International Fiscal Transmission and Terms of Trade

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Abstract

This paper examines the effects of fiscal policy shocks in a currency union emanating from the core on (a) aggregate variables and (b) intra-union trade flows. To contrast the effects of supply and demand side shocks, we compare a reduction of taxes on firms with an increase in government spending. We find a ‘beggar-thy-neighbor’ effect à la Mundell (1962) on account of a tax reduction and a bleak ‘jump-start’ effect à la Blanchard et al. (2016) following government spending in core. We also quantify intra-union trade flows through changes in real exchange rate by decomposing it into an aggregate price effect and terms of trade effect.

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1 Introduction

During the formation of the Eurozone, member countries envisaged greater market access, increased external demand and improved technology flows via FDIs (Alesina and Barro, 2002). It was assumed that external shocks to the union would be counterbalanced by improved monetary policy coordination. However, the process did not smoothen the macroeconomic imbalances within the union and lack of independent monetary policy proved to be a constraint. Due to additional constraints on government policy in the peripheral economies, effects of fiscal policy shocks emanating from the core could also not be mitigated. It is thus important to examine the spillover effects of such fiscal policy shocks to evaluate their effects on (a) aggregate variables for the currency union and (b) intra-union trade flows. This paper builds on Christiano et al. (2011a) extending it to an open economy currency union framework with core and periphery country blocks to analyze these inter-linkages.

Would the inter-dependence of macroeconomic variables across core and periphery promote use of certain policies by the core as opposed to ones outside a union? Is it possible to use external demand as a source of economic stability over business cycles and exploit the policy interdependence? These questions are especially important in a currency union without independent monetary policy. It is also argued that the divergence in output within European Union is partly attributable to these policy interdependencies. In order to answer these questions, this paper contrasts the effects of supply and demand side shocks by quantifying differences in policy transmission on account of an increase in government spending and a reduction in tax on firms. For the core economies, both these policies act on their need to provide counter-cyclical policy in times of waning domestic demand. But, the effect on periphery of the two policies is different. We find a ‘beggar-thy-neighbor’ effect à la Mundell (1962) on account of a tax reduction and a bleak ‘jump-start’ effect à la Blanchard et al. (2016) following government spending in core.

Our version of the New Keynesian model uses a richer inflation process (partial indexation to past inflation) and detailed fiscal policy function to examine the effects of fical policy by core country block. We find that a government spending spillover from core to periphery occurs via changes in monetary policy common to the union. In our baseline, an increase in government spending by 1% of GDP, increases output by less than 1%. Moreover, unless a part of government
spending is on imported goods, outside of a liquidity trap the positive effects on periphery are 0.2%. This is because of the monetary policy which responds to a rise in inflation thereby dampening the periphery economy.

On the other hand, a tax reduction in the core has a significant trade effect by directly altering the terms of trade between the two country blocks. A percent reduction in tax increases output by about 2% for our baseline. However, in this policy, the reduction in output for the periphery is also about 4%. Thus the immediate beggar-thy-neighbor effect of a tax propagates more through the periphery than a jump-start in the case of a government spending.

Our paper takes insights from the macro literature on fiscal policy and examines cross-country transmission in the case of currency unions. There are two key issues which are read in conjunction - (a) choice of policy instruments and (b) policy interdependence within countries. Within the literature which examines the types of policies lies an extensive analysis of (c) tax policies and its equivalent representations and (d) spending policies and its impact on government budget. We are interested in these policies per se, but we refrain from an analysis of the type of policies on government debt\(^1\). We will examine these separately and provide scope for a juxtaposition.

There is extensive discussion on the impact of government spending\(^2\) multipliers in a New Keynesian model\(^3\). In reading through the surging discussion of fiscal multipliers\(^4\) in currency union\(^5\), a discussion of either the magnitude or impact of a government spending is forthcoming. The resurgence of a debate on fiscal policy is timely and there exists disagreement\(^6\). Christiano et al. (2011a) undertakes simple exercises and distinguishes the results of a government expenditure in a new-classical model without price stickiness. The contrast upon adding Keynesian price rigidity divides the discussion on magnitudes.

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\(^1\) Erceg and Lindé (2013).

\(^2\) This discussion and a resurgence of fiscal policy comes on account of the crisis. It is only then that two things were realized (a) monetary policy cannot correct everything, and (b) there is a need for a fiscal spending plan so that this confidence crisis does not lead to a fiscal crisis subsequently. (Lipsky, 2008; as cited in Coenen et al. (2012))

\(^3\) Woodford (2011) and Ramey (2011a) etc.

\(^4\) Christiano et al. (2011b), Woodford (2011)


\(^6\) Perotti (2007): argues that there is disagreement on the basic theoretical effects of fiscal policy and on the interpretation of the existing empirical literature.
In addition to calibration exercises, there is a critique from a growing empirical literature that the size difference has to be identified\(^7\) in order to establish results which are model independent. Empirical estimation from continuing changes in spending, monitoring policy announcements and evaluating identification from policy news shocks\(^8\) have also gained traction. In fact, Blanchard and Leigh (2013) evaluate the size of multipliers by explicitly accounting for growth forecast errors. Caggiano et al. (2015) explores such measurement errors on account of linerization of solution functions adopted to evaluate these models. Thus there is empirical literature on measurement errors as well as numerical errors.

On the contrary, the literature on taxation talks more about the timing of taxation (Ramey (2011b)) and anticipation of fiscal policies. Christoffel et al. (2008) constructs a large scale model to examine the impacts of distortionary taxation and estimates the model. But the crucial channel of taxation is not explicitly discussed in the case of a monetary union. Further, taxes are also examined as automatic stabilizers\(^9\) albeit in a setting where the effect of tax is not obvious as in the case of Non-Ricardian consumers. There is a parallel literature on identification of tax shocks\(^10\) that deal with identification of these issues in a reduced form manner.

We try and look at the expenditure and taxation literature in conjunction to examine the issues of trade flows\(^11\). There are a few who have looked at the conjoint effect Drautzburg and Uhlig (2015) combine the models of spending in presence of a distortionary taxation\(^12\). However, it is important to distinguish between the literature which jointly analyses taxation and spending with what we are trying to do. In extending the literature to a currency union, we are able to examine the effects of these policies together by examining trade within the union. This implies that we can hold constant the impact of exchange rate volatility, which does not affect the intra union trade in

\(^7\)Auerbach and Gorodnichenko (2012)
\(^8\)Schmitt-Grohé and Uribe (2012)
\(^9\)McKay and Reis (2016)
\(^10\)Riera-Crichton et al. (2016)
\(^11\)Farhi et al. (2014) argue that they can have devaluations of the manner discussed via exchange rate changes even in a monetary union if the fiscal policies act in a manner to tilt the price ratios. This is partly the idea with which I started thinking about fiscal imbalances in currency union. The mechanism by which I thought the devaluations to take place was by export subsidies, and they also discuss in part these measures.
\(^12\)Other authors who have worked on the intersection of these two types of policies are - Uhlig (2010), Stähler and Thomas (2012)
any direct manner.

Also, by invoking the two channels of transmission\textsuperscript{13}, we are able to explicitly comment on the direction of trade. This adds to the existing literature on transmission and extends it to the currency union\textsuperscript{14}. The gaps in direction of trade as sourced from changes in fiscal policy would be addressed. The next section provides a medium scale DSGE model to explore these issues.

2 Model

In this section, we discuss the baseline new Keynesian model, adopted to open economy with home and foreign country\textsuperscript{15}. We then aggregate the agents problems and arrive at the linearized reduce system. The reduced system will form the key aggregate currency union system similar to a Smetts and Wouters (2003) system. Our key contribution is to write a disaggregation and arrive at implications on trade from exogenous policy shocks.

A representative household in the home country consumes a bundle of domestic and foreign final good in our two good open economy. The household supplies labor, buys one period of government bonds and internationally traded state contingent securities. We assume there is no borrowing and consumption is affected by economy-wide habit formation. In addition, the households pay lumpsum taxes to the government and gain utility from government spending assumed to be on public goods which are not substitutable with private consumption. While describing representative agent open economy models, the description of home economy follows the macro literature largely.

The households in the domestic economy are indexed $i \in [0,n)$ and their foreign counterparts indexed $i \in [n,1]$. The utility function is concave with the partial first and second derivatives as follows: $U_C, U'_G > 0$ and $U'_N < 0$; $U''_C, U''_G < 0$ and $U''_N > 0$. The cross partial derivatives do not matter as long as the whole function is concave and has a maximum\textsuperscript{16}. Note that the

\textsuperscript{13} An important feature influencing the effects of fiscal policy in our model is the inclusion of ‘rule of thumb’ households who consume all of their after-tax income as in Erceg et al. (2006); ample micro- and macro-evidence suggests that such non-Ricardian consumption behavior is a key transmission channel for fiscal policy.” Erceg and Lindé (2013). We do not invoke rule of thumb consumers for examining transmission.

\textsuperscript{14} See - Corsetti et al. (2010), Corsetti and Pesenti (2005), Cwik et al. (2011)

\textsuperscript{15} Foreign country variables are denoted with a *. The symmetric problem of the foreign country does not necessitate a complete exposition. We will flag the differences when we discuss the linearized system.

\textsuperscript{16} Sims and Wolff (2013), NBER working paper #19749
utility function is additively separable in all its arguments\(^ {17}\). \( \beta \in (0,1) \) is the discount factor. The households discounted life time utility is over \( C_{it}, N_{it} \) and \( G_{t} \). These variables represent household consumption, labor hours supplied, and an exogenously given level of government spending.

\[
\max_{C_{it},N_{it},B_{it+1},B_{Gt+1}} \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \nu_{\beta,t} U \left( X_{it}, N_{it}, G_t \right)
\]

\( \mathbb{E}_t \) is the mathematical expectations operator conditioned on time \( t \). \( \nu_{\beta,t} \) is the discount factor shock for the households which is a simple AR(1) process. The nominal flow budget constraint, indicative of the timing convention used in the paper, is as follows:

\[
P_tC_{it} + Q_{t+1} B_{i,t+1} + B_{it} G_{t+1} \leq W_t N_{it} + D_{it} - T_t + (1 + \epsilon_{it-1}) B_{it} G_{t} + B_{it}
\]

\( P_t \) is the consumer price index for the home country. The optimization problem for the households is as follows:

\[
\mathcal{L} = \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \nu_{\beta,t} \left\{ U(\cdot) - \lambda_t \left[ P_tC_{it} + Q_{t+1} B_{i,t+1} + B_{it} G_{t+1} - W_t N_{it} - D_{it} - T_t + (1 + \epsilon_{it-1}) B_{it} G_{t} + B_{it} \right] \right\}
\]

where we have the following separable CRRA utility function

\[
U(\cdot) = \left[ \frac{1}{1 - \epsilon_c} (C_{it} - hC_{t-1} - \mu_c \nu_{ct})^{1-\frac{1}{\epsilon_c}} - \mu_n N_{it}^{1+\epsilon_n} \nu_{nt} + \mu_g \left( \frac{G_t^{1-\epsilon_q}}{1 - \epsilon_q} \right) \right]
\]

We obtain the following first order conditions from the households problem.

\[
\lambda_t P_t = \left( C_{it} - hC_{t-1} - \mu_c \nu_{ct} \right)^{-\frac{1}{\epsilon_c}}
\]

\[
\lambda_t W_t = \mu_n \nu_{nt} N_{it}^{\epsilon_n}
\]

\[
\frac{1}{(1 + \epsilon_{it-1})} = \beta \mathbb{E}_t \frac{\nu_{\beta,t+1}}{\nu_{\beta,t}} \frac{\lambda_{t+1}}{\lambda_t}
\]

\[
Q_{t+1} = \beta \mathbb{E}_t \frac{\nu_{\beta,t+1}}{\nu_{\beta,t}} \frac{\lambda_{t+1}}{\lambda_t}
\]

\(^ {17}\text{Christiano et al. (2005) have introduced non-separability of labor and consumption and allows for more persistence of the consumption process, but we shall avoid it for simplicity sake.}\)
A few things worth mentioning. Firstly, habit persistence in consumption links the nominal marginal utility of money today with yesterday’s habits, allowing for consumption to be persistent. This prevents consumption smoothening, evidence against which are plenty in the literature. $\nu_{ct}$ is a taste shock following an exogenous AR(1) process. Secondly, the ‘Uncovered Interest Parity’ condition in this case equates the interest rate on government bonds in both countries as well as the price of internationally traded state contingent securities. Thus there is a degree of international risk sharing on account of complete markets in the model. Thirdly, the last expression can be interpreted as the real ‘Stochastic Discount Factor’ for the household for the next period as in Farhi et al. (2014).

Fourthly, the index of consumption is a weighted average of the domestic consumption and imported consumption, with $C_{Dit}$ being the total domestic goods purchased in the domestic economy and $C_{Mit}$ being the imported consumption. We assume away any frictions and trade costs in importing.

\[
C_{it} = \left[ (1 - \omega) \frac{\epsilon_{l}^{(1)} C_{Dit}}{\epsilon_{l}^{1}} + \omega \frac{\epsilon_{l}^{(1)} C_{Mit}}{\epsilon_{l}^{1}} \right]^{\frac{\epsilon_{l}}{1 - \epsilon_{l}}}
\]

Finally, we assume the ‘law of one price’ holds for both countries or we operate in a PCP paradigm. Hence we solve for only two final goods prices in the open economy model. We can obtain the consumer price index by solving for an optimal bundle given any level of income $Z$.

\[
P_{t} = \left[ (1 - \omega) P_{Dt}^{1 - \epsilon_{l}} + \omega P_{Dt}^{(1 - \epsilon_{l})} \right]^{\frac{1}{1 - \epsilon_{l}}} \quad (6)
\]

Once we have the price index, we can express the domestic consumption and imported consumption as a function of the relative prices and aggregate consumption as follows:

\[
C_{Dit} = (1 - \omega) \left[ \frac{P_{t}}{P_{Dt}} \right]^{\epsilon_{l}} C_{it}
\]
\[
C_{Mit} = (\omega) \left[ \frac{P_{t}}{P_{Dt}} \right]^{\epsilon_{l}} C_{it}
\]
We can also write the bilateral (or effective) terms of trade for the core country.

\[ \tau_t = \frac{P^*_Dt}{P Dt} \]

The firms side of the problem in the home country is the standard two types of firms. The final good producing firm is a Dixit-Stiglitz aggregator for tradables which is used for direct consumption by households. We can think of these firms as operating in perfectly competitive market, producing a single homogenous product or we can also think of final goods firm as a single firm for the entire home economy\(^{18}\). The production function is an aggregator of inputs purchased from measure \( j \in [0, 1] \) intermediate firms whose output are imperfectly substitutable. The degree of substitution between the intermediate firms is given by the parameter \( \epsilon_j > 1 \).

\[
Y_{Dt} = \left( \int_{j=0}^{1} Y_{jt}^{\epsilon_j-1} \right)^{\frac{\epsilon_j}{\epsilon_j-1}}
\]

Now the profit maximization exercise for the firm involves selecting the quantity of inputs given price at which they can sell their output \( P_{Dt} \), the output tax rate \( \tau_{yDt} \), and the price of inputs taken from the respective firms \( P_{jt} \). The expression for profit thus implies the following.

\[
\max_{Y_{jt}} \mathcal{L} = \left[ P_{Dt}(1 - \tau_{yDt}) \left( \int_{j=0}^{1} Y_{jt}^{\epsilon_j-1} \right)^{\frac{\epsilon_j}{\epsilon_j-1}} - \int_{j=0}^{1} P_{jt}Y_{jt}dj \right]
\]

We can arrive at the domestic price index from the optimization, which shows a positive relationship between an increase in taxes and the domestic price index. Thus the tax rate on output becomes important variable which pins down total consumption and the proportion of domestic

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\(^{18}\) Why Tradables vs Non Tradables: We introduce variety at non-tradable stage so that we do not have multiple global market clearing conditions for all the \( n \) variety in a country (Obstfeld, 2014) Under the heterogeneity that the Calvo assumption implies, it is not trivial to aggregate the firms that employ workers. If those firms produced final goods, you would have a separate, global equilibrium condition for each variety. This would be hard to handle analytically. But the final tradable good is an aggregator for all the economy’s heterogeneous employers.
consumption.

\[
P_{Dt} = \frac{1}{(1 - \tau_{yDt})} \left[ \int_{j=0}^{1} P_{jt}^{1-\epsilon_j} dj \right]^{1/\epsilon_j}
\]

(7)

The second type of the firm in the model economy are intermediaries, which are monopolistically competitive and set prices according to either a Calvo rule or a partially indexed thumb rule. These firms hire labor and operate a simple production function. All firms have identical productivity, and we rule out entry or exit. We break up the quantity and price setting problem into a sequential problem for convenience. The quantity setting is a cost minimization given as

\[
\min_{N_{jt}} \mathcal{L} = N_{jt} W_{t} - mc_{t} \left[ \nu_{pt} N_{jt} - Y_{Dt} \left( \frac{\frac{P_{Dt}}{P_{jt}}(1 - \tau_{ytDt})}{P_{jt}} \right)^{\epsilon_j} \right]
\]

In addition, the pricing schedule is given by the following expression. According to evidence on the Euro Area literature, the flexibility in prices can be decomposed into (a) proportion of firms who calvo adjust their prices (a proportion of \( \xi \in [0, 1] \)) and (b) firms who partially index to past prices and hence cannot use contemporaneous information into their pricing decisions (Alvarez et al., 2006).

\[
P_{jt} = \begin{cases} 
P_{jt}^{\text{opt}} & Pr(P_{jt}) \in (\xi, 1] \\
(1 + \pi_{Dt-1})^{\Lambda} P_{jt-1} & Pr(P_{jt}) \in [0, \xi]
\end{cases}
\]

This leads us to the following price setting optimization with stochastic discounting factor for these firms, generating the extra exogenous fluctuations in their pricing decisions.

\[
\max_{P_{jt}^{\text{opt}}} \mathcal{L} = \sum_{s=0}^{\infty} \xi^{s} Q_{t+s} \left[ P_{jt+s} - mc_{t+s} \right] Y_{jt+s}
\]

The firms problem gives us the optimal price setting. In addition to the consumer and producer, we have a government for both home and foreign country and a common monetary policy setting for the currency union as a whole. We describe the home country government and assume the foreign country’s government to be symmetric. We assume that the government follows balanced budget.
In particular, it spends exogenous amount every period, and finances it with either government bonds, taxes on output or lumpsum taxes. We perturb output taxes and government spending; and assume lumpsum taxes adjust for the government’s decision. This implies that we do not venture into the financing decision of the spending in any of the cases as in Baxter and King (1993).

We write the government budget constraint as follows. Note that the total expenditure is not modeled as a reaction function endogenous to the system, but is modeled exogenous in the belief that government expenditure is policy driven rather than fundamentals driven.

\[ P_t G_t + (1 + i^{cu}_{t-1}) B_{Gt} = B_{Gt+1} + T_t + \tau_{yt} P_{Dt} Y_{Dt} \]

Further, the expenditure in the baseline follows an allocation optimization is identical to consumer’s. Thus we can model part of the government expenditure on imported goods as well.

\[ G_{Dt} = (1 - \omega_g) G_t \left( \frac{P_{ Dt}}{P_t} \right) - \epsilon_i 
\]

\[ G_{Mt} = (\omega_g) G_t \left( \frac{P^*_{Dt}}{P_t} \right) - \epsilon_i \]

Finally, the model can be closed by specifying the taylor rule for the common monetary policy for the union as a whole. The monetary policy sets the interest rate on government bonds as the common nominal interest rate. We also include the interest rate (or the monetary policy) shock as a source of perturbation in policy setting. Blanchard and Galí (2007) argue the ‘divine coincidence’ in the monetary policy setting to be empirically implausible; however we assume such a coincidence. We work outside ZLB for our baseline models.

\[ \tilde{i}^{cu}_t = \max \left\{ 0; \rho_i \left[ \phi_x \tilde{x}_t + \phi_\pi \tilde{\pi}_t \right] + (1 - \rho_i) \tilde{i}^{cu}_{t-1} + \tilde{\nu}_{mt} \right\} \]

\[ 0 \leq \rho_i < 1 \]

\[ \phi_\pi, \phi_y > 0 \]

From the non linear model, we can solve the disaggregated system directly for both countries. However, numerically as well as analytically checking the existence of the system (if one exists)
is a computationally difficult exercise. We can linearize the key equations and reduce the system into the familiar three equation new Keynesian system as in Ireland (2004). This method has two implications: (a) The country differences first work through their aggregate effects on the currency union and (b) then we can trace the relative effects on the home and foreign country by using the currency level definition and the relative expressions for output, inflation, consumption and marginal cost etc. The key system comprises of

\[
\hat{x}_t = \frac{\hat{x}_{t+1}}{1 + h} + h \hat{x}_{t-1} - \frac{\epsilon c_y (1 - h)}{1 + h} \left[ \hat{\pi}^{cu}_t - \hat{\pi}_{t+1} - \hat{r}^{nat}_t \right] 
\]

\[
\hat{\pi}_{Dt} = \kappa \psi \hat{x}_t + \kappa \left[ \hat{\pi}_y - \xi \beta \hat{\pi}_{Dt+1} \right] + \kappa \left[ \xi \beta \hat{\pi}_{Dt+1} - \xi \Lambda \hat{\pi}_{Dt-1} \right] 
\]

\[
\hat{i}^{cu}_t = \max \left\{ 0; \rho i \left[ \phi x \hat{x}_t + \phi \pi \hat{\pi}_t \right] + (1 - \rho i) \hat{i}^{cu}_{t-1} + \nu_{mt} \right\} 
\]

Before we proceed to uncover the country wide effects, it is imperative to understand the deviations from the standard expressions as a result of our model. (a) All currency union level variables are population adjusted components of the two country blocks - core and the periphery - which form the currency union. (b) The linearized dynamic IS curve is the habit adjusted version of the textbook version of a new keynesian model. Introduction of habit makes the persistence of output gap \( \hat{x}_t \) to have an AR(2) effect. (c) The linearized new Keynesian Phillips curve has persistence in the intercept on account of the output tax persistence. Thus any change in the tax rate in one of the countries, has a persistent effect on the population weighted average tax rate for the union as a whole. (d) The NKPC has intercept persistence on account of partial indexation of inflation in addition to the standard forward looking term. The slope of the NKPC is a standard term. The above aspects of our closed economy currency union system mirror the deviations, but embed the compositional changes. In the next subsection, we will dwell into the relative effects of two types of fiscal policy shocks emanating from the core (or the home country).

### 2.1 Disaggregation

In addition to the aforementioned three key equations, we can derive the actual country level output. In order to do that, we write output gap and associated currency union level potential
The interest rate at the potential output is

$$\hat{r}_t^{nat} = \frac{(1 - \rho)}{1 + \epsilon_n \epsilon_n c_y} \left[ g_y \hat{G}_t + \frac{1}{\epsilon_c} \hat{\nu}_{ct} + (1 + \epsilon_n) \hat{\nu}_{pt} - \epsilon_n \epsilon_j \hat{\tau}_{yt} - \hat{\nu}_{nt} \right]$$

Thus the potential output is a composited shock in the economy. In addition, actual currency union level output is a population weighted average of component outputs $\hat{y}_t = n \hat{y}_{Dt} + (1 - n) \hat{y}_{Dt}^*$. Using these, we can write the relative output as

$$(\hat{y}_{Dt} - \hat{y}_{Dt}^*) = c_y (1 - \omega - \omega^*) (\hat{c}_t - \hat{c}_t^*) + g_y (1 - \omega_g - \omega_g^*) (\hat{G}_t - \hat{G}_t^*) + \epsilon_t \hat{\tau}_t$$

The relative output indicates two effects of any exogenous shock that can be examined analytically. (a) Relative net output is directly proportional to private consumption gap and government consumption gap. This is partly a reflection of the difference in inter-temporal substitution of consumption in these two countries. (b) In addition, the gap between domestic and foreign output is affected by a terms of trade factor which determines the degree of substitution of consumption from home to foreign (or vice versa) as in Obstfeld and Rogoff (1995).

We can further disaggregate the determinants of a relative consumption. Note that (a) relative discount factor shocks and taste shocks affect consumption. In addition, persistence of habits also makes the relative consumption persistent. Thus we do not expect deviation from the relative norm due to habits in consumption in both economies. (b) Relative consumption also gets affected by terms of trade contemporaneously. This is arguing the relative output case backwards. Changes in terms of trade reflect the opportunities in optimizing consumption by substituting domestic with...

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19 Potential output is defined as output under completely flexible prices.

20 This implies that if consumption is more in foreign economy as compared to domestic economy, output will be more in foreign economy. Note that these are already normalized for population hence they are per capita terms. We do not invoke a government expenditure which is partly imported in our baseline.
foreign or vice versa.

\[
(c_t - c_t^*) = h(c_{t-1} - c_{t-1}^*) + (\hat{\nu}_{ct} - \hat{\nu}_{ct}^*) + \epsilon_c(1 - h)(\hat{\nu}_{\beta t} - \hat{\nu}_{\beta t}^*) + (1 - \omega - \omega^*)\epsilon_c(1 - h)\hat{\tau}_t
\]

In addition to the demand side, we can draw the mechanism operating through supply side channels between the two countries. It is only the resultant market clearing channel which results in the aggregate country specific effects. Note that for the union as a whole the CPI and DPI (domestic price infaltion) can be interchangably used. However, while disaggregating, if we focus on the CPI, we will only obtain the effects which are mediated through the DPI. Hence we focus on the relative DPI differences.

\[
\Delta \hat{\pi}_{Dt} = (1 - \xi \beta)(1 - \xi)\kappa[\Delta \hat{m}_{c} R_t + (\omega + \omega^*)\hat{\tau}_t] + \kappa[\Delta \hat{\tau}_{y, Dt} - \xi \beta \Delta \hat{\tau}_{y, Dt+1}] + \kappa[\xi \beta \Delta \hat{\pi}_{Dt+1} - \xi \lambda \Delta \hat{\pi}_{Dt-1}]
\]

Again, a few things are worth mentioning. (a) While the relative government spending shows up directly in the demand side of the home and foreign countries, our output tax shows up in the supply side of the two economies. (b) Moreover, the tax on output adds in the domestic inflation persistence too. Thus we have \(\xi \beta \Delta \hat{\tau}_{y, Dt+1}\) term which drives the \(\Delta \hat{\pi}_{Dt} = \hat{\pi}_{Dt} - \hat{\pi}_{Dt}^*\) in the above expression. (c) In addition, the partial inflation indexation also shows up in the relative DPI differences also. (d) The slope of the relative phillips curves is \((1 - \xi \beta)(1 - \xi)\kappa\), affected by the calvo parameter and the relative differences in marginal costs. The relative marginal costs are a reflection of the labor market conditions in the two economies\(^{21}\).

To uncover the labor market differences, we can write an expression for the relative marginal costs differences of the two economies. We note that the marginal cost is driven by exogenous shocks as well as market demand. Hence in our model, demand pins down prices (Obstfeld, 2014).

\[
\hat{m}_{c} R_t^* - \hat{m}_{c} R_t^* = \frac{1 + \epsilon_n \epsilon_c c_y}{\epsilon_c c_y} (\hat{y}_{Dt} - \hat{y}_{Dt}^*) - \frac{g_{y}}{\epsilon_c c_y} (\hat{G}_t - \hat{G}_t^*) - \frac{1}{\epsilon_c} (\hat{\nu}_{ct} - \hat{\nu}_{ct}^*) - (1 + \epsilon_n)(\hat{\nu}_{pt} - \hat{\nu}_{pt}^*)
\]

\[+\epsilon_n \epsilon_j (\hat{\tau}_{y, Dt} - \hat{\tau}_{y, Dt}^*) + (\hat{\nu}_{nt} - \hat{\nu}_{nt}^*)
\]

The final key disaggregation is our movements in terms of trade. We can observe that the terms

\(^{21}\)If we model our labor market as monopolistically competitive instead of perfect competition, we will have additional terms associated with the relative marginal cost here.
of trade persists on its own and the relative DPI differences. (a) In comparison with the literature on terms of trade, a temporary fluctuation in terms of trade involved the calvo parameter domestic price formation, which tends to zero in the long run when prices are completely flexible. (b) As in Dornbusch (1976), price rigidity affects the real exchange rate, via a terms of trade in our case.

\[ \tilde{\tau}_t = \tilde{\tau}_{t-1} - \Delta\tilde{\pi}_{Dt} \]

Thus we have analytically arrived at the factors which extend the typical closed economy results from a currency union into country specific effects. The next section discusses calibration and results from two exogenous fiscal policy shocks.

3 Results

We calibrate our two country open economy model for the Eurozone where the home country comprises of Germany and France and the foreign country comprises of Spain and Italy. (a) We use data from 1991:01 to 2008:01 to calibrate the aggregate parameters. (b) For the baseline model we assume \( \omega_g \) and \( \omega^*_g \) to be zero, implying that a spending increase will not directly lead to increase in imports. All government spending is in the respective countries. (c) Further we have to assume that the trade between countries in the core block is zero, an assumption which helps identify the effects of shocks which originate from core to periphery. (d) We calibrate the core country blocks to have 2/3rd of the total union population, a key parameter in transmission between these two economies. (e) For calibrating the slope of the NKPC, we regress DPI for the union as a whole on output gap, and thus back out the slope parameter \( \kappa = 0.008 \) which is slightly on the higher side as compared to the Eurozone literature. Other parameters are standard population moments for the time period selected. We will first discuss the effect of a government spending in the core and draw the main mechanisms working in the model.

3.1 Government Spending Shock and Real Appreciation

In line with the large literature on government spending and a subsequent examination of the magnitude of multiplier as in Christiano et al. (2011a), there is a perceivable gap in spending
transmission literature. Moreover, the existing literature is largely involved with liquidity traps and the effect on multiplier sizes as in Farhi and Werning (2016). However, we deviate from the main macro literature and explore the fiscal transmission in our model open economy. Like before, the currency union level government spending is the population weighted average of home and foreign government expenditures.

What is a government spending shock in the core? A government spending shock can be interpreted as a demand shock. The idea is that an exogenous increase in government spending will lead to a rise in output either greater than or equal to the extent of government spending shock. What are the factors which are at work? (a) A rise in government spending leads to a rise in prices. This causes core country consumers to substitute current consumption for more of future consumption. This increases the labor supply on the margin. (b) Along with the relative fall in consumption, such a fall is mitigated by the persistence to maintain a level of consumption as is habitual for the home country consumer. Both of these limit the ‘crowding out’ and lead to an own multiplier greater than or around 1 in our case.

The aforementioned effect of a rise in government spending shock is common to the closed economy too! However, for a currency union, the rise in domestic inflation causes the real exchange rate to appreciate without independent monetary policy. The real exchange rate for the core (or home)\textsuperscript{22} economy is defined as $R_t = e_t \frac{P_a^t}{P_d^t}$. The appreciation makes way for substitution of home goods to imported foreign goods. This is the secondary effect which is obtained by a fall in terms of trade for the core country.

The effect of a spending shocks equivalent to a percentage of core GDP is given below in terms of a 40 quarter impulse response under our baseline parameterization. The output and inflation response for the currency union will always be the average of core and periphery response, hence we will not discuss them explicitly. On the contrary, the core government output rises one to one with the government spending. The rise is persistently above the steady state for upto 20 quarters. The periphery has two implications. (a) The initial rise in output is the ‘jump start’ from the immediate imports. However we observe a fall. This is the result of the monetary policy which

\textsuperscript{22}We focus on the core economy, which we consider the home economy for the purposes of discussion. A rise in government spending fosters appreciation of the exchange rate, not via adjustment of the nominal exchange rate, but the relative rates of inflation for the two economies. The constant exchange rate is a feature of the currency union by construction.
reacts to a rise in inflation, causing tightening leading to output fall. This is the aggregate effect of the spending in core. (b) The exchange rate appreciation for the core subsequently leads way to the second effect of a rise in periphery output after the first 3 quarters. This is when the terms of trade effect, overpowers the aggregate effect. Blanchard et al. (2016) argue that the ‘Jump start’ could be a persistent mechanism.

Figure 1: Aggregate effects for a government Spending shock in core

However, we argue that the terms of trade improvement for the periphery countries via the exchange rate appreciation of the core is mitigated by the aggregate response of the monetary policy for the union. The inflation response is in part dependent upon the parameterization of $\xi$ for the economies and the impluse responses follow the aggregate and terms of trade movements. The turning point in inflation response of the periphery is when the imports from core start putting pressure on periphery prices.
We have explored various spending processes and within our model, find the ‘jump start’ channel to be bleak and at best small in magnitude. This goes with Blanchard et al. (2016)’s results outside of liquidity trap. Thus in normal times, a core government spending might not be adequate a stimulus for the union as a whole. However, we must not that the choice of policy is not mindful of the positive effects on other countries in the union. In order to evaluate which policy option might be best we explore a tax reduction to contrast these results for the core. Then we examine the difference in effects on the periphery and the likely policy core countries might adopt realizing the union dependence of peripheral countries.

3.2 Output Tax Shock and Fiscal Devaluation

As opposed to a government spending to stimulate the economy, the government in the core can opt for a reduction in its taxes on firm output. While the former is a direct demand intervention, the later is a supply intervention which tries to incentivize firms to ease supply constraints. While in a closed economy there were natural arguments for limits to a supply intervention (Eggertsson, 2011), the open economy case does not limit a supply intervention especially in a currency union.

How do we expect an unanticipated reduction output tax to affect the core output and inflation? How will it affect the periphery? (a) A reduction in output tax in core implies that the marginal revenue from every unit produced by final goods firms increases. This incentivizes them to supply more and we observe a deflation. (b) As a consequence of the reduction in price current consumption increases. However, in addition to an increase in current consumption, we have a wealth effect on account of fall in prices. This implies a greater supply of labor raising the output subsequently.
This is observable in the spike in output in the core.

(a) Output Response

(b) Inflation Response

Figure 3: Aggregate effects for a reduction in output tax in core

Like before, these aggregate effects are common with a closed economy. However, in addition to these effects of taxes, the general fall in prices appears similar to a devaluation (Farhi et al., 2014). A fall in taxes reduced the relative price of home goods as compared to foreign goods, leading to a devaluation as defined by our variables. This devaluation leads to (a) substitution of foreign country goods with their lower prices home country counterparts. In addition (b) to the substitution effect, the terms of trade improvement for the core creates wealth effect which persists increases in imports. This can be observed by the impulse response for relative imports which rise indicating periphery importing from core.
The key difference in results for the two policies are worth mentioning in terms of fiscal policy transmission. Both these policies work through an aggregate price effect and a terms of trade effect. These are components of the real exchange rate. We can linearize the real exchange rate to decompose them in these two. While government spending works through aggregate price effects and causes an exchange rate appreciation, the tax reduction directly affects terms of trade without invoking any policy reactions at the currency union level at the instance. To make a more thorough comparison, we intend to examine the sustainability of these policies at a later version.

In addition, we must flag the key parameters which affect the degree of transmission of fiscal policies between core and periphery. (a) If we deviate from our baseline and allow for part of government spending to be imported, then by the nature of an increase, part of it is directed to jump starting the periphery and the cross-spending multiplier is greater. (b) In addition, if the frisch elasticity of labor supply is more, then a small rise in government spending causes larger increase in supply of labor. (c) In the case of flexible prices, the spending multiplier is lesser as domestic firms refrain from losing market but reduce the prices accordingly, acting unlike a new-keynesian firm.

4 Conclusion

We have explored the effect of fiscal shocks emanating from the core and its implications for the periphery. We have shown that the effect of any policy has two aspects - its indirect effect on periphery via its implications on aggregate currency union level variables and its direct terms of
trade effects which changes the composition of domestic and foreign consumption for the periphery. In the macro-literature, spending multipliers are explored for their direct effect on closed economies. However, for open economies, the appreciation might limit the magnitude by offering a venue for commodity substitution to periphery countries. This is the ‘Jump start’ channel explored in Blanchard et al. (2016). However, we argue that the effect outside of a liquidity trap is weak and is a policy unlikely followed by an open economy in a currency union.

On the contrary, a currency union economy might opt for a tax reduction - a policy unlikely to be implemented in a closed economy framework. However, in an open economy, a reduction in tax might have a larger front loaded effect than a government spending in stimulating its economy. Such a policy is also mindful of the plausibility that it can use foreign demand to cure for its own deficient demand. This is in line with Mundell (1962)’s 'Beggar-thy-neighbor' approach to policy setting.

Our result generalizes the mechanisms and quantifies the effects of policies in the core countries of the Eurozone and its effects on periphery. In the absence of fiscal unions, a rule based monetary policy can be circumvented by fiscal devaluations which replicate the effects of an exchange rate management.
References


