# Macroeconomic effects of sovereign risk pooling in a currency union

Cristina Badarau*, Florence Huart** and Ibrahima Sangaré***


### Abstract

Proposals for implementing Eurobonds have emerged. Their technical details have been presented to the European Parliament. However, there has not been any assessment of the macroeconomic implications of pooling sovereign risk. This paper aims at filling the gap. We build a DSGE model of a two-country currency union and compare macroeconomic outcomes under three scenarios: governments bear their own risk premia by issuing their own national bonds; they share the same risk premium by issuing Eurobonds; they have different risk premia as long as they are not allowed to issue Eurobonds more than 60 percent of their GDP.


**Keywords:** Eurobonds, euro area, public debt, DSGE

**JEL Classification:** F36, E44, E62

---

* LAREFI, University of Bordeaux, Avenue Léon Duguit, 33608 Pessac Cedex. Tel.: +(33) 5 56 84 85 36. E-mail: florina-cristina.badarau@u-bordeaux.fr

**LEM - CNRS (UMR 9221), University Lille 1, Cité Scientifique (SH2), Villeneuve d'Ascq 59655 Cedex, France. Tel.: +(33) 3 20 33 59 98. E-mail: florence.huart@univ-lille1.fr

***LAREFI, University of Bordeaux, Avenue Léon Duguit, 33608 Pessac Cedex. E-mail: ibrahima.sangare@u-bordeaux.fr

## 1. Introduction

There is no single sovereign bond market in the Euro area (EA). As a consequence, interest rates on sovereign bonds may differ across countries depending on the level of public indebtedness and risk premia. Before the financial crisis of 2008, sovereign spreads between EA member countries were extremely low though, and this, despite marked differences in public debt-GDP ratios. Lenders could have thought that there was no sovereign default risk in the Euro area or that there would be a collective bail-out if so. Anyway, in 2009, spreads started to widen considerably for Greece, after the announcement of very bad figures in public finance, and for some other distressed countries (Ireland, Portugal, Spain, and to a lesser extent, Italy). Interest rates reached so high a level that governments of these countries were hardly able to face interest payments or debt repayment. In such a context, from 2010, a debate has arisen in the European public arena about the opportunity to create sovereign Eurobonds.

A sovereign Eurobond is a debt instrument that would be issued by the Euro area as a whole. It would enable member states to borrow funds. The nationality of the sovereign issuer would not be known. The risk premium, in principle, would depend on the average level of public indebtedness in the Euro area. Interest rates of Eurobonds would be the same whatever the sovereign issuer. The main advantage of Eurobonds would be a large and liquid market for sovereign bonds, and hence lower borrowing costs. This would especially be beneficial to the currently most indebted member states: their cost of public borrowing would be lower than that borne on country-specific bond markets as long as a country-specific risk premium would not be attributed to them. However, there could be a cost for the least indebted member states (and particularly for those which enjoy a triple A credit rating): the latter could face a higher public borrowing cost if the Euro area average sovereign risk premium were higher than theirs. Furthermore, sovereign Eurobonds could raise some incentive problems in terms of fiscal discipline as long as higher public deficits would no longer be bound to be sanctioned by higher borrowing costs (moral hazard).

Does sovereign risk pooling create negative spillover effects on the least indebted governments? In this paper, we build a dynamic stochastic general equilibrium (DSGE) of a two-country currency union in order to analyze theoretically the macroeconomic implications of sovereign risk pooling with a common risk premium for member countries. We compare three scenarios: a baseline scenario where each country issues its own bonds with country-specific risk premia, a full pooling scenario where both countries share a common risk premium, and a partial pooling scenario where there are constraints on the issuance of Eurobonds. We study these scenarios by simulating a public spending shock in one country of the union and looking at the effects on output and public debt in each member country.

The literature deals mainly with the features of Eurobonds, the pros and cons, and most of the time, the analysis is essentially a financial one or set in a partial equilibrium framework (with a political economy perspective).[1] The most publicly known and thorough proposal is that of Delpla and Von Weizsäcker (2010, 2011). They propose to pool only a share of public debts. Each member state would be allowed to issue Eurobonds, but up to a limit corresponding to 60 percent of its GDP (the Maastricht criterion). These "blue bonds" could be issued with low interest rates, because all member states would collectively guarantee the repayment. Furthermore, they would be senior debt that is repaid before any other public debt (but after the IMF). Otherwise, any member state, which would need to borrow more than 60 percent of its GDP, would have to issue its own bonds dubbed "red bonds". The latter would be junior debt that would be honored only after the blue debt has entirely been serviced. Red bonds would not

[1] For a review, see De La Dehesa (2011), Eijfinger (2011). Claessens et al. (2012) assess the existing proposals of Eurobonds in terms of incentives for both lenders and borrowers.

be guaranteed by other member states, and as a result, they would likely be issued with higher interest rates. In addition, they would not be eligible for the refinancing operations of the European central bank (ECB). There is, however, opposition to Eurobonds.[2] Among others, Issing (2009) argues that Eurobonds are nothing more than a placebo for the most indebted countries (moral hazard) and would be costly for taxpayers in the least indebted countries.

From an empirical perspective, Favero and Massale (2012) use a Global VAR to test the main determinants of sovereign spreads. A significant role is played by changing risk perceptions among financial market participants. They conclude that the creation of Eurobonds could protect countries against contagion effects and could hence also benefit fiscally responsible member states. Moreover, in a VAR framework, Tielens et al. (2014) find that Eurobonds could help some countries (such as Greece, Ireland and Portugal) to prevent debt dynamics from getting into (or staying in) an unsustainable path. However, this result holds if moral hazard does not prevail.

From a theoretical perspective, there is little work on the macroeconomic effects of Eurobonds. Beetsma and Mavromatis (2012) built a political economy model of public deficits (with strategic choices over two periods) which describes a small country participating in a currency union. They showed that the guarantee of repayment by other countries should not be 100%. The maximum guaranteed should be sufficiently low to incite a government not to put into more debt than if it had no guarantee at all. More recently, Hatchondo *et al*. (2014) proposed a model of equilibrium default in which they assume that the government of a small economy is allowed to issue Eurobonds (non-defaultable debt) up to a low limit of 10 percent of trend income and can commit to a fiscal rule imposing a defaultable-debt limit of 55 percent of trend income.

[2] The Junker-Tremonti proposal was officially rejected by France and Germany in December 2010 (De La Deheasa, 2011).

They found that the decrease in the interest rate spread (*i.e.* the difference between the sovereign bond yield and the risk-free interest rate) is short-lived, because the government still has to issue defaultable debt.

To our knowledge, there is currently no work that studies the macroeconomic implications of Eurobonds within the framework of a currency union DSGE model. Our work is the first to study the effects of different risk pooling scenarios for government debt on the transmission of government spending shocks in a currency union. As such it adds to the literature on currency unions as well as to the work on Eurobonds.

The paper is organized as follows. In section 2, we describe the model and explain the determinants of risk premia in both countries depending on the scenario: *i*) national governments bear their own risk premia (there are not any Eurobonds); *ii*) national governments share the same risk premium (there is full risk pooling); and *iii*) national governments cannot issue an unlimited amount of Eurobonds (there is partial risk pooling). In the last scenario, we add the constraint that any country cannot issue Eurobonds more than 60 percent of GDP. In doing so, we follow the proposal of Delpla and Von Weizsäcker (2010). In section 3, we simulate a positive shock on public spending in one country of the union and compare the results under the three scenarios. In analyzing the effects of such a shock, we want to investigate what would happen if one government were no longer fiscally responsible in a currency union with sovereign risk pooling. Indeed, some EA member states (in particular, Germany) are currently reluctant to create a single market for Eurobonds because of the fear that some member states would no longer have incentives to stick to the European rules of fiscal discipline. In section 4, we conduct a welfare analysis in order to compare outcomes under all scenarios, and in section 5, we conclude.

## 2. The model

The paper is based on a simple model of a currency union closed with regard to the rest of the world (RoW). The union consists of two countries of equal size and with symmetrical structure: Home (H) and Foreign (F), the latter standing for the rest of the union (RoU). Each economy is populated by a continuum of unit mass households with infinite life, and produces tradable goods using labour. Monopolistic competition and sticky prices are also introduced. The law of one price holds at exports level (producer currency pricing, henceforth PCP).

We consider integrated governments bonds markets at the union level. Three scenario of bonds are analysed, as well as their implications on the real economy of member countries: *i)* no risk pooling where governments finance their public debt only by issuing national bonds (*National bonds scenario*); *ii)* full risk pooling, where every public debt is entirely financed by Eurobonds issues (*Pure Eurobonds scenario*); and *iii)*partial risk pooling, in which the public debt of each government is financed by Eurobonds issues in the limit of 60% of GDP, all the rest being subjected to issuance of national bonds (*Limited Eurobonds scenario*).

In the baseline version of the model (developed hereafter), we assume that only households consume imported goods, while governments consume only goods produced in their own economies. For robustness check, we also consider the case where both households and governments consume domestic and foreign goods. We then assume the same structure for private and public consumption index.

Since the general setup for the foreign country (RoU) is similar and symmetrical to that for the Home country, this section presents the details of the model for the latter. Variables for the foreign country are denoted by an asterisk.

## 2.1. Households

The representative household derives utility from consumption ($C_t$) of goods and disutility from hours worked ($N_t$) and maximizes the following expected discounted sum of utilities:

$$\mho = E_t \sum_{t=0}^{\infty} \beta^t \{U_t(C_t, N_t)\} = E_t \sum_{t=0}^{\infty} \beta^t \left( \frac{(C_t^i)^{1-\sigma}}{1-\sigma} - \frac{(N_t^i)^{1+\eta}}{1+\eta} \right) \qquad (1)$$

where$U_t(C_t, N_t)$ denotes the utility function and$0 < \beta < 1$ is the intertemporal discount factor.The parameters $\sigma > 0$ and $\eta > 0$ are, respectively, the inverse intertemporal elasticity of substitution and the inverse of the Frisch elasticity of labour supply.

The final consumption index is an aggregate of home ($C_{H,t}$) and foreign ($C_{F,t}$) goods, with $\theta > 0$ as the constant elasticity of substitution:

$$C_t = \left[ a_1^{\frac{1}{\theta}} \left(C_{H,t}\right)^{\frac{\theta-1}{\theta}} + (1-a_1)^{\frac{1}{\theta}} \left(C_{F,t}\right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \qquad (2)$$

where $a_1$ is the share of tradable goods produced in the Home country.

The associated price index is given by

$$P_t = \left[ a_1 \left(P_{H,t}\right)^{1-\theta} + (1-a_1)\left(P_{F,t}\right)^{1-\theta} \right]^{\frac{1}{1-\theta}} \qquad (3)$$

where ($P_{F,t}$) is the price of the foreign consumption good and ($P_{H,t}$) denotes the price of the domestic good.

The baskets of home ($C_{H,t}$) and foreign ($C_{F,t}$) goods are made up of a continuum of differentiated varieties of goods $C_{H,t} \equiv \left( \int_0^1 C_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} d_j \right)^{\frac{\epsilon}{\epsilon-1}}$and $C_{F,t} \equiv \left( \int_0^1 C_{F,t}(j)^{\frac{\epsilon-1}{\epsilon}} d_j \right)^{\frac{\epsilon}{\epsilon-1}}$ respectively, with the corresponding price indices$P_{H,t} = \left( \int_0^1 P_{H,t}(j)^{1-\epsilon} d_j \right)^{\frac{1}{1-\epsilon}}$ and$P_{F,t} = \left( \int_0^1 P_{F,t}(j)^{1-\epsilon} d_j \right)^{\frac{1}{1-\epsilon}}$and $\epsilon > 1$, the elasticity of substitution between varieties. By the expenditure minimization problem, the following optimal demands for different goods yield:

$$C_{H,t} = a_1 \left(\frac{P_{H,t}}{P_t}\right)^{-\theta} C_t \tag{4}$$

$$C_{F,t} = (1 - a_1) \left(\frac{P_{F,t}}{P_t}\right)^{-\theta} C_t \tag{5}$$

The household faces the following period-by-period budget constraint (in real terms):

$$\left(1 - \tau_{c_t}\right)C_t + \frac{B_{t+1}}{P_t} = \left(1 - \tau_{w_t}\right)\frac{W_t N_t}{P_t} + B_t R_t \Psi_t^G + \frac{TR_t}{P_t} + \Delta_t \tag{6}$$

where $W_t$ denote household's nominal wage, $\Delta_t$ are profits rebated equally to the households by firms, $B_{t+1}$is the household's portfolio of sovereign bonds, $R_t\Psi_t^G$ gives the global real return on household's portfolio of sovereign bonds, composed by the real risk-free interest rate $R_t$ and a global risk premium attached to the portfolio $\Psi_t^G$. $TR_t$ denotes transfers from government.

The solution to the household problem implies the following optimality conditions:

$$\frac{-U_{N,t}(C_t, N_t)}{U_{C,t}(C_t, N_t)} = \frac{W_t}{P_t} \tag{7}$$

$$\frac{U_{C,t}(C_t, N_t)}{\left(1 - \tau_{c_t}\right)} = \beta(1 + i_{t+1})\Psi_{t+1}^G \frac{P_t}{P_{t+1}} \frac{U_{C,t+1}(C_{t+1}, N_{t+1})}{\left(1 - \tau_{c_{t+1}}\right)} \tag{8}$$

where $i_t$ is the nominal risk free interest rate.

Under complete markets, the optimal risk sharing implies:

$$\frac{U_{C,t}^*(C_t^*, N_t^*)/\left(1 - \tau_{c_t}^*\right)}{U_{C,t}(C_t, N_t)/\left(1 - \tau_{c_t}\right)} = \frac{P_t^*}{P_t} \tag{9}$$

Where $\frac{P_t^*}{P_t} \equiv RR_t$ is the real exchange rate. The relation (9) states that the relative consumption across countries is proportional to real exchange rate and predicts a positive high cross-correlation between the real exchange rate and the relative consumption. Foreign household preferences and choices can be defined symmetrically.

As for the household's portfolio of sovereign bonds ($B_t$), it is composed of (domestic or foreign) national bonds and (if applicable) Eurobonds:

$$B_t = B_t^N + B_t^{Eh} \tag{10}$$

$B_t^N$is an aggregate index of investment in national bonds, and $B_t^{Eh}$ the household's investment in Eurobonds (independent of the issuer).Thus,$B_t^N$ indexis an aggregate of home ($B_{H,t}$) and foreign ($B_{H,t}^*$) bonds issued on the home market, with $\theta_b > 0$ as the constant elasticity of substitution between home and foreign bonds:

$$B_t^N = \left[ b_1^{\frac{1}{\theta_b}} \left(B_{H,t}\right)^{\frac{\theta_b - 1}{\theta_b}} + (1 - b_1)^{\frac{1}{\theta_b}} \left(B_{H,t}^*\right)^{\frac{\theta_b - 1}{\theta_b}} \right]^{\frac{\theta_b}{\theta_b - 1}} \tag{11}$$

$b_1$denotes the share of domestic bonds in the household's portfolio of national bonds.[3] This parameter can be used in order to introduce a domestic bias in the household's behaviour ($b_1 > 0.5$).[4]

Opposite national bonds, Eurobonds are managed at the union-wide level. It would then be very difficult for households to clearly distinguish which government they are really linked to. That

[3] Symmetrically, for the foreign country, this index becomes: $B_t^{N*} = \left[ b_1^{\frac{1}{\theta_b}} B_{F,t}^{*\,\frac{\theta_b - 1}{\theta_b}} + (1 - b_1)^{\frac{1}{\theta_b}} B_{F,t}^{\frac{\theta_b - 1}{\theta_b}} \right]^{\frac{\theta_b}{\theta_b - 1}}$.

It is an aggregate of the RoU national bonds ($B_{F,t}^*$) and of the home country ($B_{F,t}$) bonds issued on the RoU (foreign) market, with $\theta_b > 0$ the constant elasticity of substitution between different national bonds.

[4]Home bias in asset holdings is well documented in the literature and is often given exogenously either in empirical models (Portes and Rey, 2005) or in theoretical models (Coeurdacier, 2009). For Euro area investors, see Floreani and Habib (2015).

is the reason why we assume that the share of Eurobonds used to finance the debt of Home country in the total household's investment in Eurobonds ($b_2$) is equal to 0.5:

$$B_t^{Eh} = B_{H,t}^{E} + B_{H,t}^{E*} \tag{12}$$

where $B_{H,t}^{E}$= $B_{H,t}^{E*}$stand for Eurobonds used to finance the debt of the Home country issued on Home market, and for Eurobonds used to finance the debt of the Foreign country (see *) issued on Home market, respectively.[5]

The corresponding global risk premium ($\Psi_t^G$) related to the household's portfolio of bonds comes from the maximization of the portfolio return given the composition of indexes previously defined in (10), (11) and (12):

$$\Psi_t^G = (1 - \Theta_t)\Psi_t^N + \Theta_t \Psi_t^E \tag{13}$$

$\Psi_t^E$denotes the risk premium attached to Eurobonds. $\Theta_t = \frac{B_{H,t}^{E} + B_{H,t}^{E*}}{B_{H,t}^{E} + B_{H,t}^{E*} + B_{H,t} + B_{H,t}^{*}}$ gives the weight of Eurobonds in the households' portfolio; it is endogenous and varies over time depending on investment opportunities.$\Psi_t^N$ is the risk premium attached to the index of national bonds$B_t^N$, given by :

$$\Psi_t^N = \left[b_1 \Psi_t^{1-\theta_b} + (1 - b_1)(\Psi_t^*)^{1-\theta_b}\right]^{\frac{1}{1-\theta_b}} \tag{14}$$

where $\Psi_t$ and $\Psi_t^*$ are the sovereign risk premiums for national bonds issues in the Home country and Foreign country respectively (defined in section 2.4 *infra*).

[5]Symmetrically, for the foreign country, this index becomes: $B_t^{Eh*} = B_{F,t}^{E*} + B_{F,t}^{E}$ and $B_{F,t}^{E*} = B_{F,t}^{E}$

### 2.2 Open economy expressions

Let us define the terms of trade ($T_t$) as $T_t = \frac{P_{F,t}}{P_{H,t}}$. Since the law of one price holds,

$T_t^* = \frac{P_{H,t}}{P_{F,t}} = \frac{1}{T_t}$.

Given the definition for the terms of trade, the following equation holds:

$$\frac{P_t}{P_{H,t}} = \left[a_1 + (1 - a_1)(T_t)^{1-\theta}\right]^{\frac{1}{1-\theta}} \equiv f(T_t) \tag{15}$$

$$\frac{P_t}{P_{F,t}} = \frac{f(T_t)}{T_t} \tag{16}$$

Finally, we can relate the real exchange rate to the terms of trade as follows:

$$RR_t = \frac{P_t^*}{P_t} = \frac{f^*(T_t^*)}{f(T_t)} T_t \tag{17}$$

### 2.3 Firms and Price Setting

For each country, we assume that the production comes from a continuum of monopolistically competitive firms of measure unity, indexed by $j$, which produce output $Y_t(j)$ using the technology:

$$Y_t(j) = A_t N_t(j) \tag{18}$$

where $N_t$ denotes hours worked; $A_t$ is a technological shock that is common to all firms and follows a stationary first-order autoregressive process: $\log(A_t) = \rho_A \log(A_{t-1}) + e_{A,t}$, with $e_{A,t} \sim i.i.d(0, \sigma_{e_A}^2)$.

Cost minimization by firms implies that the real marginal cost of production is (in real terms):

$$mc_t = \frac{W_t}{A_t P_t} = \frac{W_t}{A_t P_t} \tag{19}$$

Following Calvo (1983), we assume that firms set nominal prices on a staggered basis: at each period, a fraction $(1-\phi)$ of firms are randomly selected to set new prices ($P_t^n(j)$), while the remaining fraction $\phi \in [0,1]$of firms keep their prices unchanged.

The optimal price setting problem for a firm ($j$) that is able to reset its price at time $t$ is:

$$\max_{P_t^n(j)} E_t \left\{ \sum_{s=0}^{\infty} (\phi)^s \Lambda_{t,t+s} \left[ \frac{P_t^n(j)}{P_{t+s}} \left( \frac{P_t^n(j)}{P_{t+s}} \right)^{-\epsilon} Y_{t+s} - mc_{t+s} \left( \frac{P_t^n(j)}{P_{t+s}} \right)^{-\epsilon} Y_{t+s} \right] \right\} \quad (20)$$

where$\Lambda_{t,t+s} = \beta^s \frac{U_{C,t+s}(C_{t+s},N_{t+s})}{U_{C,t}(C_t,N_t)}$ is the discount factor for future real profits.

The first order condition implies:

$$P_t^n(j) = \frac{\epsilon}{\epsilon-1} \frac{\sum_{s=0}^{\infty} (\beta\phi)^s U_{C,t+1}(C_{t+s}, N_{t+s}) Y_{t+s} P_{t+s}^{\epsilon} mc_{t+s}}{\sum_{s=0}^{\infty} (\beta\phi)^s U_{C,t+1}(C_{t+s}, N_{t+s}) Y_{t+s} P_{t+s}^{\epsilon-1}} \quad (21)$$

Given the Calvo-type setup, the aggregate domestic price index evolves according to the following law of motion,

$$P_t^{1-\epsilon} = (1-\phi)(P_t^n)^{1-\epsilon} + \phi P_{t-1}^{1-\epsilon} \quad (22)$$

The foreign economy has an analogous price setting mechanism.

Since the assumption that prices are set in the producer currency for exports and that the international law of one price holds for the tradable goods in this baseline model, the prices of home goods sold abroad and those of foreign goods sold in home country are given, respectively, by: $P_{H,t}^* = P_{H,t}$ and $P_{F,t} = P_{F,t}^*$.

### 2.4 Government

Home government spends in purchases of aggregate goods $(G_t)$ and transfers to households $(TR_t)$. The government collects tax revenues on consumption and wages, and it is allowed to issue bonds on both markets of the union, according to three different scenarios. The debt accumulation and the budgetary constraint equations are specific to each scenario.

*i)* ***Under National Bonds***, governments finance their public debt only by issuing national bonds. There are no Eurobonds and the risk premium of each government only depends on its own debt/GDP ratio deviation from the 60% limit defined by the Maastricht Treaty. The dynamics of public debt, the budgetary constraint, the financing scenario of debt and the definition of the risk premium are respectively described in relations (23), (24), (25) and (26):

$$D_t = D_{t-1}\Psi_t R_t - PS_t \tag{23}$$

$$PS_t = \tau_{c_t} C_t P_t + \tau_{w_t} W_t - TR_t - G_t P_t \tag{24}$$

$$D_t = B_{H,t} + B_{F,t} \tag{25}$$

$$\Psi_t = \exp\left[\psi_N\left(\frac{D_{t-1}}{Y_{t-1}} - 0.6\right)\right] \tag{26}$$

$PS_t$ stands for primary budget surplus, $D_t$public debt financed by national bonds issued on the home market $B_{H,t}$ and on the Foreign market $B_{F,t}$, and $\psi_N$ is the sensibility coefficient of the risk premium to public indebtedness. The value of this coefficient is relatively higher under national bonds than under risk pooling. More precisely, a higher public debt level can raise the sovereign risk premium because it can raise the probability of sovereign default (see Bi, 2012). This effect is less strong if investors believe in the joint guarantee of repayment.

*ii)* ***Under Pure Eurobonds***, public debt of each country is entirely financed by Eurobonds. There are no national bonds and the risk premium of all governments simply depends on the union-wide debt/GDP ratio deviation from the 60% limit defined by the Maastricht Treaty. The dynamics of public debt, the budgetary constraint, the financing scenario of debt and the definition of the risk premium are respectively described in relations (23'), (24'), (25') and (26'):

$$D_t = D_{t-1}\Psi_t^E R_t - PS_t \tag{23'}$$

$$PS_t = \tau_{c_t} C_t P_t + \tau_{w_t} W_t - TR_t - G_t P_t \tag{24'}$$

$$D_t = B_{H,t}^E + B_{F,t}^E \tag{25'}$$

$$\Psi_t^E = \exp\left[\psi_E \left(\frac{D_{t-1}^{UM}}{Y_{t-1}^{UM}} - 0.6\right)\right] \tag{26'}$$

Public debt is financed only by Eurobonds issued on the home market $\left(B_{H,t}^E\right)$ and on the Foreign market$\left(B_{F,t}^E\right)$, $\Psi_t^E$ is the risk premium on Eurobonds and $\psi_E \leq \psi_N$ is the sensibility coefficient of this risk premium to union-wide public indebtedness. We assume that if Eurobonds are credible, the value of $\psi_E$ is very low. Alternatively, Eurobonds could not be credible, if lenders on financial markets suspect that there could be a lack of solidarity (a partial guarantee of repayment). In this case, $\psi_E$would be higher, for example as high as in the case of national bonds in a worst case scenario.

***iii)*** ***Under Limited Eurobonds***, public debt of each government is financed by Eurobonds in the limit of 60% of GDP, all the rest being subjected to the issuance of national bonds. In this case, Eurobonds are risk-free assets and the risk premium on national bonds is defined by the relation (26) from the national bonds scenario. The dynamics of public debt, the budgetary constraint, the financing scenario of debt and the definition of the risk premiums are respectively described in relations (23”), (24”), (25”) and (26”):

$$D_t = \left(B_{H,t-1} + B_{F,t-1}\right)\Psi_t R_t + \left(B_{H,t-1}^E + B_{F,t-1}^E\right)\Psi_t^E R_t - PS_t \tag{23''}$$

$$PS_t = \tau_{c_t} C_t P_t + \tau_{w_t} W_t - TR_t - G_t P_t \tag{24''}$$

$$D_t = B_{H,t}^E + B_{F,t}^E + B_{H,t} + B_{F,t} \tag{25''}$$

$$\Psi_t^E = 1 \; and \; \Psi_t = \exp\left[\psi_N \left(\frac{D_{t-1}}{Y_{t-1}} - 0.6\right)\right] \tag{26''}$$

Equations for the foreign government are symmetrical to those written for the Home government.

*Fiscal policy instrument*

The government needs to adjust tax revenues or expenditure to finance its deficit and stabilize its debt. We choose public spending as the fiscal policy instrument. Government spending adjustments in response to output and public debt/GDP deviations from their respective steady-state values are endogenously made according to the following fiscal rule:

$$G_t = G\left(\frac{G_{t-1}}{G}\right)^{\rho_g}\left(\frac{Y_t}{Y}\right)^{\rho_y}\left(\frac{D_t/Y_t}{D/Y}\right)^{(1-\rho_g)\rho_{gd}} e_{g,t} \tag{27}$$

where $\rho_g, \rho_y, \rho_{gd}$ capture, respectively, the degree of public spending smoothing, the fiscal reaction to output and the fiscal reaction to debt/GDP ratio; $e_{g,t}$ is an exogenous shock to government spending ($e_{g,t} \sim i.i.d.\left(0, \sigma_{e_g}^2\right)$).[6]

## 2.5. Monetary policy rule

The common central bank sets the short term nominal interest rate by reacting to the union-wide endogenous variables (active monetary policy), according to the following Taylor-type interest rate rule:

$$\log\left(\frac{R_t}{R}\right) = \beta_0 \log\left(\frac{R_{t-1}}{R}\right) + (1-\beta_0)\left[\beta_1 \log\left(\frac{E_t \pi_{t+1}^{um}}{\pi^{um}}\right) + \beta_2 \log\left(\frac{Y_t^{um}}{Y^{um}}\right)\right] + e_{r,t} \tag{28}$$

with $e_{r,t} \sim i.i.d.\left(0, \sigma_{e_r}^2\right)$. $R$, $\pi^{um}$ and $Y^{um}$ are the steady-state values of $R_t$, $\pi_t^{um}$ and $Y_t^{um}$, that are, respectively, the nominal interest rate, the inflation rate and output of the union. The

[6] In Tielens et al. (2014), the parameter $\rho_{gd}$ ($\psi_3$ in their framework) is lowered in the Eurobonds scenario in order to illustrate the moral hazard problem (fewer incentives of fiscal discipline). Here, we do not consider different values of the parameter across scenarios and focus instead on the public spending shock and borrowing constraints.

variables $\pi_t^{um}$ and $Y_t^{um}$ are the average values of inflation and output of the two equal-size countries:

$$\pi_t^{um} = \frac{1}{2}(\pi_t + \pi_t^*) \text{ and } Y_t^{um} = \frac{1}{2}(Y_t + Y_t^*) \qquad (29)$$

$\beta_1 > 1$ and$\beta_2 < 1$ are coefficients that measure central bank responses to expected inflation and output deviations. The parameter $0 < \beta_0 < 1$ captures the degree of interest rate smoothing.

### 2.6. Market clearing

The aggregate goods market clearing satisfies,

$$Y_t = C_{H,t} + X_t + G_t \qquad (30)$$

where $X_t = C_{H,t}^* = (1 - a_1)\left(\frac{P_{H,t}}{P_t^*}\right)^{-\theta} C_t^*$ denotes total exports to foreign country. The foreign market clearing conditions are symmetrical. The balance of payments equation takes a different form under the three scenarios:

***i) National Bonds***

$$B_{F,t} - B_{H,t}^* = B_{F,t-1}\Psi_t R_t - B_{H,t-1}^* \Psi_t^* R_t + M_t - X_t \qquad (31)$$

where $X_t = C_{H,t}^*$ and $M_t = C_{F,t}$ are exports and imports of home country respectively.

***ii) Pure Eurobonds***

$$B_{F,t}^E - B_{H,t}^{E*} = B_{F,t-1}^E \Psi_t^E R_t - B_{H,t-1}^{E*} \Psi_t^E R_t + M_t - X_t \qquad (31')$$

***iii) Limited Eurobonds***

$$B_{F,t} - B_{H,t}^* + B_{F,t}^E - B_{H,t}^{E*}$$
$$= B_{F,t-1}\Psi_t R_t - B_{H,t-1}^* \Psi_t^* R_t + B_{F,t-1}^E R_t - B_{H,t-1}^{E*} R_t + M_t - X_t \qquad (31'')$$

Equations (31), (31’) and (31”) depict simultaneously the balance of payment for the two countries of the union.

## 3. Simulations and results

We solve the non-linear stochastic model and then run simulations by using the program Dynare (Adjemian et al., 2011). The calibration of the model is displayed in Table 1. For the parameter of home bias in consumption ($a_1$ = 0.75), we derived it from import contents of private consumption on average in EA countries (Buissière et al, 2011). The parameter of home bias in asset holdings ($b_1$ = 0.70) is computed using data from the ECB on the share of securities issued by EA governments in total securities held by EA MFIs (Monetary and Financial Institutions).The elasticity of substitution between domestic and foreign bonds is set at 3.4. It is higher than that between domestic and foreign goods (1.5) and is taken from Alpanda and Kabaca (2015). The parameters of the monetary policy rules are taken from Kollmann et al. (2013). For the fiscal policy rule, we assume that the persistence parameter is as high as in the case of monetary policy. We disregard any cyclical response of public spending in order to focus on the impact of the discretionary public spending shock. As for the response of public consumption to public debt, we use a result from table 3 in Holm-Hadulla et al. (2010). The steady-state ratio of public debt-to-GDP is set at 100%, approximately the average of this ratio in Euro area countries in 2014 (97% based on AMECO database of the European Commission). Tax rates are computed using data from the European Commission (*Taxation trends in the European Union*, 2011): we used the implicit tax rates in the Euro area in 2009 for labour income ($\tau_w$ = 0.33) and consumption ($\tau_c$ = 0.2). Finally, we set the elasticity of the risk premium to deviation of the public debt-GDP ratio from steady-state at different values under the three scenarios. To get an idea of its size, we use the results of Corsetti *et al*. (2013) with regard to the slope of the risk premium with respect to debt which varies from 0.0005 when the debt level is 60 percent to 0.0083 when the debt level is 150 percent. We set the elasticity at 0.009 under national bonds and at 0.001 under credible Eurobonds (in any case, the elasticity should be higher in the former case than in the latter case). For the partial pooling scenario, since

Eurobonds are limited to 60 percent of GDP in each country, we consider them as risk-free bonds and we set their elasticity with regard to the debt level at 0.

As a baseline, we first look at the effects of a positive public spending shock (1 percent deviation from the steady state) in the domestic country under the scenario of national bonds (Figure 1)[7]. Public consumption is increased in the domestic country. The shock causes higher output and inflation in the domestic country. The nominal interest rate set by the central bank is raised, but not as much as inflation. As a result, the real interest rate is lower than its steady-state. The transmission mechanism of interest rate on the real economy relies on the behaviour of households who smooth consumption over time and hold public bonds. The shock has a negative effect on private consumption. At first, private consumption decreases because of higher inflation. Then, it decreases more because of a higher future expected global return on the bond portfolio. The latter depends on the interest rate of the central bank and on the sovereign risk premium. Both increase. The sovereign risk premium increases because there is a primary deficit and a rise in public debt. For the RoU, the impact of the shock is negative both in terms of lower output and higher public debt because of a fall in private consumption and in exports (due to lower consumption in the domestic country) and given that public consumption is not increased in the RoU.

We now compare the effects of the shock in all three scenarios. From the point of view of the domestic country (Figure 2), the scenario of credible pure Eurobonds with full risk-pooling is the most favorable one in terms of the fiscal multiplier: the impact of the public consumption shock on domestic output is the strongest in this case compared with the other two scenarios. Since the domestic government benefits from a lower risk premium, the return on households' portfolio is lower, and hence the decline in consumption. In terms of output effects, the scenario

[7] In figures, variables are in deviation from their steady-state level.

with limited Eurobonds (partial risk-pooling) is the worst for the domestic country due to a sharp decline in exports (following a real appreciation with regard to the RoU).

In contrast, from the point of view of the RoU (Figure 3), the limited Eurobonds scenario is preferable both in terms of higher output and lower public debt. In this scenario, imported inflation from the domestic country is limited, and hence, the impact of the shock on private consumption in the RoU is lessened. Moreover, since inflation is lower in the RoU than in the domestic country, the former enjoys a stronger real depreciation with regard to the latter, and hence an increase in exports and output. Note that a decrease in consumption means a higher marginal utility in consumption, and at the optimum, a higher wage. The rise in wages is small under the third scenario (and smaller than in the domestic country, which leads to relative lower prices). Thanks to higher output and an increase in labor income tax receipts, the ratio of public debt/GDP decreases in this scenario, which explains why the sovereign risk premium in the RoU is lower than at its steady-state level. In turn, this explains why the global risk premium in the bond portfolio of households in the RoU decreases (along with the fact that households now hold a larger amount of risk-free Eurobonds) and why these households have hardly any incentive to postpone consumption to compare with the two other scenarios. It's also worth noting that under pure Eurobonds (full-pooling scenario), the public debt/GDP ratio increases more in the long run, because of a higher overall level of public debt in the currency union.

In Figure 4, we compare the case where Eurobonds are not considered as a credible institutional arrangement (they are considered as risky as the national bonds with $\Psi_E = \Psi_N = 0.009$) with the case where they are credible ($\Psi_E = 0.001$). The relative level of output (i.e. output under Eurobonds minus output under national bonds) in the domestic country is the highest when Eurobonds are credible, but national bonds are preferable to Eurobonds if the latter lacks credibility. From the point of view of the RoU, limited Eurobonds are the best option in terms of the output effects of the shock, and national bonds are preferable to non-credible Eurobonds. Note that in terms of public debt, limited Eurobonds are the best option, because the ratio of public debt/GDP would be lower than under the scenario of national bonds. Indeed, under limited Eurobonds, the rising bond premium only applies to the debt issued above the threshold while under national bonds, it applies to the entire stock of debt.

As an extension of the model, we consider public purchases of both domestic goods and foreign goods.[8] In doing so, we find that the spillover effects on output in the RoU are positive, thanks to higher exports to the domestic country (Figure 5). Previous results are confirmed: in terms of output effects of the shock, pure credible Eurobonds are the best scenario for the domestic country while the limited Eurobond scenario is the best one for the RoU (the transmission mechanisms being the same as before).

## 4. Welfare analysis

We, finally, lead a welfare analysis in order to compare the welfare costs (or gains) in all scenarios under the positive shock on public spending in the domestic country. Following Lucas (1987), we use a measure of the welfare costs in terms of business cycles given by the fraction of steady state consumption that households would need in the deterministic world (at the steady state) to yield the same welfare as would be achieved in the stochastic world (under the shock).

Formally, the unconditional welfare metric is $u$ that solves:

[8] This extension is available upon request. We assume that there is the same home bias in public purchases than in private consumption. Blanchard *et al*. (2015) also consider an import content of public purchases in studying spillover effects of fiscal policy, but they do not look at the effects on public debt and cost of borrowing.

$$E_t \sum_{t=0}^{\infty} \beta^t \left\{ \mathcal{E}_t \left[ \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\eta}}{1+\eta} \right] \right\}$$

$$= \frac{1}{1-\beta} \left[ \frac{1}{1-\sigma} \left( \left( 1 + \frac{u}{100} \right) C \right)^{1-\sigma} - \frac{N^{1+\eta}}{1+\eta} \right] \qquad (32)$$

Where variables without subscript $t$ are the steady state variables[9].

For $u$ positive, there is a welfare gain: households prefer the stochastic allocation compared to that of the steady state as long as consumption in steady state must be raised in order to yield the same utility as under the shock. In contrast, a negative value of $u$ represents a welfare cost: households prefer the non-stochastic allocation and are willing to give up a percentage of consumption to get the same utility as under the shock.

The welfares costs (or gains) in each scenario are computed for the monetary union as a whole. They are reported in table 2. We find that the shock causes welfare costs in all scenarios. Welfare costs are the lowest in the scenario of credible pure Eurobonds and the highest in the scenario of national bonds. In the extended model with foreign goods in public purchases (the spillover effects *via* the trade channel are reinforced), the welfare costs are still the lowest in the scenario of credible pure Eurobonds, but the strongest if Eurobonds are not credible. The scenario of limited Eurobonds appears to be a good intermediate option where the welfare loss is higher than under credible pure Eurobonds but much lower than under non-credible pure Eurobonds.

[9] Further details are available upon request.

## 5. Conclusion

In studying the proposal of creating Eurobonds, we compared two cases of pure Eurobonds and one case of limited Eurobonds. We first considered that Eurobonds are safe assets and that the institutional arrangement (joint guarantee by all sovereign issuers) is credible. In this case, we assumed that the sensitivity of the risk premium to deviation of the average public debt/GDP ratio from the 60 percent norm is lower than that for national bonds. We then considered instead that Eurobonds lacks credibility if participants in financial markets perceive that some member states are not willing to back-up other member states known to be less fiscally responsible. In such a case, participants in financial markets would react more to any variation in the public debt/GDP ratio in setting risk premia. The sensitivity parameter would be higher than initially assumed, and as high as under national bonds under a worst case scenario. We finally considered a limited Eurobond scenario which relies on the proposal made by Delpla and von Weiszäcker (2010), namely imposing a cap on the issuance of Eurobonds.

We analyzed the effects of a positive public spending shock in one country. For a big spending government, pure Eurobonds would be the best option in terms of output as long as the framework is credible. In contrast, for the other country (or fiscally responsible country), the proposal made by Delpla and von Weiszäcker (2010) would be the best option in terms of the spillover effects of the shock on output and public debt. Our welfare analysis confirm that the pure Eurobonds framework would be the best if it were credible, and if not, limited Eurobonds would be less costly. It is worth noting that for the rest of the union, the limited Eurobonds framework is better than the national bonds framework. Thus, the current concerns about the implementation of Eurobonds are not warranted (one has to take into account the exchange rate channel). Furthermore, as regards pure Eurobonds, our results illustrate a kind of trade-off between credibility and moral hazard: Beetsma and Mavromatis (2014) concluded that the joint guarantee by all sovereign issuers should not be complete, because there would be few incentives to be fiscally responsible. However, our work shows that if the joint guarantee is not full, the framework lacks credibility, and in such a scenario, the macroeconomic outcomes are the least favorable. We conclude that if Eurobonds are to be credible, there should be a full joint guarantee of repayment along with enforceable rules of fiscal discipline, whatever they are.

**References**


Adjemian S., H. Bastani, M. Juillard, F. Karamé, F. Mihoubi, G. Perendia, J. Pfeifer, M. Ratto and S. Villemot (2011), *Dynare: Reference Manual, Version 4*, CEPREMAP.

Alpanda S. and S. Kabaca (2015), "International Spillovers of Large-Scale Asset Purchases", *Bank of Canada Staff Working Paper* 2015-2.

Beetsma R. and K. Mavromatis (2014), "An Analysis of Eurobonds", *Journal of International Money and Finance*, vol. 45(C), 91-111.

Bi H. (2012), "Sovereign Default Risk Premia, Fiscal Limits, and Fiscal Policy", *European Economic Review*, 56, 389-410.

Blanchard O., C. J. Erceg and J. Lindé (2015), "Jump starting the euro area recovery: would a rise in core fiscal spending help the periphery?" *NBER Working Paper* No. 21426.

Bussière M., G. Callegari, F. Ghironi, G. Sestieri and N. Yamano (2011), "Estimating trade elasticities: demand composition and the trade collapse of 2008-09", *NBER Working Paper* No. 17712.

Claessens S., A. Mody and S. Vallée (2012), "Paths to Eurobonds", *IMF Working Paper* No. 12/172, July.

Coeurdacier N. (2009), "Do trade costs in goods market lead to home bias in equities", *Journal of International Economics*, 77, 86-100.

Corsetti G., K. Kuester, A. Meier and G. J. Müller (2013), "Sovereign Risk, Fiscal Policy, and Macroeconomic Stability", *The Economic Journal*, Vol. 123, No. 566, 99-132.

De La Dehesa G. (2011), "Eurobonds: Concepts and Implications" in European Parliament, *Eurobonds: Concepts and Implications*. Compilation of Notes for the Monetary Dialogue.

Delpla J. and J. von Weizsäcker (2010), "The Blue Bond Proposal", *Bruegel Policy Brief* 2010/3, May.

Delpla J. and J. vonWeizäcker (2011), "Eurobonds: The blue bond concept and its implications", in European Parliament, *Eurobonds: Concepts and Implications*. Compilation of Notes for the Monetary Dialogue.

Eijfinger S. C.W. (2011) "Eurobonds: Concepts and Implications" in European Parliament, *Eurobonds: Concepts and Implications*. Compilation of Notes for the Monetary Dialogue.

Favero C. and A. Missale (2012), "Sovereign spreads in the Euro Area: Which Prospects for a Eurobond?" *Economic Policy* 70, 231-273.

Floreani V. A. and M. M. Habib (2015), "Financial exposure to the euro area before and after the crisis: Home bias and institutions at home", *ECB Working Paper* No. 1799.

Hatchondo J.C., L. Martinez and Y. K. Onder (2014), "Non-Defaultable Debt and Sovereign Risk", *IMF Working Paper* No. 14/198.

Holm-Hadulla F., S. Hauptmeier and P. Rother (2010), "The impact of numerical expenditure rules on budgetary discipline over the cycle", *ECB Working Paper* No. 1169.

Issing O. (2009). “Why a Common Eurozone Bond isn’t such a Good Idea”, *Center for Financial Studies White Paper* No. III, July.

Kollmann R., M. Ratto, W. Roeger and J. in't Veld (2013), “Fiscal policy, banks and the financial crisis", *Journal of Economics Dynamics and Control*, 37(2), 387-403.

Lucas R. (1987), “Models of Business Cycle”, *Yrrjo Jahnsson Lectures Series*, Blackwell.

Portes R. and H. Rey (2005), “The determinants of cross-border equity flows”, *Journal of International Economics*, 65, 269-96.

Tielens J., B. van Aarle and J. Van Hove (2014), “Effects of Eurobonds: a stochastic sovereign debt sustainability analysis for Portugal, Ireland and Greece”, *Journal of Macroeconomics*, 42.

**Table 1. Calibration**

| Description | Parameter | Value |
|---|---|---|
| Inverse intertemporal elasticity of substitution | $\sigma$ | 2 |
| Inverse of the Frisch elasticity of labour supply | $\eta$ | 1 |
| Subjective discount factor | $\beta$ | 0.99 |
| Home bias in consumption | $a_1$ | 0.75 |
| Home bias in holding national bonds | $b_1$ | 0.70 |
| Elasticity of substitution between domestic and imported goods | $\theta$ | 1.5 |
| Elasticity of substitution between domestic and foreign bonds | $\theta_b$ | 3.4 |
| Fraction of firms keeping their prices unchanged | $\phi_i$ | 0.8 |
| Sensibility coefficient of the risk premium for national bonds to public indebtedness | $\psi_N$ | 0.009 |
| Sensibility coefficient of the credible Eurobonds' risk premium to public indebtedness | $\psi_E$ | 0.001 |
| Sensibility coefficient of the non-credible Eurobonds' risk premium to public indebtedness | $\psi_E$ | 0.009 |
| Sensibility coefficient of the Eurobonds' risk premium to public indebtedness (in the Limited Eurobonds scenario) | $\psi_E$ | 0 |
| Public expenditures/GDP ratio | $G / Y$ | 0.20 |
| Smoothing coefficient in the monetary rule | $\rho_r$ | 0.9 |
| Inflation coefficient in the monetary rule | $\rho_\pi$ | 2.2 |
| Output coefficient in the monetary rule | $\rho_y$ | 1 |
| Smoothing coefficient in the public expenditure rule | $\rho_g$ | 0.9 |
| Output coefficient in the public expenditure rule | $\rho_{gy}$ | 0 |
| Debt coefficient in the public expenditure rule | $\rho_{gd}$ | 0.1 |
| Tax rate on consumption | $\tau_c$ | 0.20 |
| Tax rate on wages | $\tau_w$ | 0.33 |
| Steady-state public debt | $D / Y$ | 1 |
| Autoregressive coefficient shock | $\rho$ | 0.8 |

**Table 2. Welfare analysis**

| | National Bonds | Credible Pure Eurobonds | Non-Credible Pure Eurobonds | Limited Eurobonds |
|---|---|---|---|---|
| Baseline model | -1.4572 | -0.1448 | -1.1687 | -0.4559 |
| Extended model | -1.1693 | -0.1037 | -1.2490 | -0.3519 |

**Figure 1. National bonds**

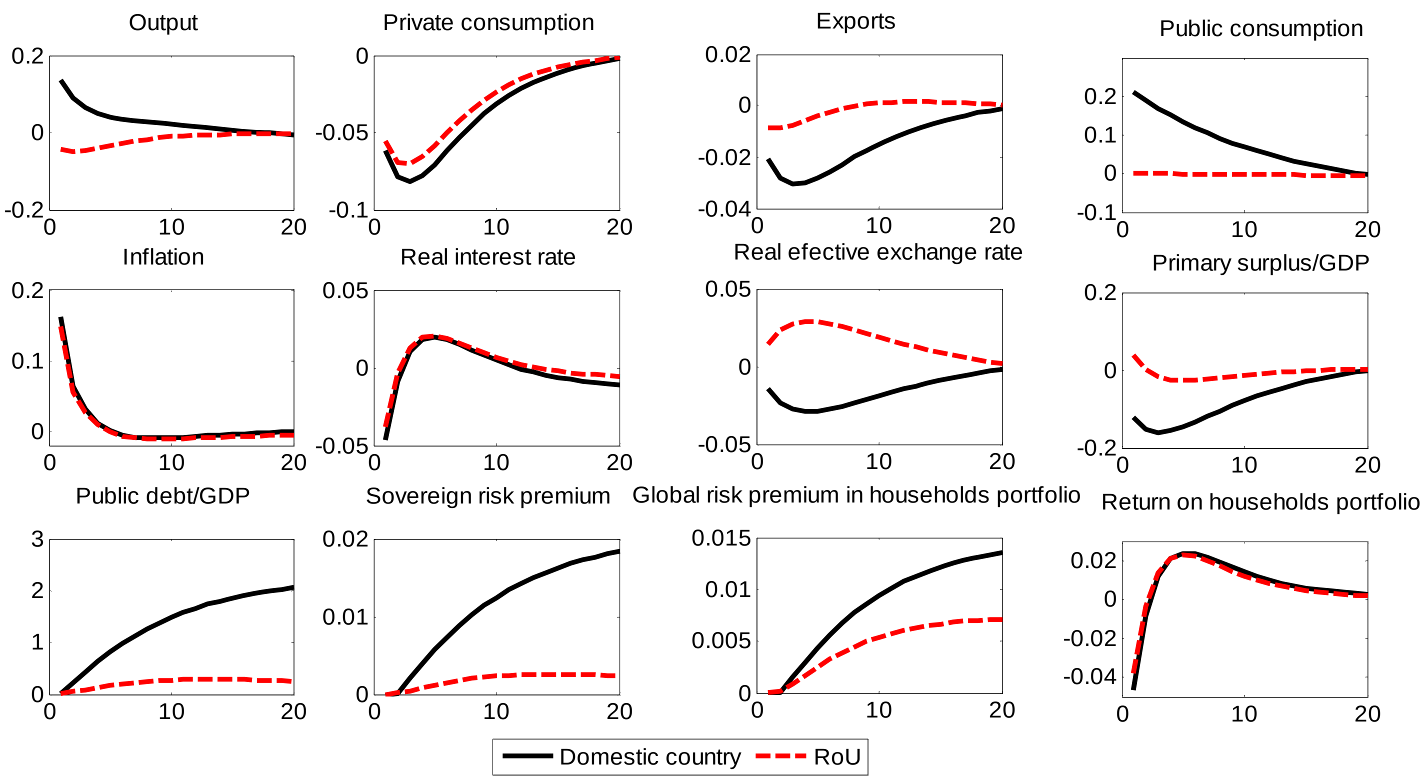

**Figure 2. Effects on domestic country under the three scenarios**

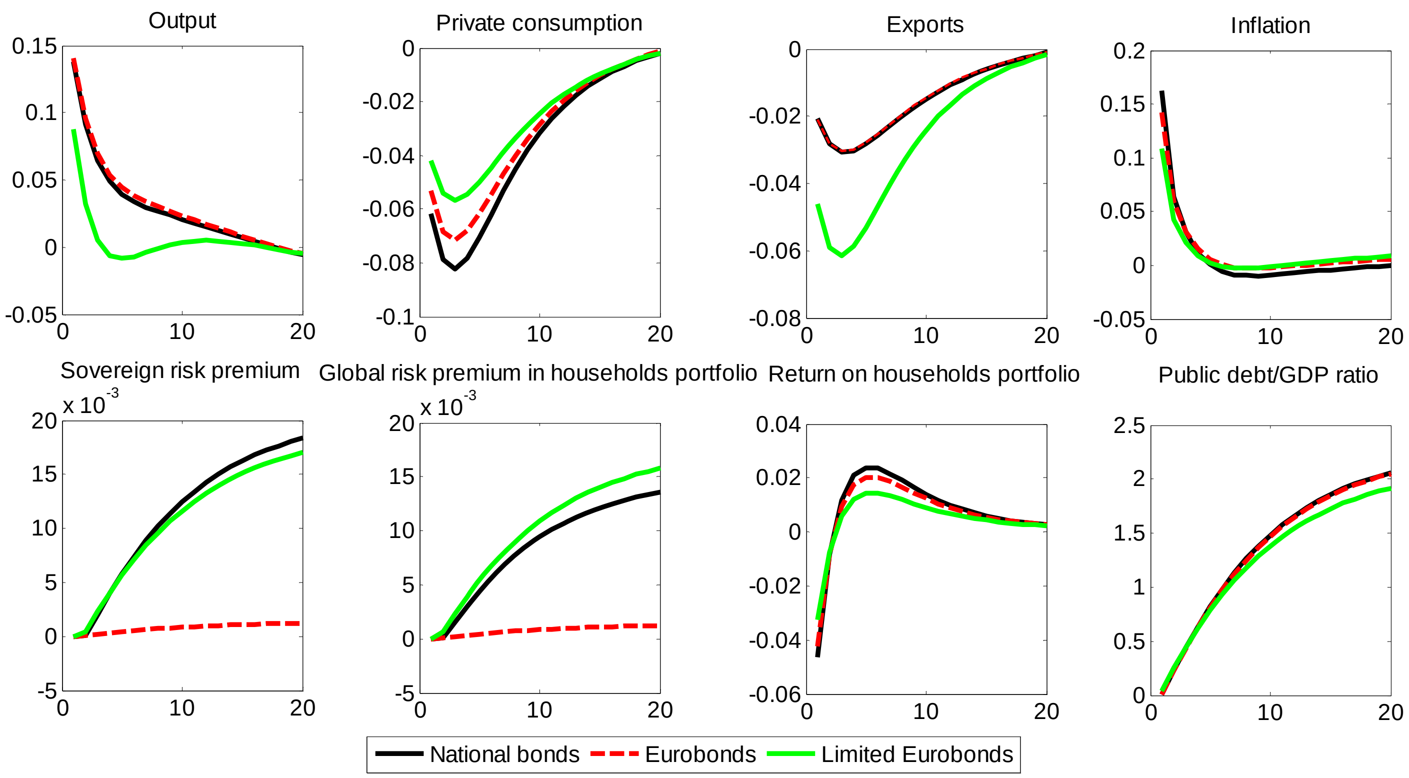


**Figure 3. Effects on the RoU under the three scenarios**

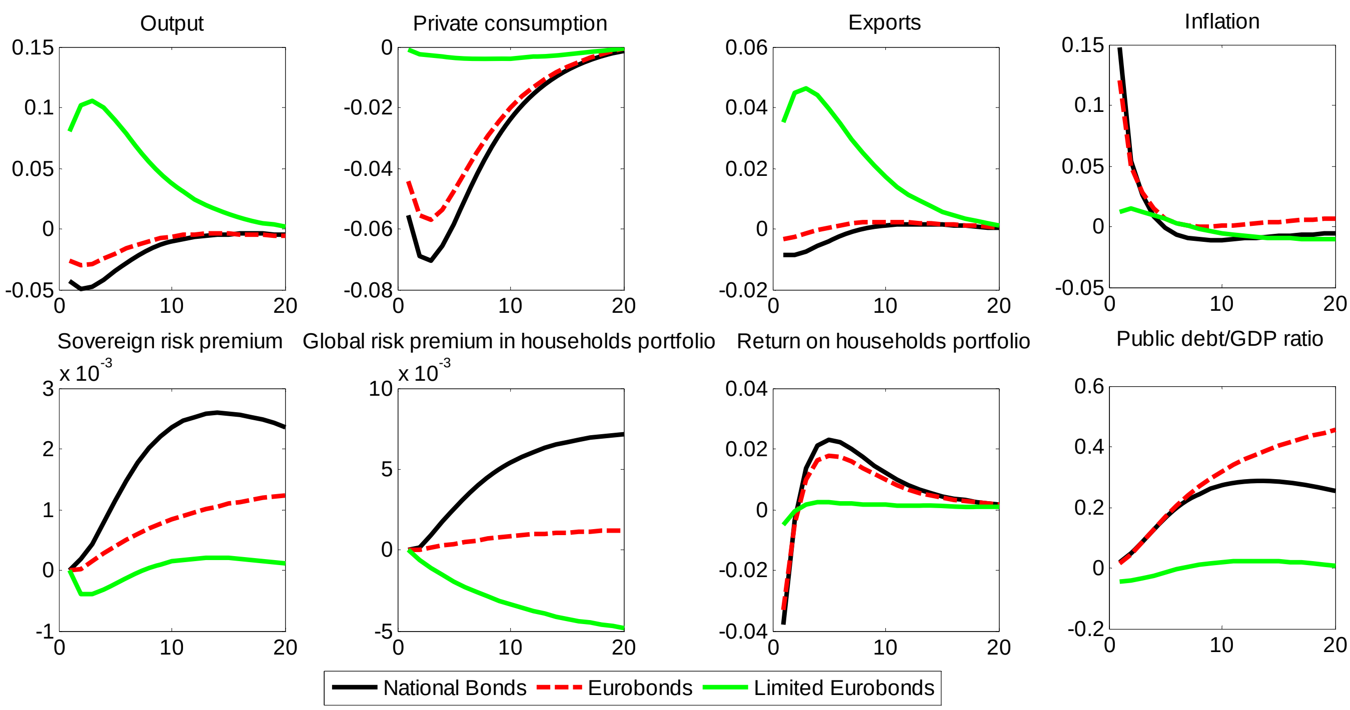

**Figure 4. Credibility of Eurobonds**

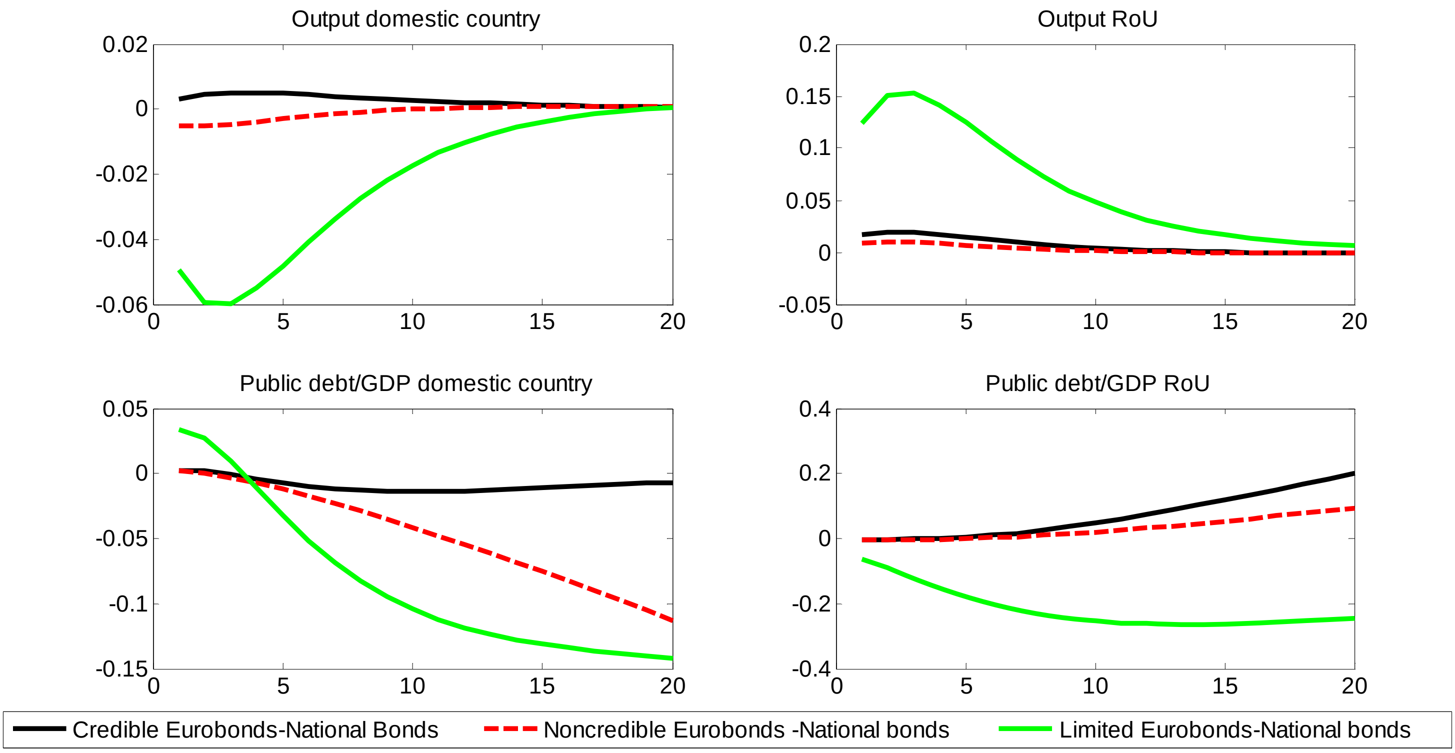


**Figure 5. Effects on the RoU under the three scenarios ($\Psi^E = 0.001$) with imported goods in both private and public consumption**