the variables in this horizon. By observing the responses of unemployment and the Lagrange multiplier on the collateral constraint we can guarantee that the combined shocks led to a transition in regimes. Second, we record the same set of responses adding to the crisis shocks an additional one-time fiscal shock (governed by equation (3.3.10)) in the period in which the growth rate of output turns negative. Third, we compute the difference between the second and the first step to obtain the effects of the marginal response of the fiscal shock. Given that we choose to insert the fiscal shock on the period of transition from a regime with binding collateral constraints and no unemployment to a regime with slack collateral constraint and positive unemployment, we can adequately study the effects of fiscal policy in influencing the distortions.

The parameters for the augmented model can be seen in Table (3.2). As can be seen we assume a common parameterisation for the exogenous determination of the fiscal instruments.

Table 3.2: Parameter Values for Model with Fiscal Policy

Parameter	Label	Value
σ	Risk aversion	2
ζ	Intratemportal elasticity of substitution between T and NT	0.45
η	Share of tradables	0.3
β	Discount factor	0.945
ξ	Labor share in NT sector	0.75
γ	Degree of wage rigidity	0.997
$\bar{n}$	Labor endowment	1
χ	Tax rule (multiplicative term)	0.5
ϕ	Tax rule (exponent)	0.6
ψ	Public capital share	0.25
δ^g	Depreciation rate of public capital	0.025
ρ_{dg}	Autocorrelation coefficient for debt-to-GDP target	0.7
ρ_{Ψ_0}	Share of fiscal instrument response	0.8

Impulse Response Functions

A fiscal consolidation in this setting is interpreted as a decrease in government consumption, following the deviation of the government debt-to-GDP ratio from the stochastic target. The impulse response functions following a triggered fiscal consolidation can be seen in Figures (3.4.2). A decrease in government expenditures acts as a negative demand shock and can be interpreted as the negative terms of trade shock mentioned before. The key difference however is the stronger decline in private debt, which arises due to the fact that consumption is crowded out on impact. Although a negative government spending shock incentivizes savings (correcting for the first distortion and the slow deleveraging process observed in the crisis), this comes at a cost of high unemployment. On the other hand, following a positive government spending shock (Figure 3.4.3) we see that unemployment is reduced, at the cost of an increase in private debt. In conclusion, a government spending policy alone (regardless of the direction) cannot affect the combination of distortions that arise due to the crisis. Figure (3.4.4) plots impulse response functions following a positive government investment shock. Again, we observe that the debt-unemployment trade-off is present. The difference with the government spending shock is that now an increase in government investment raises unemployment, rather than decrease it. The reason is due to the fact that investment requires resources from the nontradable production sector, and given the assumed technology for production it displaces private labor. Finally, Figure (3.4.5) plots the impulse responses from a shock that increases the capital control tax (negative shock). This clearly incentivizes a deleveraging, but at the cost of an increase in unemployment.

Qualitative Results

The impulse responses presented above only illustrate the marginal effect of the fiscal shocks in the environment (recall that crisis shocks are active throughout the horizon). In turn, Figures (3.4.6), (3.4.7), and (3.4.8) present a comparison between a baseline case with only crisis shocks active (black lines) and a case where both the crisis shocks and the fiscal policy shocks are active. This is purely done for illustrative reasons, and as such we increase the size of the fiscal shocks to 10% of GDP in order to gain a visual understanding of the effects. The main message, which comes across is that there does not exist a specific fiscal shock, which can undo both distortions at the same time. That is, reduce debt and unemployment simultaneously.

Welfare Multipliers

Since no fiscal instrument can offset both distortions simultaneously we attempt to gauge the effects of fiscal policy in this setting by reporting welfare multipliers. Following Sims and Wolff (2013) we define the welfare multiplier as the ratio of the response of welfare, to the response of the fiscal shock on impact. Welfare is given by the value function of the household (V_t) specified in a recursive form

$$V_t = U\left(C_t\right) + \beta E_t V_{t+1}$$

In order to render the units of welfare into an interpretable measure we scale the ratio of the response of welfare to the response of the fiscal shock by dividing by the steady state marginal utility of consumption $\left(U'\left(\bar{C}_t\right)\right)$. In this way, the welfare multiplier corresponds to the one period consumption equivalent change in welfare for a one unit change in the fiscal instrument under consideration.

$$M^W = \frac{\partial V_t}{\partial \Psi_t}\left(\frac{1}{U'\left(\bar{C}_t\right)}\right)$$

We report welfare multipliers in Table (3.3). These can be interpreted as the units of steady state consumption in the period of the shock that would cause an equivalent change in welfare to the fiscal shock. For example, the change in welfare from a decrease in government spending is equivalent to an increase in consumption of 0.14. As can be seen, the negative government investment shock produces the largest welfare gains, measurable in these terms.

Table 3.3: Welfare Multipliers

Instrument	Direction of shock	Welfare multiplier
Government spending	Positive shock	4.51
	Negative shock	0.14
Government investment	Positive shock	4.70
	Negative shock	5.61
Capital control tax	Positive shock	-2.56
	Negative shock	-5.89

3.4 Conclusion

This paper has analyzed the effects of fiscal policy in a crisis environment where the joint interaction of labor market and financial frictions give rise to unemployment and an increasing private sector debt level. It has shown that following three types of crisis shocks, the economy is pushed to tighten borrowing constraints for households and via the real exchange rate this distortion is propagated to the labor market. Active financial crisis management from the side of fiscal policy fails to correct both of these distortions simultaneously leaving it toothless in the face of a debt-unemployment trade-off.

On the policy front, and given an agenda for tackling unemployment and promoting debt deleveraging, the analysis suggests that there is no correct side to the debate on austerity against stimulus of an economy. Certain specifications of fiscal consolidations can incentivize debt deleveraging, but at the cost of accompanied unemployment. On the other hand, certain types of fiscal expansions lead to opposite results. In terms of welfare multipliers, the model predicts that a negative shock to government investment produces the most beneficial effects, despite the distortions it leaves uncorrected. Thus, in a setting, which is reminiscent of the current environment in the Eurozone, there is no one correct policy prescription to combat the effects of financial crisis shocks.

Possible extensions to the investigation could be made on the following dimensions. The analysis so far has been implemented under unconditional fiscal shocks. That is, when one instrument is active, the rest are assumed to be switched off. A mixed strategy whereby more tha one instruments move in the same, or opposite direction could potentially affect both distortions in a corrective manner. Furthermore, it would be of interest to incorporate an empirical component into the analysis, by studying the effect of regime-dependent fiscal shocks on unemployment, private debt, private consumption and the real exchange rate using vector auto-regressions. Finally, although this has deliberately been omitted from the scope of this paper, it would be important to characterize the optimal policy (in terms of distortionary taxes) that can offset the wedges that arise from the the pecuniary externality and the nominal rigidity.

Appendix

Figure 3.4.1: Dynamics of a Crisis

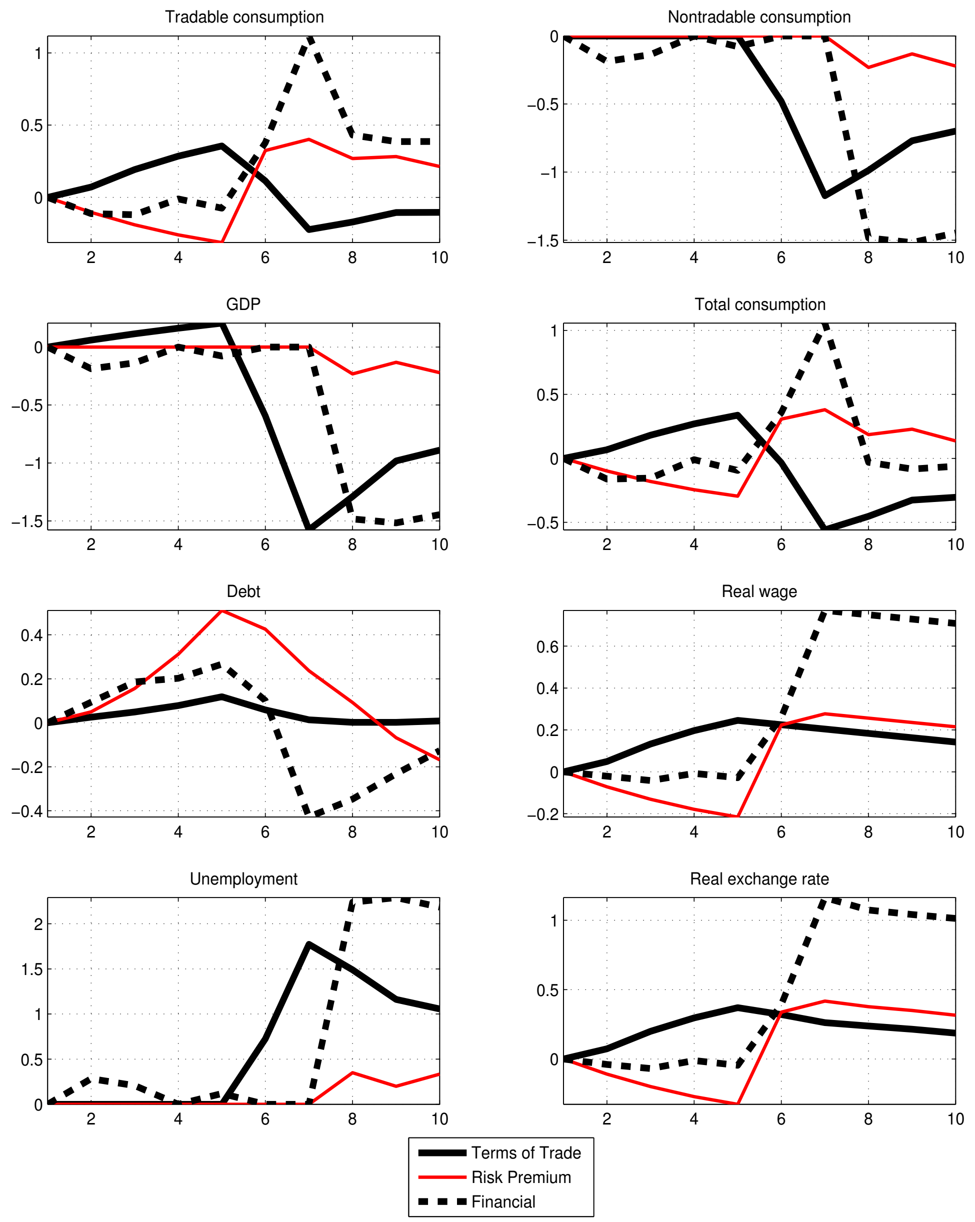


Figure 3.4.2: IRFs following a Negative Government Spending Shock

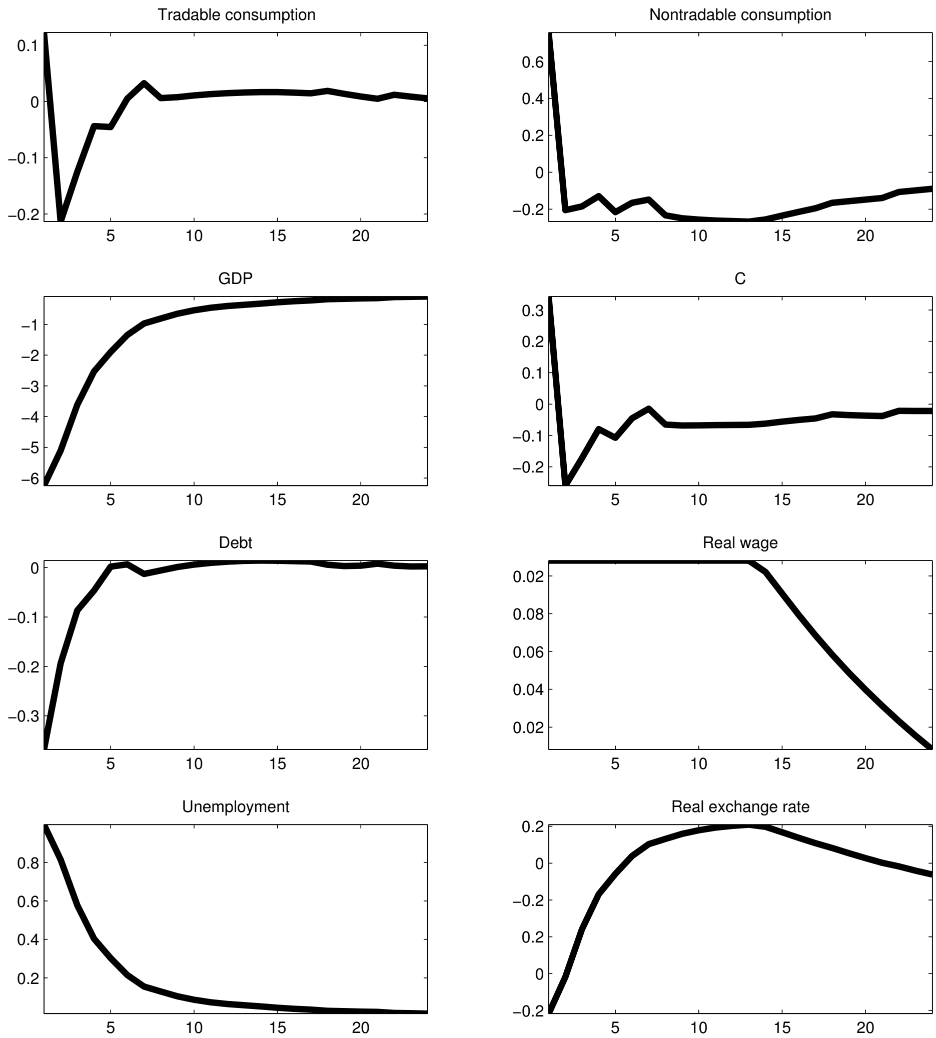


Figure 3.4.3: IRFs following a Positive Government Spending Shock

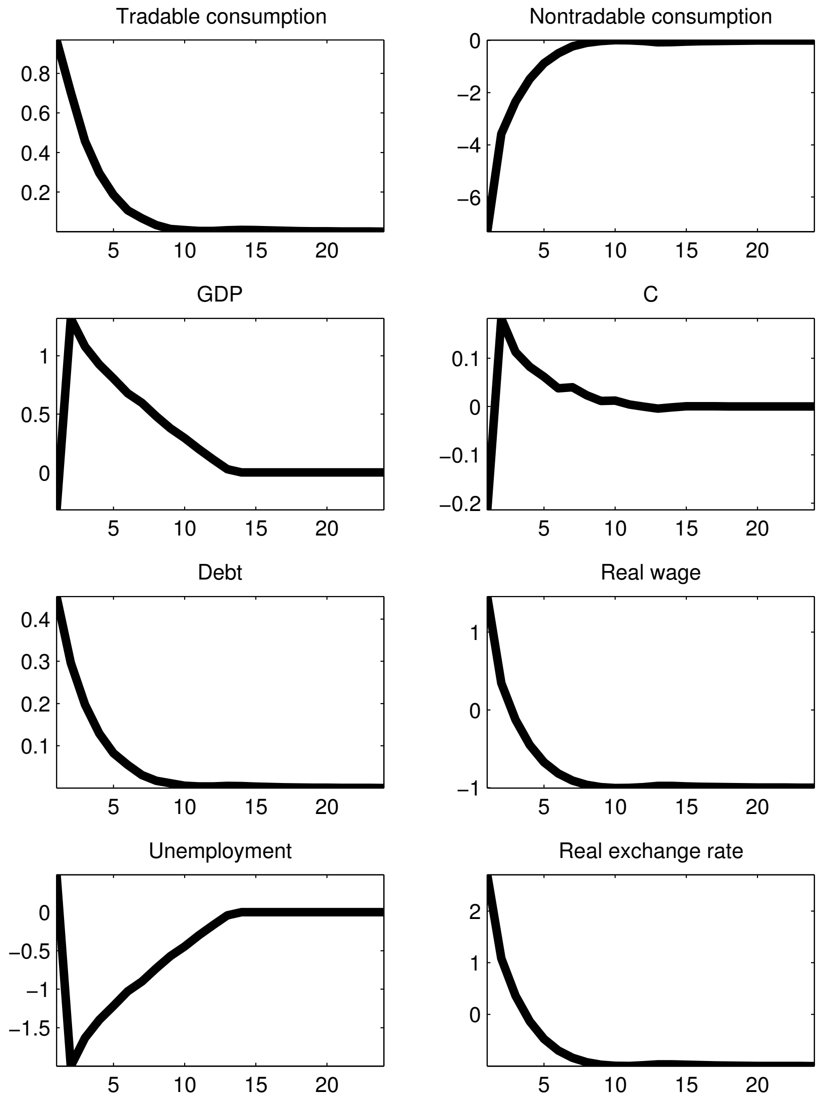


Figure 3.4.4: IRFs following a Positive Government Investment Shock

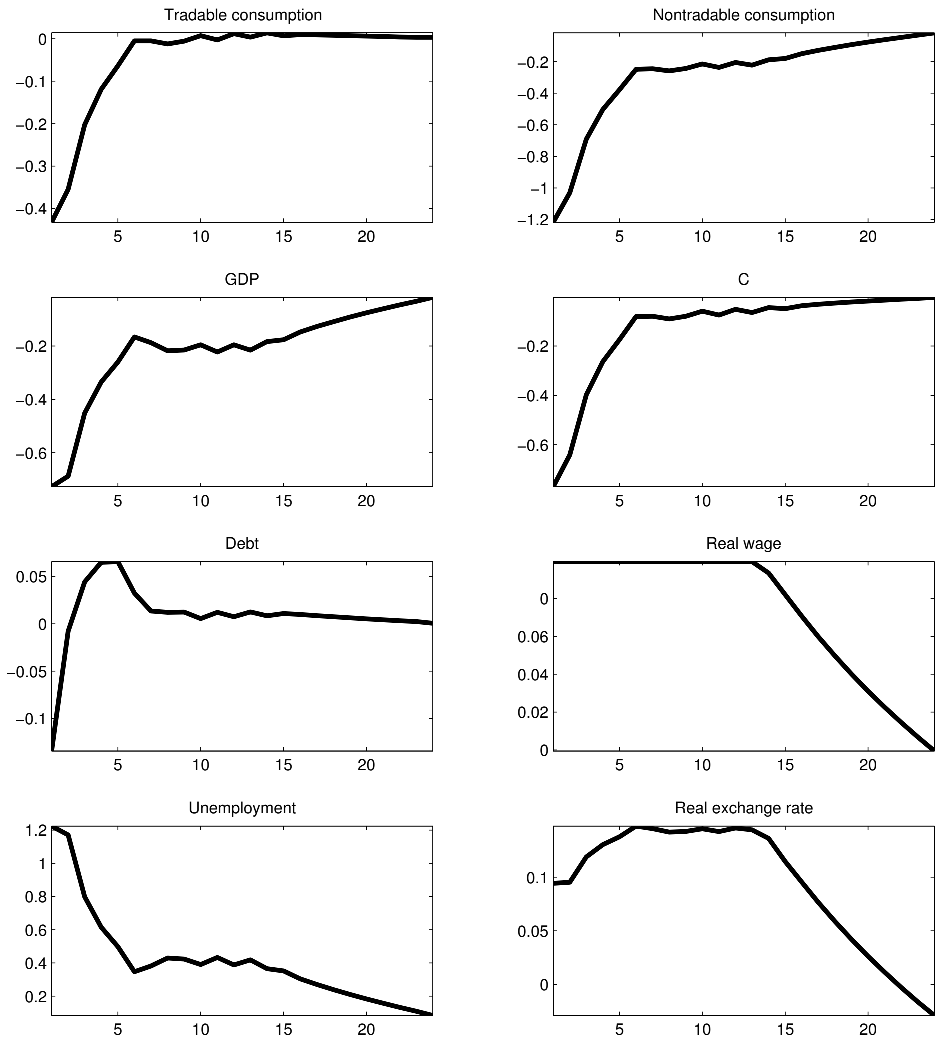


Figure 3.4.5: IRFs following a Negative Capital Control Tax Shock

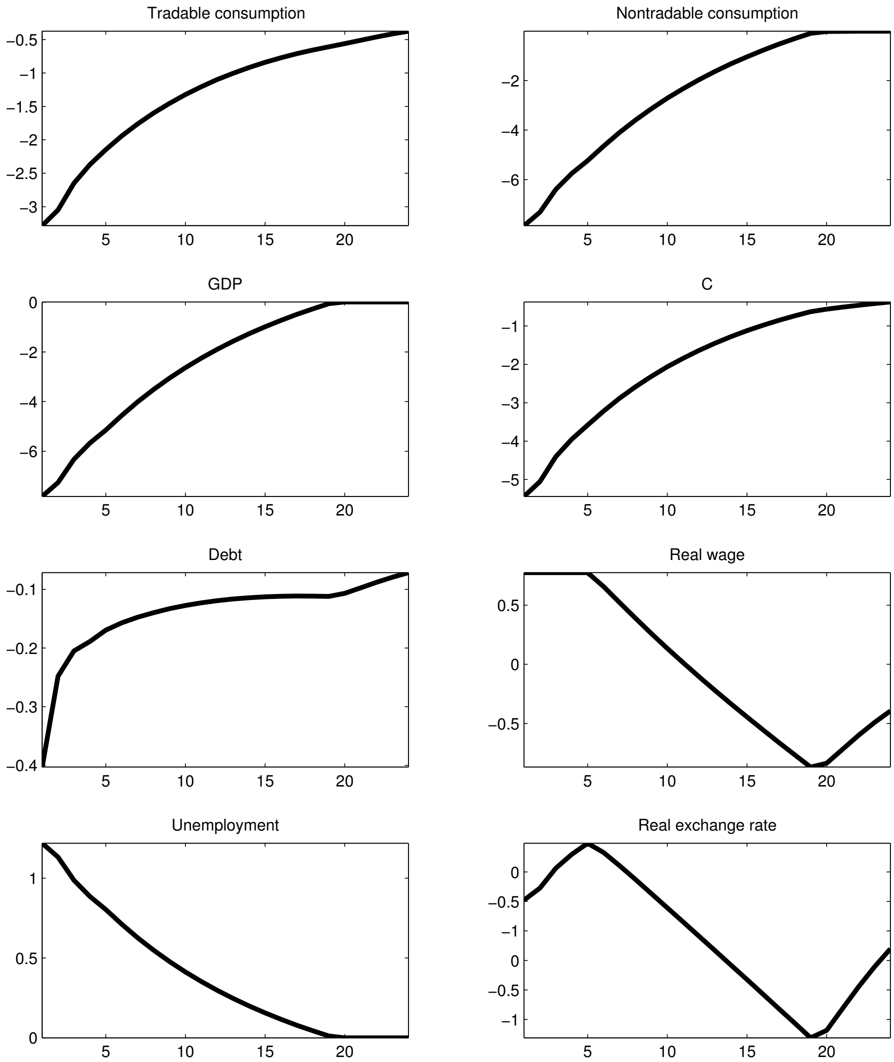


Figure 3.4.6: Simulations following a Negative Government Consumption Shock

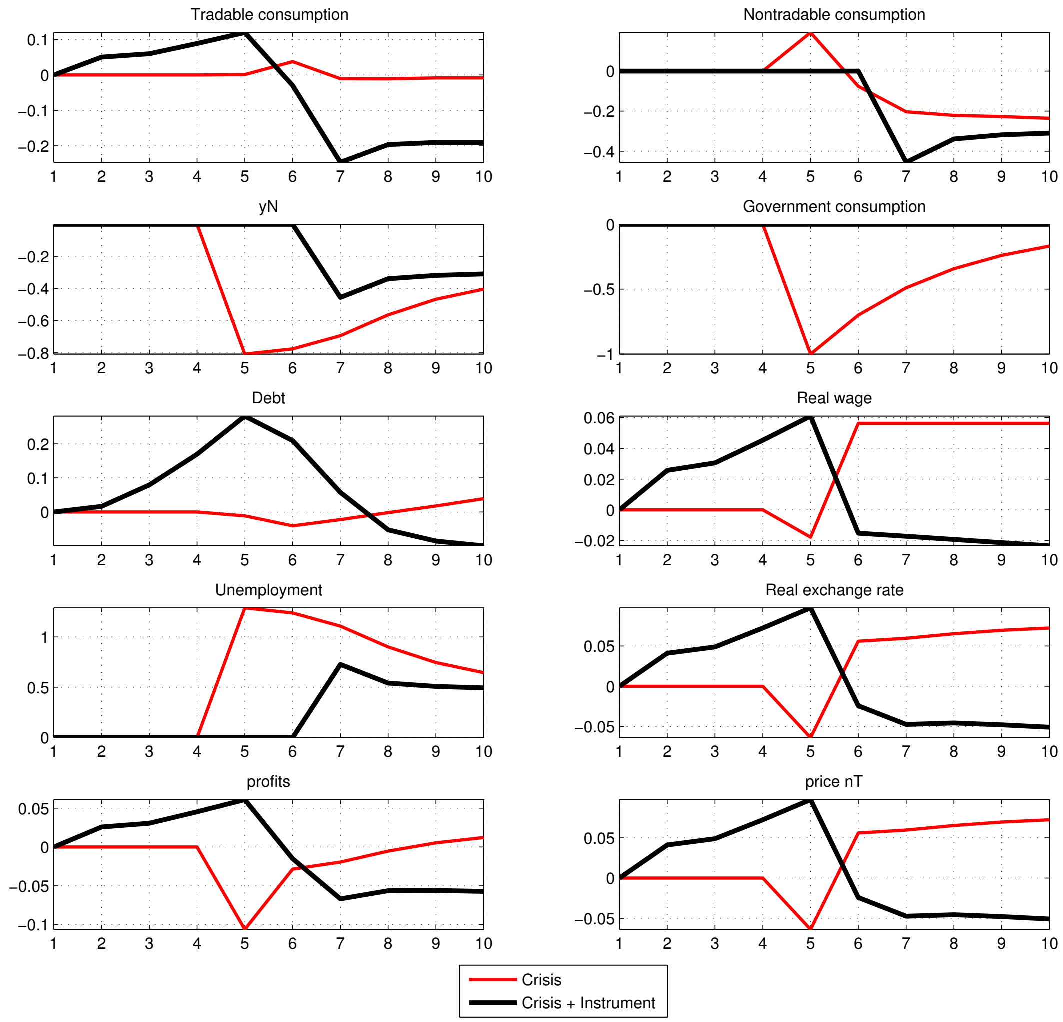


Figure 3.4.7: Simulations following a Positive Government Investment Shock

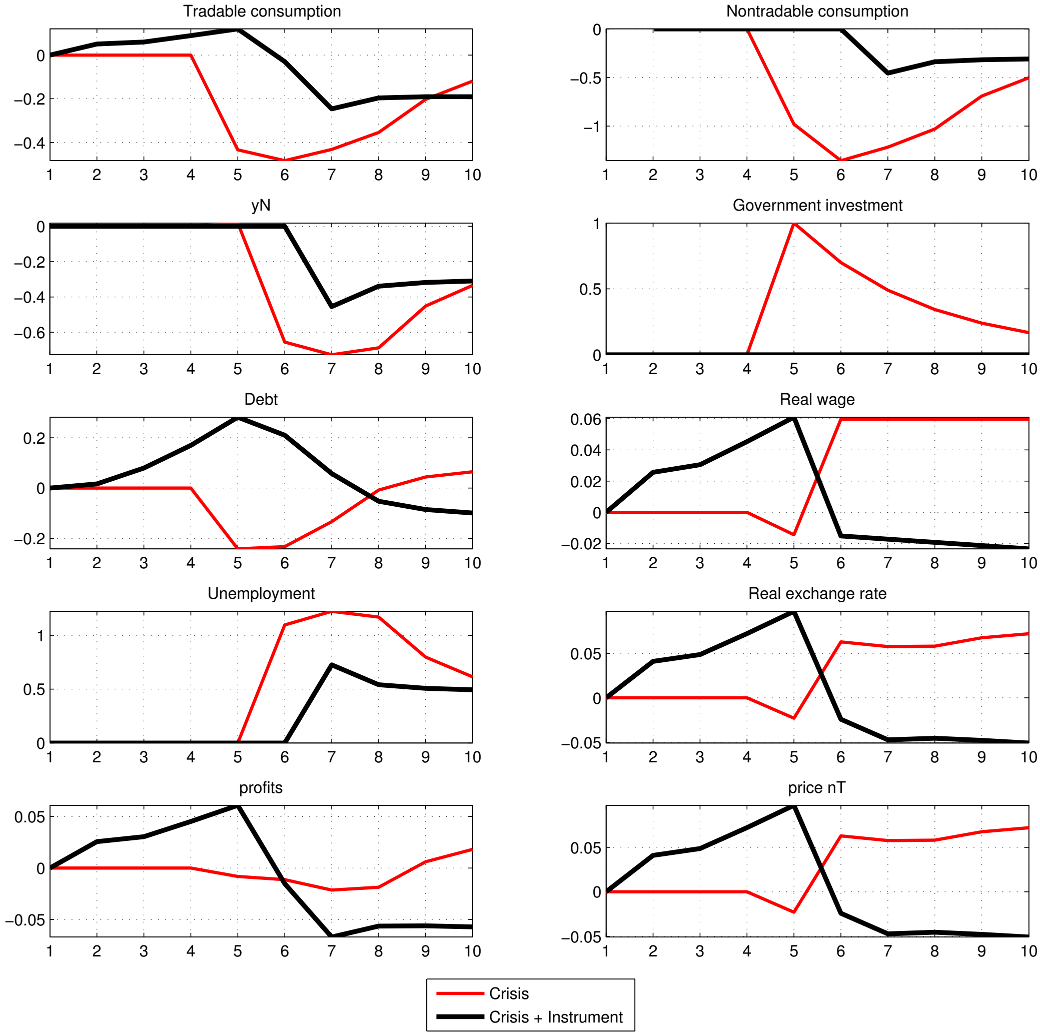
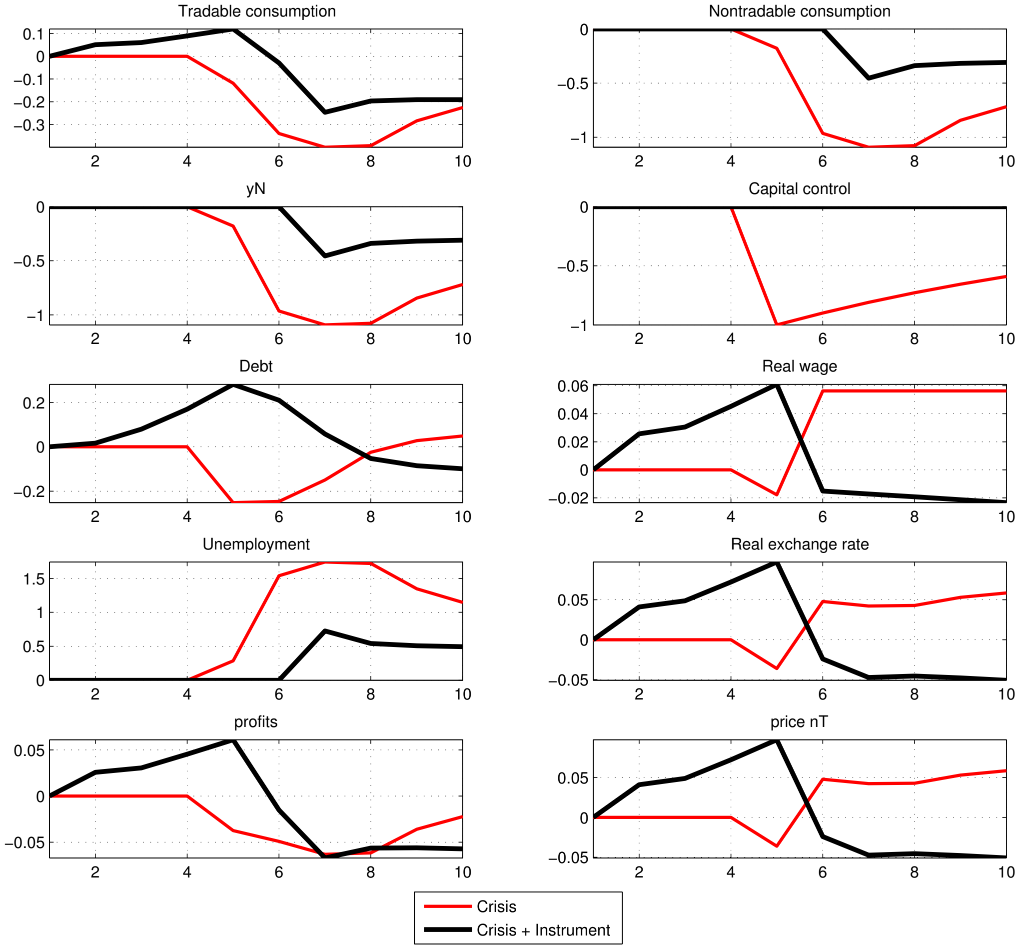


Figure 3.4.8: Simulations following a Negative Capital Control Tax Shock



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