Essays on Fiscal Policy

Author: Ekin Elcin Watson

ESSAYS ON FISCAL POLICY

EKIN ELCIN WATSON

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ESSAYS ON FISCAL POLICY

by

EKIN ELCIN WATSON

Dissertation Committee:

FABIO GHIRONI (co-chair)

PETER IRELAND (co-chair)

GEORG STRASSER

ABSTRACT

In this dissertation I study the impacts of fiscal policies in different monetary settings. In the first chapter, I empirically analyze the impact of fiscal policies on pairwise co-movements of business cycles in the European Monetary Union between the years of 1999 and 2016. In the second chapter, I develop a theoretical model which let me examine the impact of future fiscal consolidation around the zero lower bound interest rate. I explore welfare implications of the timing of future fiscal consolidation.

In the first chapter, I empirically examine the impact of national fiscal policies on the bilateral synchronization of business cycles among the euro zone countries and discuss how this impact changes over time between 1999 and 2016. I find that divergences in fiscal balances significantly decrease the synchronization among EZ countries on average. However, this relation is not linear in time. In fact, in the last period when the fiscal austerity measures are adopted, bilateral BCS increases with an increase in differences in fiscal balance. I also discover that the impact of an expansionary fiscal policy (decreasing the surplus or increasing the deficit) on the BCS is greater if the country is running a surplus rather than a deficit. On the other hand, I observe that between 2013 and 2016 if a country with budget deficit performs an expansionary fiscal policy, this increases the BCS which implies that the expansionary fiscal policies in that period are likely countercyclical in nature to neutralize

the impacts of asymmetric shocks in the EZ area.

In the second chapter, I analyze the effects of different timing of fiscal consolidations under different fiscal policy rules in a New Keynesian framework with endogenously binding zero lower bound. I find that the anticipated future government spending cuts have amplifying effects on the current fiscal stimulus only if the cuts are enacted in a timely manner and government spending does not respond endogenously to the economy. Spending reversals in the very short-run are very costly, while consolidation in the medium-run reduces welfare costs. However, the precise optimal timing of consolidation varies with different fiscal policy rules. If the labor income tax rate is used to stabilize the economy in addition to spending adjustment, the economy is stimulated more compared to a lump-sum taxation rule and no fiscal rule cases. When the government spending responds to output and debt endogenously, the fiscal consolidation occurs endogenously. In this case, additional spending cuts depress the economy and the welfare gain of the cuts at the optimal timing is negligible.

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Chapter 1

Effects of Fiscal Policies on Business Cycle Synchronization in the Euro Zone

1.1 Introduction

Highly synchronized economies are fundamentally important for a monetary union to function properly (Mundell, 1961[38]; Alesina and Barro, 2002[1]). An important determinant of synchronization is national fiscal policy. Recent financial and sovereign crises in the euro area present an opportunity to investigate this determinant, where both national fiscal stimulus and then austerity programs have been implemented. Hence, in this paper, I analyze the impact of bilateral differences in fiscal positions of the euro zone countries on the bilateral synchronization of business cycles and how it changes across time periods.

To highlight possible correlation between fiscal position differences and the co-movements of the economies, Figure 1.1 shows GDP movements (in the left y-axis) and budget balances per GDP (in the right y-axis) for Ireland and Germany.[1] After the start of the Great Recession in 2008q2, the output levels in both countries drop very sharply, however Germany experiences a deeper bust cycle compared to Ireland. Both recover slowly, but Ireland experiences another deep bust cycle following sovereign turmoil in the euro area. We also observe that starting from 2008, public budget balances deteriorate for both countries, due to

[1] The drastic rise of Ireland's GDP in 2015q1 can mislead the interpretations, however, here I only focus on the years between 2008 and 2014. Nonetheless, using GNI in my analysis doesn't change the main results.

possible drops in government revenues in the recession, the fiscal stimulus programs in both countries[2] and the Irish-banking crisis in case of Ireland. After 2010, Germany promptly starts austerity measures bringing its budget to positive levels with cuts in government expenditures and increases in revenues.[3] Ireland adopts austerity measures rather slowly, accumulating debt and increasing interest payments which worsen its budget balance.[4] After 2010 amplified desynchronization of two economies is likely associated with increasing wedge between their budget balances.

With the observation above in mind, I empirically examine possible causal association between bilateral differences in fiscal positions and the business cycle synchronization (BCS), i.e., GDP correlations in the euro zone (EZ) area. The data includes for 15 EZ countries, dating from 1999q1 to 2016q4, separated into four sub periods: 1999q1-2003q4, 2004q1-2008q2, 2008q3-2012q4, 2013q1-2016q4. In a panel data set-up, I employ pooled OLS, fixed effects and instrumental variables methods. I analyze the dynamics of the impact of fiscal position differences. To study the dynamics further, I run moving-window regressions of fixed effects model, after switching to an "instantaneous" synchronization measure. I propose a bilateral measure for fiscal position which can reveal more information on how each national fiscal policy changes bilateral BCS. As a robustness check, different synchronization measures for BCS and components of fiscal balance are used in the last section.

I find that the impact of differences in fiscal balance on BCS is negative in the euro area for the whole time sample. Nonetheless, I observe that this impact is not linear. In fact, in the last period of the sample, bilateral BCS increases with an increase in differences in fiscal balance. This result highlights that studies which treat the impact of fiscal stance differences among EZ countries as time-invariant fail to notice the circumstances where expansionary and yet stabilizing fiscal policy can contribute to positive co-movement of the business cycles

[2]In 2009 and 2010 the total stimulus package in Germany was 1.4% and 1.9%, where as in Ireland it was 0.5% and 0.5% (ECB, 2012[21])

[3]Cuts are mostly done in public administration and military spending (Ferreiro et al., 2015[24])

[4]Ireland's austerity measures mostly include increase in VAT and income tax for both high income and low income households (Ferreiro et al., 2015[24]) which might curb the non-government expenditure, hence aggregate demand and keep the economy in a deeper bust.

in the euro area.

This study finds that the national fiscal policies that have been implemented since the financial crisis and beyond are a positive determinant of BCS, although current high expansionary fiscal policies can raise the question of the sustainability of high debt and persistent deficit levels. This result is consistent with the notion (of counter-cyclical fiscal policy) that asymmetric national fiscal policies can be implemented as a response to asymmetric shocks or to the same shocks with asymmetric results, and helps to retain the stability. These fiscal policies neutralize the effects on the cycles and maintain synchronization of business cycles among monetary union countries.[5]

I discover that the expansionary fiscal policies (reducing the surplus or increasing the deficit) reduces the BCS. Similarly, the contractionary fiscal policies (increasing the surplus or decreasing the deficit) increases the BCS. However, the magnitude of the impact changes if the country runs a deficit or a surplus. This can be explained by different expectations of future offsetting fiscal policies. For instance, an expansionary fiscal policy results in lower inflationary effect as consumers expect future fiscal contraction if the country currently runs a deficit. As the results are expected to be less permanent, the decline in BCS will be smaller.

In the initial part of my analysis, the absolute difference of government budget balance for each country pair proxies the bilateral fiscal stance difference.[6] Unfortunately this measure treats the fiscal position divergences similarly regardless of whether they are due to changes in surplus or deficit. Moreover, it takes into account only bilateral fiscal positions rather than the fiscal positions for individual countries. Nonetheless, I apply it to my analysis for comparability to the previous literature (Darvas et al., 2005[17]; Furceri and Karras, 2008[26];

[5]On the other hand, fiscal policy can be a source to generate fluctuations in the economy, for instance, for political or demographic reasons. In this case, pro-cyclical fiscal policy can reduce co-movements of business cycles (Darvas et al., 2005[17]).

[6]Fiscal stance is used to refer to the cyclically adjusted primary balance by the European Council. Here I am using it interchangeable with cyclically adjusted budget balance.

Hauge and Skulevold, 2012[28]). In the second part of the paper I present variables that measure the impact of individual fiscal policies and take into account the direction of the balance.

Studying the impact of economic policies raises a problem of endogeneity, i.e., the policies may be responses to the economic situations. There are a couple of ways to identify the impact of fiscal policy in the literature. One is using narrative approach, where the fiscal measure is fiscal policy rules, implemented independently of the economic situation, for instance, increase in military expenditures, or reduction of the income taxes, or implementation of new lump-sum subsidies. The other method is to use instrumental variables that are related to the fiscal measure but not related to the errors - the part of the dependent variable that cannot be explained by the fiscal measure. In this study I use the latter. I use gravity model instrumental variables, such as bilateral distance between countries, common language, common border and growth differences for bilateral trade. Following Crespo-Cuaresma et al. (2011)[15], I identify the fiscal measure by the number of years left of the government until the next election, the ratio of government votes share to opposition votes share, and the ratio of working age population to population over 65. Additionally, following political economy literature[7], I use the government's political position as an IV. I employ three stage least squares (3SLS) and GMM-IV method by Arellano-Bond where lags of level or differenced regressors are utilized as instruments.

Business cycle synchronization in monetary unions and its determinants are widely studied in the literature (Fatás, 1997[23]; Frankel and Rose, 1997[25]; Imbs, 2004[30]; Baxter and Kouparistas, 2005[6]; Haan et al., 2008[27]; Inklaar et al., 2008[31]). My paper complements those with a focus on the fiscal policy and its effects on the BCS in the European monetary union.[8] It contributes to the existing literature by (i) analyzing the time-varying aspect of the effect, (ii) covering the recent time period aftermath of the financial and sovereign debt turmoils,

[7] Hibbs, 1977[29]; Besley and Coate, 1997[7]

[8] There are studies which analyze the fiscal policy impact across OECD countries (Camacho et al., 2006[10]; Darvas et al., 2005; Inklaar et al.,2008; Crucini et al., 2011[16]) or in monetary unions such as the US or some regions of France and Germany (Clark and Wincoop, 2001[12]; Kalemli-Ozcan et al. 2001[33]).

(iii) constructing a different fiscal measure which takes into account asymmetric impacts of fiscal policies when countries run a surplus or a deficit, (iv)solving the endogeneity problem with IV estimations.

In the literature there are four main studies that have the same question at the core as in this paper: Böwer et al. (2006)[8], Hauge et al. (2012), Crespo-Cuaresma et al. (2011), and Degiannakis et al. (2016)[19]. The first two studies focus on the fiscal convergence as in Darvas et al. (2005) and conclude that country-pair fiscal convergence (divergence) increases (decreases) country-pair BCS. By allowing this impact to change over time I conclude differently that the impact of fiscal policy is time varying and higher differences in fiscal positions are associated with higher BCS in the last period. Böwer et al. (2006) apply extreme-bond analysis to examine the robustness of factors of the correlation of business cycles for the period before and after the introduction of the euro until 2004. Hauge et al. (2012) only employ pooled OLS and fixed effects model for 1980-2010.

Crespo-Cuaresma et al. (2011) focus on the impact of both fiscal policy and trade integration on the union-wide business cycles. They use structural unobserved components model to measure BCS and they employ pooled OLS, GMM and IV methods. They find that as budget surplus increases for each country, the synchronization of this country with respect to the European Union increases. They measure fiscal policy by only budget balance and only for the period 1995-2008.

Defiannakis et al. (2016), on the other hand, estimate dynamic impacts of national fiscal policies on the co-movement of each country with union-wide business cycles (following Artis, 2003[4]). Whereas I follow Darvas et al. (2005) and Camacho et al. (2006) and use bilateral measure for BCS, Defiannakis et al. (2016) use a Diag-BEKK model which requires large volatilities in the data with an annual panel from 1980 until 2012 for 10 euro area countries. Although the focus of my study is also on time-varying impact of differences in fiscal policy, the measurement method in Defiannakis et al. (2016) varies significantly from other studies and is less straightforward. In fact, their measure for the impact of fiscal policy is calculated rather indirectly without any economic interpretation of business cycles.[9] Nonetheless, my findings that fiscal policy significantly affects the business cycle synchronization in the euro area, and that this effect is significantly changing over time, overlaps with their results.

In Section 1.2, I explain the data and the specification of the variables. I introduce the basic empirical model, steps to improve the results, and the estimation methods to be used. In Section 1.3, I analyze the dynamics of the impact of fiscal balance differences. In Section 1.4, I propose a new measure for fiscal balance that can gauge the individual effect of national fiscal policies on the BCS. Last in Section 1.5, I apply different measures for bilateral BCS and fiscal stance differences to examine the robustness of the findings in the previous sections. In Section 1.6, I discuss possible economic explanations for the empirical results. In Section 1.7, I conclude and discuss applications of the findings.

1.2 Empirical Model

1.2.1 Data and Specification of Variables

I use quarterly data from 1999q1 until 2016q4 for 15 EZ countries; Austria, Belgium, Estonia, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia and Spain.[10] Data sources are mainly OECD National Accounts, Eurostat Quarterly National Accounts, Eurostat Quarterly Government Statistics, and IMF Direction of Trade.[11] I divide the whole sample into four periods: 1999q1-2003q4, 2004q1-2008q2, 2008q3-2012q4, 2013q1-2016q4, leaving me a panel set with 420 number of observations.[12] Although selection of cut-offs for the sub periods is manual, each can

[9]The authors first estimate dynamic correlation coefficient between business cycles of monetary union and each country. Next, they calculate the errors from a linear regression of business cycles on lag of government net lending with constant coefficients. They propose that the dynamic correlation coefficient between the errors and union-wide business cycles gives the synchronization from which impact of fiscal policy is removed. Then by subtracting two dynamic correlation coefficients, they end up a measure for time-varying effect of fiscal policy on the business cycle synchronization between EMU12 and each country.

[10]The rest of euro zone countries; Cyprus, Latvia, Lithuania, Malta are not included in the sample since there is limited data available for these countries.

[11]For the details of data sources see the appendix.

[12]There are 105 (15x14/2) unique country pairs with four periods.

be justified by an economic reasoning. The first period, 1999q1-2003q4 corresponds to the initial years of adopting the euro; the second period, 2004q1-2008q2 include the years of advancing the integration in the EZ area; the third period, 2008q3-2012q4 covers the Great Recession and the sovereign crisis in Europe; and the last period, 2013q1-2016q4, includes the years of adopting fiscal austerity measures. *Quarterly* data series limit time dimension of the panel data, only going back to 1999q; although, it allows me to analyze the business cycles in the last decade with a larger number of observations.

$$BusinessCycleSynchronization_{ijt} = \beta_0 + \beta_1 FiscalBalanceDifference_{ijt} + u_{ijt} \quad (1.1)$$

Equation 1.1 is a baseline empirical model to be estimated. β_1 is the coefficient of interest. Following the literature (Frankel and Rose, (1997) (1998)) I use GDP correlations between two countries over a given period of time as a measurement of business cycle synchronization (BCS) for the country pairs, (i,j). To construct BCS variable, I take the logarithm of real GDP. I de-trend the series with Hodrick-Prescott filter to capture the cyclical fluctuations.[13]

As a next step, to specify fiscal balance difference variable for the country pairs, I gather seasonally and calendar adjusted data series of general government net balance as percentage of GDP for each country.[14] Cyclical adjustment of the series is calculated by the method that OECD applies.[15] Following Darvas et al. (2005), I take absolute difference of fiscal balance series for each country pair. For instance, Germany and Ireland have overall fiscal balances of -2.7% and 1% in 1999q1, respectively. Therefore the difference in their fiscal position in 1999q1 is 3.7%. For each sub period, fiscal balance difference is defined as the average of balance difference over period t for each country pair (i,j). Simply Equation 1.1

[13] In the literature HP is highly used method for BCS. However, there are some papers showing the results of different filtering methods; such as first differencing, Baxter-King (BK) filter, Christiano-Fitzgerald (CF) filter, and Butterworth (BW) filter (Artis, 2003; Frankel and Rose,1997)

[14] I adjust the unadjusted series by a simple moving average method. I double check the method by comparing the series that are also reported in seasonally adjusted form by Eurostat and the series that I manually adjust. I find that the difference between the series was negligible.

[15] For the details see the appendix.

can be rewritten in the following form:

$$BCS_{ijT_n} = \beta_0 + \beta_1 FD_{ijT_n} + u_{ijT_n} \tag{1.2}$$

where $BCS_{ijT_n} = Corr(GDP_i, GDP_j)_{T_n}$ and $FD_{ijT_n} = \frac{1}{T_n}\Sigma_{t_k}|FD_{it_k} - FD_{jt_k}|$, $n = 1, 2, 3, 4$ and $T_n \in \{T_1, T_2, T_3, T_4\}$.

Table 1.1 displays the descriptive statistics for bilateral BCS measure and bilateral fiscal balance difference in the first two rows. Time variation and cross-individual variation are not significantly different from each other. However, variation of fiscal measure differences and BCS among country pairs is more than variation over time. Figure 1.2 is plotting bilateral FD on the x-axis and bilateral BCS on the y-axis for whole time sample. Each dot refers to a country pair. Red dots are bilateral measures of France with respect to other EZ countries. Similarly blue dots are for Germany. There is an obvious correlation between bilateral BCS and FD shown in the plot, however it is not enough to conclude any causal one before discussing the results in the next section.

1.2.2 Basic Model Results

The results of pooled OLS estimation for Equation 1.2 with time period dummies are shown in Table 1.4. There are 15x14/2 country pairs with 4 time periods; hence, the number of observation is 420. The standard errors in the parentheses are clustered by panel individuals, i.e., country pairs.

The coefficient of fiscal balance differences on the business cycle synchronization is statistically significant and negative, suggesting that as two countries implement fiscal policies that cause differences in their fiscal balances, the synchronization between their business cycles decreases. This is the same conclusion found in Darvas et al. (2005), Hauge et al. (2012) and Böwer et al. (2006).

In this estimation, the constant term refers to the base period which is 1999q1-2003q4 in this case. It is significantly different than zero and positive. The remaining coefficients

D2, D3, and D4, identify the differences between the base period and the associated period. Significant positive coefficients of D2 and D3 suggest that on average the BCS is higher in the second and third period compared to the initial years of the euro. In the last period, the economies correlate less however the difference is not statistically significant.

Fixed and random effects models handle the bias due to excluding the time-invariant variables which can be country specific or country pair specific variables. For example, common border between a country pair can affect the correlation of these two economies. Or the year of adopting the euro can affect the correlation of this country with the rest of the country sample. Even after accounting for fixed and random effects, column (2) and (3) in Table 1.4 suggest that fiscal balance differences have significant negative effect on the pairwise BCS.

Certainly this is a basic model with problems of omission bias, endogeneity bias. Each is managed and discussed in the following sections.

1.2.3 Control Variables and Their Specifications

In this section I estimate Equation 1.2 with control variables which reduce the omission bias. There is an extensive empirical work on the determinants of the business cycle synchronization (Haan et al., 2007). I utilize a few that are common to these studies such as bilateral trade, similarity in industrial structure, and openness of trade to the rest of the world. Additionally, I include the variables for current account differences, real exchange rates, and government bond yield differences.[16]

Bilateral Trade: In theory (Inklaar et al., 2008[31]) the impact of bilateral trade on business cycle co-movements is ambiguous. In the case of an increase in income in one country, demand for both domestic and foreign goods increases, and if the business cycles are dominated by demand fluctuations, then the trade between these countries lead to increasing BCS (Inklaar et al. 2008). On the other hand, international trade can cause industry specialization

[16]Factor endowments, similarity in baskets of traded goods are other factors in Baxter et al., 2005).

(Kalemli-Ozcan et al., 2001) in partner countries leading to decreasing BCS if the economies are dominated by industry specific shocks.

Majority of empirical studies (Frankel and Rose, 1997, 1998; Baxter and Kouparitsas, 2005; Imbs, 2004; Inklaar et al. 2008) show that as countries increase trade between each other, the business cycle synchronization among them increases, too.[17] Hence, I expect the sign to be positive.

Following the previous literature, I assume bilateral trade measure between country i and j for period, T_n is;

$$BilateralTrade_{ijT_n} = \frac{1}{T_n} \sum_t \log \left(\frac{X_{ijt} + X_{jit}}{X_{it} + M_{it} + X_{jt} + M_{jt}} \right) \tag{1.3}$$

where X_{ijt} (X_{jit}) refers to export volume from country i (j) to country j (i) at time t, X_{it} and M_{it} (X_{jt} and M_{jt}) refer to total export and import with respect to the rest of the world for country i (j) at time t. Data series are collected from IMF Direction of Trade dataset. Export and import values are gross values in US dollars and exclude the services.

Similarity in Production Structure: Convergence in the production structure increases BCS since industry specific shocks likely have similar impacts among countries if industry specific shocks cause the variations of business cycles. Following Calderon et al. (2007)[9], (Imbs (1998, 1999, 2003); Baxter and Kouparitsas (2005); Kalemli-Ozcan et al. (2001)), I compute an index for similarity in industrial structure by collecting the data for the shares of eleven sectors in the total production of each country[18], S^h_{it}, where h refers to the sector, i refers to the country, and t refers to the time. Next, I calculate similarity in industrial production index for a country pair (i , j) at time t as;

$$SIP_{ijt} = 1 - \sum_h^n |S^h_{it} - S^h_{jt}| \tag{1.4}$$

[17]Kalemli-Ozcan et al. (2013)[32] find that adding financial integration in the models reduces the impact of bilateral trade. Duval et al. (2016)[20] on the other hand shows that using value added bilateral trade data rather than gross bilateral trade data captures the trade impact and that it is significantly positive even with inclusion of financial integration.

[18]Data source is Eurostat Production Sectoral Breakdown Data Series.

Note that if the sectoral production shares converge each other - two countries have a similar sectoral structure, the sum approaches to 0, hence SIP_{ijt} approaches to one. For the panel dataset, I take the average of SIP_{ijt} for each period; $SIP_{ijT_n} = 1/T_n \sum_t SIP_{ijt}$. If the business cycles are influenced mostly by the sectoral supply shocks, then as SIP_{ijT_n} increases, bilateral BCS is expected to increase as well.

Openness to Trade: The paper focuses only on the countries that are in the euro zone. However, in the sample there are countries, such as Germany, France, Italy which have higher volumes of trade from/to the non-euro zone countries. Having a measure for the openness to trade with the rest of the world (the non-euro zone countries) incorporates external factors that cause business cycle fluctuations.[19] Therefore, I calculate the following measure;

$$nonEZTrade_{ijT_n} = \frac{1}{T_n} \sum_t \log \left(\frac{T_{it}^{-EZ} + T_{jt}^{-EZ}}{T_{iEZt}^{-j} + T_{jEZt}^{-i}} \right) \tag{1.5}$$

where T_{it}^{-EZ} refers to total trade (export and import) volume of country i with the non-euro zone countries, (-EZ) at time t, and T_{iEZt}^{-j} refers to total trade level of country i with respect to the euro zone countries, excluding the country j at time t. If country i increases its trade volume with respect to the non-euro zone countries and imports the shocks from its non EZ trade partners, one can expect that this leads to lower BCS with EZ trade partners, *ceteris paribus*. On the other hand, if two EZ countries have common non-EZ trading partners, external shocks from this common partner affect both EZ countries. In this case increasing trade with common non EZ trading partners tends to increase the BCS among EZ countries.

Current Account Differences: Another control variable of interest in this paper is current account balance difference which is measured as $CA_{ijT_n} = 1/T_n \sum_t \left| CA_{it} - CA_{jt} \right|$. In this calculation CA_{it} refers to the current account balance per GDP for country i at time t. Thus positive values of CA_{it} refers to current account surpluses.

Current account balance can be interpreted as inter-temporal trade between present and

[19] For instance, Germany, the 3rd largest export economy in the world with an export destination, the U.S. in the first place, experienced great fall in demand for its exported goods in the Great Recession.

future, or a proxy for the level of consumption smoothing, hence smoothing output fluctuations. Therefore as two countries differ in level of current balances -higher CA_{ijt} - they also differ in level of consumption smoothing mechanism. Their economies tend to synchronize less, *ceteris paribus*.

Price Level Index: The price level differences between country i and j is another relevant control variable. CPI_{it} is consumer price index for overall goods for country i at time t.[20] [21] Average of consumer price index ratios, $CPI_{ijT_n} = 1/T_n \sum_t \log\left(\frac{CPI_{it}}{CPI_{jt}}\right)$ gives a measure for average real exchange rate of country i with respect to j for the period, T_n. If the real exchange rate of i increases, the goods in country i become relatively more expensive and the goods in country j become relatively cheaper. There occurs expenditure switching towards country j's goods, increasing the demand for country j's goods, hence the output of country j. On the other hand, the demand for more expensive goods of country i falls and it decreases country i's output. This results in lower BCS between i and j.

Government Bond Yields: The last control variable of interest in the paper is the differences of government bond yields for country pairs. I collect European Monetary Union harmonized rates for each euro zone country in the sample. Long-term government bonds in the secondary market are considered to compute the data series. As it is available in monthly frequency, I use the end of quarter values. I calculated the government bond "spreads" between country i and j for the period, T_n as;
$EMUrate_{ijT_n} = 1/T_n \sum_t \left| EMUrate_{it} - EMUrate_{jt} \right|$. Expected sign is negative for this variable.
Including the control variables in Equation 1.2 leads to;

$$\begin{aligned} BCS_{ijT_n} = \beta_0 + \beta_1 FD_{ijT_n} + \beta_2 BiTrade_{ijT_n} + \beta_3 SIP_{ijT_n} + \beta_4 nonEZTrade_{ijT_n} \\ + \beta_5 CA_{ijT_n} + \beta_6 CPI_{ijT_n} + \beta_7 EMUrate_{ijT_n} + u_{ijT_n} \end{aligned} \tag{1.6}$$

[20] Eurostat Harmonized Consumer Price Index is used.
[21] Another price index that can be used in this context is unit labor cost index. It gives similar results with CPI.

1.2.4 Results with Control Variables

In this section I study the estimation results for Equation 1.6 that are given in Table 1.5. The estimation methods that I employ are pooled OLS, fixed effect, and random effect.

Column (1) in Table 1.5 gives pooled OLS coefficients with robust standard errors in parentheses. In this estimation the number of observations decreases to 364 due to lack of EMU rate data for Estonia. Adding the control variables significantly reduces the upward bias due to omission of relevant variables. The impact of fiscal balance difference is still significantly negative as it is in the basic OLS model. On average if there is a one percent increase in the difference of fiscal balances per GDP between two countries, correlation of their GDP drops by 0.0213.

To see if the model is acceptable, it is beneficial to check whether the coefficients of the control variables align with expectations. Bilateral trade between countries has a positive impact on the BCS as expected.However it is not statistically significant. Additionally, the variables such as similarity of industrial production, ratio of trade volume with the non-euro and the euro zone partners have insignificant negative effects on BCS in the euro zone. The first one is not inconsistent with the studies which find insignificant weak causality from similarity of production structure to BCS.[22] The latter can be explained by opposing impacts of having a group of mutual or uncommon non-EZ trading partners. Moreover current account balance difference, CPI ratios, EMU rate differences have significant negative signs as expected.

Adding control variables can help to improve the results, however there are still other variables that are not in this estimation but can affect BCS. Some of them are time invariant. One of the main advantages of fixed effects model is to treat the problem of missing time-invariant variables. Also if the assumed model is FE, pooled OLS estimators of the coefficients will be inconsistent. The results in column (2) in Table 1.5 show that the coefficient of fiscal

[22] Böwer et al. (2006) find that it is not robust in EBA.

balance difference preserves its significance and sign; although, it drops to 0.0137.[23]

Random effects (RE) model assumes that the time-invariant random variables are not correlated with the regressors in the estimation. If the preceding assumption under which RE coefficients are consistent holds then RE coefficients are also efficient compared to OLS and FE models (Cameron and Trivedi (2005)[11]). Table 1.5 displays the estimation results for RE coefficients in column (3). Pooled OLS estimation is a special case of GLS estimation of RE model where the weighted matrix is the identity matrix. Since there is a singular solution in RE estimation, the variation in random effects is assumed to be zero. Therefore, the results from RE estimation are the same as from pooled OLS.[24]

1.2.5 IV and GMM-IV Estimations

So far I have not addressed that fiscal measure is endogenous. Cyclical adjustment of budget balance reduces simultaneity. However, it doesn't account for the fact that fiscal authorities may respond to the fluctuations in the output, for instance, by changing the tax code or by increasing the public expenditure. In this case the causality runs from the dependent variable to the regressor. To remove the endogeneity bias, I employ IV and GMM-IV method.

3SLS IV estimation: Identification and Results

I initially use four main political and demographic instruments (Crespo-Cuaresma et al., 2011; Hibbs 1977) for the fiscal measure variable. These are (i) bilateral differences in government's political position, (ii) bilateral differences in government's terms left until the next election, (iii) bilateral differences in government's vote share per opposition's vote share and (iv) bilateral differences in population over age 65 per working population.[25]

[23] The estimate of ρ, fraction of variance due to fixed effects is 0.903 which suggests that almost all the variation in bilateral BCS is associated with country-pair differences in BCS. F(10,90) statistics of the fixed effects is 34.38 with p-value>0.0000. This suggests that there is significant country-pair effects, implying that pooled OLS would be unfit.

[24] Hausman test for FE and RE estimators suggests that FE estimator is consistent and RE estimator is inconsistent and not efficient.

[25] The data source for political and election system is QoG, 2017[43]. The data source for demographic variables is EU population structure and ageing data[22].

For bilateral trade, I utilize growth difference and three gravity model variables; (i)natural logarithm of distance between capitals, (ii) common language, (iii) contagious proxy which takes into account common language, common border, common colonial history (Mayer et al. (2011)[34]).

Following Hibbs (1977)[29] and Roesel (2016)[40], I include government political position with respect to the opposition. The political positions are categorized by three main positions: right-wing (takes the value of 1), center (takes the value of 2), and left-wing (takes the value of 3). Hence, bigger values of government political position indicate that the government has a left-wing ruling party or coalition relative to the opposition parties on average over each period. In the light of the results of Roesel (2016); left-wing local governments run higher deficits than right-wing supervisors, one would expect that the fiscal balance decreases as government political position gets closer to the left-wing ideology. In my paper I rather use bilateral differences of government political positions relative to the opposition parties positions for country pairs. Therefore, I would expect that the more the ruling parties differ ideologically, the more the fiscal balance differences are.

Likewise, motivated by the results of Crespo-Cuaresma et al. (2011)[15], I exploit two instruments: differences in the number of years left for the current ruling government until the next election, i.e., GovtsLeftTerm and differences in the ruling party/parties votes share with respect to the opposition party/parties votes share, i.e., PowerDistribution. The theory[26] behind the first instrument is the political cycles theory which suggests that as the government gets closer to the end of its term, it utilizes the policy means to increase the chances of getting reelected. Therefore smaller number of years left in the term are associated with higher fiscal deficits. Similarly, the power of the ruling government relative to the opposition is also associated with differences in fiscal deficits in the literature.[27]. This suggests that if ruling government has a dominant position, i.e., higher votes share with

[26] As it is referred to Nordhaus (1975)[39]; Hibbs (1977); Sapir and Sekkat (2002)[42]; Mourao and Veiga (2010)[35] in Crespo-Cuaresma et al., (2011)

[27] Roubini and Sachs (1989)[41]; Corsetti and Roubini (1991)[13]; de Haan et al. (1999)[18] are some of the papers.

respect to the opposition, it is likely to reduce the fiscal deficits. Hence as an application of this literature to my model, countries with varying distribution of political power between the ruling government and the opposition likely to differ in their fiscal balances, as well.

Last but not least, demographic instrument, i.e., the ratio of working population relative to population over 65 has fiscal implications. Aging population above working population directly strain fiscal budget through increasing public spending on old-age pensions and health and long-term care and indirectly through falling government revenues due to likely lower economic growth that comes with a shift in population towards less active groups.[28] Accordingly, I take into account bilateral differences of the ratios of population over 65 to working age population for each country pair. I expect that as this demographic structure differs among countries, the fiscal stance divergences increase.

The first column of Table 1.6 displays the performance of the instruments for fiscal measure variable. Although the sign of each instrument is positive as expected, only two variables; government political position and governing term left until the next election, are statistically significant. Nevertheless, $R^2 = 0.542$ suggests that the model is performing fairly well for a dynamic panel estimation.

The instruments for bilateral trade are rather very common in the literature. The first stage OLS estimation results in the second column of Table 1.6 indicate that all instruments are significantly relevant to the bilateral trade except differences in growth.

The first column of Table 1.7 demonstrates the results for three stage least square estimation with the instrumental variables mentioned above. After tackling the endogeneity bias in the fiscal measure and the bilateral trade, highly significant and negative coefficient of fiscal balance difference affirms the findings in the previous section, i.e., fiscal balance differences affect bilateral business cycles co-movements significantly and negatively among the euro

[28]Policy papers at this webpage[2] and at this webpage[22] are two policy papers on the demographics and its fiscal implications in European Area and OECD countries.

zone countries. Moreover, bilateral trade and other control variables preserve the expected sign with statistically significant coefficients except the coefficient of nonEZvsEZTrade variable.

GMM-IV estimation

Regardless of the theory and the intuition, supporting the use of political and demographic instruments, it is necessary to show that the results are not weak with different choices of instruments. Therefore, I utilize lags and differences of dependent and independent variables as instruments in GMM-IV method. I estimate the coefficients with GMM-IV by Arellano and Bond (1991)[3]. The results for one-step and two-step GMM-IV estimations are presented in the second and the third column of Table 1.7, respectively.

The results from both estimations are consistent with previous findings. However, there is a slight decrease in the magnitude of the effect of fiscal measure difference. Hansen test statistics (not reported in the table) implies that the null hypothesis: the coefficients are robust but weakened by many instruments cannot be rejected with p-value of 0.883. C-test statistics (not reported in the table) verifies the joint validity of instruments with p-value of 0.920.

1.3 Does the impact of fiscal balance differences on BCS change through time?

In this section, I study the dynamics of the impact of fiscal balance differences on BCS. As theory suggests that fiscal policy can affect BCS in either way (Haan et al., 2007), a method that assumes the effect is the same through out the sample may lead to underestimation of the impact on average. In Figure 1.3 each dot displays bilateral BCS on the y-axis and bilateral FD on the x-axis for four sub periods. This plot suggests time-varying nature of the fiscal policy impact. Indeed, the direction of the impact can also change, as in the last period it seems to be positive.

I employ the same methods that I used in the previous sections; pooled OLS, FE, 3SLS IV estimations with interactive time dummies for the fiscal balance differences. Therefore the equation to be estimated takes the following form;

$$BCS_{ijt} = (\beta_0 + \beta_1 D1 + \beta_2 D2 + \beta_3 D3) * FD_{ijt} + Z'_{ijt}\alpha + u_{ijt} \tag{1.7}$$

where Z_{ijt} is a vector of control variables and constant term. Base period for the coefficient of fiscal balance difference is the last period, 2013q1-2016q4. β_1, β_2, and β_3 give information about the additional impact of FD on BCS for the time periods, 1999q1-2003q4, 2004q1-2008q2 and 2008q3-2012q4 relative to the base period, respectively.

Table 1.8 shows the estimation results for Equation 1.7. Statistically significant values for interactive dummy terms show that the impact of FD on BCS differs for these periods. Moreover, the impact is found out to be positive for the last period where the EZ countries taking austerity measures aftermath of sovereign turmoil in the monetary union.

These results lead me to the next section where I use a different measure for BCS where I can investigate more on the dynamics of the impact of the fiscal balance difference on the BCS.

1.3.1 Quasicorrelation Measure for BCS

So far the analysis depends on the selection of the time periods (time windows). However it is also possible to study the impacts of fiscal stance on BCS with quasicorrelation of GDP for country pairs.[29] It is sometimes referred as "instantaneous" business cycle synchronization (Li (2017)). Following is the quasi correlation measure for each country pair:

$$Qcorr_{ijt} = \frac{(Y_{it} - Y_i^m)(Y_{jt} - Y_j^m)}{\sigma_i \sigma_j}$$

where Y_i^m, Y_j^m are averages of GDP for the whole period for country i and j, respectively. σ_i, σ_j are the standard errors of GDP for the whole period for country i and j, respectively.

[29] This measure has been used in the literature by Duval et al. (2016); Abiad (); Kalemli Ozcan et al. (2013

Similarly I calculate instantaneous measures for fiscal balance difference and for the control variables;

$$\text{FD}_{ijt} = \Big| FD_{it} - FD_{jt} \Big|$$

$$\text{BiTrade}_{ijt} = \log\left(\frac{X_{ijt}+X_{jit}}{X_{it}+M_{it}+X_{jt}+M_{jt}}\right)$$

$$\text{SIP}_{ijt} = 1 - \sum_h^n \Big| S_{it}^h - S_{jt}^h \Big|$$

$$\text{CA}_{ijt} = \Big| CA_{it} - CA_{jt} \Big|$$

$$\text{CPI}_{ijt} = \log\left(\frac{CPI_{it}}{CPI_{jt}}\right)$$

$$\text{EMUrate}_{ijt} = \Big| EMUrate_{it} - EMUrate_{jt} \Big|$$

$$\text{nonEZTrade}_{ijt} = \log\left(\frac{T_{it}^{-EZ}+T_{jt}^{-EZ}}{T_{iEZt}^{-j}+T_{jEZt}^{-i}}\right)$$

1.3.2 Estimation Results with Quasicorrelation BCS Measure

In this section as I have a panel with $T = 72$ and $N = 91$, I restrict my methods to POLS, FE and RE to compare the findings with the ones in the previous sections.[30] Table 1.9 displays the results for Equation 1.7 where $t \in T$, and D1, D2, D3, and D4 are dummy variables for each time period $t \in T_1, t \in T_2, t \in T_3$, and $t \in T_4$, respectively.

The results in Table 1.9 show that the effect of fiscal stance differences on bilateral BCS changes across time periods, similar to the findings in the previous section. It is more evident in the second and third column. The magnitude of the impact of bilateral FD

[30] GMM-IV method causes to lose efficiency with T=72 and N=91.

displayed in column (1) and (2), on the other hand, is estimated to be smaller compared to Column (1)-(2) in the Table 1.8.

The other finding that holds in current analysis is that differences in fiscal positions increase bilateral BCS in the last period. The sign of the estimated coefficients in the last period holds the same for three methods. However pooled OLS estimator is not statistically significant.[31] To summarize, the more divergent two countries are in terms of their fiscal positions, the more synchronized their economies are in the last period of the sample.

One can - along the lines in Darvas et al. (2007) - interpret the divergences in fiscal positions as a divergence in fiscal disciplines. However, differences in budget balance can be divided into two measures; differences in primary balance and differences in net interest payments. One country can run both primary surplus and budget deficit at the same time if it inherits high amount of debt with high interest payments. Therefore analyzing only budget balance values would be misleading to conclude that one country lacks fiscal discipline at that current time. For this reason, I estimate the impact of bilateral primary balance differences on the bilateral BCS. The results are displayed in Table 1.10.

Table 1.10 shows that the impact of differences in bilateral primary balance on the BCS is statistically significant - slightly higher than estimates for the effect of differences in budget balance in Table 1.9. Until the first quarter of 2013, this effect is significantly negative. However in the last period, it is positive, which is consistent with the previous findings.

Moving Window Fixed Effects Regression

Switching to "instantaneous" output correlation helps to analyze the dynamics, yet in the previous section I still decide on the time periods for the dummies. Therefore next I iteratively employ fixed effects regressions with a 20-quarter window. The equation that I am interested is Equation 1.6 with primary balance differences as fiscal measure difference.

[31] R-squared values for POLS and FE also suggests that FE is better fit. Hausmann test for FE and RE result in that FE model gives the consistent estimator. These values are not reported in the table

Figure 1.4 shows the coefficient of primary balance difference, averaged over there groups of country pairs: in the first row it is averaged among EZ 15 countries, in the second row among Germany, France and Italy, and in the third row among Greece, Ireland, Italy, Portugal and Spain (GIIPS).

Looking at the first row of Figure 1.4 the coefficient of primary balance difference seems to be negative most of the time with a positive trend at the end of the last period. However it becomes positive just after the first quarter of 2016 which is different from the previous findings.

Another interesting observation is that the biggest three economies in the EZ area, Germany, France and Italy (GFI) have a very different pattern and magnitude for the impact of primary balance difference on the bilateral BCS compared to overall mean (the first row) and to the mean among GIIPS (the third row). Bilateral primary balance differences start to reduce the synchronization among GFI after the first quarter of 2013 and have a negative sign until the second quarter of 2016. This time period overlaps with the times when high fiscal austerity measures are taken. On the other hand, GIIPS starts to experience a positive impact of fiscal stance difference in the same period.

To see the variation of the values among country pairs at each quarter, I add the coefficient values of each country pair to the Figure 1.4, ending up with a new figure, Figure 1.5. In the first row, I also add the band with a width of $\pm 2\text{x}mean_{overN}(std.err.)$, shown in blue lines. It seems that the sign of the coefficient is ambiguous, however the variation over country pairs decreases through time.

Similarly, the variation among GIIPS follows a similar pattern to overall EZ 15 countries, and it declines through time. However, GFI experiences smaller variations between the second quarter of 2009 and the first quarter of 2013 - right after the financial crisis erupts. Following the second quarter of 2013, the variation of how much the fiscal position difference affect bilateral BCS among GFI increases.

Bilateral fiscal balance difference gives a measure for a fiscal stance divergence or convergence. However it is not sufficient to suggest a national fiscal policy direction regardless of being measured by either budget balance or primary balance. In fact one cannot infer an answer for the question how an increase in government expenditure of country i affects the bilateral BCS between country j as there is no one to one correspondence between changes in the individual fiscal position and changes in bilateral fiscal position differences.[32] Additionally it doesn't take into account the direction of the changes. The conclusion that the impact of fiscal balance difference becomes positive in the last period of time can be result of the fact that the EZ countries improve their fiscal positions, and divergences occur when they run surpluses. Therefore in the next section I propose a measure which takes into account these shortcomings.

1.4 How does an increase in fiscal balance of country i affect BCS between country i and j ?

Absolute differences in fiscal budget balance cannot answer this question. Here I propose a measure that can give that information in the following steps:

Step 1: Fiscal stance measure for country i at time t is defined as $newFD_{it} = \left|FD_{it} - T^*\right|$ where T^* is a constant to be targetted.[33]

Step2: Fiscal stance sign dummies for country i at time t are defined as $FD^b_{it} = 1$ if $FD_{it} < T^*$, zero otherwise, and $FD^g_{it} = 1$ if $FD_{it} \geq T^*$, zero otherwise.

Step 3: Fiscal stance measure below T^* for country i at time t is defined as $newFD^b_{it} = newFD_{it} \times FD^b_{it}$. Similarly, fiscal stance measure above T^* for country i at time t is defined

[32] To make the argument clear assume that FD_{ij} goes down by 10%. However this may be the results of two cases; the result of that country i decreases its balance by 10% or the result that country j increases its balance by 10%. Also assume that fall in FD increases BCS between i and j. Therefore, we can conclude the same thing about $corr(GDP_i, GDP_j)$ if country i decreases its balance or country j increases its balance.

[33] It will be helpful in the following analysis where I discuss the divergence from the threshold of Stability and Growth Pact.

as $newFD_{it}^{g} = newFD_{it} \times FD_{it}^{g}$. This measure gives the magnitude and the direction of the budget position for each country at time t.

Step 4: In a set-up where the whole period is divided into four sub-periods as in the initial analysis, fiscal stance measure below T^{*} for country i for the period T_n is defined as $newFD_{iT_n}^{b} = \frac{1}{T_n}\sum_t newFD_{it}^{b}$. Similarly, fiscal stance measure above T^{*} for country i for the period T_n is defined as $newFD_{iT_n}^{g} = \frac{1}{T_n}\sum_t newFD_{it}^{g}$. n$\in 1, 2, 3, 4$.

Step 5: For each country pair (i,j) and each period T_n, two fiscal stance measures are defined; $newFD_{ijT_n}^{b} = newFD_{iT_n}^{b} + newFD_{jT_n}^{b}$ and $newFD_{ijT_n}^{g} = newFD_{iT_n}^{g} + newFD_{jT_n}^{g}$. The first one gives the sum of the mean of deficits (below T^{*}) and the second one gives the sum of the mean of surpluses (above T^{*}).

To calculate $newFD_{ijT_n}^{b}$ and $newFD_{ijT_n}^{g}$ I use cyclically and seasonally adjusted budget balance per GDP series like in the previous sections and I assume $T^{*} = 0$. Descriptive statistics for new fiscal stance measure that are displayed in Table 1.3 suggest that similar to the previous measures, the variation of the variable comes mostly from individual differences among country pairs.

Alternatively, I also use cyclically and seasonally adjusted primary budget balance per GDP. However, in this case, $T^{*} = -3\%$ as it is an imposed budget deficit threshold by the Stability and Growth Pact in the EU area. It is denoted by $newPrime_{ijT_n}^{b}$ and $newPrime_{ijT_n}^{g}$

The first equation to be estimated is;

$$BCS_{ijT_n} = \beta_0 + \beta_1 newFD_{ijT_n}^{g} + \beta_1 newFD_{ijT_n}^{b} + Z_{ijT_n}'\alpha + u_{ijT_n} \tag{1.8}$$

where X can be either budget balance or primary balance and Z_{ijT_n} is the vector of control variables from the previous section.

I use pooled OLS, 3SLS, and GMM-IV methods with country pair fixed effects. Unlike in the previous section, the instrumental variables for fiscal measure variable are not bilateral differences. In fact they are the sum for each country pair. The same gravity model instruments are used for bilateral trade. Table 1.11 indicates that years left in government's term is a strong instrument for budget surplus, however, it has a negative sign (-0.226), showing that as the government gets closer to the next election, the budget surplus increases. Government political position is the strongest instrument for budget deficit, supporting that as the ruling government is close to the left-wing ideology, budget deficit goes up (0.222).

Table 1.12 shows the estimation results. There are three main conclusions. First, if country i - symmetrically country j- implements an expansionary fiscal policy that increases the budget deficit, BCS with country j falls (Each coefficient estimator of $newFD^b$ is significantly negative, displayed in the second row). Secondly, if country i - symmetrically country j - implements a contractionary fiscal policy that increases the budget surplus, BCS with country i increases (Each coefficient estimator of $newFD^g$ is significantly positive, displayed in the first row). However, thirdly, the magnitude of the impact of fiscal policies on BCS significantly depends on whether the country is running a surplus or a deficit. In fact, a contractionary fiscal policy in a country with a surplus has a bigger impact relative to a same-size expansionary fiscal policy in a country with a deficit.

To see how the impact of the new fiscal measure changes across periods, I use interactive time dummies in addition to above estimation and the results are shown in Table 1.13. Impact of a rise in fiscal surplus is not consistently positive in all periods. As it becomes insignificantly negative in some periods, it is not possible to certainly claim that its sign significantly changes among periods, though. The impact of a rise in fiscal deficit, on the other hand, significantly changes over time. It becomes positive in the last period, suggesting that if country i adopts austerity measures and decreases its fiscal deficit, BCS with country j decreases.

Table 1.15 presents the estimators for primary balance measure. Similar to the results with budget deficit, $newFD^b$, an increase in primary deficit significantly decreases bilateral BCS. However, the impact of primary surplus is not significant and consistently positive. Moreover, primary deficit has a bigger impact on the synchronization relative to primary surplus.

Ambiguity of the impact of primary surplus continues to exist at different periods as shown in the first four rows of Table 1.16. The sign of coefficient estimators among different estimation methods is inconsistent and insignificant. On the other hand, the impact of primary deficit is consistently negative in the first three periods and significant for the first and the third period for all methods of estimations (Table 1.16). In the last period, an increase in primary deficit increases bilateral BCS.

1.5 Various Analysis on Different Measures for Bilateral BCS and Differences in Fiscal Stance

1.5.1 Different Measures for Bilateral BCS

Following the previous literature[34], I analyze the co-movements of manufacture production, investment, consumption in percentages of national GDP and GNI. Investment and consumption per GDP give non-government main macroeconomic aggregates. Manufacture production cannot be taken as gauging aggregate economic activity in a country, however, it gives partial but solely supply side of the economy. Gross national income on the other hand gauge the production by the nationals, taking into account net taxes and subsidies from abroad. All data series are HP filtered and bilateral correlations among EZ countries are calculated.[35]

[34] See (i) Camacho et al., (2006); Haan and Inklaar, (2007) for industrial production (ii) Crucini et al., (2011); Kose et al., (2008) for consumption, investment (iii) Austeriou P. et al., (2015) for growth

[35] For data sources please see Appendix.

Table 1.17 and Table 1.18 give the estimation results for equation 1.6 with new measures for BCS as dependent variable. Fiscal (budget balance) differences among EZ countries significantly lead to a decline in the co-movement of manufacture production, and the co-movement of investment. However, the strong negative correlation doesn't hold for co-movement of the consumption.

1.5.2 Different measures for Differences in Fiscal Stance

In this section I break down fiscal budget balance data into cyclically adjusted total government revenue and expenditure. As total revenue is believed to be more cyclical than total expenditure, separating two is helpful to analyze less cyclical component of budget. The columns (1)-(3) in Table 1.19 give the coefficient estimates for differences in total revenue and differences in total expenditure.

Columns (4)-(6) in Table 1.19 give the results when the differences in government consumption are used as a fiscal stance measure. Government consumption can be seen as a discretionary fiscal policy tool compared to total government revenue and total government expenditure. Positive coefficient of differences in government consumption expenditure can be explained by the responsiveness of the monetary policy to the changes in government expenditure.

1.6 Discussion of the Results

The first main result of the paper is as countries differ in their fiscal balances, BCS among them decreases. This result is consistent with the results of pro-cyclical fiscal policies that cause idiosyncratic fiscal shocks as mentioned by Darvas et al. (2005). However, the literature on the fiscal policy spillovers provides an economical explanation, such as the channels through which pro-cyclical fiscal policies can decrease the BCS in a monetary union (Corsetti et al., 2010[14]; Attinasi et al., 2017[5]).

Suppose that country i conducts an expansionary fiscal policy, increasing the fiscal divergence with country j. Expansionary fiscal policy in country i increases not only the demand for domestic goods in country i but also the demand for foreign goods in country j. Hence in both countries, the output increases via international trade. However if the monetary authority in country i responds to the rise in aggregate demand by increasing the interest rate, country i experiences appreciation of its currency via free flow of capital. Foreign goods in country j becomes relatively cheaper than the goods in country i. As a second mechanism, this increases the demand for goods in country j. Both channels can cause a rise in country j's output while country i also is experiencing expansion. However, in a monetary union, any monetary response to the rise in aggregate demand in country i also affects the interest rate and the exchange rate in country j. Therefore, appreciation of the common currency causes the demand for country j's goods to drop. When country i may benefit from a rise in aggregate demand by an expansionary fiscal policy in a monetary union, aggregate demand, hence, output in country j may decline. BCS between country i and j decreases which explains the main result of the paper; i.e., bilateral fiscal policy divergence, or a reduction in budget surplus, or an increase in budget deficit decreases bilateral BCS.

Suppose the case where the monetary authority cannot respond to the national fiscal policy. For instance, if the official rates are already almost zero, the European Central Bank cannot decrease the short-term interest rates as a response to the contractionary national fiscal policies in the EZ area. Hence, the drop in demand for country j's goods that comes with a contractionary fiscal policy in country i, reduces country j's output without any offsetting force through the interest rates and exchange rates. Moreover, both countries experience a rise in the real interest rates, decreasing the consumption levels. As a result they both become subject to a decline in output, increasing the synchronization of their business cycles.

The above scenario actually explains the second result of the paper, i.e., in the last four years of the sample, if there is an increase in fiscal balance and hence an increase in fiscal divergences, BCS increases. This result is consistent with the picture of the euro zone countries, undergoing fiscal consolidations while the official rates are almost zero.

On the other hand, the difference between the magnitude of the impact of fiscal policy in case of running a surplus or a deficit can be explained by different expectations of consumers in each situation. If country i runs a deficit and conducts an expansionary fiscal policy, due to higher expectations on future contractionary fiscal policy, the inflationary effect of the current expansionary fiscal policy will be less compared to the case where country i runs a surplus. Therefore, the appreciation of the common currency will be less, affecting country j's aggregate demand less. Although there is a decline in BCS between country i and j for both cases, when country i runs a deficit, the magnitude will be smaller.

1.7 Conclusion

Recent financial and sovereign crises in the euro area present an opportunity to investigate the national fiscal policies as determinants of business cycle synchronization. In this paper, I analyze the impact of bilateral differences in fiscal positions of the euro zone countries on the bilateral synchronization of business cycles and how it changes across time periods.

I conduct a panel data analysis to examine possible causal association between bilateral differences in budget balance positions and the business cycle synchronization (BCS), i.e., GDP correlations in the euro zone (EZ) area for 1999q1-2016q4. I analyze the dynamics of the impact of fiscal position differences. I compute a bilateral measure for national fiscal position which can reveal more information on how each national fiscal policy changes bilateral BCS.

I find that the impact of differences in fiscal balance on BCS is negative in the euro area for the whole time sample which aligns with pro-cyclical feature of fiscal policy Nonetheless, I observe that this impact is not linear. In fact, in the last period of the sample, bilateral BCS increases with an increase in differences in fiscal balance. This result is consistent with the notion (of counter-cyclical fiscal policy) that asymmetric national fiscal policies can be implemented as a response to asymmetric shocks or to the same shocks with asymmetric results, and helps to retain the stability.

I find that the magnitude of the fiscal policy impact on the BCS depends on whether the country runs a surplus or a deficit. This result can be explained by different expectations on future policy in case of a deficit and a surplus. However, here it is crucial to remind that in the empirical model, there is no measure for the sustainability of the fiscal position in which case different results can emerge. For instance, there is no mechanism to treat country i, running one percent deficit and conducting an expansionary fiscal policy and country j, running eight percent deficit and conducting the same size expansionary policy.

Although I attempt to measure the impact of fiscal policy via instrumental variables, fiscal position variable still contains some endogeneity. It would be interesting to see the effects of structural fiscal policies implemented in the euro area as a future study.

One should accept the explanation of the results with a caveat as it is assumed that the ECB responds to each nation's fiscal policy the same. However, it is necessary to differentiate the impacts of the fiscal policies of big and small economies.

1.8 Appendix

1.8.1 Data Sources

Business Cycle Synchronization Measure Data

Real GDP: The raw data is obtained from OECD National Accounts Quarterly Data set. US Dollar in Millions. OECD reference year 2010, fixed PPPs, annual level, seasonally adjusted. I take the natural logarithm of the values and filter the data with HP method where $\lambda = 1600$. As next step I calculate the correlation of the outputs for each country pair.

Gross National Income: OECD National Accounts[36] is the data source. It is in Millions of US dollars and in annual frequency. I take the natural logarithm of the values and filter it with HP method where $\lambda = 100$. Similar to GDP measure, I calculate pair-wise correlation of GNI.

Industrial Production Index: OECD Revisions Analysis Dataset- Infra-annual Indicators, Index of Industrial Production. Monthly frequency, base year is 2010. (indicator: INDPROD, subject: TOT, measure: IDX2010, frequency: Q). λ I filter the industrial production index. Then I calculate the correlation of the production indices of countries with each other. Similarly, I follow the same steps for manufacture production index (INDPROD, MFG, IDX2010,Q).

Consumption: Private final consumption expenditure is in millions US dollars volume estimates PPPs OECD with reference year 2010. It is seasonally adjusted, quarterly data. I take the natural logarithm of the data, then I filter it with HP method, and then calculate the pair-wise correlations.

[36] OECD (2017), Gross national income (indicator). doi: 10.1787/8a36773a-en (Accessed on 21 June 2017)

Investment: For gross capital formation: it is from OECD. The subject is Gross capital formation. The measure is National Currency , chained volume estimates, national reference year, quarterly levels, seasonally adjusted. The unit is Euro in Millions, the reference year is 2010. Similarly I took the natural logarithm of the data then I filtered it with hp method. calculated the correlations.

Unemployment: From OECD, Main Economic Indicator. Subject is labor force survey, quarterly data, harmonized unemployment, monthly rates, all persons. The unit is in percentages. I took the differences of unemployment rates of each country pair for each quarter. Then I took the average of the absolute value of differences for the period that is of interest. It gives the average unemployment rate difference between two countries for that period.

Fiscal Policy Measure Data

Government Deficit: The raw data is collected from EuroStat, government statistics, Non-financial account, general government. Net Lending/Borrowing (budget) is percentage of GDP. Most of the series are seasonally and calendar adjusted. I adjust the unadjusted series with moving average method, following the literature. The files can be provided upon request. I remove cyclical output impacts from the series by cyclically adjusting following OECD method.

Government Gross Debt: Quarterly gross government debt is collected from EuroStat government statistics. The unit is percentage of GDP. I took the absolute difference for each country pair for t and averaged it. I didn't filter or seasonally adjust the data. Make sure there is no trend in the data. This is a stock variable. It is important to know how the raw data should be treated. The other point is the difference in this variable doesn't give deficit level. Net Lending/Borrowing and Gross Government Debt are not related. ESA 2010 deficit or surplus = net lending/borrowing. EDP government debt is defined as total consolidated gross debt at face value (currency and deposits, debt securities and loans)

Government Expenditure: Raw data for GDP and Government expenditures are collected from EuroStat (Namq10gdp). The series are chain linked volumes (reference year is 2010) in million Euros. They are seasonally and calendar adjusted data. For government expenditure measure, I calculated government expenditure as a percentage of GDP. Then I filtered the series with HP method. I took the absolute value of differences of government spending for each country pair.

Bilateral Trade: Raw data is collected from IMF Direction of Trade Data base. The export series gives value of exported goods in US dollars (free on board). The import series gives the value of imported goods in million US Dollars (Cost insurance freight). Bilateral trade flow for two countries are calculated as the total trade flow between these two countries divided by their total trade volume with respect to the world. Then I take the mean for the period and take the natural logarithm of it. I took the mean first because I didn't want the negatives and positives to cancel out each other. But I should try different method. Total Trade Volume to the euro zone and the non-euro zone countries:

Current Account Balance: Balance of payments data from OECD statistics. I used the current account per GDP values. Quarterly international trade statistics data set. I took the absolute value of differences of current account balances of the countries. Then I took the average of these differences for the period of interest.

Price Level Index: The harmonized consumer price index is from EuroStat. The base year is 2005. For the price differences , I take the ratio of CPI for each country , then I take the log of it and then I?took the average for the period.

Government Bond Yields Index: EMU convergence criterion series are quarterly data for bond yields. The Maastricht Treaty EMU convergence criterion series relates to interest rates for long-term government bonds denominated in national currencies. Selection guidelines require data to be based on central government bond yields on the secondary market, gross of tax, with a residual maturity of around 10 years. The bond or the bonds of the basket have to be replaced regularly to avoid any maturity drift. OECD Rates are very similar. Still need to figure out the main difference. I took the absolute difference and average it for the period.

Industrial Structure Similarity Eurostat data Gross value added and income A10 industry breakdowns ($namq_1 0_a 10$) industries: Agriculture, Industry, Manufacturing, Construction, Wholesale and retail trade, Information and communication, Financial and insurance activities, Real estate activities, Professional, scientific and technical activities; administrative and support service, public administration, defence, education, human health and social work , Arts, entertainment and recreation; other services activities.. They are seasonally and calendar adjusted. They are percentages of GDP for each country.

Broad measures of fiscal stance: Total Revenue, Total Expenditure, Government Consumption Expenditure, Net Interest Payments, Primary Balance, Tax revenues on production and imports, income and wealth, and products, Social benefits, Compensation of employees, Subsdy, debt in terms of loans, debt securities, currency and deposits, short term debt securities and loans, long term debt securities and loans.

Gravity variables: Geodist data set is from CEPII.

1.8.2 Cyclical Adjustment Method

I use the cyclical adjustment method that is one of the methods that are used by OECD and European Commission (Mourre et al., 2013[37]). The method has two steps. First the output gap is estimated by Hodrick-Prescott filter. Secondly the cyclical budget balance which is calculated by multiplying the output gap with the marginal rates of change of net budget balance with respect to GDP is removed from the actual government budget balance. The method is as the following;

$$BB^{cab} = BB^{act} - \varepsilon\left(\frac{Y^{act} - Y^{pot}}{Y^{pot}}\right)$$

where BB^{cab} is the cyclically adjusted budget balance per GDP, BB^{act} is the actual budget balance per GDP, ε is the marginal rates of change in net budget balance with respect to GDP, Y^{act} is actual GDP, Y^{pot} is the potential GDP or trend components of GDP that is calculated by HP filter. ε is computed by Mourre et al. (2014)[36].

1.8.3 Figures

Data	Data Source	Time Period	Frequency/Unit/Reference Year/Seasonally Adjusted
Real GDP	OECD National Accounts Quarterly Dataset	1999q1-2016q4	Quarterly, US Dollars, 2010, Fixed PPPs, Annual level SA
Industrial Production Index	OECD Revisions Analysis Dataset	1999q1-2016q4	Monthly, Index, end of quarter values
Consumption	OECD National Accounts Quarterly Dataset, Private Consumption	1999q1-2016q4	Quarterly, US Dollars, 2010, Fixed PPPs, Annual level SA
Investment	OECD National Accounts Quarterly Dataset, Gross Capital Formation	1999q1-2016q4	Quarterly, National Currency, chained volume estimates
Unemployment	OECD Main Economic Indicator Dataset, Labor Force Survey	1999q1-2016q4	Quarterly, Harmonized in percentages, all persons
Government Deficit	EuroStat Government Statistics Non-financial account, Net Lending/Borrowing	1999q1-2016q3	Quarterly, GDP %, SA (author's calculation)
Government Gross Debt	EuroStat Government Statistics Non-financial account, Gross Debt	1999q1-2016q3	Quarterly, GDP %, Stock variable
Government Expenditure	Eurostat (Namq10gdp)	1999q1-2016q3	Quarterly, Mn Euros, 2010, Chain linked vol., SA calendar adjusted, GDP %
Bilateral Trade Data	IMF Direction of Trade Dataset	1999q1-2016q3	Quarterly, US Dollars Mn, Export (free on board), Import (cost insurance
Current Account Balance	OECD Balance of Payment statistics Dataset	1999q1-2016q3	Quarterly, GDP %
Price Level Index	Eurostat Harmonized consumer price index	1999q1-2016q3	End of quarter values, Index, 2005,
Government Bond Yields Index	Eurostat EMU convergence rates	1999q1-2016q3	End of quarter values, Index

Figure 1.1: GDP movements and government budget balance for Germany and Ireland

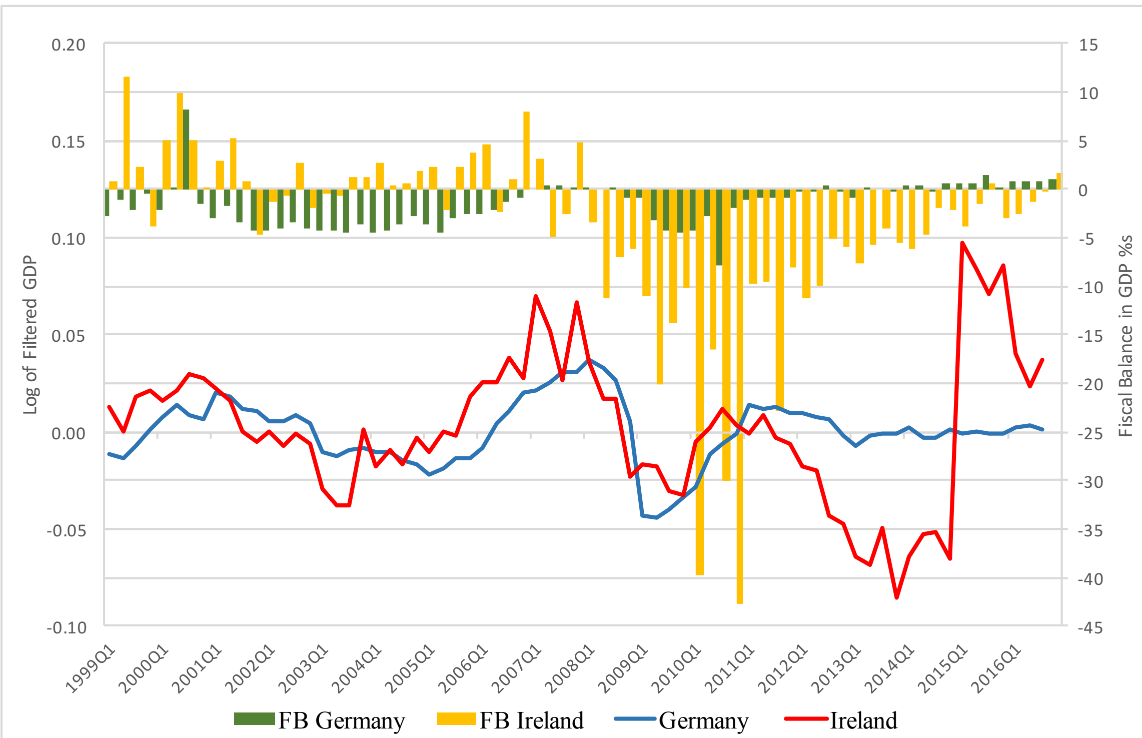


Figure 1.2: GDP correlations and fiscal deficit differences for 1999Q1-2016Q4

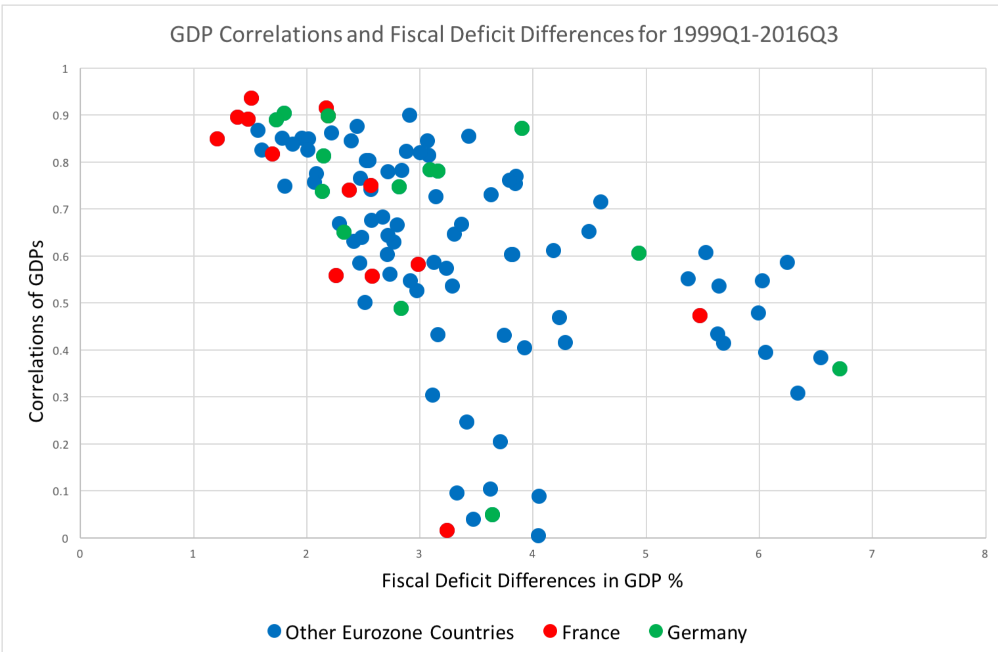


Figure 1.3: GDP correlations and fiscal balance differences for 1999Q1-2016Q4

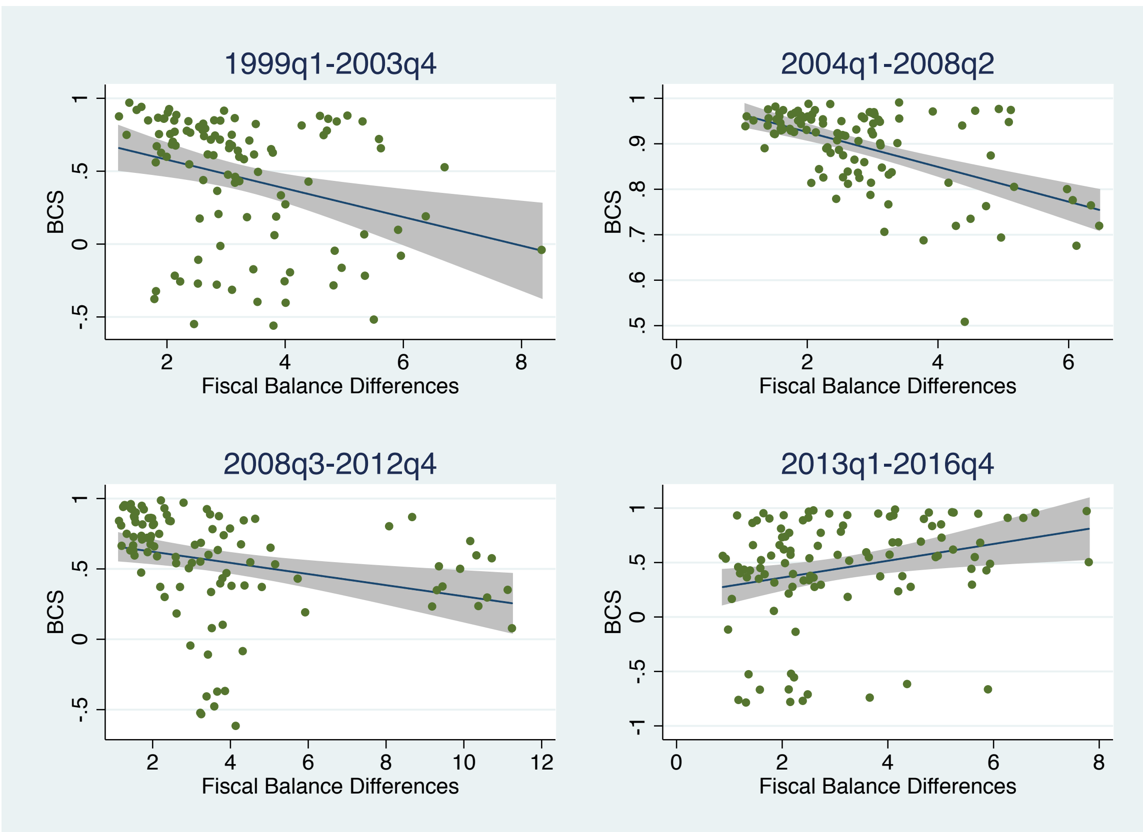


Figure 1.4: Mean of time-varying effect of primary balance differences on bilateral BCS.

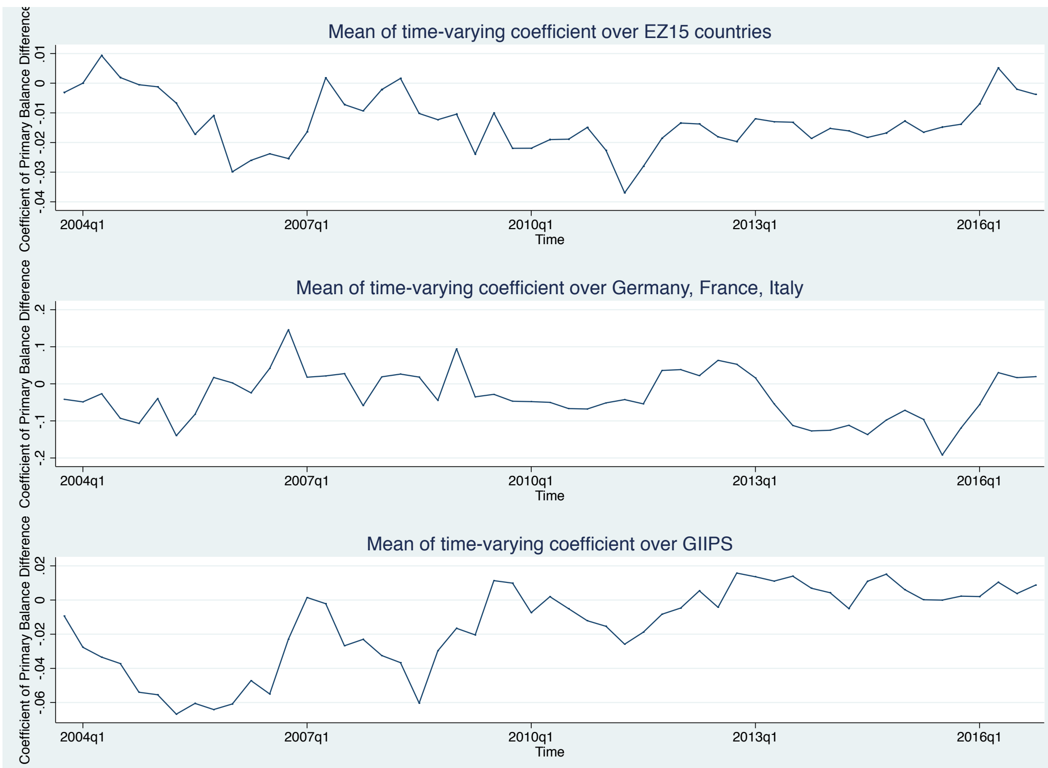
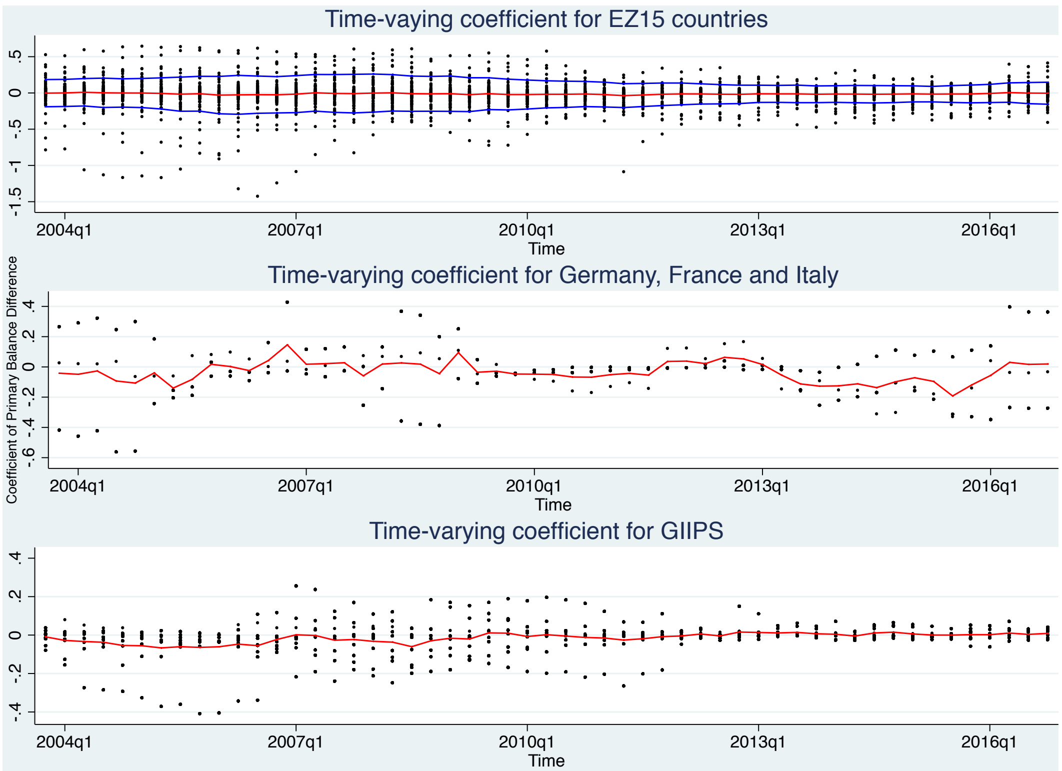


Figure 1.5: Time-varying effect of primary balance differences on bilateral BCS.



In the first row, mean of time-varying effect over all country pairs is shown with the red line. The blue lines give the band width of $\mp 2 mean_{overN}$(std.err.). Each dot refers to the effect of primary balance difference for a country pair at each quarter. Similarly, in the second row, the red line displays the mean of the coefficient over country pairs of three countries; Germany, France, and Italy. Hence each dot refers to the effect of primary balance difference for either Germany and France, or France and Italy, or Germany and Italy. In the third row, the graph is plotted with the same merit as the graph in the second row. It includes, however, Greece, Ireland, Italy, Portugal and Spain.

1.8.4 Tables

Table 1.1: Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
	overall	0.5891	0.4165	-0.7572	0.9908	N = 420
BCS	between		0.2251	-0.1347	0.9024	n = 105
	within		0.3509	-0.5368	1.4365	T = 4
	overall	4.1337	2.5290	0.5048	15.8435	N = 420
FD	between		1.7093	1.3982	9.4886	n = 105
	within		1.8695	-0.8768	13.0547	T = 4
	overall	41.7506	29.1336	0.8125	164.9467	N = 420
Debt	between		25.9031	4.5372	124.2198	n = 105
	within		13.5130	6.0570	82.4774	T = 4
	overall	2.1436	1.1736	0.2250	6.9278	N = 420
Debtdiff	between		0.7535	0.6551	4.1092	n = 105
	within		0.9020	-0.0175	5.6825	T = 4
	overall	-5.6349	1.5208	-9.8187	-2.6881	N = 420
BiTrade	between		1.5121	-8.9245	-2.7234	n = 105
	within		0.2071	-6.5292	-5.0939	T = 4
	overall	1.4332	1.0341	0.2747	6.6676	N = 420
nonEZvsEZTrade	between		1.0169	0.3317	5.3120	n = 105
	within		0.2068	0.3575	2.7888	T = 4
	overall	6.7703	4.3426	0.6514	21.1996	N = 420
CA	between		3.3332	1.7014	16.6698	n = 105
	within		2.7977	-1.9215	15.1906	T = 4
	overall	0.0439	0.0466	0.0021	0.2774	N = 420
CPI	between		0.0292	0.0074	0.1294	n = 105
	within		0.0364	-0.0737	0.1919	T = 4
	overall	1.3851	1.9851	0.0167	9.5567	N = 364
EMUrate	between		1.2146	0.0567	4.6247	n = 91
	within		1.5740	-2.9512	6.3171	T = 4
	overall	-3.2755	6.2050	-21.6966	0.6594	N = 420
SIP	between		6.1998	-20.8565	0.5054	n = 105
	within		0.5830	-4.9124	-1.5128	T = 4

Table 1.2: Descriptive statistics of various fiscal measure variables

Variable		Mean	Std. Dev.	Min	Max	Observations
TE	overall	7.1980	4.3286	0.6500	23.3188	N = 420
	between		3.8346	1.6054	17.9504	n = 105
	within		2.0341	1.1698	14.5995	T = 4
TR	overall	6.7958	4.3480	0.6333	23.7188	N = 420
	between		4.0914	0.9628	19.4639	n = 105
	within		1.5118	2.7149	14.9522	T = 4
GOV	overall	2.8344	2.0169	0.2000	10.8813	N = 420
	between		1.7536	0.5124	7.6139	n = 105
	within		1.0072	-0.3996	6.5131	T = 4
Debtdiff	overall	2.1436	1.1736	0.2250	6.9278	N = 420
	between		0.7535	0.6551	4.1092	n = 105
	within		0.9020	-0.0175	5.6825	T = 4
Primebalance	overall	4.3668	2.0310	0.9438	14.0944	N = 420
	between		1.2207	1.8374	8.1243	n = 105
	within		1.6265	-0.4175	12.2807	T = 4
Ntintpay	overall	2.0258	1.3542	0.0625	6.8735	N = 420
	between		1.1716	0.3169	5.4191	n = 105
	within		0.6864	-0.4778	4.0945	T = 4
Prodimp	overall	2.9495	1.7330	0.3938	8.7000	N = 420
	between		1.5226	0.7273	7.6718	n = 105
	within		0.8375	0.9211	7.1918	T = 4
Incwlth	overall	4.1099	2.1795	0.4375	11.0050	N = 420
	between		2.0919	1.1379	10.2019	n = 105
	within		0.6366	2.2119	6.0159	T = 4
Prdcts	overall	2.0848	1.5541	0.2389	8.7000	N = 420
	between		1.4364	0.3509	7.6718	n = 105
	within		0.6056	0.2933	4.5089	T = 4
Socbnft	overall	4.3079	2.9436	0.6222	16.0310	N = 420
	between		2.6407	0.8806	12.4917	n = 105
	within		1.3197	-0.1365	9.4321	T = 4
STdebt	overall	4.0903	2.0377	0.3556	9.8333	N = 351
	between		1.5833	1.1615	8.7324	n = 91
	within		1.2948	1.1338	8.1981	bar = 3.85714
STloans	overall	1.7707	1.1936	0.2600	6.9722	N = 351
	between		0.8688	0.3497	3.7240	n = 91
	within		0.8180	-0.3801	5.9221	bar = 3.85714
LTdebt	overall	6.6922	2.6435	1.7600	18.1067	N = 351
	between		1.7786	2.8879	11.7967	n = 91
	within		2.0015	-0.6044	13.0023	bar = 3.85714
LTloans	overall	2.6576	2.8478	0.4222	13.7889	N = 351
	between		1.6404	0.9788	7.5515	n = 91
	within		2.3317	-3.3991	11.2513	bar = 3.85714
FDwrtSGP	overall	9.0087	10.4913	0.2112	102.4853	N = 420
	between		6.5846	1.5273	37.4592	n = 105
	within		8.1866	-17.4522	74.0348	T = 4
FDbelowSGP	overall	2.7336	3.4210	0.0000	20.7038	N = 420
	between		1.9558	0.0553	8.6219	n = 105
	within		2.8117	-2.9324	15.8177	T = 4

Table 1.3: Descriptive statistics of new fiscal measure variables

Variable		Mean	Std. Dev.	Min	Max	Observations
	overall	6.4424	4.4696	0.1296	26.7038	N = 420
$newFD^b$	between		2.6744	1.3031	13.2116	n = 105
	within		3.5884	-1.2579	22.0125	T = 4
	overall	0.9293	1.3631	0.0000	7.7941	N = 420
$newFD^g$	between		0.9173	0.0000	3.9587	n = 105
	within		1.0112	-2.1376	4.7648	T = 4
	overall	6.3452	4.6903	0.0000	27.8734	N = 420
$newPrime^b$	between		3.2844	0.0610	15.2015	n = 105
	within		3.3599	-1.2262	20.8029	T = 4
	overall	1.9138	2.5647	0.0000	13.9018	N = 420
$newPrime^g$	between		2.0650	0.0000	9.0228	n = 105
	within		1.5311	-3.3371	6.8390	T = 4

Table 1.4: Basic Model Estimation

	(1)	(2)	(3)
VARIABLES	Pooled OLS	Fixed Effects	Random Effects
FD	-0.0525***	-0.0384***	-0.0506***
	(0.00721)	(0.00939)	(0.00716)
D2	0.419***	0.424***	0.420***
	(0.0380)	(0.0385)	(0.0381)
D3	0.157***	0.143***	0.155***
	(0.0356)	(0.0403)	(0.0361)
D4	-0.0476	-0.0369	-0.0461
	(0.0599)	(0.0599)	(0.0599)
Constant	0.674***	0.615***	0.666***
	(0.0425)	(0.0426)	(0.0423)
Observations	420	420	420
R-squared	0.285	0.304	
Number of pan_id		105	105

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively.

Table 1.5: POLS, FE, and RE estimations with control variables

VARIABLES	(1) Pooled OLS	(2) Fixed Effects	(3) Random Effects
FD	-0.0218***	-0.0180**	-0.0218***
	(0.00672)	(0.00799)	(0.00718)
BiTrade	0.0114	0.337***	0.0114
	(0.0124)	(0.0832)	(0.0117)
SIP	-0.00189	0.0666***	-0.00189
	(0.00227)	(0.0206)	(0.00204)
nonEZvsEZTrade	-0.0343	0.568**	-0.0343
	(0.0479)	(0.234)	(0.0438)
CA Diff	-0.0108***	-0.0184***	-0.0108***
	(0.00366)	(0.00510)	(0.00374)
CPI	-2.990***	-2.307***	-2.990***
	(0.743)	(0.756)	(0.718)
EMUrate	-0.0408***	-0.0104	-0.0408***
	(0.0125)	(0.0114)	(0.0100)
D2	0.254***	0.301***	0.254***
	(0.0481)	(0.0484)	(0.0431)
D3	0.101**	0.00982	0.101***
	(0.0470)	(0.0568)	(0.0355)
D4	0.0765	-0.0601	0.0765
	(0.0518)	(0.0821)	(0.0620)
Constant	0.911***	2.878***	0.911***
	(0.0589)	(0.417)	(0.0556)
Observations	364	364	364
R-squared	0.441	0.489	
Number of pan_id		91	91

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively.

Table 1.6: First stage OLS results of 3SLS estimation for endogenous variables; fiscal balance and bilateral trade.

	OLS	
VARIABLES	FD	BiTrade
GovtPoliticalPosition	0.694***	
	(0.170)	
GovtsLeftTerm	1.719**	
	(0.762)	
PowerDistribution	0.384	
	(0.432)	
Working/Age over65	1.236	
	(1.028)	
Distance		-0.516***
		(0.142)
Common Ethnicity		1.002**
		(0.392)
Contagious		1.334***
		(0.311)
GrowthDiff		-0.0150
		(0.102)
Constant	-2.759	-2.355**
	(1.715)	(1.026)
Observations	200	200
R-squared	0.542	0.358
Number of group		

Note: Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country pair dummies and period dummies are included but not reported.

Table 1.7: 3SLS, one-step GMM, and two-step GMM estimations

	IV	GMM	
VARIABLES	3SLS	One-step	Two-step
FD	-0.0439***	-0.0385***	-0.0385***
	(0.0146)	(0.0107)	(0.0127)
BiTrade	0.0374**	0.0493**	0.0507**
	(0.0174)	(0.0194)	(0.0205)
SIP	-0.0121***	-0.0117***	-0.0129***
	(0.00438)	(0.00363)	(0.00355)
nonEZvsEZTrade	-0.0892	-0.0958	-0.0976
	(0.0702)	(0.0798)	(0.0825)
CA	-0.0271***	-0.0301***	-0.0329***
	(0.00758)	(0.00751)	(0.00917)
CPI	-3.446***	-3.642***	-3.375***
	(0.489)	(0.476)	(0.774)
Constant	1.049***	1.127***	1.116***
	(0.0939)	(0.101)	(0.0966)
Observations	200	200	200
R-squared	0.501		
Number of group		100	100

Note: Robust standard errors are in parentheses for GMM estimations. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. Bilateral trade and fiscal measures are assumed to be endogenous. Country pair dummies and period dummies are included but not reported.

Table 1.8: POLS, FE and 3SLS estimations with interactive fiscal measure dummies

VARIABLES	Pooled OLS	Fixed Effects	3SLS
D1FD	-0.0607***	-0.0582***	-0.274***
	(0.0154)	(0.0158)	(0.0861)
D2FD	-0.00678	0.0141	-0.0525
	(0.00697)	(0.0146)	(0.0679)
D3FD	-0.0394***	-0.0240***	0.0222
	(0.0100)	(0.00872)	(0.0432)
D4FD	-0.00247	0.0425*	0.135**
	(0.0157)	(0.0229)	(0.0675)
BiTrade	0.0352***	0.172**	0.335
	(0.0111)	(0.0758)	(0.251)
SIP	-0.00522**	0.0909***	0.101**
	(0.00221)	(0.0235)	(0.0474)
nonEZvsEZTrade	-0.0424	0.307	-0.341
	(0.0507)	(0.298)	(0.370)
CA Diff	-0.00911**	-0.00811*	0.00408
	(0.00372)	(0.00469)	(0.00908)
CPI	-3.538***	-3.817***	-2.574***
	(0.350)	(0.484)	(0.915)
Constant	0.898***	1.778***	3.330***
	(0.0896)	(0.451)	(1.153)
Observations	420	420	335
R-squared	0.502	0.523	0.441
Number of group		105	

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively. Bilateral trade and fiscal measures with interactive dummies are assumed to be endogenous.

Table 1.9: POLS, FE and RE estimations with quasi-correlation GDP.

VARIABLES	(1) POLS	(2) FE	(3) RE
FD	0.00975	0.0165**	0.0107**
	(0.00726)	(0.00638)	(0.00547)
D1FD	0.0219	-0.0538***	-0.0509***
	(0.0187)	(0.0128)	(0.0121)
D2FD	-0.00616	-0.0493***	-0.0502***
	(0.0249)	(0.0168)	(0.0153)
D3FD	-0.0203*	-0.0508***	-0.0482***
	(0.0107)	(0.00892)	(0.00861)
BiTrade	0.0179	0.309***	0.0398***
	(0.0191)	(0.0739)	(0.0153)
SIP	-0.00128	0.00301	0.00189
	(0.00202)	(0.00347)	(0.00158)
nonEZvsEZTrade	-0.215***	-0.278	-0.0273
	(0.0706)	(0.265)	(0.0673)
CA Diff	-0.000107	-0.000180**	-0.000192***
	(8.09e-05)	(7.43e-05)	(7.33e-05)
CPI	-0.911	1.416***	1.263***
	(0.549)	(0.444)	(0.469)
EMUrate	-0.0269	0.673***	0.673***
	(0.0474)	(0.0256)	(0.0258)
D1	0.165	-1.504***	-1.453***
	(0.190)	(0.0943)	(0.0784)
D2	0.438**	-0.229***	-0.138*
	(0.179)	(0.0862)	(0.0776)
D3	0.194	0.151**	0.173**
	(0.125)	(0.0750)	(0.0853)
Constant	0.557***	2.104***	0.552***
	(0.110)	(0.482)	(0.0868)
Observations	6,259	6,317	6,317
R-squared	0.022	0.259	
Number of group		91	91

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively.

Table 1.10: POLS, FE and RE estimations with quasi-correlation GDP for primary balance and net interest payments differences.

VARIABLES	(1) POLS	(2) FE	(3) RE
Primbalance	0.0130**	0.0181***	0.0152***
	(0.00541)	(0.00603)	(0.00563)
Ntintpay	-0.0627***	-0.0455***	-0.0545***
	(0.0128)	(0.0159)	(0.0124)
D1Primbalance	-0.0493***	-0.0485***	-0.0502***
	(0.00974)	(0.0102)	(0.00987)
D2Primbalance	-0.0208	-0.0212*	-0.0203
	(0.0128)	(0.0126)	(0.0126)
D3Primbalance	-0.0299***	-0.0329***	-0.0312***
	(0.00619)	(0.00712)	(0.00648)
BiTrade	0.0284*	0.300***	0.0420***
	(0.0144)	(0.0741)	(0.0153)
SIP	0.00138	0.00323	0.00178
	(0.00161)	(0.00356)	(0.00174)
nonEZvsEZTrade	-0.00361	-0.298	-0.0354
	(0.0652)	(0.258)	(0.0687)
CA Diff	-0.000205***	-0.000181**	-0.000191***
	(7.32e-05)	(7.50e-05)	(7.39e-05)
CPI	1.217***	1.404***	1.243***
	(0.456)	(0.442)	(0.461)
EMUrate	0.674***	0.673***	0.673***
	(0.0247)	(0.0242)	(0.0246)
D1	-1.442***	-1.517***	-1.444***
	(0.0705)	(0.0880)	(0.0703)
D2	-0.238***	-0.330***	-0.247***
	(0.0649)	(0.0746)	(0.0629)
D3	0.0837	0.0616	0.0840
	(0.0758)	(0.0639)	(0.0733)
Constant	0.600***	2.123***	0.650***
	(0.0889)	(0.479)	(0.0903)
Observations	6,317	6,317	6,317
R-squared	0.252	0.255	
Number of group		91	91

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively.

Table 1.11: First stage OLS results of 3SLS estimation

VARIABLES	newFD^g	OLS newFD^b	BiTrade
GovPosition	-0.0334	0.222**	
	(0.0324)	(0.0903)	
Working/Age +65	-0.00604	-0.0150	
	(0.0195)	(0.0544)	
GovtsLeftTerm	-0.226***	0.174	
	(0.0562)	(0.156)	
PowerDistribution	0.187	-0.181	
	(0.131)	(0.365)	
Distance			-0.617***
			(0.123)
Common Ethnicity			0.759**
			(0.332)
Contagious			1.357***
			(0.268)
Constant	0.481	3.943*	-1.501*
	(0.727)	(2.025)	(0.898)
Observations	279	279	279
R-squared	0.510	0.482	0.383
Number of group			

Note: Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time and country pair dummies are included in the estimation but not reported. As the new fiscal measure is addition of the fiscal measures for country pairs (not fiscal divergence), accordingly the instrumental variables are addition of the values of each instrument for country pairs.

Table 1.12: POLS, 3SLS and GMM-IV estimations with new fiscal stance measures.

VARIABLES	POLS	3SLS	GMM-IV
newFD^g	0.0379***	0.0567**	0.0346*
	(0.0105)	(0.0260)	(0.0190)
newFD^b	-0.0199***	-0.0390***	-0.0422***
	(0.00446)	(0.00834)	(0.00693)
BiTrade	0.0422***	0.0477***	0.0420***
	(0.0114)	(0.0147)	(0.0146)
SIP	0.00381	0.0101**	0.00891**
	(0.00246)	(0.00458)	(0.00447)
nonEZvsEZTrade	-0.129**	-0.0736	-0.0489
	(0.0512)	(0.0642)	(0.0628)
CA Diff	-0.0136***	-0.0138***	-0.0129**
	(0.00341)	(0.00520)	(0.00550)
CPI	-4.047***	-3.929***	-4.164***
	(0.374)	(0.444)	(0.463)
Constant	1.135***	1.193***	1.195***
	(0.0685)	(0.0896)	(0.0891)
Observations	420	279	279
R-squared	0.505	0.533	
Number of group			84

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. Time and country pair dummies are included in the estimation but not reported.

Table 1.13: POLS, 3SLS and GMM-IV estimations with time dummy interactions of new fiscal stance measures.

VARIABLES	(1) POLS	(2) 3SLS	-3 GMM-IV
D1newFD^g	-0.0217	-0.0158	0.0137
	(0.0173)	(0.0469)	(0.0143)
D2newFD^g	-0.00455	-0.0265	0.00879
	(0.0147)	(0.0543)	(0.0115)
D3newFD^g	0.110*	-0.272**	0.101**
	(0.0619)	(0.136)	(0.0491)
D4newFD^g	0.0882	-0.0629	0.0385
	(0.0594)	(0.217)	(0.0701)
D1newFD^b	-0.0965***	-0.111***	-0.0753***
	(0.0147)	(0.0317)	(0.0151)
D2newFD^b	-0.00783	-0.105***	-0.000145
	(0.00744)	(0.0400)	(0.00733)
D3newFD^b	-0.0260***	-0.0748***	-0.0509***
	(0.00688)	(0.0184)	(0.00651)
D4newFD^b	0.0718***	0.0743***	0.0725***
	(0.00920)	(0.0277)	(0.00835)
BiTrade	0.0587***	0.0316**	0.0449***
	(0.0113)	(0.0143)	(0.00810)
nonEZvsEZTrade	-0.0866	0.0476	0.0371
	(0.0574)	(0.0661)	(0.0376)
CA Diff	-0.00964**	-0.00632	-0.00839***
	(0.00371)	(0.00543)	(0.00290)
CPI	-2.845***	-2.474***	-3.261***
	(0.463)	(0.638)	(0.411)
SIP	-0.00101	0.00383	0.00600***
	(0.00264)	(0.00494)	(0.00202)
Constant	0.543***	0.299	0.459***
	(0.101)	(0.215)	(0.0841)
Observations	420	279	279
R-squared	0.637	0.609	
Number of group			84

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively. Time and country pair dummies are included but not reported.

Table 1.14: First stage OLS results of 3SLS estimation with new fiscal measure.

		OLS	
VARIABLES	newPrime^g	newPrime^b	BiTrade
GovPosition	-0.0643	0.178**	
	(0.0479)	(0.0827)	
Working/Age +65	-0.0313	0.0159	
	(0.0289)	(0.0498)	
GovtsLeftTerm	-0.274***	0.0862	
	(0.0831)	(0.143)	
PowerDistribution	0.290	0.358	
	(0.193)	(0.334)	
Distance			-0.621***
			(0.123)
Common Ethnicity			0.758**
			(0.332)
Contagious			1.353***
			(0.268)
Constant	0.902	2.832	-1.476
	(1.075)	(1.854)	(0.897)
Observations	279	279	279
R-squared	0.665	0.634	0.383
Number of group			

Note: Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time and country pair dummies are included in the estimation but not reported. As the new fiscal measure is addition of the fiscal measures for country pairs (not fiscal divergence), accordingly the instrumental variables are addition of the values of each instrument for country pairs.

Table 1.15: POLS, 3SLS and GMM-IV estimations with new fiscal stance measures.

VARIABLES	(1) POLS	(2) 3SLS	(3) GMM-IV
newPrime^g	0.00433	0.0193	-0.00323
	(0.00667)	(0.0144)	(0.0112)
newPrime^b	-0.0256***	-0.0359***	-0.0443***
	(0.00426)	(0.00688)	(0.00583)
BiTrade	0.0329***	0.0313**	0.0239*
	(0.0105)	(0.0142)	(0.0144)
SIP	0.00346	0.0102**	0.00656
	(0.00250)	(0.00500)	(0.00480)
nonEZvsEZTrade	-0.0789*	-0.0490	-0.0101
	(0.0465)	(0.0618)	(0.0616)
CA Diff	-0.0116***	-0.0119**	-0.0107*
	(0.00300)	(0.00513)	(0.00547)
CPI	-3.897***	-3.534***	-3.895***
	(0.352)	(0.422)	(0.451)
Constant	1.086***	1.013***	1.059***
	(0.0663)	(0.0795)	(0.0821)
Observations	420	279	279
R-squared	0.521	0.558	
Number of group			84

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. Time and country pair dummies are included in the estimation but not reported.

Table 1.16: POLS, 3SLS, and GMM-IV estimations with time dummy interactions of new fiscal stance measures.

VARIABLES	(1) POLS	(2) 3SLS	(3) GMM-IV
$D1newPrime^g$	-0.0203**	0.00706	-0.0150
	(0.00877)	(0.0229)	(0.0103)
$D2newPrime^g$	0.00314	-0.000446	0.00656
	(0.00654)	(0.0293)	(0.00596)
$D3newPrime^g$	-0.00407	-0.0775	-0.0292*
	(0.0240)	(0.0787)	(0.0175)
$D4newPrime^g$	-0.00385	-0.0312	-0.0252
	(0.0202)	(0.0551)	(0.0204)
$D1newPrime^b$	-0.0889***	-0.0982***	-0.0970***
	(0.0107)	(0.0209)	(0.0107)
$D2newPrime^b$	-0.00104	-0.0411	0.000116
	(0.00485)	(0.0273)	(0.00549)
$D3newPrime^b$	-0.0347***	-0.0599***	-0.0587***
	(0.00784)	(0.0161)	(0.00647)
$D4newPrime^b$	0.0354***	0.0505**	0.0352***
	(0.00937)	(0.0219)	(0.00975)
BiTrade	0.0413***	0.0351***	0.0262***
	(0.00948)	(0.0133)	(0.0102)
nonEZvsEZTrade	-0.0536	-0.00323	0.0171
	(0.0464)	(0.0561)	(0.0370)
CA Diff	-0.00723**	-0.00436	-0.00345
	(0.00317)	(0.00542)	(0.00232)
CPI	-3.546***	-3.461***	-3.539***
	(0.359)	(0.358)	(0.243)
SIP	-0.000187	0.00392	0.00520***
	(0.00224)	(0.00504)	(0.00190)
Constant	0.736***	0.548***	0.631***
	(0.1000)	(0.158)	(0.0908)
Observations	420	279	279
R-squared	0.641	0.668	
Number of group			84

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively. Time and country pair dummies are included but not reported.

Table 1.17: POLS, FE and 3SLS estimations with different BCS measures

	Manufacture Production			Investment		
VARIABLES	POLS	FE	3SLS	POLS	FE	3SLS
FD	-0.0431***	-0.0349***	-0.0571***	-0.0223***	-0.00835	-0.0436***
	(0.00655)	(0.00766)	(0.00933)	(0.00592)	(0.00751)	(0.00883)
BiTrade	0.00773	-0.00318	-0.00927	0.0568***	0.188**	0.0291***
	(0.0108)	(0.0772)	(0.0118)	(0.0113)	(0.0732)	(0.0112)
SIP	-0.00237	0.0561**	-0.000506	0.00666***	0.0873***	0.00582**
	(0.00220)	(0.0234)	(0.00262)	(0.00206)	(0.0254)	(0.00248)
nonEZvsEZTrade	0.0961**	0.431	0.0966**	-0.0442	0.103	-0.0233
	(0.0447)	(0.293)	(0.0477)	(0.0440)	(0.267)	(0.0451)
CA Diff	-2.75e-05	-0.00255	0.00202	-0.00391	-0.00641	-0.000541
	(0.00342)	(0.00537)	(0.00416)	(0.00336)	(0.00477)	(0.00393)
CPI	-2.396***	-2.576***	-2.674***	-1.058***	-0.705*	-1.312***
	(0.381)	(0.485)	(0.373)	(0.385)	(0.394)	(0.352)
Constant	0.807***	0.938**	0.470***	0.745***	1.681***	0.659***
	(0.0582)	(0.445)	(0.0650)	(0.0544)	(0.404)	(0.0615)
Observations	420	420	348	420	420	348
R-squared	0.503	0.551	0.532	0.403	0.363	0.443
Number of pan_id		105			105	

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively.

Table 1.18: POLS, FE and 3SLS estimations with different BCS measures

	Consumption			National Income		
VARIABLES	POLS	FE	3SLS	POLS	FE	3SLS
FD	-0.00643	-0.00992	0.00220	-0.0342***	-0.0100	-0.0603***
	(0.00679)	(0.00808)	(0.0126)	(0.0111)	(0.0148)	(0.0181)
BiTrade	0.0380**	0.346***	0.0228	0.0635***	0.361***	0.0364
	(0.0148)	(0.0829)	(0.0159)	(0.0189)	(0.126)	(0.0229)
SIP	0.00894***	0.0623**	0.00426	-0.00626*	-0.0606	-0.00959*
	(0.00306)	(0.0263)	(0.00353)	(0.00351)	(0.0440)	(0.00509)
nonEZvsEZTrade	-0.0157	-0.496	-0.00434	-0.0651	-0.115	0.0722
	(0.0583)	(0.336)	(0.0643)	(0.0892)	(0.506)	(0.0928)
CA Diff	-0.0112**	-0.0126**	-0.0150***	-0.0199***	-0.00826	-0.0210***
	(0.00493)	(0.00568)	(0.00561)	(0.00628)	(0.00969)	(0.00807)
CPI	-0.992**	-1.186**	-0.191	1.595*	2.803***	0.996
	(0.500)	(0.492)	(0.502)	(0.851)	(0.972)	(0.723)
Constant	0.540***	2.441***	0.625***	0.875***	2.155***	0.485***
	(0.0912)	(0.459)	(0.0877)	(0.0915)	(0.694)	(0.126)
Observations	420	420	348	420	420	348
R-squared	0.281	0.344	0.263	0.327	0.387	0.329
Number of pan_id		105			105	

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively.

Table 1.19: POLS, FE AND GMM-IV estimations with different fiscal measures

VARIABLES	(1) POLS	(2) FE	(3) GMM-IV	(4) POLS	(5) FE	(6) GMM-IV	(7) POLS	(8) FE	(9) GMM-IV
Tot. Rev.	-0.00605	0.0212**	-0.0156*						
	(0.00620)	(0.00984)	(0.00817)						
Tot. Exp.	0.00796	0.0257***	0.0277***						
	(0.00581)	(0.00850)	(0.00772)						
Gov't. Exp.				0.0153**	0.0135	0.0216**			
				(0.00601)	(0.0147)	(0.00974)			
Change in Debt							-0.0246	-0.0249	-0.000868
							(0.0165)	(0.0235)	(0.0165)
BiTrade	0.0193	0.338***	0.00266	0.0182	0.349***	-0.00421	0.0207*	0.354***	0.0134
	(0.0131)	(0.0859)	(0.0177)	(0.0122)	(0.0869)	(0.0146)	(0.0122)	(0.0876)	(0.0131)
SIP	0.000303	0.0299	0.00467*	0.000111	0.0697***	0.00270	-0.000627	0.0742***	0.000224
	(0.00233)	(0.0219)	(0.00254)	(0.00219)	(0.0212)	(0.00207)	(0.00203)	(0.0204)	(0.00185)
nonEZvsEZTrade	-0.0657	0.637**	-0.0622	-0.0535	0.608**	-0.0183	-0.0639	0.600**	-0.0448
	(0.0467)	(0.262)	(0.0580)	(0.0458)	(0.256)	(0.0480)	(0.0458)	(0.252)	(0.0495)
CA Diff	-0.0125***	-0.0251***	-0.0103***	-0.0139***	-0.0200***	-0.0138***	-0.0133***	-0.0188***	-0.0124***
	(0.00377)	(0.00504)	(0.00361)	(0.00382)	(0.00504)	(0.00360)	(0.00373)	(0.00498)	(0.00348)
CPI	-3.022***	-2.467***	-3.613***	-3.172***	-2.407***	-3.855***	-3.134***	-2.361***	-3.504***
	(0.744)	(0.721)	(0.746)	(0.733)	(0.774)	(0.729)	(0.740)	(0.783)	(0.750)
EMUrate	-0.0514***	-0.0169*	-0.0669***	-0.0481***	-0.0156	-0.0643***	-0.0420***	-0.00860	-0.0462***
	(0.00904)	(0.00976)	(0.00817)	(0.00860)	(0.0110)	(0.00860)	(0.0102)	(0.0132)	(0.0108)
D2			0.221***			0.215***			0.242***
			(0.0419)			(0.0401)			(0.0451)
D3			0.134***			0.0931**			0.0859**
			(0.0350)			(0.0374)			(0.0400)
D4			0.0811			0.0723			0.0935
			(0.0634)			(0.0628)			(0.0617)
Constant	0.875***	2.453***	0.768***	0.859***	2.869***	0.787***	0.935***	2.966***	0.880***
	(0.0575)	(0.465)	(0.0766)	(0.0581)	(0.441)	(0.0688)	(0.0549)	(0.433)	(0.0619)
Observations	364	364	364	364	364	364	364	364	364
R-squared	0.429	0.516		0.432	0.481		0.429	0.483	
Number of pan_id		91	91		91	91		91	91

Note: Robust standard errors are in parentheses. They are clustered by country pairs. *** p<0.01, ** p<0.05, * p<0.1. D2, D3, and D4 refer to the time period dummies for 2004q1-2008q2, 2008q3-2012q4, and 2013q1-2016q4, respectively. Time dummies are not reported.

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Chapter 2

The Optimal Timing of Fiscal Consolidation Around the Zero Lower Bound

2.1 Introduction

Aftermath of the global financial crisis of 2008, the economies of the United States, and the United Kingdom are distressed with high levels of debt which were resulted from the expansionary fiscal policies in 2008 and beyond (Figure 2.1). The reason that these countries relied heavily on fiscal policy was that with the financial crash, the policy interest rates reached to minimum levels, i.e., zero lower bound, leaving no room for monetary policy (Figure 2.2). In 2011 when this paper was written, the UK started fiscal consolidation rather earlier than the US. The critics of this early retrenchment pointed out the possibility of slowing down the economy even further when the interest rates were so close to zero. Whereas, in the US, the condition of the economy was downgraded due to the doubts in sustainability of high levels of debt whilst the fiscal consolidation wasn't seen in the horizon.

Currently the zero lower bound is not binding for the US anymore[1] and the Bank of England is signalling the possibility of rising the official rates sooner.[2] However, the European

[1] Federal Reserve FOMC statement https://www.federalreserve.gov/newsevents/pressreleases/monetary 20170614a.htm

[2] In June 2017, the monetary policy committee decided to keep the rates at its lowest point with a three out of eight votes for a rise to keep inflation as targeted https://www.theguardian.com/business/2017/jun/15/bank-of-england-uk-interest-rates-inflation

Central Bank (ECB) still keeps the lower rates in the second period of 2017 (Figure 2.2) and announces they will remain unchanged "*...for an extended period of time, and well past the horizon of the net asset purchases.*"[3] Moreover, in this economic environment, the euro zone countries are adopting fiscal austerity measures which makes the research on the fiscal consolidation and its timing around the zero lower bound still relevant.

In this paper I study different timing of future fiscal consolidation once the economy is hit by a large recessionary demand shock and the interest rate endogenously falls to the zero lower bound (ZLB). I compare the impacts of early and late fiscal consolidations by analyzing the fluctuations in the economy, such as the duration of ZLB, output and consumption level, labor supply and so on. I also study the welfare gains (loss) in case of different timing of government spending reversals. I allow the interest rate endogenously to hit the ZLB and then endogenously to exit the ZLB. Therefore, the duration that the economy stays at the ZLB is also endogenously determined.

In the baseline model, I borrow the perfect foresight New-Keynesian closed economy model with sticky prices a la Calvo, following Corsetti et al. (2010)[19]. The economy is hit by a negative time preference shock which is a standard way to generate a drop in aggregate demand and the ZLB becomes endogenously binding. Government spending increases for eight quarters to stimulate the economy. Some time after the end of fiscal stimulus, government expenditure drops below the steady state levels to do the fiscal retrenchment with the same amount of initial fiscal expansion. Government spending is financed by debt so that lump-sum tax is constant. In the baseline set up there is no distortionary taxation. Time between the end of fiscal stimulus and the beginning of the fiscal retrenchment is defined as time gap. I analyze the effect of current and future fiscal policy and study welfare implications for different time gap values. Both stimulus and future consolidation are known to the public at the time of the demand shock and policy is conducted under full commitment.

[3]Monetary policy decisions http://www.ecb.europa.eu/press/pr/date/2017/html/ecb.mp170608.en.html

In the second part of the paper, I augment the model with fiscal rules. I utilize automatic stabilizer coefficients, estimated for the US economy by Leeper et al. (2010)[44]. In this set up, the fiscal tools such as lump-sum tax or labor income tax or government spending are endogenously determined by the output level and the debt to output ratio. Fiscal retrenchment refers to the additional government spending cuts some time after the increase in government spending.

In parallel to the findings of many theoretical and empirical results (Eggertsson, 2001[25]; Eggertsson, 2011[26]; Parker, 2011[50]), I first show that the magnitude of the effect of the fiscal policy depends on whether the economy is at the ZLB. For instance, if the nominal interest rate is at the ZLB, the deflationary effect of reducing the government spendings increases the real interest rate, i.e., the relative cost of current consumption which results in further contraction in the economy.

Government spending cuts have contractionary effect on output at the time of implementation. Nevertheless, similar to the findings of Corsetti et al. (2010)[19] and Corsetti et al. (2012)[18], I show that future government spending cuts may amplify the stimulating effect of today's fiscal expansion, depending on time gap between the expansion and the cuts. The intuition behind this result is as follows: future government spending cuts imply a decline in aggregate demand and the price level. If the economy is at the ZLB when future government spending reversal takes place, the fall in price level increases future real interest rate which reduces future consumption and output. If the fiscal contraction comes some time after the recovery of the economy such that nominal interest rate is sufficiently away from the ZLB, (hence the monetary policy has room to respond to deflationary effect of spending cuts by reducing the nominal interest rate) this will lower future real interest rate and hence increases future consumption and current consumption through consumption smoothing. Therefore, the fiscal stimulus that is followed by an anticipated future fiscal contraction that comes in a timely manner has bigger positive impact on the economy.

To determine when to implement government spending cuts, I perform welfare analysis. In the baseline set up, the optimal time gap to do the fiscal retrenchment is three years after the end of fiscal stimulus. The cuts that are implemented just after the end of the stimulus are not welfare-improving. In fact, welfare cost of doing the fiscal retrenchment earlier is much higher than welfare cost of delaying it to later periods.

I find that the amplification of current fiscal stimulus by future government spending cuts is stronger when the lump-sum tax plays a role as an automatic stabilizer. Yet this still depends on the time gap. If lump-sum tax responds to the output and the debt to output ratio, future government spending cuts, implemented at the optimal period, imply not only lower future real interest rate both also lower lump-sum tax which increases future consumption, today's consumption and the output even further.

Similarly, if distortionary income tax endogenously responds to output and debt to output ratio, the amplification effect of future spending cuts at the optimal time period on current stimulus will be mitigated. This stems from the fact that future spending cuts increase future consumption further because of the lower real interest rate and the lower income tax rate. This helps the economy exit from the ZLB earlier. Therefore, the monetary policy can effectively increase the nominal interest rate in response to the additional consumption rise due to future government spending and consequently amplification effect is weaken.

Last but not least, I show that if government spending cuts endogenously determined by output and debt to output ratio, the spending reversal has insignificant stimulating effect. Moreover, if the government cuts spending further in addition to the endogenous spending reversal, the welfare gain from additional spending cuts is negligible. Spending cuts at the optimal timing is as welfare costly as not implementing it.

There has been a growing interest in the fiscal multipliers[4], the zero lower bound[5] and the effectiveness of the fiscal policy at the zero lower bound[6] aftermath of the financial crash in 2008.[7] My paper contributes to the literature, focusing on the future fiscal consolidation as an exit strategy from expansionary fiscal policies during the crisis, its interaction with the zero lower bound, and the timing of the fiscal consolidation. Unlike other studies, I search for the optimal timing of the fiscal consolidation at the ZLB. I also augment the model with different fiscal rules, allowing distortionary and automatic fiscal stabilization mechanisms.

In the literature there are studies with models of endogenously binding ZLB (Corsetti et al.(2010)[19];Nakata (2016, 2017)[47]**nakata2017optimal**; Eggertsson and Singh (2016)[29]). In my paper I follow Corsetti et al. (2010)[19]. Although Corsetti et al. (2010) also demonstrates the importance of the timing of the future fiscal consolidation, differently I analyze the welfare implications of the timing, rather than only focusing on the impact multiplier. I obtain the optimal timing of future fiscal consolidation in extent of the specifications of the presumed fiscal rules.[8][9]

The rest of paper is organized as follows. Next section presents the model and calibration. Section 3 analyzes impulse responses and performs welfare analysis. Section 4 studies different fiscal rules such as lump-sum taxation, distortionary income taxation, and government spending rule. Section 5 concludes.

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[4]Gali, Lopez-Salido and Valles (2007)[36]; Monacelli and Perotti (2008)[46]; Ramey (2011)[53]; Woodford (2011)[61]; Christiano et al. (2011)[15]

[5]Swanson and Williams (2014)[59]; Fernandez-Villaverde et al. (2015)[34]; Lim and McNelis (2016)[45]; Flotho (2017)[35]

[6]Eggertsson (2001)[25]; Wieland (2014)[60]; Christiano, Eichenbaum, and Rebelo (2009)[14]; Corsetti et al. (2010)[19], Corsetti et al. (2012)[18]; Eggertsson (2011)[26]; Eggertsson and Krugman (2012)[28]; Erceg and Linde (2014)[33]

[7]For fiscal multipliers in a "Real Business Cycle" setting, see Baxer and King (1993)[5]; Aiyagari, Christiano and Eichenbaum (1992)[4]; Burnside, Eichenbaum and Fisher (2004)[13]

[8]There are also papers, demonstrating the timing and the size of fiscal consolidation such as Blanchard and Leigh (2013)[9]. However, they do not study the welfare implications.

[9]Schmidt (2013)[55]; Nakata et al. (2011)[48]; Paltalidis (2017)[49] also study the optimal fiscal policy which the timing of the optimal fiscal policy can be inferred.

2.2 The Model

I start my analysis with a standard New-Keynesian model with sticky prices a la Calvo in the product market. There are infinite number of households indexed by $i \in [0,1]$. Each maximizes expected life-time utility over consumption $C_{i,t}$ and hours of work N_{it} ;

$$\max_{C_t,N_t,b_t} E_t \sum_{s=0}^{\infty} \bar{e}_{t+s}\beta^s \left[\log C_{i,t+s} - \chi \frac{N_{i,t+s}^{1+\omega}}{1+\omega}\right] \tag{2.1}$$

subject to the budget constraint.

$$C_{i,t} + T_{i,t} + b_{i,t} = N_{i,t}w_t + b_{i,t-1}\frac{R_{t-1}}{\pi_t} + D_{i,t} \tag{2.2}$$

where $\chi, \omega > 0$, β denotes the time discount factor and $\bar{e}_t$ is the demand shock which provides a mechanism for the binding ZLB in the economy. w_t denotes the real wage rate. b_t equals to $\frac{B_t}{P_t}$ and B_t denotes nominal government bonds with a nominal gross return rate R_t.π_t is the inflation rate $\frac{P_t}{P_{t-1}}$.D_t denotes dividends from the firms, T_t denotes net lump-sum taxes. C_t denotes Dixit-Stiglitz consumption bundle of differentiated goods $C_{j,t}$ with the price level, $P_{j,t}$, for each good $j \in [0,1]$.

$$C_{i,t} = \left(\int_0^1 C_{j,t}^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\varepsilon}{\varepsilon-1}}$$

Since the households have the same preferences, I drop the index i for each household who has the following demand for each differentiated good $C_{j,t}$.

$$C_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\varepsilon} C_t$$

Hence the aggregate price level in the economy is P_t[10].

$$P_t = \left(\int_0^1 P_{j,t}^{1-\varepsilon} dj\right)^{\frac{1}{1-\varepsilon}} \tag{2.3}$$

The demand shock hits the economy and the discount factor rises below one persistently enough to make the ZLB start binding. The stream of preference shock to the growth rate

[10]The aggregate price index and the demand function of each household can be found by cost-minimization; $min\ P_tC_t \ \ st.\ C_t = \left(\int_0^1 C_{j,t}^{\frac{\varepsilon}{\varepsilon-1}} dj\right)^{\frac{\varepsilon-1}{\varepsilon}}$.

of $\bar{e}$, i.e., $ed_t \equiv \frac{\bar{e}_{t+1}}{\bar{e}_t}$, follows an exogenous stream $\{\varepsilon_{ed,t}\}_{t=0}^{\infty}$.

The Euler Equation from the households maximization problem gives;

$$E_t\left[\frac{\beta R_t}{\pi_{t+1}} ed_t \left(\frac{C_{t+1}}{C_t}\right)^{-1}\right] = 1 \tag{2.4}$$

The labor supply decision is given by;

$$\chi N_t^{\omega} = C_t^{-1} w_t \tag{2.5}$$

In the production side there are infinite number of monopolistic competitive firms indexed by $j \in [0,1]$. Each has a linear production function;

$$Y_{j,t} = Z N_{j,t}$$

where Z is the production technology which is constant. Each faces demand from households and government. As government spending, G_t is isomorphic to C_t, the demand for each product is;

$$Y_{j,t}(P_{j,t}) = \left(\frac{P_{j,t}}{P_t}\right)^{-\varepsilon} Y_t, \qquad where \quad Y_t = C_t + G_t$$

Instead of working through the linearized New-Keynesian Phillips curve, I follow the model of Schmitt-Grohé and Uribe (2004)[56] (SGU(2004))which allows non-linear analysis. The firms set the optimal price level, $\widetilde{P}_{j,t}$ with probability $1-\theta$. The firms that cannot set the optimal price level adjust the previous period price level with steady state inflation level. $\widetilde{P}_{j,t}$ is the price level which maximizes the present discounted value of future profits and hence equal to

$$\widetilde{P}_{j,t} \equiv \arg\max_{P_{j,t}} E_{t i=o}^{\infty} q_{t,t+i} \theta^i \left[\frac{Y_{j,t+i}(P_{j,t}) P_{j,t}}{P_{t+i}} - \frac{w_{t+i} Y_{j,t+i}(P_{j,t})}{Z}\right]$$

where $q_{t,t+i}$ is the stochastic discount factor of the firms. The relative optimal price level is denoted by $P_{j,t}^* \equiv \widetilde{P}_{j,t}/P_t$. Following SGU (2004), the optimal price level expression can be written as[11]

$$F_t = P_t^{*1-\varepsilon} Y_t + \frac{\pi_{t+1}}{R_t}\theta\left(\frac{P_t^*}{P_{t+1}^*\pi_{t+1}}\right)^{1-\varepsilon} F_{t+1} \tag{2.6}$$

$$H_t = \frac{w_t}{Z} P_t^{*-\varepsilon} Y_t + \frac{\pi_{t+1}}{R_t}\theta\left(\frac{P_t^*}{P_{t+1}^*\pi_{t+1}}\right)^{-\varepsilon} H_{t+1} \tag{2.7}$$

such that

$$F_t = \frac{\varepsilon}{\varepsilon - 1} H_t \tag{2.8}$$

As a result of resource constraint the aggregate production in the economy is equal to the aggregate demand.

$$\int_0^1 Y_{j,t} dj = \int_0^1 \left(\frac{P_{j,t}}{P_t}\right)^{-\varepsilon} Y_t dj$$

After replacing the production function and $\int_0^1 N_{j,t} dj = N_t$, I get

$$Z N_t = Y_t S_t \tag{2.9}$$

where $S_t \equiv \int_0^1 \left(\frac{P_{j,t}}{P_t}\right)^{-\varepsilon} dj$ is the price dispersion. Backward iteration of the price dispersion gives[12];

$$S_t = (1-\theta)\left(P_t^*\right)^{-\varepsilon} + \theta\left(\frac{\pi_t}{\pi}\right)^{\varepsilon} S_{t-1} \tag{2.10}$$

If the firms cannot set the optimal price, they update the price level with the steady state inflation rate, $\bar{\pi}$.[13] This fact combined with the aggregate price index equation (3) gives;

$$1 = (1-\theta)\left(P_t^*\right)^{1-\varepsilon} + \theta\left(\frac{\bar{\pi}}{\pi_t}\right)^{1-\varepsilon} \tag{2.11}$$

Government issues bonds B_t which pays real interest rate R_t, collects lump-sum taxes, T_t and make expenditures G_t.

$$b_t + T_t = b_{t-1}\frac{R_{t-1}}{\pi_t} + G_t \tag{2.12}$$

As a fiscal policy rule, government spendings and lump-sum taxes may respond to the

[11]See Appendix A for the derivations of the FOCs.

[12]See Appendix A for the backward iteration.

[13]In the model the distortion at the steady state level due to the monopolistic competition is not subsidized, the price stability may not necessarily be optimal which makes the assumption of non-zero inflation at the steady state less arguable.

output and debt level deviations from the target values as well as the fiscal shocks.

$$\log(G_t/\bar{G}) = \phi_{gb} \log(b_{t-1}/\bar{B}) + \phi_{gy} \log(Y_t/\bar{Y}) + \varepsilon_{g,t} \tag{2.13}$$

$$\log(T_t/\bar{T}) = \phi_{Tb} \log(b_{t-1}/\bar{B}) + \phi_{Ty} \log(Y_t/\bar{Y}) \tag{2.14}$$

$\phi_{gy} \leq 0$ implies that an expansionary fiscal policy is enacted in case of a fall in output and $\phi_{gb} \leq 0$ implies that as the expansionary fiscal policy is debt-financed, there should be government spendings reversals in the future, keeping everything else constant. Similarly $\phi_{Tb}, \phi_{Ty} \geq 0$ implies that the net lump-sum taxes are procyclical and are used to correct budget imbalances.

The nominal policy rate is determined by simple Taylor[14]

$$\log\left(\frac{R_t^*}{R}\right) = \phi_\pi \log\left(\frac{\pi_t}{\bar{\pi}}\right) \tag{2.15}$$

where $\phi_\pi > 1, R = \bar{\pi}/\beta, \pi_t = P_t/P_{t-1}$. However, the nominal interest rate may be bounded below by the ZLB. Hence the nominal interest rate in the economy is

$$R_t = \max\left(1, R_t^*\right) \tag{2.16}$$

Equation 2.2 - Equation 2.16 give a system of 15 equations with 15 variables $\{C_t$,N_t,b_t, Y_t,G_t,T_t ,w_t, P_t^*,π_t,S_t,R_t,R_t^*,ed_t,F_t,$H_t\}$ with $\{\varepsilon_{e,t}, \varepsilon_{g,t}\}$ exogenous variables. Following Corsetti et al. (2010) the nonlinear system of equations is solved by stacked-time Newton-Raphson algorithm (originally Hollinger (1996)[38]) rather than log-linearization method.[15]

2.2.1 Calibration

Before describing the structural and policy parameters, it is worth to give some descriptive statistics about the US economy before and during the great recession. Annual federal funds rate has a mean of 4.3% for the time period 1990Q1-2008Q3. The rate started to fall below 5 base points in the fourth quarter of 2008 and stayed below 0.2% up until the second quarter

[14] I assume that monetary authority can not conduct unconventional policies such as quantitative easing.

[15] The nature of big recessionary shock moves the economy from the steady state hence I prefer non-linear numerical solution of the equilibrium rather than local linearization around the steady state.

of 2011. In the third quarter of 2011, it is below 1 base points which imply that the US economy has been experiencing binding ZLB for almost 12 quarters. The annual inflation rate is on average around 2.3%.[16] Meanwhile, in 2008Q3 and 2008Q4 the price levels (GDP Deflator-Personal Consumption Expenditures) fall by 1.4 % and 0.41% in quarter to quarter terms, respectively.[17] The real GDP in 2005 prices fell subsequently after the third quarter of 2008 until the last quarter of 2009 in year to year base for up to 5%.[18] Until 2011Q3, the growth wasn't promising as quarter to quarter growth stayed below 1%. In the current model, I calibrate the model such that the preference shock will cause the ZLB to bind for 8 quarters and the output to drops by 5% on impact. The government spending for the time period 1990Q1-2008Q3 varied around the mean 21% of GDP.[19] In the fourth quarter of 2008, the government purchases increase to 24% of GDP then kept rising above 26%.

The model is solved for $T = 2000$ periods and one period is one quarter. Government expenditure, G and consumption, C are normalized by aggregate output. The steady state output which is also target output level is set to 1. The steady state and the target government expenditure as share of output, $\bar{G}$ is 20% which is close to historical average of the US for the period 1990Q1-2008Q3. The steady state employment level is set to 1/3. The steady state bond level, $\bar{b}$ is assumed to be 0. The target annual inflation rate, $\bar{\pi}$ is set to 3%.[20] The discount factor is assumed to be 0.995 which leads to 4.75% steady state annual nominal interest rate. The Fischer labor supply elasticity, $1/\omega$ is assumed to be 1. The degree of price stickiness is set to 0.85. The elasticity of substitution among differentiated goods, ε is assumed to be 11. The rest of the parameters and the steady state values are computed from the equilibrium conditions. As a benchmark analysis, the government spending rises from 20% to 21% for 8 quarters, and it is financed by lump-sum

[16] CPI year to year inflation rate is 2.8% for the specified time period.

[17] According to CPI inflation calculations, quarter to quarter inflation is -2.82% and -0.49% for 2008Q3 and 2008Q4, respectively.

[18] From 2008Q3 to 2009Q2, real GDP fell (QTQ) by 1%, 2.3%, 1.7%, 0.1%. In year to year, the contraction started from 2008Q2 and kept going until 2009Q4, by 0.6%, 3.3%, 4.5%, 5%, 3.73% and 0.5%.

[19] The government purchases calculated as the sum of current expenditures plus capital transfer payments minus net purchases of non-produced assets from BEA Table 3.2 (line 41+line43-line44).

[20] Optimal monetary policy may require a different annual inflation rate. I assume that it is non-zero, following Khan, King and Wolman (2003)[42] and Schmit-Grohe and Uribe (2007)[57].

taxation. The government spending and lump-sum taxes do not respond to the output or the debt level in the economy. The government spending cut comes after the end of the fiscal stimulus. The time-gap is defined as the time between the end of the fiscal stimulus and the start of the government spending cut. The present discounted value of the government cut is the same as the present discounted value of fiscal stimulus, and it is kept the same through the analysis.

2.3 Impulse Responses

2.3.1 Why does the ZLB matter?

Before going into details of the numerical results of the model, it is worth showing that the ZLB matters for the effect of fiscal policy. Initially, the negative preference shock (higher discount rate) (in the left panel of Figure 2.3) reduces today's consumption as households prefer to save more for future with or without the ZLB. However, if the monetary policy cannot reduce the nominal interest rate below the ZLB, then the deflationary effect of preference shock will reduce today's consumption more due to a rise in real interest rate through Fisher equation. Hence, when I allow the ZLB to be binding, the output and the consumption will fall more than the case without ZLB (Figure 2.4 - Figure 2.5).

When the ZLB starts binding, fiscal policy can be used to stimulate the economy. In this case, I assume that government spending rises from 20% to 21% for 8 quarters as the economy is hit by the preference shock (in the right panel of Figure 2.3). The effect of the fiscal stimulus is shown in Figure 2.6 and Figure 2.7. This policy causes the output to rise both in the absence and in the presence of the ZLB due to higher public demand for the goods. However, consumption shows different responses, depending whether the ZLB is binding or not. In fact, there can be three channels that can affect the consumption decision when the government spending increases. First, the rise in government spending may be financed by the taxes which in return curbs the private spending if the Ricardian equivalence does not hold. Second, government's demand for the goods makes the firms increase the demand for labor, leading to higher employment and wage rate in the sticky price environment. Hence, the income effect works in the opposite direction and it increases the consumption. The third channel that can affect the consumption decision is the real interest rate whose direction depends on whether the ZLB is binding or not. If the nominal interest rate is not constrained by the ZLB, then the net effect of government spending on the nominal interest rate will be positive, as monetary authority can respond the inflationary fiscal stimulus by increasing the interest rate. In this case, the real interest rate will increase, too which would crowd out consumption (the red line in the upper right panel of Figure 2.6). On the other hand, if the ZLB is binding, the net effect of fiscal stimulus on the real interest rate is negative since the nominal interest rate is constant at the ZLB. Therefore the third channel amplifies the income effect and increases the consumption if the ZLB is binding (the blue line in the upper right panel of Figure 2.6).

As a third impact in addition to the impact of negative demand shocks and the impact of fiscal stimulus, the effect of future government spending cuts after the initial fiscal stimulus is to be analyzed. I first assume that the time gap between the fiscal stimulus and the government spending cut is one quarter. The left panel of Figure 2.3 shows how the government spending evolves over time.

I analyze the net effect of this fiscal program (initially, fiscal stimulus and then fiscal consolidation) with and without the ZLB. Figure 2.8 and Figure 2.9 show the effect of the fiscal program matters if the ZLB is binding or not. The net effect on the output is positive on impact and it curbs the consumption in both cases. However, conditional on the timing of the government spending cut, the magnitude of the changes in both variables is smaller when the ZLB is binding. In order to see why consumption drops with this fiscal program, I examine the net effect of the anticipated future government cuts that come two years after the negative shock.

Figure 2.10 and Figure 2.11 give the net effect of the anticipated future government cuts with and without ZLB. As mentioned above, government spending can affect the economy through three channels and the direction of the effect of the interest rate channel depends on the ZLB. The future government cuts reduce the inflationary expectations today which results in higher real interest rate and lower current consumption when the ZLB is binding. However, the effect of the third channel is conditional on the timing of the government cuts.

2.3.2 Why does the timing of the government cuts matter?

Analyzing three different timing (one, eleven, and twenty quarters of time gap) of government cuts reveals that the effect of the future anticipated cuts on the economy is highly dependent on the timing. The early cuts have depressing effect on the economy since deflationary effect of the cuts keeps the economy at the ZLB for longer period of time in which case higher real interest rate suppresses the consumption. In Figure 2.13 the blue line with circles shows that if the cuts come right after the fiscal stimulus, the reversal suppresses the economy which can creates deflationary spirals in the economy[21] as mentioned in Corsetti et. al. (2010). Similarly the green line with cross shows the impulse responses with 20 quarters time-gap. Future anticipated reversal stimulates the economy today but the magnitude of the initial effect is less compared to the impact multiplier effect of the cuts with 11 quarter time-gap.

2.4 Welfare Analysis of the Timing of Fiscal Consolidation

In the current section, I analyze the welfare cost of the future reversals with different timing in order to see if there is a gain by delaying it. Although the timing affects the dynamics, it does not change the steady state values for the economy. For that reason, instead of comparing the welfare costs at the steady state, I compute the percentage of consumption to make the consumers indifferent between the life-time allocations under the policy of future cuts with each time-gap and the steady state allocations. The consumption

[21] Since the solution method forces the economy to go back to the steady state levels, the ZLB will be binding temporarily. In this model, by construction the economy never gets stuck at the ZLB as a second equilibrium.

equivalence of the each timing compared to the steady state can be calculated by[22]

$$\sum_{i=0}^{T} \beta^i \bar{e}_i U((1+\lambda_t)C_i^t, N_i^t) = \sum_{i=0}^{T} \beta^i U(C_{ss}, N_{ss}) \text{ for } t = 0, 1, 2...$$

$$\lambda_t = \exp\left(\frac{V^s - V^t}{\sum_{i=0}^{T} \beta^i \bar{e}_i}\right) - 1 \quad \text{for } t = 0, 1, 2...$$

where

$$V^s = \sum_{i=0}^{T} \beta^i U(C_{ss}, N_{ss}) \text{ and } V^t = \sum_{i=0}^{T} \beta^i \bar{e}_i U((1+\lambda_i)C_i^t, N_i^t)$$

where C_i^t, N_i^t are the consumption and the employment levels of households when the government cuts start t quarters after the initial fiscal stimulus. In the solution of the model the life time period, T is set to be 2000 periods.[23]

Figure 2.14 displays how the welfare cost of the future government cuts differs as the time-gap changes. In the graph, t = 0 shows the welfare cost of the preference shock and fiscal stimulus as a response to the shock in the economy without consolidation. The consolidation that comes right after the end of the fiscal stimulus curbs the consumption as the real interest rate rises. Hence, the early consolidations are more costly than not consolidating. However, as the economy recovers and as the government cuts are delayed, the welfare cost decreases. 0.07 percent points welfare gain is possible if it is delayed for eleven quarters.

Despite the U shape of the welfare cost, the results with too early and too late cuts are not symmetric. The earlier reversals depress the economy more than the late ones. Regardless of the timing, the government cuts decrease the demand, hence, this causes the output to fall. However, if it is enacted early around the ZLB, it also suppresses the private demand due to higher real interest rate.

[22] $\sum_{i=0}^{T} \beta^i \bar{e}_i \left(\log(1+\lambda)C_i - \chi \frac{N_i^{1+\omega}}{1+\omega}\right) = \sum_{i=0}^{T} \beta^i \left(\log C_{ss} - \chi \frac{N_{ss}^{1+\omega}}{1+\omega}\right)$

[23] However, the effect of the fiscal consolidation can be analyzed for very short run, short run, medium run and long-run by adjusting T values.

2.5 Models with Different Fiscal Rules

2.5.1 Lump-sum Taxation Rule

In the current section, I let the net lump-sum taxes respond to the output and debt fluctuations to introduce one more fiscal instrument and to provide some debt dynamics in the model. The fiscal rule for the lump-sum taxes follows as;

$$\log\left(T_t/\bar{T}\right) = 0.13\log\left(Y_t/\bar{Y}\right) + 0.21\log\left(b_{t-1}/\bar{Y}\right)$$

where the steady state lump-sum tax, $\bar{T}$ is 20% of output as the net supply of government bonds is assumed to be 0. The parameters are Bayesian estimates for the US economy that are borrowed from Leeper, Plante and Traum (2010)[44].[24] In their paper fiscal rules include not only responses to debt level but also output level by all of the fiscal instruments, such as lump-sum transfers, labor and capital income. They also take into account different fiscal rules and their combinations in their model which gives the power of consistent robustness checks for different fiscal rules. The automatic stabilizer parameter suggests that if the output falls by 5% on impact, the lump-sum tax falls by 0.65%.

In Figure 2.15 and Figure 2.16 the blue line with circles shows the impulse responses to the preference shock, the government spending rise and the future cuts. The red line with stars shows the net effect of the future government cuts in the economy. The preference shock hits the economy at t = 0 and the government announces that the government spendings will be increased to 21% for 8 quarters and fiscal consolidation will occur 9 quarters after the end of the stimulus.[25] The rise in the government spending increases the debt and the lump-sum taxes rise as a response to increasing debt. The net effect of future cuts mitigates the current recession by increasing the current consumption through deflationary expectations and fall in the future taxes. Anticipated future cuts decreases inflation expectations. As the economy already exits the ZLB, monetary authority can reduce the nominal interest rate

[24] one should take the fit of these parameters in my model with a caveat since the model of Leeper et al. (2010) is neoclassical growth model.

[25] Time-gap is set to 9 quarters since it minimizes the welfare cost in the economy which will be shown below.

hence the real interest rate, responding to the government cuts. Additionally, the future lump-sum taxes decrease due to fall in the debt level and the output which will lead to higher consumption in the future. Through consumption smoothing, on impact current consumption increases.

The timing of the future cuts matters in this case, too. Figure 2.17 shows the relation between the welfare cost and the timing of fiscal consolidation when there is a lump-sum taxation rule which is an automatic stabilizer and a debt stabilization. Similar to the initial case, the earlier and the late reversals are more costly compared to the medium-run fiscal consolidations. The optimal timing can provide 0.06 percent points welfare gains if the government spending reversals start almost two years after the end of the fiscal stimulus. Therefore the result that the cuts should come in the medium run after the recovery of the economy is invariant to the constant lump-sum tax.

Figure 2.18 and Figure 2.19 give how the net effect of future fiscal consolidation differs with the presence of the lump-sum taxation rule compared to the benchmark setup. The impact multipliers for both consumption and output are higher when the fiscal consolidation is partly done by the lump-sum taxation.

2.5.2 Distortionary Income Tax Rule

In this section, labor income taxation is incorporated in the model in order to see the effect of fiscal consolidation. Labor income taxation affects the budget constraints of both the households and the government in addition to labor supply decision due to the separable form of utility function.

$$\chi N_t^{\omega} = C_t^{-1}(1 - \tau_t)w_t$$

$$b_t + \tau_t N_t w_t = b_{t-1}\frac{R_{t-1}}{\pi_t} + G_t$$

Given $\bar{G} = 0.20$, the steady state level of labor income tax rate, $\bar{\tau}$ is 0.22. The distortionary tax responds to the output and debt fluctuations as in the case of lump-sum taxes.[26]

$$\log\left(\frac{\tau_t}{\bar{\tau}}\right) = 0.40\log\left(\frac{Y_t}{\bar{Y}}\right) + 0.18\log\left(\frac{b_{t-1}}{\bar{Y}}\right)$$

The net effect of future anticipated reversal is shown in Figure 2.20 and Figure 2.21 by the red line with stars. An increase in labor income tax on impact distorts the labor supply and hence reduces the output level. However, the net effect of future expectations about the falling income tax rates is positive on consumption and output. The future income effect of government spending cuts stimulates the private demand today, and it reduces the duration of the ZLB as shown in lower left panel of Figure 2.21. Exiting the ZLB earlier in return increases the stimulating effect of government reversals as the monetary policy effectively reduces the interest rates. The timing of the reversal reserves its importance with the distortionary taxation. Figure 2.23 suggests that still the reversal should come in the medium run but later than the first two cases.

Figure 2.24 and Figure 2.25 display how the dynamics of the economy alter when there is different type of fiscal instruments, stabilizing the economy. For each case the time-gap is set to be the *optimal* one.[27] The results show that analyzing the impact multiplier as a performance indicator of the fiscal policy may lead to different results. For instance, the economy where the lump-sum taxes stabilize the economy has bigger output and consumption multiplier compared to benchmark case and distortionary taxation. However, in the longer horizon, the consumption and the output are stimulated more with distortionary income tax due to shorter duration of the ZLB and higher future income effect.

2.5.3 Government Spending Rule

In the current section the government spending is allowed to move endogenously with the output and the debt fluctuations. Government spending rule follows;

[26] The fiscal rule parameters are borrowed from Leeper et. al (2010).

[27] It refers to the time-gap which minimizes the welfare cost in consumption terms.

$$\log(G_t/\bar{G}) = -0.24\log(b_{t-1}/\bar{Y}) - 0.033\log(Y_t/\bar{Y}) + \varepsilon_{g,t} \tag{2.17}$$

As the output falls below the steady state level, the government expenditure rises as an expansionary fiscal policy. Similarly, as the debt level increases, the government reduces its spendings to stabilize the fiscal imbalances. If the economy is hit by a negative preference shock, in this set-up the spendings are increased as lump-sum fashion ($\varepsilon_{g,t}$) to 21% of output and also, endogenously as a response to the fall in the output on impact. In the upcoming period, the government spendings decline slowly to stabilize the rising debt. In order to have determinacy in the model, it is necessary to have lump-sum taxation rule (Baxter and King (1993)[5]). For consistency with previous analysis I use the estimated coefficients from Leeper et al. (2010) for a model with fiscal rules for both the government spendings and the lump-sum taxes. This lets the tax level be determined as a response to the output as in the following:

$$\log(T_t/\bar{T}) = 0.11\log(Y_t/\bar{Y})$$

Due to the automatic stabilization, the spending reversals endogenously take place even if there is no announced future spending cuts. Figure 2.26 shows how the dynamics of the economy evolve in case of only preference shock (the blue line with circles) and in the presence of both fiscal stimulus and preference shock (the red line with stars). The net effect of initial rise in government spending increases the public demand and therefore the output. However, unlike the previous cases, the endogenous reversal does not have stimulating effect on the private demand. In fact, it crowds out consumption for the first four quarters. It is because as the debt level increases, automatic stabilization has to come earlier around the ZLB, eight quarters after the shock hits the economy. Hence the deflationary effect of government cuts increases today's real interest rate at the ZLB.

In the next step, I introduce the future government cuts as a consolidation policy in addition to automatic stabilization rule. In other words, the government announces at time

0 that in addition to the fiscal policy rules, the government spending rises to 21% for eight quarters and then government cuts start and last for four quarters The net effect of this additional spending crowds out consumption and reduces the output on impact (Figure 2.27). The additional spending cut causes a bigger magnitude of downsizing in the government budget. When the monetary authority becomes effective to respond to this effect, the nominal interest rate decreases, and hence the real interest rate does, too.

The welfare cost of the timing of additional spending cuts in the current set up shows that the welfare gain from additional consolidation is negligible. In fact, too early spending cuts are more costly than letting the government spendings be endogenously determined (Figure 2.28). As the fiscal policy responds to the dynamics of the output and the debt, the fiscal imbalances can be corrected with less welfare cost.

2.6 Conclusion

In the current paper, I analyze the effects of the timing of government reversals to correct the fiscal imbalances. I find the *optimal* timing of fiscal consolidation by minimizing the welfare cost over the time-gap. Although the current simple model shows that there are gains with delaying the consolidation to a later time and it is robust to the different fiscal rules, the fiscal policy rules are not necessarily *optimal*. As a next step, a model where the welfare can be maximized by choosing the responsiveness of the fiscal instruments is to be developed. In this setup the size and the timing of fiscal stimulus and consolidation can be determined optimally. However, with the current solution method, it is hard to incorporate such optimization problem. It may require linearization of the system of the equations - second-order linearization of the policy functions for the welfare analysis- in which case the solution analysis becomes around the steady state.

As a summary the anticipated future government spending cuts have amplifying effect on the current fiscal stimulus and reduces the time that the economy is constrained by ZLB only if it is enacted timely manner and when the government spending cuts do not endogenously respond to the economy. However the precise *optimal* timing varies with the different fiscal policy rules, the fiscal consolidation in the medium run reduces the welfare cost and the spending reversals in the very short-run are much costly.

When the labor income tax rates follow a stabilization rule, the future anticipated drop in the labor income tax rate will stimulate the economy more than lump-sum taxation rule and no fiscal rule cases. Although the impact multiplier for output and consumption is smaller compared to other cases, in the medium run it increases the consumption and output much more. It shows that only the impact multiplier analysis to evaluate the fiscal policies may be misleading.

When the government spendings respond to the output and debt endogenously, the fiscal consolidation occurs endogenously. In this case, additional government cuts depress the economy further down. The welfare gain of additional cuts at the *optimal* time-gap is negligible.

Moreover, for each analysis the government fully commits to the fiscal policy. Hence there is no time-consistency problem however, discretionary fiscal consolidations (unanticipated government spending cuts) might lead to different results as current consumption is affected by expectations of future fiscal policies.

2.7 Appendix

2.7.1 Derivations of the Equations

Derivation of demand from households and aggregate price level:

$$\min_{C_{jt}} {}_0^1 P_{jt} C_{jt} dj \qquad s.t. \quad C_t = \left({}_0^1 C_{jt}^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

$$\min_0^1 P_{jt} C_{jt} dj + P_t \left[C_t - \left({}_0^1 C_{jt}^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \right]$$

$$P_{jt} = P_t C_t^{1/\varepsilon} C_{jt}^{-1/\varepsilon}$$

$$C_{jt} = \left(\frac{P_{jt}}{P_t} \right)^{-\varepsilon} C_t$$

Plug in this equation into the consumption aggregate

$$C_t = \left\{ {}_0^1 \left[\left(\frac{P_{jt}}{P_t} \right)^{-\varepsilon} C_t \right]^{\frac{\varepsilon-1}{\varepsilon}} dj \right\}^{\frac{\varepsilon}{\varepsilon-1}}$$

$$P_t = \left({}_0^1 P_{jt}^{1-\varepsilon} dj \right)^{\frac{1}{1-\varepsilon}}$$

Derivation of nominal marginal cost of firms :

$$\min_{N_t} w_t P_t N_t + MC_t \left(Y_t - Z N_t \right)$$

$$\frac{w_t P_t}{Z} = MC_t^{nom}$$

$$\frac{w_t}{Z} = MC_t^{real}$$

Derivation of optimal price level of firms:

$$\widetilde{P}_{j,t} \equiv \arg\max_{P_{j,t}} E_{t i=o}^{\infty} q_{t,t+i} \theta^i \left[\frac{Y_{j,t+i}(P_{j,t}) P_{j,t}}{P_{t+i}} - \frac{w_{t+i} Y_{j,t+i}(P_{j,t})}{Z} \right]$$

then $\widetilde{P}_{j,t}$is such that

$$E_{t i=o}^{\infty} q_{t,t+i} \theta^i \left[\frac{Y_{j,t+i} \left(\widetilde{P}_{j,t} \right) (1-\varepsilon)}{P_{t+i}} + \varepsilon \frac{w_{t+i} Y_{j,t+i} \left(\widetilde{P}_{j,t} \right)}{Z \widetilde{P}_{j,t}} \right] = 0$$

Multiply by $1/(1-\varepsilon)$ and plug in the aggregate demand function for $Y_{j,t+i}\left(\widetilde{P}_{j,t}\right)$,

$$E_{t}{}_{i=o}^{\infty}q_{t,t+i}\theta^{i}\left[\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{-\varepsilon}\frac{Y_{t+i}}{P_{t+i}}-\frac{\varepsilon}{\varepsilon-1}\frac{w_{t+i}}{Z\widetilde{P}_{j,t}}\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{-\varepsilon}Y_{t+i}\right] = 0$$

$$E_{t}{}_{i=o}^{\infty}q_{t,t+i}\theta^{i}\left[\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{-\varepsilon}\frac{Y_{t+i}}{P_{t+i}}\right]-\frac{\varepsilon}{\varepsilon-1}E_{t}{}_{i=o}^{\infty}q_{t,t+i}\theta^{i}\left[\frac{w_{t+i}}{Z\widetilde{P}_{j,t}}\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{-\varepsilon}Y_{t+i}\right] = 0$$

$$E_{t}{}_{i=o}^{\infty}q_{t,t+i}\theta^{i}\left[\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{1-\varepsilon}\frac{Y_{t+i}}{\widetilde{P}_{j,t}}\right]-\frac{\varepsilon}{\varepsilon-1}E_{t}{}_{i=o}^{\infty}q_{t,t+i}\theta^{i}\left[\frac{w_{t+i}}{Z\widetilde{P}_{j,t}}\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{-\varepsilon}Y_{t+i}\right]=0$$

Then multiply each side by $\widetilde{P}_{j,t}$

$$E_{t}{}_{i=o}^{\infty}q_{t,t+i}\theta^{i}\left[\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{1-\varepsilon}Y_{t+i}\right]=\frac{\varepsilon}{\varepsilon-1}E_{t}{}_{i=o}^{\infty}q_{t,t+i}\theta^{i}\left[\frac{w_{t+i}}{Z}\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{-\varepsilon}Y_{t+i}\right]$$

Define F_t and H_t

$$F_t \equiv E_{t}{}_{i=o}^{\infty}q_{t,t+i}\theta^{i}\left[\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{1-\varepsilon}Y_{t+i}\right]$$

$$H_t \equiv E_{t}{}_{i=o}^{\infty}q_{t,t+i}\theta^{i}\left[\frac{w_{t+i}}{Z}\left(\frac{\widetilde{P}_{j,t}}{P_{t+i}}\right)^{-\varepsilon}Y_{t+i}\right]$$

such that

$$F_t=\frac{\varepsilon}{\varepsilon-1}H_t$$

Then F_t can be written as

$$F_t\equiv\left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{1-\varepsilon}Y_t+E_t\left[\begin{array}{c}q_{t,t+1}\theta\left(\frac{\widetilde{P}_{j,t}\bar{\pi}}{P_{t+1}}\right)^{1-\varepsilon}Y_{t+1}\\+q_{t,t+2}\theta^2\left(\frac{\widetilde{P}_{j,t}\bar{\pi}^2}{P_{t+2}}\right)^{1-\varepsilon}Y_{t+2}+...\end{array}\right]$$

$$F_t\equiv\left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{1-\varepsilon}Y_t+q_{t,t+1}\theta\left(\frac{\widetilde{P}_{j,t}\bar{\pi}}{\widetilde{P}_{j,t+1}}\right)^{1-\varepsilon}E_t\left[\begin{array}{c}\left(\frac{\widetilde{P}_{j,t+1}}{P_{t+1}}\right)^{1-\varepsilon}Y_{t+1}\\+\frac{q_{t,t+2}}{q_{t,t+1}}\theta\left(\frac{\widetilde{P}_{j,t+1}\bar{\pi}}{P_{t+2}}\right)^{1-\varepsilon}Y_{t+2}+...\end{array}\right]$$

By definition of $q_{t,t+1}$ $q_{t,t+s}/q_{t,t+m} = q_{t+m,t+s}$ where $s > m > 0$ hence

$$F_t \equiv \left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{1-\varepsilon} Y_t + q_{t,t+1}\theta \left(\frac{\widetilde{P}_{j,t}\bar{\pi}}{\widetilde{P}_{j,t+1}}\right)^{1-\varepsilon} E_t \begin{bmatrix} \left(\frac{\widetilde{P}_{j,t+1}}{P_{t+1}}\right)^{1-\varepsilon} Y_{t+1} \\ +q_{t+1,t+2}\theta \left(\frac{\widetilde{P}_{j,t+1}\bar{\pi}}{P_{t+2}}\right)^{1-\varepsilon} Y_{t+2} + ... \end{bmatrix}$$

$$F_t \equiv \left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{1-\varepsilon} Y_t + q_{t,t+1}\theta \left(\frac{\widetilde{P}_{j,t}}{\widetilde{P}_{j,t+1}}\right)^{1-\varepsilon} \bar{\pi}^{1-\varepsilon} F_{t+1}$$

Then define $P_t^* = \frac{\widetilde{P}_{j,t}}{P_t}$

$$\begin{aligned} F_t &\equiv P_t^{*1-\varepsilon} Y_t + q_{t,t+1}\theta \left(\frac{P_t^*}{P_{t+1}^*}\right)^{1-\varepsilon} \left(\frac{P_t}{P_{t+1}}\right)^{1-\varepsilon} \bar{\pi}^{1-\varepsilon} F_{t+1} \\ F_t &\equiv P_t^{*1-\varepsilon} Y_t + q_{t,t+1}\theta \left(\frac{P_t^*}{P_{t+1}^*}\right)^{1-\varepsilon} \left(\frac{\bar{\pi}}{\pi_{t+1}}\right)^{1-\varepsilon} F_{t+1} \end{aligned}$$

Similarly H_t can be written as

$$H_t \equiv \frac{w_t}{Z} \left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{-\varepsilon} Y_t + E_t \begin{bmatrix} q_{t,t+1}\theta \frac{w_{t+1}}{Z} \left(\frac{\widetilde{P}_{j,t}\bar{\pi}}{P_{t+1}}\right)^{-\varepsilon} Y_{t+1} \\ +q_{t,t+2}\theta^2 \frac{w_{t+1}}{Z} \left(\frac{\widetilde{P}_{j,t}\bar{\pi}^2}{P_{t+2}}\right)^{-\varepsilon} Y_{t+2} + ... \end{bmatrix}$$

$$H_t \equiv \frac{w_t}{Z} \left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{-\varepsilon} Y_t + q_{t,t+1}\theta \left(\frac{\widetilde{P}_{j,t}\bar{\pi}}{\widetilde{P}_{j,t+1}}\right)^{-\varepsilon} E_t \begin{bmatrix} \frac{w_{t+1}}{Z} \left(\frac{\widetilde{P}_{j,t+1}}{P_{t+1}}\right)^{-\varepsilon} Y_{t+1} \\ +\frac{q_{t,t+2}}{q_{t,t+1}}\theta \frac{w_{t+1}}{Z} \left(\frac{\widetilde{P}_{j,t+1}\bar{\pi}}{P_{t+2}}\right)^{-\varepsilon} Y_{t+2} + ... \end{bmatrix}$$

By definition of $q_{t,t+1}$ $q_{t,t+s}/q_{t,t+m} = q_{t+m,t+s}$ where $s > m > 0$ hence

$$\begin{aligned} H_t &\equiv \frac{w_t}{Z} \left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{-\varepsilon} Y_t + q_{t,t+1}\theta \left(\frac{\widetilde{P}_{j,t}\bar{\pi}}{\widetilde{P}_{j,t+1}}\right)^{-\varepsilon} E_t \begin{bmatrix} \frac{w_{t+1}}{Z} \left(\frac{\widetilde{P}_{j,t+1}}{P_{t+1}}\right)^{-\varepsilon} Y_{t+1} \\ +q_{t+1,t+2}\theta \frac{w_{t+1}}{Z} \left(\frac{\widetilde{P}_{j,t+1}\bar{\pi}}{P_{t+2}}\right)^{-\varepsilon} Y_{t+2} + ... \end{bmatrix} \\ H_t &\equiv \frac{w_t}{Z} \left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{-\varepsilon} Y_t + q_{t,t+1}\theta \left(\frac{\widetilde{P}_{j,t}}{\widetilde{P}_{j,t+1}}\right)^{-\varepsilon} \bar{\pi}^{-\varepsilon} H_{t+1} \end{aligned}$$

Then define $P_t^* = \frac{\widetilde{P}_{j,t}}{P_t}$

$$H_t \equiv \frac{w_t}{Z} P_t^{*-\varepsilon} Y_t + q_{t,t+1}\theta \left(\frac{P_t^*}{P_{t+1}^*}\right)^{-\varepsilon} \bar{\pi}^{-\varepsilon} \left(\frac{P_t}{P_{t+1}}\right)^{-\varepsilon} H_{t+1}$$

$$H_t \equiv \frac{w_t}{Z} P_t^{*-\varepsilon} Y_t + q_{t,t+1}\theta \left(\frac{P_t^*}{P_{t+1}^*}\right)^{-\varepsilon} \left(\frac{\bar{\pi}}{\pi_{t+1}}\right)^{-\varepsilon} H_{t+1}$$

$q_{t,t+1}$ is stochastic discount factor which is;

$$\beta \frac{ed_{t+1}}{ed_t} \left(\frac{C_{t+1}}{C_t}\right)^{-1}$$

$$\beta ed_t \left(\frac{C_{t+1}}{C_t}\right)^{-1} = \frac{\pi_{t+1}}{R_t}$$

Derivation of price dispersion law of motion:

$$\begin{aligned} S_t &\equiv \int_0^1 \left(\frac{P_{j,t}}{P_t}\right)^{-\varepsilon} dj = (1-\theta)\left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{-\varepsilon} + \theta(1-\theta)\left(\frac{\widetilde{P}_{j,t-1}\bar{\pi}}{P_t}\right)^{-\varepsilon} \\ &\quad + \theta^2(1-\theta)\left(\frac{\widetilde{P}_{j,t-2}\bar{\pi}^2}{P_t}\right)^{-\varepsilon} + ... + \theta^t \left(\frac{P_0}{P_t}\right)^{-\varepsilon} \end{aligned}$$

$$S_t = (1-\theta)\left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{-\varepsilon} + \theta\left(\frac{P_{t-1}}{P_t}\right)^{-\varepsilon} \bar{\pi}^{-\varepsilon} \left[\begin{array}{c} (1-\theta)\left(\frac{\widetilde{P}_{j,t-1}}{P_{t-1}}\right)^{-\varepsilon} \\ +\theta(1-\theta)\left(\frac{\widetilde{P}_{j,t-2}\bar{\pi}}{P_{t-1}}\right)^{-\varepsilon} + ... + \theta^{t-1}\left(\frac{P_0}{P_{t-1}}\right)^{-\varepsilon} \end{array}\right]$$

$$S_t = (1-\theta)\left(\frac{\widetilde{P}_{j,t}}{P_t}\right)^{-\varepsilon} + \theta\left(\frac{P_{t-1}}{P_t}\right)^{-\varepsilon} \bar{\pi}^{-\varepsilon} S_{t-1}$$

$$S_t = (1-\theta) P_t^{*-\varepsilon} + \theta\left(\frac{\bar{\pi}}{\pi_t}\right)^{-\varepsilon} S_{t-1}$$

Derivation of relation of relative optimal price level and inflation:

$$P_t = \left(\int_0^1 P_{j,t}^{1-\varepsilon} dj\right)^{\frac{1}{1-\varepsilon}} = (1-\theta)\left(\widetilde{P}_t\right)^{1-\varepsilon} + \theta\left(\bar{\pi} P_{t-1}\right)^{1-\varepsilon}$$

$$1 = (1-\theta)\left(\frac{\widetilde{P}_t}{P_t}\right)^{1-\varepsilon} + \theta\left(\bar{\pi}\frac{P_{t-1}}{P_t}\right)^{1-\varepsilon}$$

$$1 = (1-\theta)\left(P_t^*\right)^{1-\varepsilon} + \theta\left(\frac{\bar{\pi}}{\pi_t}\right)^{1-\varepsilon}$$

where $\widetilde{P_t}$ is the optimal price level of each firm which is the same under identical firm assumption.

2.7.2 Steady State Values

The steady state values of G, T, R, π, Y and N will be calibrated for the US data. B can be assumed to be zero or non-zero. For now, steady state values of government debt and whether the ZLB binds or not is not taken into account.

From Euler Equation β can be found from steady state values as in the following

$$\frac{\beta R}{\pi} = 1$$

Labor supply decision of the households will give

$$\chi N^{\omega} = C^{-1} w$$

In the steady state it is assumed that the price dispersion is unitary since the optimal prices are adjusted. Hence

$$\begin{aligned} ZN &= Y \\ Z &= Y/N \end{aligned}$$

The aggregate production is equal to aggregate expenditure in the economy

$$Y = C + G$$

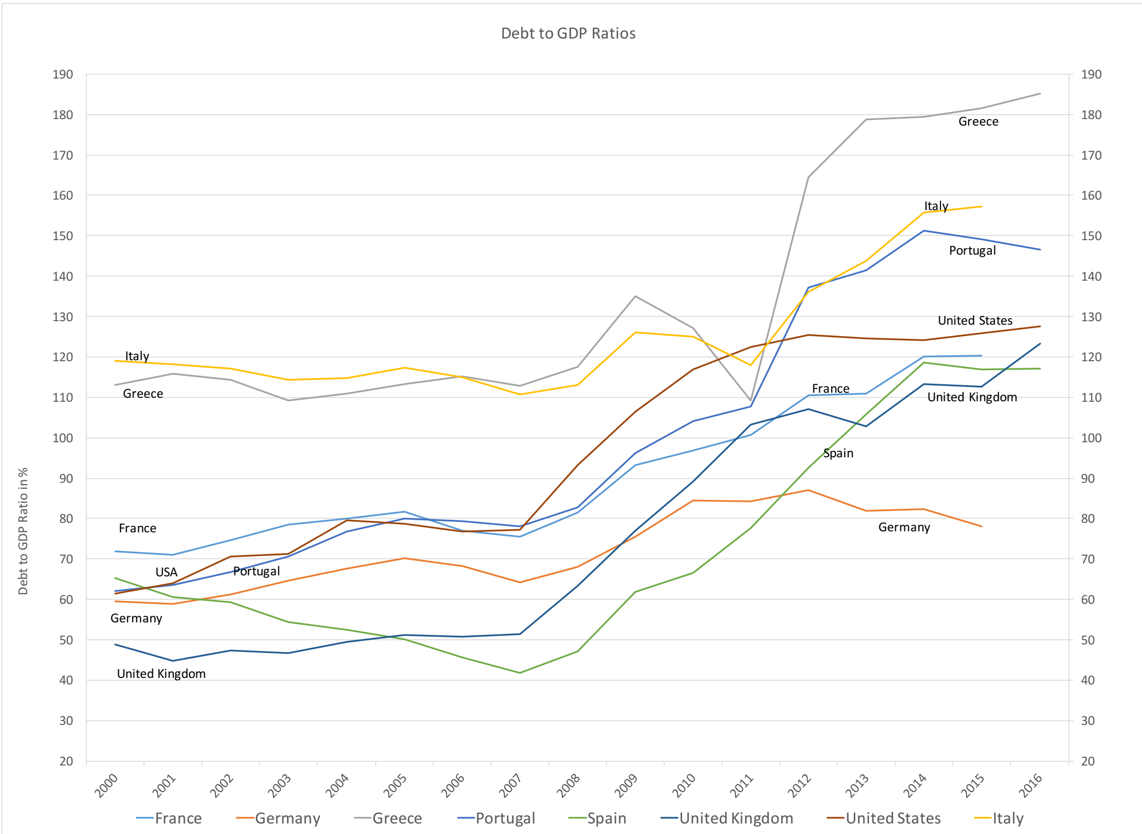
$$F = \frac{\varepsilon}{\varepsilon - 1} H$$

$$\begin{aligned} F &= \frac{1}{1 - \beta\theta} Y \\ H &= \frac{1}{1 - \beta\theta} Y \frac{w}{Z} \end{aligned}$$

$$\frac{w}{Z} = \frac{\varepsilon - 1}{\varepsilon}$$

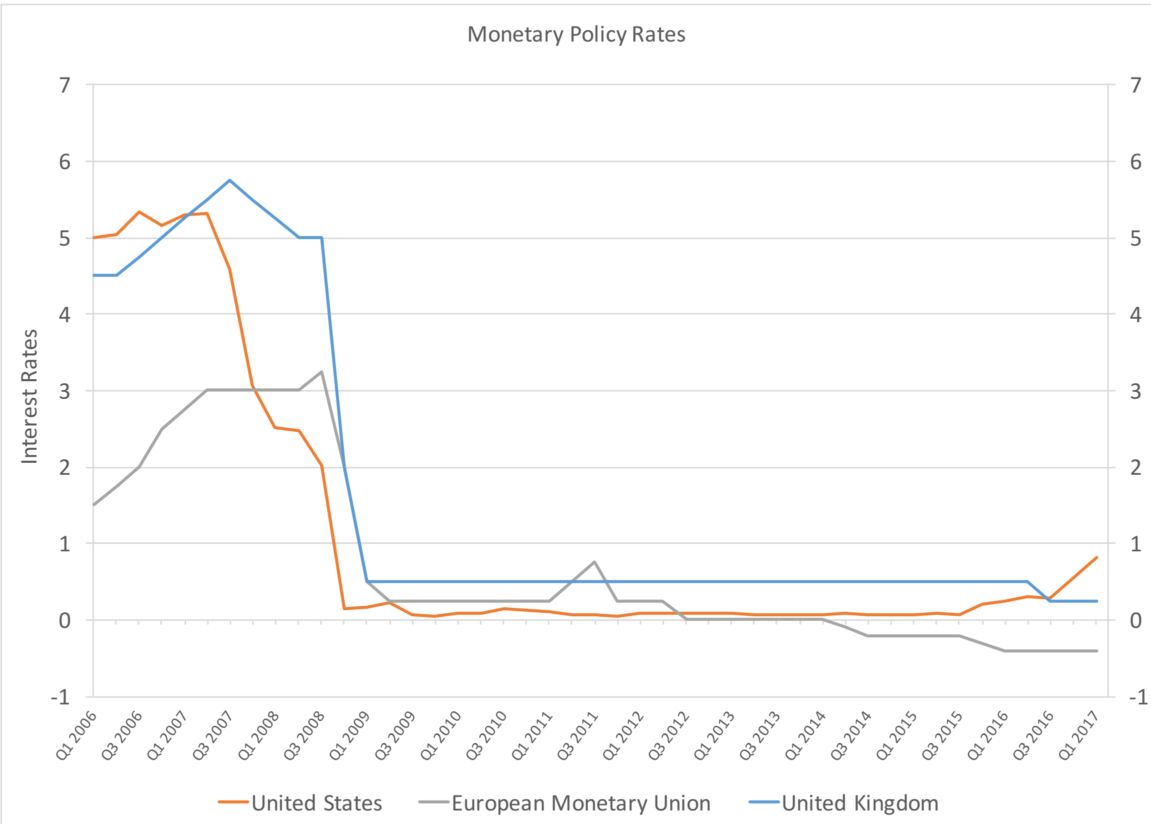
2.7.3 Figures

Figure 2.1: Annual debt per GDP in percentages for the US, the UK, France, Germany, Greece, Italy, Portugal, and Spain between 2004-2017



Note: OECD (2017), General government debt (indicator). doi: 10.1787/a0528cc2-en

Figure 2.2: The policy rates for the US, the UK, and the Eurozone for 2006Q1-2017Q1



Note: The source of the federal fund rates is the Board of Governors of the Federal Reserve System (US) Statistical Interactive Database. The source of the official bank rate of Bank of England is Bank of England at this webpage[2]. The source of deposit facility rates of European Central Bank (ECB) is key ECB interest rates at this webpage[1]

Figure 2.3: Path of the growth rate of the discount factor as a negative demand shock and path of the government spending as a fiscal policy instrument

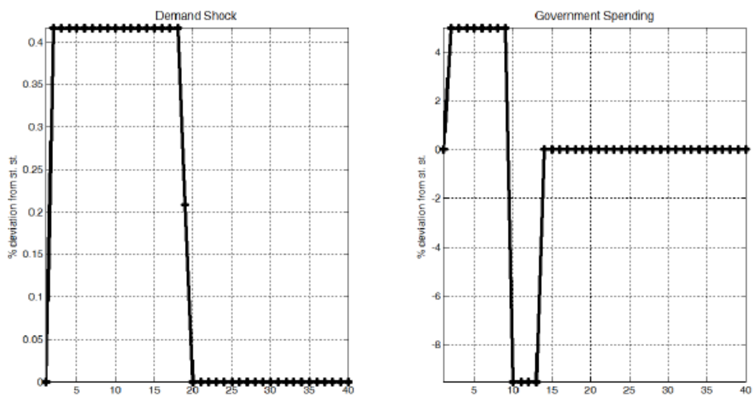
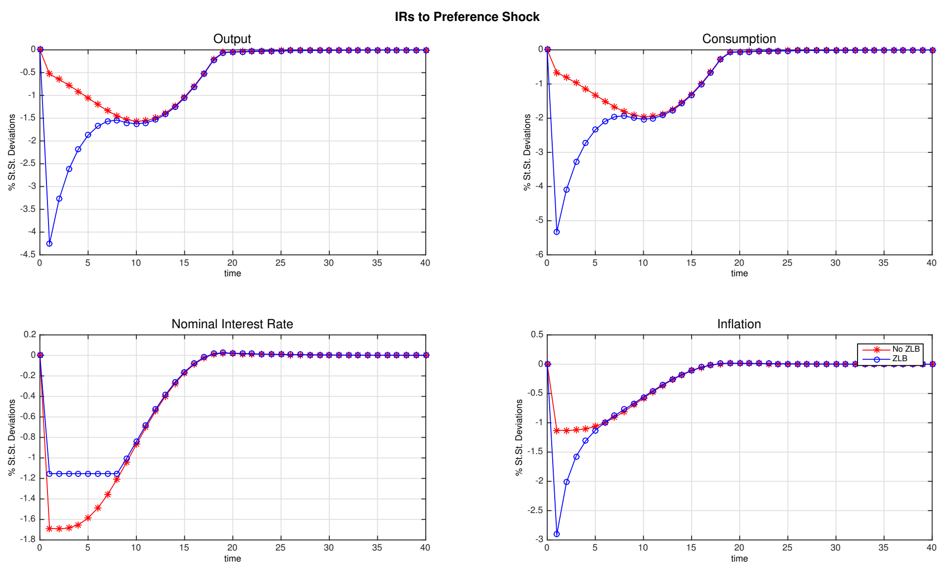
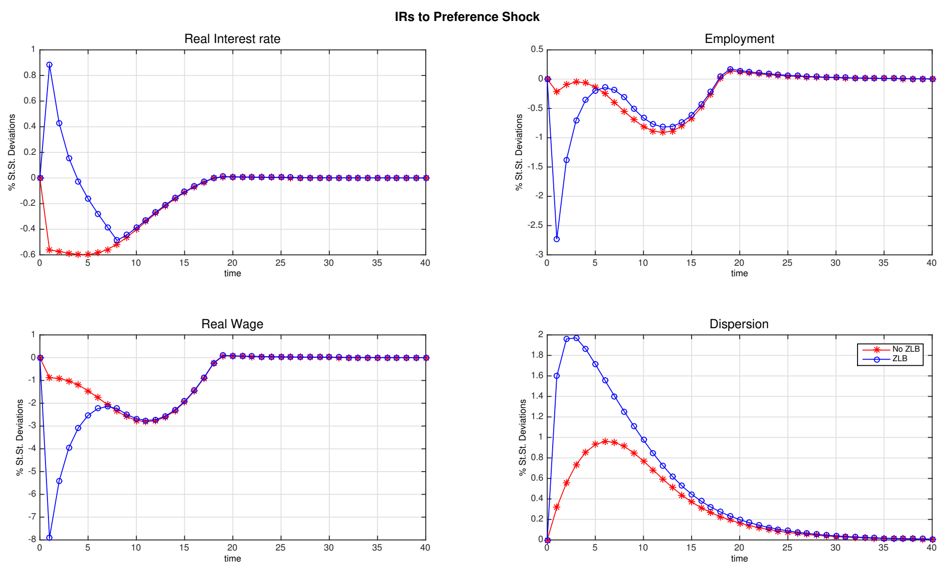


Figure 2.4: Impulse responses to the preference shock with and without the ZLB



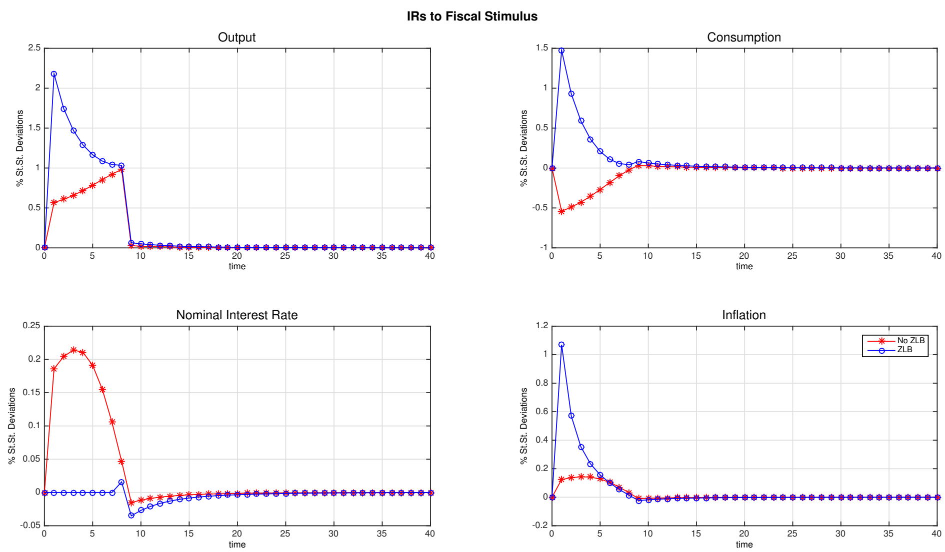
Note: The blue line with circles shows the impulse responses with a binding ZLB. The red line with stars shows the impulse responses with no binding ZLB.

Figure 2.5: Impulse responses to the preference shock with and without the ZLB



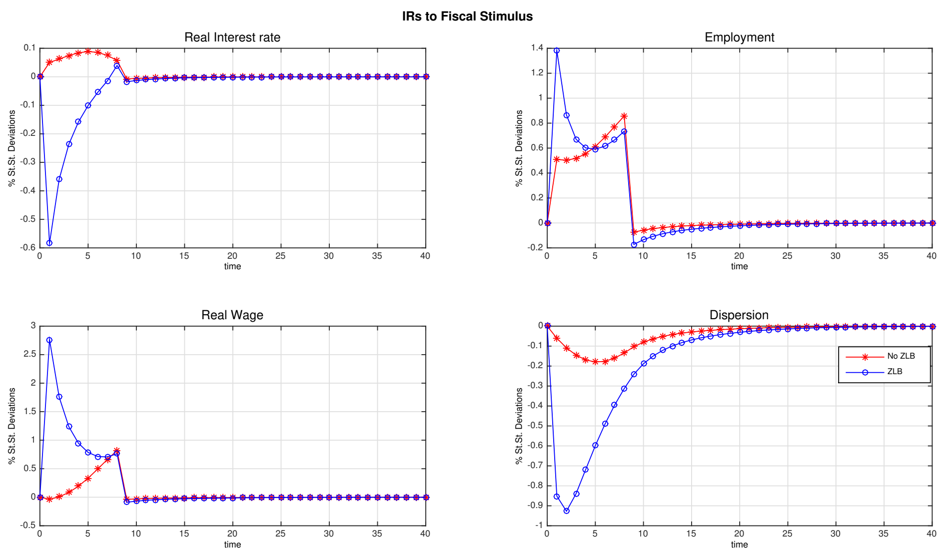
Note: The blue line with circles shows the impulse responses with a binding ZLB. The red line with stars shows the impulse responses with no binding ZLB.

Figure 2.6: Impulse responses to fiscal stimulus with and without the ZLB



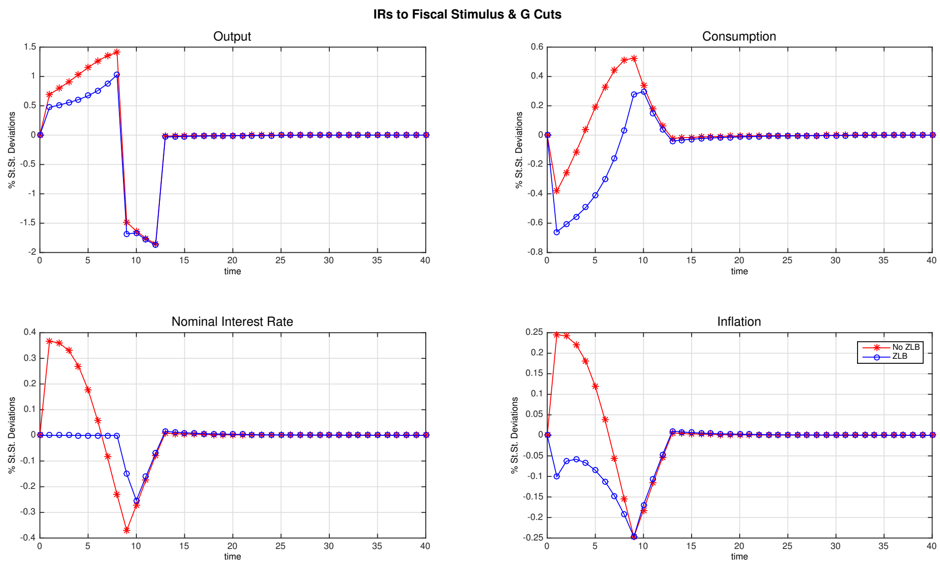
Note: Net effect of fiscal stimulus means the difference between the case with the negative demand shock and the fiscal stimulus and the case with the negative demand shock. The blue line with circles shows the impulse responses with a binding ZLB. The red line with stars shows the impulse responses with no binding ZLB.

Figure 2.7: Impulse responses to fiscal stimulus with and without the ZLB



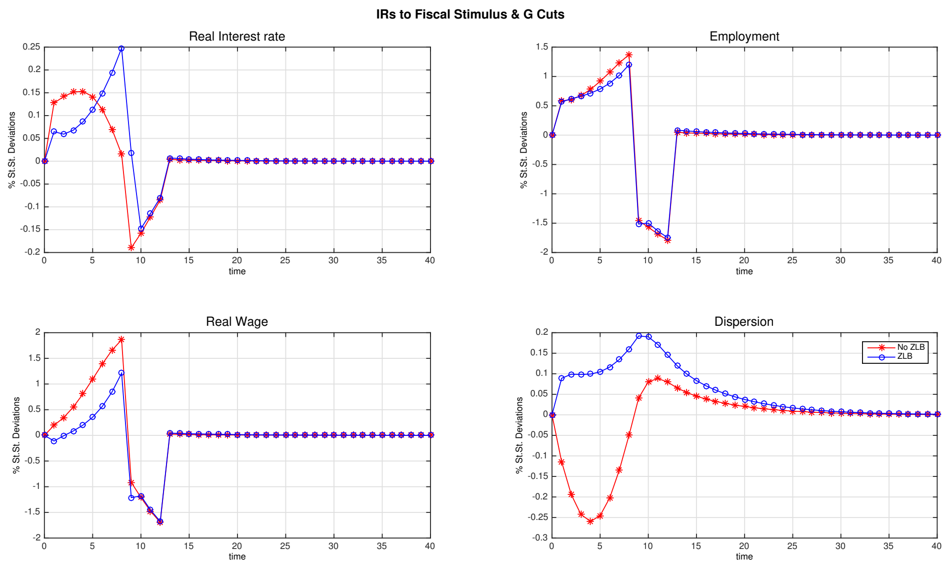
Note: Net effect of fiscal stimulus means the difference between the case with the negative demand shock and the fiscal stimulus and the case with the negative demand shock. The blue line with circles shows the impulse responses with a binding ZLB. The red line with stars shows the impulse responses with no binding ZLB.

Figure 2.8: Impulse responses to fiscal stimulus and future government spending reversal.



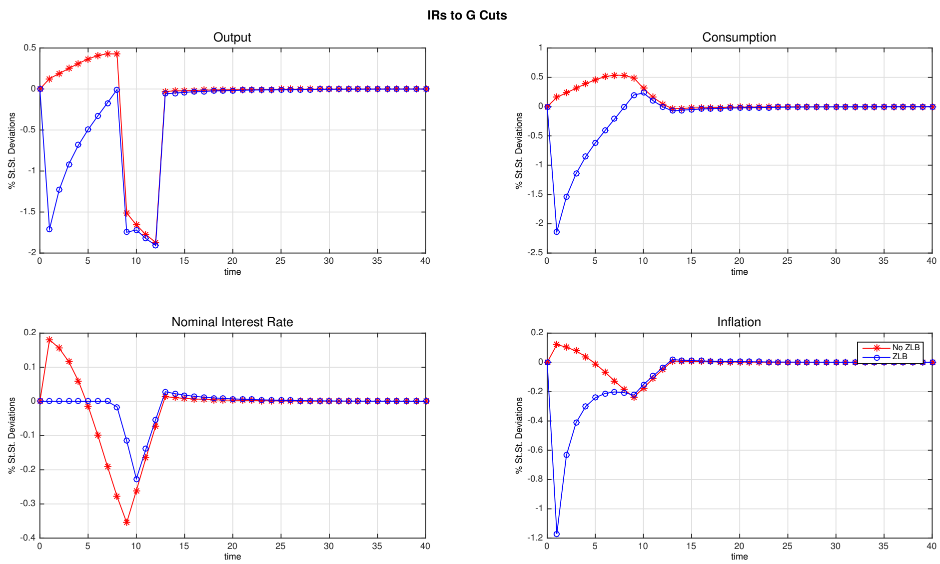
Note: Net effect of fiscal stimulus and spending reversal means the difference between the case with the negative demand shock, the fiscal stimulus and the spending reversal and the case with the negative demand shock.The blue line with circles shows the impulse responses with a binding ZLB. The red line with stars shows the impulse responses with no binding ZLB.

Figure 2.9: Impulse responses to fiscal stimulus and future government spending reversal.



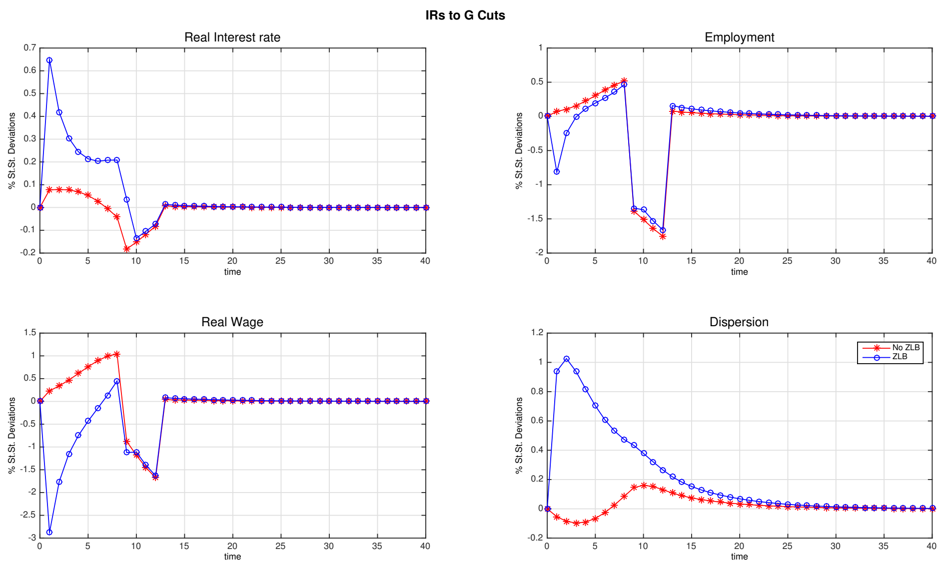
Note: Net effect of fiscal stimulus and spending reversal means the difference between the case with the negative demand shock, the fiscal stimulus and the spending reversal and the case with the negative demand shock.The blue line with circles shows the impulse responses with a binding ZLB. The red line with stars shows the impulse responses with no binding ZLB.

Figure 2.10: Impulse responses to future government spending reversal.



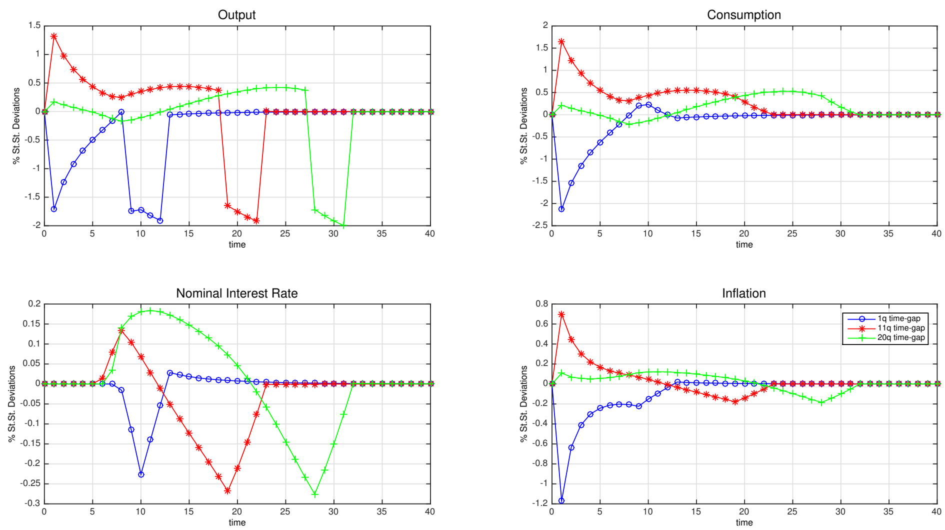
Note: Net effect of the spending reversal means the difference between the case with the negative demand shock, the fiscal stimulus and the spending reversal and the case with the negative demand shock and the fiscal stimulus.The blue line with circles shows the impulse responses with a binding ZLB. The red line with stars shows the impulse responses with no binding ZLB.

Figure 2.11: Impulse responses to future government spending reversal.



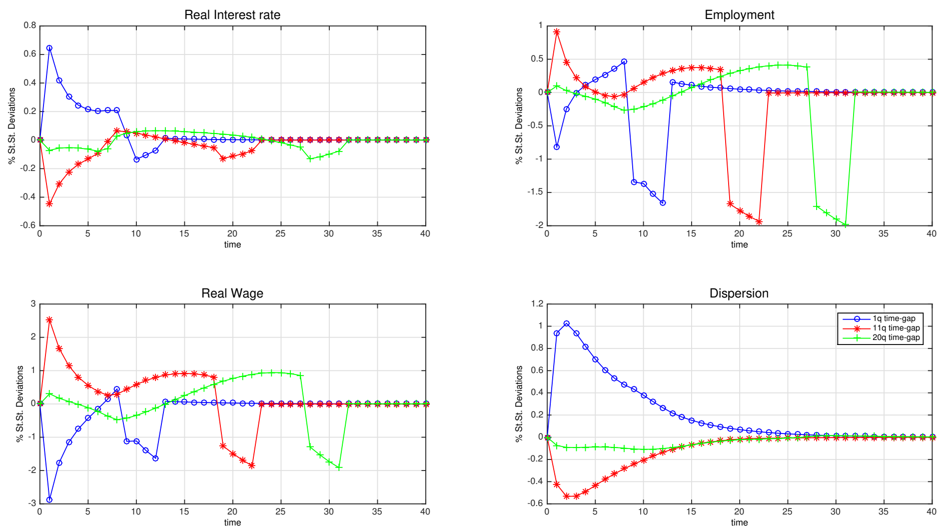
Note: Net effect of the spending reversal means the difference between the case with the negative demand shock, the fiscal stimulus and the spending reversal and the case with the negative demand shock and the fiscal stimulus.The blue line with circles shows the impulse responses with a binding ZLB. The red line with stars shows the impulse responses with no binding ZLB.

Figure 2.12: Impulse responses to future government reversal with different timing.



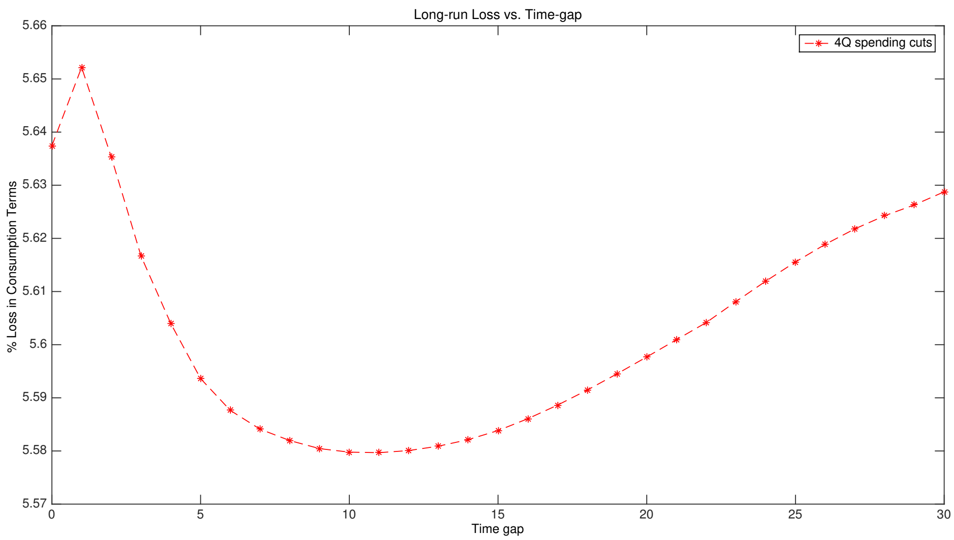
Note: The blue line with circles shows the impulse responses to net spending reversal that is conducted one quarter after the end of the fiscal stimulus. The red line with stars shows the impulse responses to net spending reversal that is conducted eleven quarters after the end of the fiscal stimulus.The green line with pluses shows the impulse responses to net spending reversal that is conducted twenty quarters after the end of the fiscal stimulus.

Figure 2.13: Impulse responses to future government reversal with different timing.



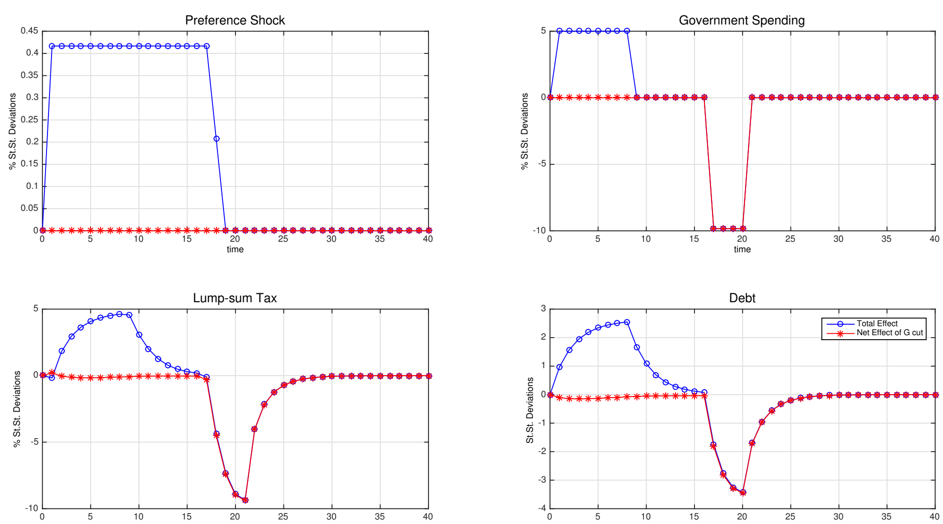
Note: The blue line with circles shows the impulse responses to net spending reversal that is conducted one quarter after the end of the fiscal stimulus. The red line with stars shows the impulse responses to net spending reversal that is conducted eleven quarters after the end of the fiscal stimulus.The green line with pluses shows the impulse responses to net spending reversal that is conducted twenty quarters after the end of the fiscal stimulus.

Figure 2.14: The relation between the welfare cost and the timing of the future government reversals when there is no fiscal rule in the economy.



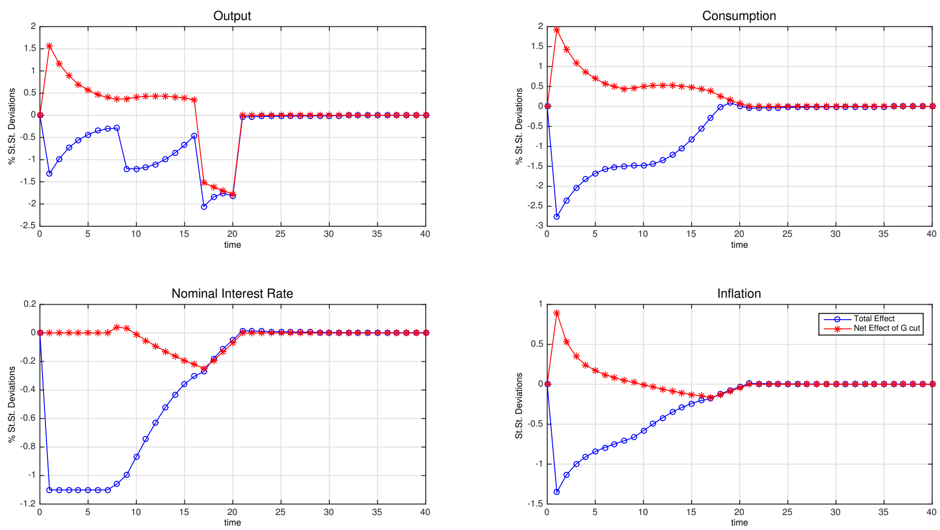
Note: X-axis displays the time-gap between the end of fiscal stimulus and the beginning of spending reversal that lasts four quarters. Y-axis displays the welfare loss in percentages of consumption terms.

Figure 2.15: Impulse responses with the lump-sum tax rule.



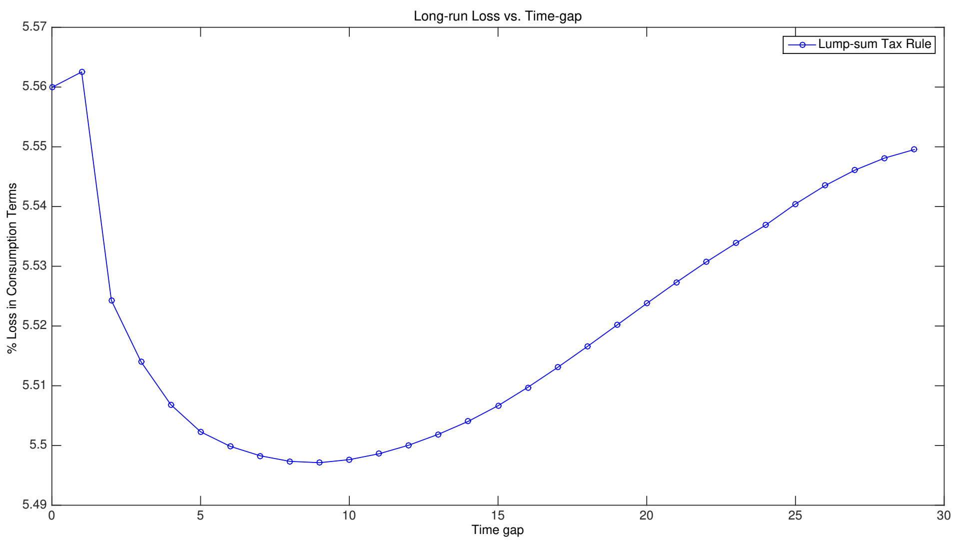
The blue line with circles shows the impulse responses to preference shock, fiscal stimulus and future government reversal. The red line with stars shows the net effect of future government reversal with 9 quarters time-gap.

Figure 2.16: Impulse responses with the lump-sum tax rule.



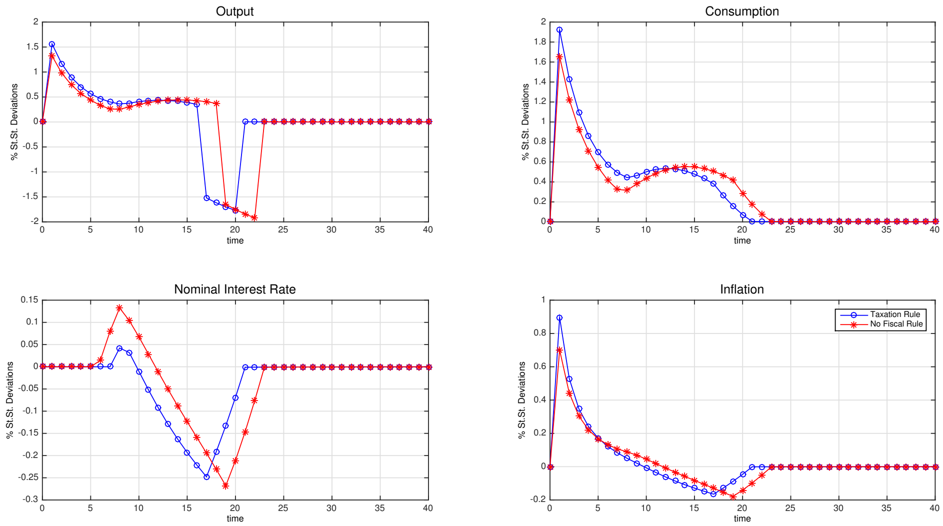
The blue line with circles shows the impulse responses to preference shock, fiscal stimulus and future government reversal. The red line with stars shows the net effect of future government reversal with 9 quarters time-gap.

Figure 2.17: The relation between the welfare cost and the timing of the future government reversals when there is lump-sum taxation rule in the economy.



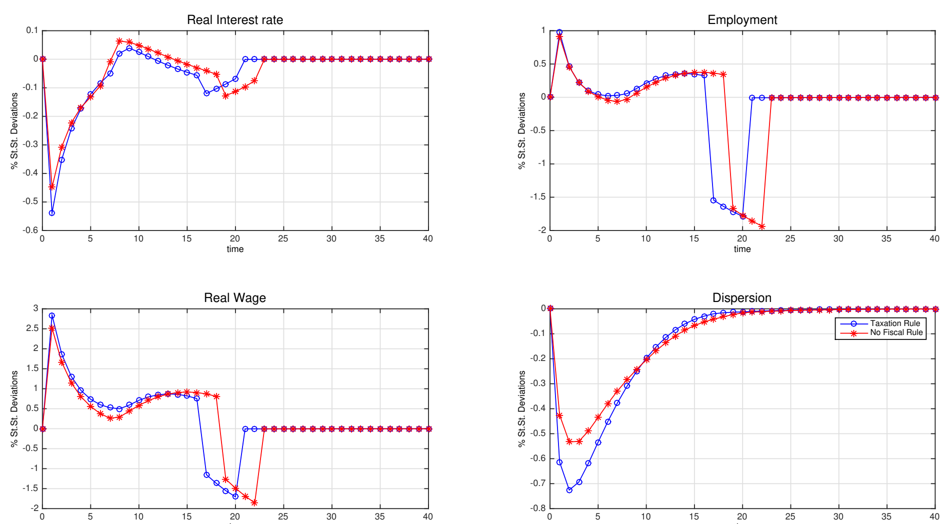
Note: X-axis displays the time-gap between the end of fiscal stimulus and the beginning of spending reversal that lasts four quarters. Y-axis displays the welfare loss in percentages of consumption terms. In this set-up there is also lump-sum taxation rule.

Figure 2.18: Net effect of future fiscal consolidation with and without lump-sum tax rule.



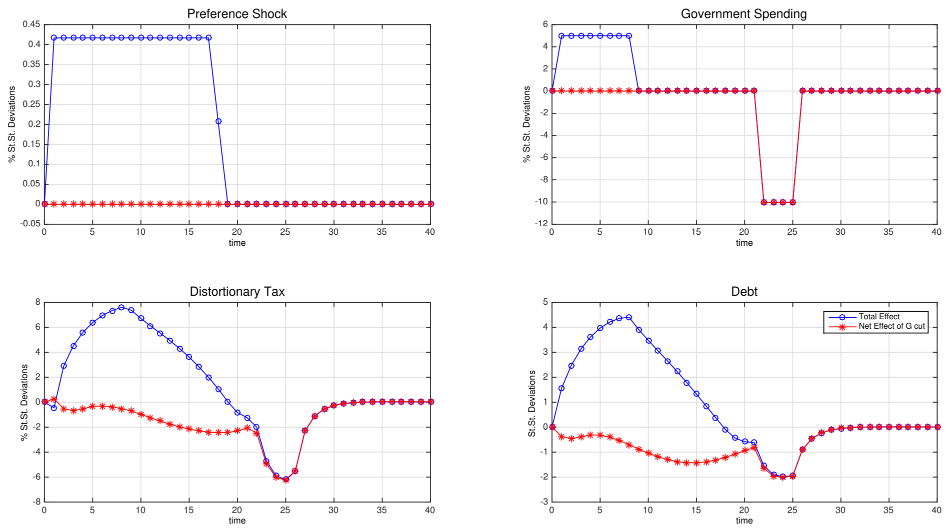
Net effect of future government reversals without fiscal rule (the red line with stars) and with lump-sum taxation rule (the blue line with circles).

Figure 2.19: Net effect of future fiscal consolidation with and without lump-sum tax rule.



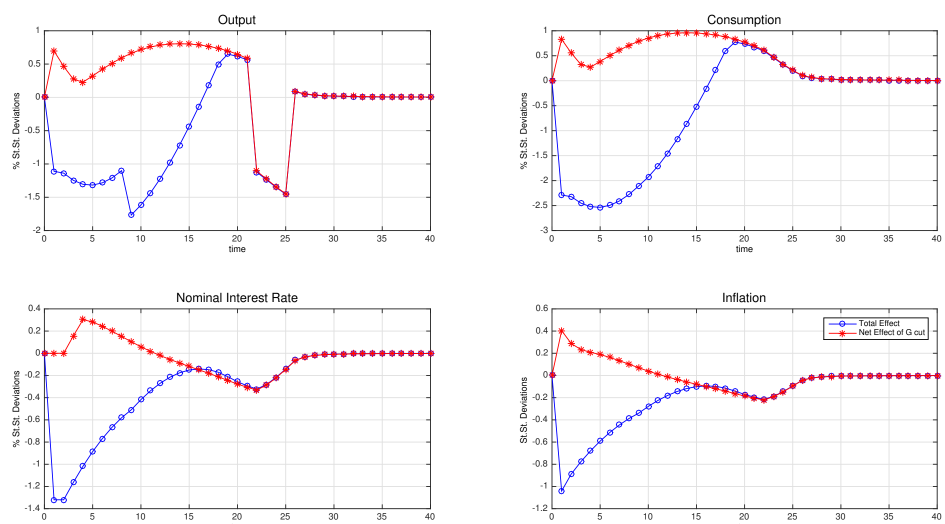
Net effect of future government reversals without fiscal rule (the red line with stars) and with lump-sum taxation rule (the blue line with circles).

Figure 2.20: Impulse responses with distortionary income tax rule



The blue line with circles shows the impulse responses to preference shock, fiscal stimulus and future government reversal. The red line with stars shows the net effect of future government reversal with 15 quarters time-gap in the presence of labor income taxation rule.

Figure 2.21: Impulse responses with distortionary income tax rule.



The blue line with circles shows the impulse responses to preference shock, fiscal stimulus and future government reversal. The red line with stars shows the net effect of future government reversal with 15 quarters time-gap in the presence of labor income taxation rule.

Figure 2.22: The effect of timing of future government spending cuts on the duration of the ZLB.

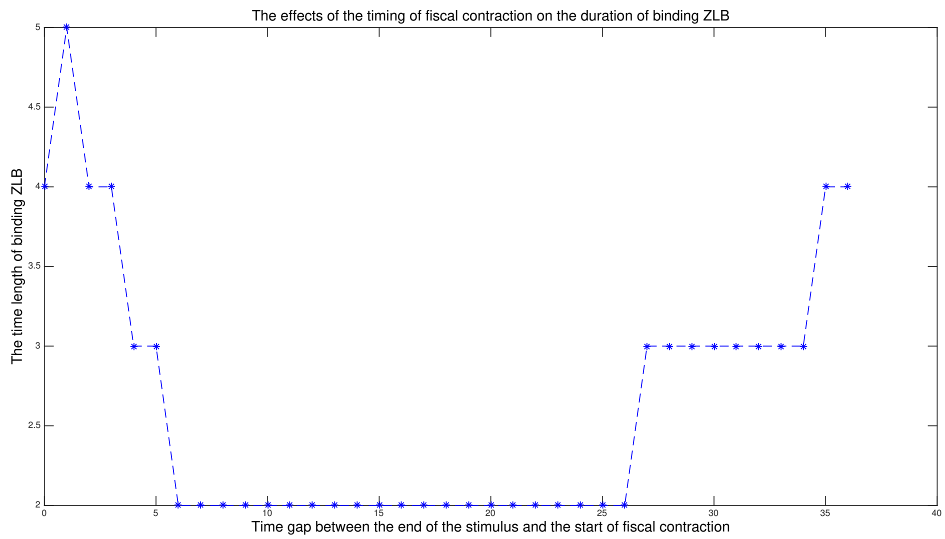


Figure 2.23: The relation between the welfare cost and the timing of the future government reversals in the presence of the labor income tax rate rule.

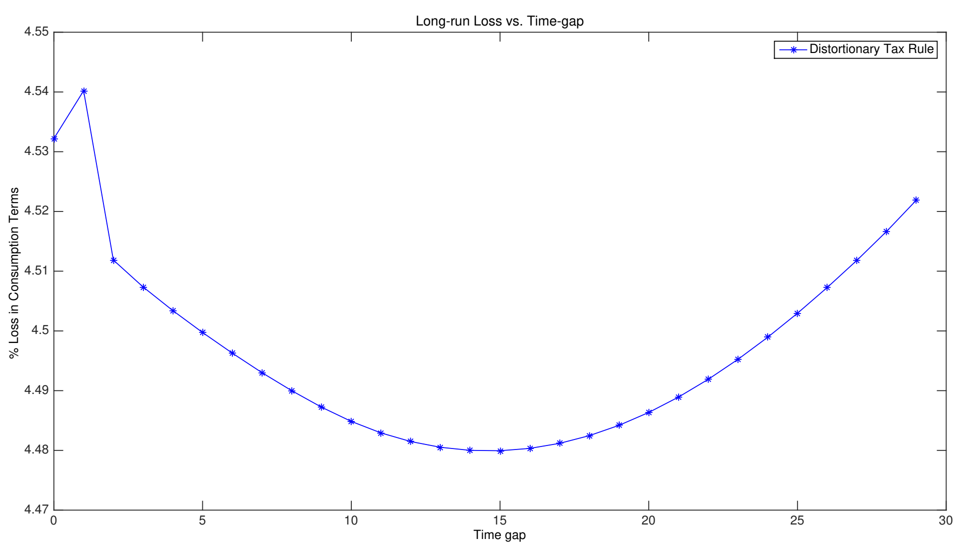
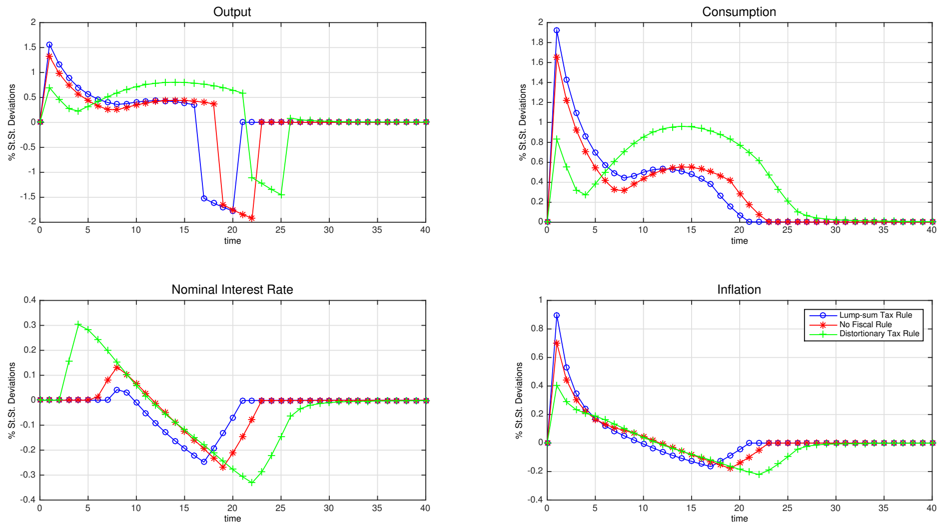
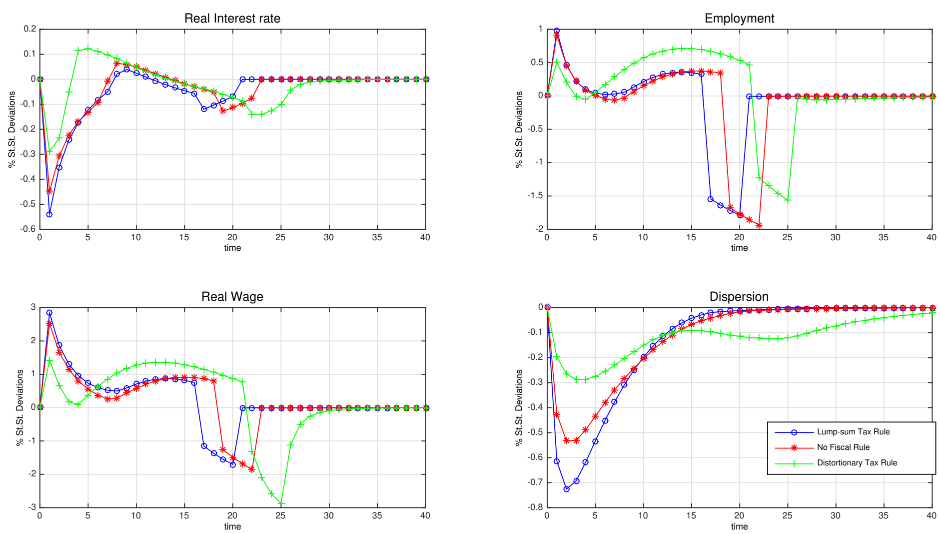


Figure 2.24: Impulse responses without fiscal consolidation, with lump sum tax rule and with labor income tax rule



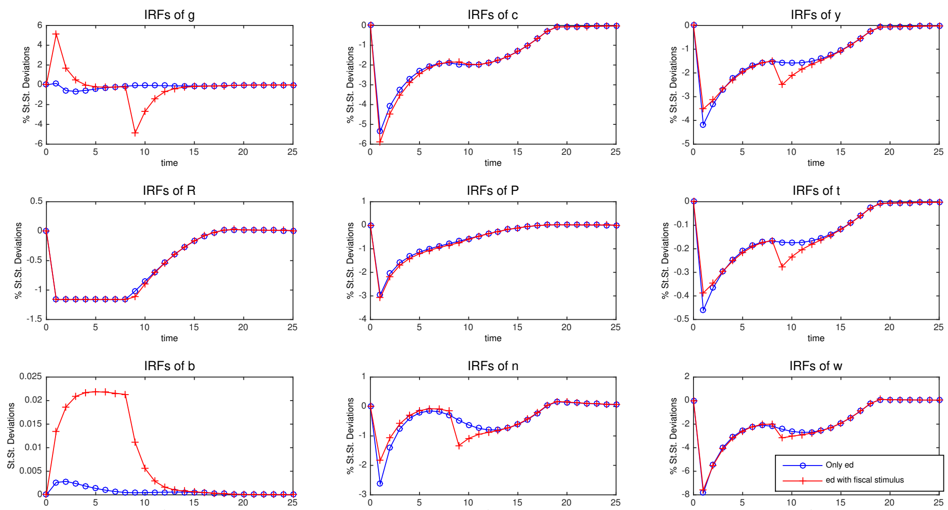
Net effect of future government reversals without fiscal rule (the red line with stars), with lump-sum taxation rule (the blue line with circles) and with distortionary income taxation rule (the green line with pluses).

Figure 2.25: Impulse responses without fiscal consolidation, with lump sum tax rule and with labor income tax rule



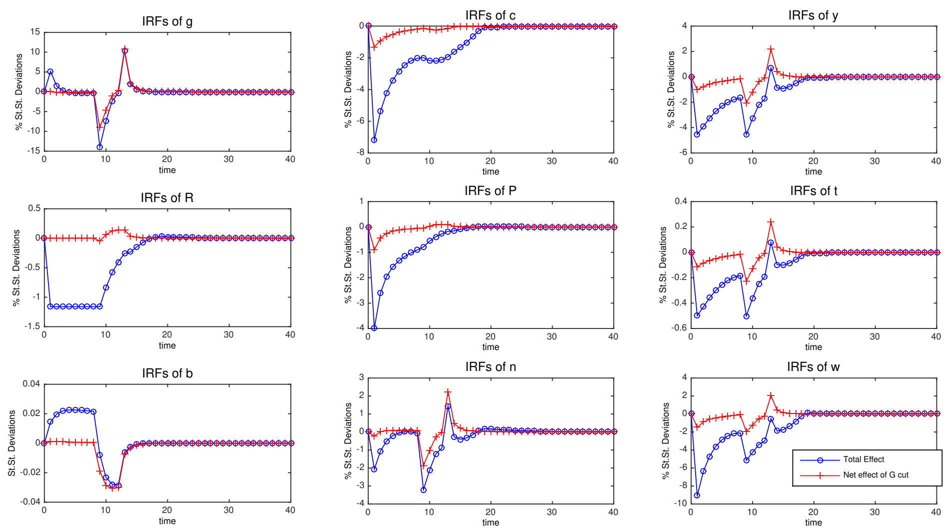
Net effect of future government reversals without fiscal rule (the red line with stars), with lump-sum taxation rule (the blue line with circles) and with distortionary income taxation rule (the green line with pluses).

Figure 2.26: Impulse responses with a government spending rule



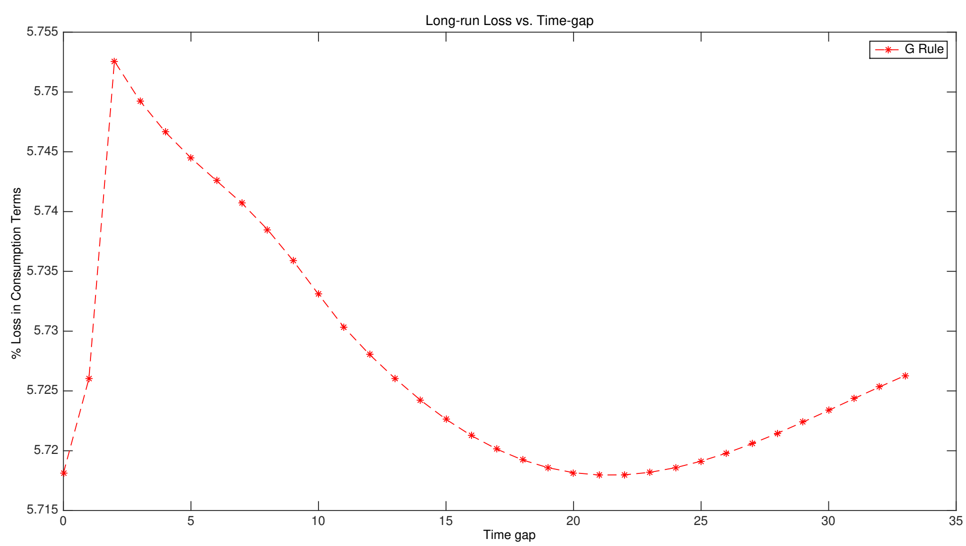
The blue line with circles shows the impulse responses to only preference shock. The red line with stars shows the impulse responses to both preference shock and fiscal stimulus when the government spending follows a fiscal rule.

Figure 2.27: Impulse responses with both a government spending rule and an additional fiscal consolidation



The blue line with circles show the impulse responses to preference shock, fiscal stimulus and the government cuts. The red line with stars show the impulse responses to government spending cut when the government spending follows a fiscal rule.

Figure 2.28: The relation between the welfare cost and the timing of the future government reversals in the presence of the government spending rule



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