Household savings and economic recovery in the euro area

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Abstract

In some euro area countries, it is likely that households will start trying to lower consumption and save more (in order to repay their debts, for instance). Would a rising household saving rate impair economic recovery in the euro area? We study the effects of such a shock in one country of a monetary union using an open-economy dynamic stochastic general equilibrium (DSGE) model. We find that the effects on output both in the country hit by the shock and in the rest of union can be positive as long as net exports to the rest of the world can increase and fiscal policy is not restrictive.

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1. Introduction

Before the financial crisis in 2008, households became increasingly indebted in the Euro Area (EA) countries – except in Germany. The ensuing economic and sovereign debt crisis caused huge losses of output and jobs, and higher long-term interest rates in the most affected countries (Greece, Ireland, Portugal, Spain and Italy). As a result, private indebtedness continued to grow (and public indebtedness as well). Yet, in some countries, households have started trying to reduce their indebtedness. For instance, in 2010, the ratio of household liabilities to GDP started to decline in Ireland, Spain and Portugal.

As many households were facing a fall in income, they could be tempted to use their savings in order to pay their expenses in goods and services. Indeed, the household gross saving rate fell in the EA from 10% of GDP in 2009 to 8% in 2012. However, economic prospects are still not improving five years after the start of the crisis in several EA countries. Precautionary saving might pile up. Households might also reduce consumption and increase saving in order to repay their debts (what is usually called deleveraging). As a matter of fact, it seems that the saving rate of households has started to rise in some countries, such as in Austria, Ireland, Portugal and Finland.[4]

What could be the consequences of a higher saving rate – that is a decline in household consumption – in terms of economic recovery? Would this impair economic rebound? Would this make fiscal consolidation harder? To answer these questions, we build a micro-founded New Keynesian open-economy dynamic stochastic general equilibrium (DSGE) model which describes a monetary union between two countries. The union is open to the rest of the world (RoW). We calibrate and simulate the model in order to study a positive asymmetric shock on savings in one country of the union. We are interested in the effects of the shock on output growth and public debt in both countries of the monetary union.

There are a few recent papers about the issue of household savings related to deleveraging. From an empirical point of view, Bauer and Nash (2012) believe that U.S. household deleveraging plays a significant role in the sluggish recovery along with the decrease in household net worth (due to falling house prices) and uncertain future income (due to weak employment growth and persistently high unemployment). On the contrary, Cooper (2012) argues against the idea that deleveraging would explain the slow growth of U.S. household consumption between 2007 and 2009.

On the theoretical side, Eggertsson and Krugman (2012) propose a closed-economy New-Keynesian model where aggregate demand is composed of consumption by impatient agents (net borrowers) and consumption by patient agents (savers). There is no investment. Deleveraging is triggered when impatient agents have reached an exogenous debt limit. As a result, they are forced to cut spending. If debt overhang has reached a high level, then the extent of deleveraging can be so large that it induces the so-called debt-deflation vicious circle stated by Irving Fisher. In other respects, Cuerpo et al. (2013) assess the need for deleveraging in the non-financial private sector in European countries. They use a DSGE model – a three-region version of the QUEST model developed by the European Commission – in order to study the impact of household sector deleveraging on economic activity. In their model, there are two kinds of households: Ricardian

[4]It was also the case in the United Kingdom in 2009-2010 and in the United States in 2008 and in 2010. Source: AMECO database of the European Commission.

households are net lenders while credit-constrained households are net borrowers. They consider a combination of two shocks, namely a fall in access to credit and a fall in house prices in order to account for household deleveraging. They also assume an exogenous increase in Ricardian households' desire to hold foreign assets so that the net financial asset (NFA) position of the nation improves. They found that deleveraging leads to a "marked contraction" in output.

Our paper also describes an open monetary union DSGE model, but with a different structure and a different nature of the saving shock. Since households are not credit constrained in our model, the saving shock is simply equivalent to a shock on consumer preferences. The increase in savings results from a sudden household decision to postpone consumption.[5] As far as we are interested in the effects of the shock on public debt, we pay special attention to the modelling of public sector finance and propose an original approach. Specifically, each government finances public purchases (consumption and transfers) by levying taxes (on consumption, labor income and capital income) and issuing debt. Each one adjusts the fiscal instrument (public consumption in our model) with reaction to output growth (in a counter-cyclical way) and to the debt/GDP ratio (in deviation with a non-zero steady-state level). In each country of the union, banks use household deposits in order to lend funds. We segment banking activity into financing public debts and financing private investment in such a way that the evolution of public indebtedness has an impact on the cost of borrowing for the private sector. The model also allows for financial frictions via a financial accelerator mechanism. Another specific feature of our model is to allow each government to borrow from domestic banks and foreign banks in the RoU (by selling sovereign bonds). With such a characteristic, our model can account for a home bias in banking loans to governments. Furthermore, the cost of public borrowing may differ whether the government borrows from domestic banks or foreign banks. Indeed, it is determined by two elements: the banking lending benchmark rate which may differ across countries and the sovereign risk premium which depends on the gap between the ratio of public debt to GDP and its non-zero steady-state level. In addition, we assume that there are internationally traded bonds that allow households to borrow from the RoW or lend to the RoW. There is a risk premium on internationally traded bonds which depends on the net aggregate foreign financial position of households, as in the new area-wide model (NAWM) of the euro area described by Coenen, McAdam and Straub (2008).[6] Moreover, since monetary union is open with the RoW, we can take into account both intra and extra-zone net exports of each country and underline the importance of trade openness in times of regional economic turmoil.

We find that when households start to reduce consumption and save more, the effects on output in both countries can be positive as long as net exports to the rest of the world can increase and fiscal policy is not restrictive.

In the following, we describe the structure of the model (section 2), explain the results (section 3) and conclude (section 4).

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[5] Such a shock may be related to deleveraging. Indeed, in order to repay their debts, households may suddenly decide to postpone consumption.

[6] However, the original version of the NAWM cannot be used for studying spillovers across EA member countries, since the euro area is modeled as a single big country. A four-country version of the NAWM was developed by Gomes, Jacquinot and Pisani (2010), but in this version, public debt is issued only on domestic financial markets and the financial sector is not explicitly modeled.

2. Model

We consider two symmetric countries of equal size, home(h) and foreign(f). They are members of a monetary union and are open to the rest of the world (w) which is fully exogenous (in the small open economy perspective). The model contains monopolistic competition in final goods market, price stickiness, capital adjustment costs, financial market frictions and fiscal policy instruments.

Each economy is populated by households, banks, government and three types of firms: entrepreneurs, capital producers, and retailers. There is a common monetary authority that sets the unique nominal risk-free interest rate for both countries. Capital producers build new capital and sell it to the entrepreneurs. Entrepreneurs produce wholesale goods and sell them to domestic goods retailers. Retailers set nominal prices of final goods *à la* Calvo (1983). Banks convert households' deposits in loans to finance the government deficit in both countries and the entrepreneurial purchase of capital. Each government decides upon fiscal policy.

2.1. Households

Each country $i \in \{h, f\}$ is populated by a continuum of unit mass households with infinite life. The representative household of country i maximizes the following expected discounted sum of utilities:

$$E_t \sum_{t=0}^{\infty} \beta^t \left(\varepsilon_t^i \frac{(C_t^i - hC_{t-1}^i)^{1-\sigma}}{1-\sigma} - \frac{(N_t^i)^{1+\eta}}{1+\eta} \right) \tag{1}$$

where C_t^i is aggregate consumption and N_t^i denotes the number of hours worked. E_t is the conditional expectation operator. The parameters $0 < \beta < 1$, $\sigma > 0$, $\eta > 0$ and $0 < h < 1$ are, respectively, the subjective discount factor, the inverse intertemporal elasticity of substitution, the inverse of the Frisch elasticity of labour supply, and the parameter that controls habit persistence. The variable ε_t^i represents a saving shock and follows a stationary first order autoregressive process. A negative ε_t^i shock implies that agents wish to postpone consumption over time, and will thus increase their desired savings.

The household's period-by-period budget constraint is defined by:

$$\begin{aligned}(1+\tau_{c,t}^i)C_t^i + \frac{D_t^i}{P_t^i} + \frac{S_t B_{w,t}^i}{P_t^i} \\ = (1-\tau_{w,t}^i)\frac{W_t^i}{P_t^i}N_t^i + R_{t-1}\frac{D_{t-1}^i}{P_t^i} + R_{w,t-1}\Psi_{b,t-1}^i(b_{t-1}^i, Z_{t-1}^i)\frac{S_t B_{w,t-1}^i}{P_t^i} + \frac{TR_t^i}{P_t^i} \\ + \Lambda_t^i\end{aligned} \tag{2}$$

where P_t^i is the consumer price index (CPI), $W_t^i$the nominal wage, D_t^i nominal deposits that pay gross nominal interest rate R_t and $B_{w,t}^i$ nominal internationally traded bonds, denominated in rest of the world currency, that pay a gross nominal interest rate $R_{w,t-1}\Psi_{b,t-1}^i$. S_t is the nominal exchange rate (expressed in terms of units of home currency per unit of foreign currency). $\tau^i_{c,t}$, $\tau^i_{w,t}$, TR^i_t and Λ^i_t are, respectively, tax rate on consumption, tax rate on wages, government transfers and real profits from the monopolistic sector. Finally, $\Psi^i_{b,t}$ represents a risk premium that is a function of the household's real level of net foreign financial asset position in percentage of output, as follows:

$$\Psi^i_{b,t}\left(b^i_t, Z^i_t\right) = exp\left(-\psi^i_b\left(\frac{S_t B^i_{w,t}}{Y^i_t P^i_t}\right)\right) \tag{3}$$

where $b^i_t \equiv \frac{S_t B^i_{w,t}}{Y^i_t P^i_t}$ is the household's real aggregate net foreign financial position in percentage of output (household is a net borrower when $b^i_t < 0$); $\psi^i_b > 0$ is a measure of the elasticity of the risk premium with respect to household's net financial assets position. The term $\Psi^i_{b,t}\left(b^i_t\right)$ is assumed to be strictly decreasing in b^i_t and satisfies $\Psi^i_b(0,0) = 1$. It captures imperfect integration in the international financial markets and ensures a well-defined steady-state in the model (Schmitt-Grohé and Uribe, 2003).

Households choose the paths for $\left\{C^i_t, N^i_t, D^i_t, B^i_{w,t}\right\}_0^\infty$ in order to maximize (1) subject to the budget constraint in (2). The following optimality conditions hold:

$$\varepsilon^i_t(C^i_t - hC^i_{t-1})^{-\sigma} - \beta h\, E_t \varepsilon^i_{t+1}(C^i_{t+1} - hC^i_t)^{-\sigma} = \lambda^i_t\left(1 + \tau^i_{c,t}\right) \tag{4}$$

$$\lambda^i_t \frac{\left(1 - \tau^i_{w,t}\right)W^i_t}{P^i_t} = (N^i_t)^\eta \tag{5}$$

$$-\frac{\lambda^i_t S_t}{P^i_t} + E_t\beta\frac{\lambda^i_{t+1} S_{t+1}}{P^i_{t+1}} R_{w,t}\Psi^i_{b,t}\left(b^i_t, Z^i_t\right) = 0 \tag{6}$$

$$-\frac{\lambda^i_t}{P^i_t} + E_t\beta\frac{\lambda^i_{t+1}}{P^i_{t+1}} R_t = 0 \tag{7}$$

$\lambda^i_t$is the Lagrangian multiplier in (4), (5), (6) and (7).

The final good, X^i_t, is allocated to consumption, C^i_t, investment, I^i_t, and public spending, G^i_t. It is an aggregate function of goods produced in the home country, $X^i_{i,t}$, in the RoU, $X^i_{k,t}$, and in the RoW, $X^i_{w,t}$:

$$X^i_t = \left[\left(1 - a^i_1 - a^i_2\right)^{\frac{1}{\theta}}\left(X^i_{i,t}\right)^{\frac{\theta-1}{\theta}} + (a^i_1)^{\frac{1}{\theta}}\left(X^i_{k,t}\right)^{\frac{\theta-1}{\theta}} + (a^i_2)^{\frac{1}{\theta}}\left(X^i_{w,t}\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{8}$$

for $X = \{C, I, G\}$; $i, k \in \{h, f\}$and $i \neq k$.

The parameters $\theta > 1$, a^i_1, and a^i_2 are, respectively, the elasticity of substitution between the three types of goods, the share of imported goods from the RoU and the share of imported goods from the RoW. We suppose that these shares are identical reciprocally between each country $i \in \{h, f\}$ of the union and the RoW. Therefore, the fraction$\left(1 - a^i_1 - a^i_2\right)$ is the degree of home bias in consumption, investment and public goods.

The price index (CPI) associated to (8) is given by:

$$P_t^i = \left[\left(1 - a_1^i - a_2^i\right)\left(P_{i,t}^i\right)^{1-\theta} + a_1^i\left(P_{k,t}^i\right)^{1-\theta} + a_2^i\left(P_{w,t}^i\right)^{1-\theta}\right]^{\frac{1}{1-\theta}} \quad (9)$$

where $P_{i,t}^i P_{k,t}^i$ and $P_{w,t}^i$ are, respectively, the domestic price of home goods, the domestic price of imported goods from the RoU and the domestic price of imported goods from the RoW.

We define $X_{i,t}^i \equiv \left(\int_0^1 X_{i,t}^i(j)^{\frac{\chi-1}{\chi}} d_j\right)^{\frac{\chi}{\chi-1}}$, $X_{k,t}^i \equiv \left(\int_0^1 X_{k,t}^i(j)^{\frac{\chi-1}{\chi}} d_j\right)^{\frac{\chi}{\chi-1}}$ and

$X_{w,t}^i \equiv \left(\int_0^1 X_{w,t}^i(j)^{\frac{\chi-1}{\chi}} d_j\right)^{\frac{\chi}{\chi-1}}$

as the composite aggregates of differentiated varieties produced domestically, inside and outside the monetary union, respectively, with χ being the elasticity of substitution between varieties originating in the same country; $X_{i,t}^i(j)$, $X_{k,t}^i(j)$ and $X_{w,t}^i(j)$ being a typical variety j of domestic goods, imported goods from the RoU and imported goods from the RoW, respectively. The corresponding prices are derived easily and are given by, respectively:

$$P_{i,t}^i = \left(\int_0^1 P_{i,t}^i(j)^{1-\chi} d_j\right)^{\frac{1}{1-\chi}}, \quad P_{k,t}^i = \left(\int_0^1 P_{k,t}^i(j)^{1-\chi} d_j\right)^{\frac{1}{1-\chi}}, \quad P_{w,t}^i = \left(\int_0^1 P_{w,t}^i(j)^{1-\chi} d_j\right)^{\frac{1}{1-\chi}},$$

where $P_{i,t}^i(j)$ (respectively $P_{k,t}^i(j)$ and $P_{w,t}^i(j)$) is the price of a typical variety j produced in the home country (respectively imported prices from the RoU and the RoW).

We assume that the law of one price holds, thus: $P_{k,t}^i = P_{k,t}^k$ and $P_{w,t}^i = S_t P_{w,t}^w$. By assuming that the RoW is fully exogenous, we can write the following identity $P_{w,t}^w = P_t^w$.

The optimal demands for domestic, RoU and RoW goods, are derived from expenditure minimization[7]:

$$X_{i,t}^i = \left(1 - a_1^i - a_2^i\right)\left(\frac{P_{i,t}^i}{P_t^i}\right)^{-\theta} X_t^i \quad (10)$$

$$X_{k,t}^i = a_1^i\left(\frac{P_{k,t}^k}{P_t^i}\right)^{-\theta} X_t^i \quad (11)$$

$$X_{w,t}^i = a_2^i\left(\frac{S_t P_{w,t}^w}{P_t^i}\right)^{-\theta} X_t^i \quad (12)$$

$\forall\ i, k \in \{h, f\}$ and $i \neq k$.

[7] The optimization program is $min_{C_{i,t}^i, C_{k,t}^i, C_{w,t}^i, C_t^i} P_{i,t}^i C_{i,t}^i + P_{k,t}^i C_{k,t}^i + P_{w,t}^i C_{w,t}^i = P_t^i C_t^i$ subject to the following constraint: $C_t^i = \left[(1 - a_1 - a_2)^{\frac{1}{\theta}}\left(C_{i,t}^i\right)^{\frac{\theta-1}{\theta}} + (a_1)^{\frac{1}{\theta}}\left(C_{k,t}^i\right)^{\frac{\theta-1}{\theta}} + (a_2)^{\frac{1}{\theta}}\left(C_{w,t}^i\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}$.

2.2. Banks

Banks are in charge of the financial intermediation. We explicitly specify their activity in order to let fiscal and monetary policies influence the economy via the bank-lending channel. Banks are assumed to have two segments in their activity: a segment where they finance less-risky borrowers (public debt segment) and a segment where they finance riskier borrowers (corporate banking segment).

At the beginning of each period t, the representative bank takes deposits, D_t^i, from the representative household at the (gross nominal) risk-free rate R_t.[8] It lends not only to domestic entrepreneurs *via* the corporate banking segment, but also to domestic government and foreign government (in the RoU) *via* the public debts segment.

Bank total loans are defined by L_t^i such as:

$$D_t^i = L_t^i = L_{G,t}^i + L_{E,t}^i \qquad (13)$$

where $L_{G,t}^i$ and $L_{E,t}^i$ denotes banking loans provided respectively for financing public debts of both governments (domestic and foreign) and for financing purchases of capital by domestic entrepreneurs.

The share of loans provided by the representative bank in each country to domestic government and foreign government are given respectively by $\zeta^i L_{G,t}^i$ and $(1-\zeta^i)L_{G,t}^i$. The parameter ζ^i measures the "home bias" in the banking loans provided to governments. Furthermore, we suppose that this banking activity is undertaken in a competitive market so that the representative bank sets interest rates on loans to governments under a zero profit hypothesis.

Governments are less risky than entrepreneurs. Nevertheless, they may face a sovereign risk premium in their cost of borrowing, depending on the level of their indebtedness. We thus introduce risk premia $\Psi_{l,t}^i(l_t^i, l_t^k)$ and $\Psi_{l,t}^k(l_t^i, l_t^k)$ that are a function of the government debt/GDP ratios.[9] In setting the interest rate on the loans to governments, the representative bank adds the sovereign risk premium to a nominal benchmark interest rate, $R_{L,t}^i$, which would be applied to loans to a hypothetical borrower (without a specific risk premium).

The profit function of the bank in the public debt segment is given by:

$$R_{L,t}^i \Psi_{l,t}^i(l_t^i, l_t^k)\zeta^i L_{G,t}^i + R_{L,t}^i \Psi_{l,t}^k(l_t^i, l_t^k)(1-\zeta^i)L_{G,t}^i - R_t D_{G,t}^i, \qquad \forall\, i,k \in \{h,f\} \text{ and } i \neq k \quad (14)$$

where $D_{G,t}^i$ represents household deposits that finance debt of domestic and foreign governments.

The zero profit condition guarantees that:

$$R_{L,t}^i = \frac{R_t}{\left[\zeta^i \Psi_{l,t}^i + (1-\zeta^i)\Psi_{l,t}^k\right]} \qquad (15)$$

$\forall\, i,k \in \{h,f\}$ and $i \neq k$.

[8] That is possible under the assumption that banking activity is risk-free for depositors, since the banks' assets portfolio is perfectly diversified.

[9] Sovereign risk premia are defined in section 2.4 below.

Equation (15) shows that the benchmark interest rate that is applied to the hypothetical borrower decreases when risk premia of relative risky agents increase, and thus when their debts increase. Thus, the risk of lending to governments is analysed as a relative risk compared to the reference agent (risk-free hypothetical borrower). Therefore, banks provide loans in a way consistent with a portfolio management goal. Specifically, the cost of borrowing for a given government depends on its relative risk compared to the risk of other borrowers. For instance, if government f becomes riskier than government h ($\Psi_{l,t}^{f}\left(l_t^h, l_t^f\right)$ goes up), *ceteris paribus*, the benchmark rate $R_{L,t}^h$ goes down and this leads to a decrease of the cost of borrowing for government h for a given risk premium of government h (and hence for a given indebtedness of the latter).[10]

In the riskier business segment (corporate banking segment), the setting of interest rates on loans to firms is determined as in the traditional financial accelerator. Accordingly, the bank opportunity cost would be the rate that it could obtain by financing the public debt instead of lending to entrepreneurs. Thus, the nominal rate applied to loans to entrepreneurs (their external financing cost) is given by:

$$R_{E,t}^i = R_{L,t}^i \Psi_{l,t}^i\left(l_t^i, l_t^k\right) \Psi_{\mathrm{E},t}^i(\cdot) \tag{16}$$

$\forall\, i,k \in \{h,f\}$ and $i \neq k$, where $\Psi_{\mathrm{E},t}^i(\cdot)$ is entrepreneur's (specific) external finance premium at the beginning of each period t (see section 2.3 below).

2.3. Production sector

2.3.1. Entrepreneurs

The behaviour of entrepreneurs is specified in order to introduce the financial accelerator mechanism. As in Bernanke et *al.* (1999), there is a continuum of firms $j \in [0,1]$ that produce wholesale (intermediate) goods in a perfectly competitive market, using K_t^i units of capital and N_t^i units of labour, according to the following technology:

$$Y_t^i(j) = A_t^i K_t^i(j)^{\alpha} N_t^i(j)^{1-\alpha} \tag{17}$$

where A_t^i is a technological (productivity) shock that is common to all firms and follows a stationary first-order autoregressive process; $\alpha \in [0,1]$ is the share of capital in the production technology.

The representative firm maximizes its profit by choosing K_t^i and N_t^i subject to the production function (17). The first-order conditions for this optimization problem are:

$$w_t^i = (1-\alpha) mc_t^i \frac{Y_t^i}{N_t^i} \tag{18}$$

$$mpc_t^i = \alpha\, mc_t^i \frac{Y_t^i}{K_t^i} \tag{19}$$

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[10] The Government (h) costs of borrowing in domestic and foreign market are $R_{L,t}^h \Psi_{l,t}^h\left(l_t^h, l_t^f\right)$ and $R_{L,t}^f \Psi_{l,t}^h\left(l_t^h, l_t^f\right)$, respectively.

wheremc_t^i is the Lagrangian multiplier associated with the production function (17) and denotes the real marginal cost; w_t^i is the real wage; and mpc_t^i is the real marginal productivity of capital.

Entrepreneurs are risk neutral and borrow in order to finance a share of capital used in the production process. Following Bernanke *et al.* (1999), we assume that entrepreneurs have a finite expected horizon, so that they do not accumulate enough funds to fully self-finance their activity. In each period t, entrepreneurs face a constant probability $(1-\nu)$ of leaving the economy. We also follow Christensen and Dib (2008) in allowing newly entering entrepreneurs to inherit a fraction of the net worth of those firms which exit from the business. This assumption is made in order to ensure that new entrepreneurs start out with a positive net worth.[11] At the end of each period, entrepreneurs purchase capital, K_{t+1}^i, that will be used in the next period at the real price q_t^i. Thus, the total funding needed by an entrepreneur to purchase capital is $q_t^i\, K_{t+1}^i$. The capital acquisition is financed partly by their net worth, NW_{t+1}^i, and partly by borrowing, $q_t^i\, K_{t+1}^i - NW_{t+1}^i$, from a financial intermediary. Financial intermediaries (banks) obtain their funds from household deposits (section 2.2). In optimum, the entrepreneur's aggregate demand for capital in the economy depends on the expected marginal return and on the expected marginal financing cost at $t+1$. Thus, the capital demand must satisfy the following differentiation between the *ex post* marginal return on capital, $E_t\left(R_{K,t+1}^i\right)$, and the marginal productivity of capital at $t+1$, mpc_t^i, which is the rental rate of capital:

$$E_t\left(R_{K,t+1}^i\right) = E_t\left[\frac{\left(1-\tau_{K,t}^i\right) mpc_{t+1}^i + (1-\delta)q_{t+1}^i}{q_t^i}\right] \tag{20}$$

where δ is the capital depreciation rate, $\tau_{K,t}^i$ is the tax rate on capital-income (whose introduction here is a specific feature of our model) and $(1-\delta)q_{t+1}^i$ is the value of one unit of capital used in $t+1$. According to the optimal financial contract between borrower and lender, the entrepreneur's demand for capital satisfies, optimally, the equality between expected return on capital and gross premium for external finance plus the gross real opportunity costs equivalent to the gross real interest rate on loans[12]:

$$E_t\left(R_{K,t+1}^i\right) = E_t\left[\Psi_{\mathrm{E},t+1}^i(\cdot)\,\frac{R_{L,t}^i \Psi_{l,t}^i\left(l_t^i, l_t^k\right)}{\pi_{t+1}^i}\right] \tag{21}$$

where $R_{L,t}^i$ is the gross nominal interest rate on banks loans. $\Psi_{\mathrm{E},t+1}^i(\cdot)$ is the function that describes how the external finance premium depends on the financial position of the firm and is given by: $\Psi_{\mathrm{E},t+1}^i(\cdot) = \left(\frac{NW_{t+1}^i}{q_t^i K_{t+1}^i}\right)^{-\gamma}$ with $\left(\Psi_{\mathrm{E},t+1}^i(\cdot)\right)' < 0$, $\Psi_{\mathrm{E}}^i(1) = 1$ and γ is the elasticity of the external finance premium with respect to firm's leverage ratio. Thus, the external finance premium is an equilibrium inverse function of the aggregate financial position in the economy, expressed by the leverage ratio. Equation (21) provides the basis for the financial accelerator. If entrepreneur's net worth goes up, the external finance premium falls, the cost of borrowing falls and firms get cheaper access to credit.

[11] In contrast, Bernanke *et al.* (1999) ensure this by assuming that entrepreneurs also work. This difference does not affect the results.

[12] For details, see Bernanke *et al*. (1999).

Aggregate entrepreneurial net worth accumulation of the economy depends on profits earned in previous periods plus the bequest, Ω_t^i, that newly entering entrepreneurs receive from entrepreneurs who leave the economy, and evolves according to:

$$NW_{t+1}^i = \nu\left[R_{K,t}^i q_{t-1}^i K_t^i - \frac{R_{L,t-1}^i}{\pi_t^i}\left(\frac{NW_t^i}{q_{t-1}^i K_t^i}\right)^{-\gamma}\left(q_{t-1}^i K_t^i - NW_t^i\right)\right] + (1-\nu)\Omega_t^i \quad (22)$$

2.3.2. Capital producers

Competitive capital producers use a linear technology to produce new capital K_{t+1}^i from final investment goods I_t^i and existing capital stock leasing from entrepreneurs without costs. When producing capital, they are subject to quadratic capital adjustment costs specified as

$\frac{\psi_I}{2}\left(\frac{I_t^i}{K_t^i} - \delta\right)^2 K_t^i$.

The aggregate capital stock used by producers in each economy i evolves as follow:

$$K_{t+1}^i = \left[\frac{I_t^i}{K_t^i} - \frac{\psi_I}{2}\left(\frac{I_t^i}{K_t^i} - \delta\right)^2\right] K_t^i + (1-\delta)K_t^i \quad (23)$$

where $\psi_I > 0$ is the parameter that measures the adjustment costs elasticity.

Capital producers face an optimization problem which consists, in real terms, in choosing the level of investment that maximizes their profits:

$$\max_{I_t^i}\left\{q_t^i I_t^i - I_t^i - \frac{\psi_I}{2}\left(\frac{I_t^i}{K_t^i} - \delta\right)^2 K_t^i\right\} \quad (24)$$

The following equilibrium condition holds:

$$q_t^i - \psi_I\left(\frac{I_t^i}{K_t^i} - \delta\right) = 1 \quad (25)$$

which is the standard Tobin's Q equation that links the price of capital to the marginal adjustment costs.

2.3.3. Retailers: price and inflation dynamics

The existence of retailers provides the source of nominal stickiness in the economy. Retailers take wholesale goods as inputs, repackage the latter costlessly, and sell them in a monopolistically competitive market. Following Calvo (1983), we assume that retailers set nominal prices on a staggered basis: at each period, a fraction $(1-\phi^i)$ of retailers are randomly selected to set new prices while the remaining fraction ϕ^i of retailers keep their prices unchanged. In each country $i, k \in \{h, f\}$, home goods retailers purchase the wholesale goods from entrepreneurs at a price equal to the entrepreneurs' nominal marginal cost. Each retailer j who sets prices at t will choose the optimal price, $\widetilde{P}_{i,t}^{i}$, that maximizes the expected profits for s periods, so that:

$$\max_{\widetilde{P}_{i,t}^{i}(j)} E_t \left\{ \sum_{s=0}^{\infty} \left(\beta\phi^i\right)^s \frac{\lambda_{t+s}^i}{\lambda_t^i} \left[Y_{i,t+s}^i(j) \left(\widetilde{P}_{i,t}^i(j) - P_{i,t+s}^i mc_{t+s}^i \right) \right] \right\} \tag{26}$$

subject to the demand function, $Y_{i,t+s}^i(j) = \left(\frac{\widetilde{P}_{i,t+s}^i(j)}{P_{i,t+s}^i}\right)^{-\chi} Y_{i,t+s}^i$, where $\frac{\lambda_{t+s}^i}{\lambda_t^i}$ is the households' marginal utilities ratio between $t+s$ and t.

The first-order condition for this problem yields,

$$\widetilde{P}_{i,t}^i(j) = \frac{\chi}{\chi-1} \frac{E_t\left\{\sum_{s=0}^{\infty}\left(\beta\phi^i\right)^s \lambda_{t+s}^i Y_{i,t+s}^i(j) P_{i,t+s}^i mc_{t+s}^i\right\}}{E_t\left\{\sum_{s=0}^{\infty}(\beta\phi^i)^s \lambda_{t+s}^i Y_{i,t+s}^i(j)\right\}} \tag{27}$$

Aggregating across all retailers, the price index for domestically produced goods is given by,

$$P_{i,t}^i = \left[\left(1-\phi^i\right)\left(\widetilde{P}_{i,t}^i\right)^{1-\chi} + \phi^i\left(P_{i,t-1}^i\right)^{1-\chi}\right]^{\frac{1}{1-\chi}} \tag{28}$$

Combining log-linearized versions of equations (27) and (28) yields an expression of the inflation rate for domestically produced goods, defined by the following New Keynesian Phillips curve:

$$\hat{\pi}_{i,t}^i = \beta E_t \hat{\pi}_{i,t+1}^i + \frac{\left(1-\phi^i\right)\left(1-\beta\phi^i\right)}{\phi^i} \widehat{mc}_t^i \tag{29}$$

where mc_t^i is the real marginal cost, $\pi_{i,t}^i = (\frac{P_{i,t}^i}{P_{i,t-1}^i})$ is domestic inflation and variables with hats are log deviations from their steady-state values.

Finally, from equation (29) and since firms do not segment markets by country, CPI inflation $\hat{\pi}_t^i$ is a composite of domestic, foreign and world goods prices variation, such that:

$$\hat{\pi}_t^i = \left(1 - a_1^i - a_2^i\right)\hat{\pi}_{i,t}^i + a_1^i \hat{\pi}_{k,t}^k + a_2^i \hat{\pi}_{w,t}^w \Delta S_t \tag{30}$$

$\forall\ i,k \in \{h,f\}$and $i \neq k$.

2.4. Government Budget Constraint and Fiscal policy

In each economy, government spends in purchases of aggregate goods G_t^i and transfers to households TR_t^i. The government finances its purchases by collecting tax revenues on consumption, wages and capital income, and borrowing funds from domestic and foreign banks ($\zeta^i L_{G,t}^i$ and $(1-\zeta^k)L_{G,t}^k$ respectively).

The government budget constraint is given by:

$$\zeta^i L_{G,t}^i + (1-\zeta^k) L_{G,t}^k = R_{L,t-1}^i \Psi_{l,t-1}^i\left(l_{t-1}^i, l_{t-1}^k\right)\zeta^i L_{G,t-1}^i + R_{L,t-1}^k \Psi_{l,t-1}^i\left(l_{t-1}^i, l_{t-1}^k\right)(1-\zeta^k) L_{G,t-1}^k + PD_t^i \tag{31}$$

In equation (31), PD_t^i is the nominal primary deficit and is expressed by:

$$PD_t^i = P_t^i G_t^i + TR_t^i - \tau_{c,t}^i P_t^i C_t^i - \tau_{w,t}^i w_t^i N_t^i P_t^i - \tau_{K,t}^i mpc_t^i K_t^i P_t^i \tag{32}$$

The term $\Psi_{l,t}^i(l_t^i, l_t^k)$ is the government's risk premium:

$$\Psi_{l,t}^i(l_t^i, l_t^k) \equiv exp\left(\psi_l^i\left(\frac{\zeta^i L_{G,t}^i + (1-\zeta^k) L_{G,t}^k}{Y_t^i P_t^i}\right)\right) \tag{33}$$

where ψ_l^i is the elasticity of the risk premium with respect to government debt; $l_t^i \equiv \frac{L_{Gt}^i}{Y_t^i P_t^i}$ and $l_t^k \equiv \frac{L_{Gt}^k}{Y_t^k P_t^k}$ are respectively the total of real loans/GDP made by banks in economy i and k.

Fiscal policy instruments

The government needs to adjust tax revenues or expenditure to stabilize its deficit and debt. We choose public consumption as the fiscal policy instrument. Government spending adjustments in response to cyclical fluctuations are endogenously made according to the following fiscal rule:

$$\log\left(\frac{G_t^i}{G^i}\right) = \rho_g \log\left(\frac{G_{t-1}^i}{G^i}\right) - (cg)(1-\rho_g)\rho_{gy}\log\left(\frac{Y_t^i}{Y^i}\right) - (1-\rho_g)\rho_{gl}\log\left(\frac{DY_t^i}{DY^i}\right) \tag{34}$$

where $\rho_g, \rho_{gy}, \rho_{gl} \in [0,1]$ capture, respectively, the degree of public consumption smoothing, fiscal reaction to output deviation and fiscal reaction to debt/GDP ratio ($DY_t^i \equiv \frac{\zeta^i L_{G,t}^i + (1-\zeta^k) L_{G,t}^k}{Y_t^i P_t^i}$).

The parameter (cg) captures the degree of fiscal policy cyclicality. If $(cg) = 1$ (resp.$(cg) = -1$), public consumption is counter-cyclical (resp. procyclical).

As for the other fiscal instruments, government transfers (TR_t^i), taxes on consumption ($\tau_{c,t}^i$), wages ($\tau_{w,t}^i$) and capital income ($\tau_{K,t}^i$) follow a stationary autoregressive process AR (1).

2.5. Monetary authority

In the monetary union, the common central bank sets the nominal interest rate according to the following Taylor-type interest rate rule:

$$\log\left(\frac{R_t}{R}\right) = \beta_0 \log\left(\frac{R_{t-1}}{R}\right) + (1-\beta_0)\left[\beta_1 \log\left(\frac{E_t \pi_{t+1}^{um}}{\pi^{um}}\right) + \beta_2 \log\left(\frac{Y_t^{um}}{Y^{um}}\right)\right] \tag{35}$$

R, π^{um} and Y^{um} are the steady-state values of R_t, π_t^{um} and Y_t^{um}, that are, respectively, the nominal interest rate, the inflation rate and output of the union. The variables π_t^{um} and Y_t^{um} are the average values of inflation and output of the two equal-size countries:

$$\pi_t^{um} = \frac{1}{2}\left(\pi_t^h + \pi_t^f\right) \text{ and } Y_t^{um} = \frac{1}{2}\left(Y_t^h + Y_t^f\right) \tag{36}$$

$\beta_1 > 1$ 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. General equilibrium conditions

In equilibrium, the factor markets, the final goods market, the loan market and the international traded bonds market must clear in each country $i \in \{h, f\}$.

Equilibrium in factor markets requires:

$$N_t^i = \int_0^1 N_t^i(j)dj \text{ and } K_t^i = \int_0^1 K_t^i(j)dj \tag{37}$$

The loan market clears when the household deposits equalize the total funds lent to entrepreneurs, domestic government and government in the RoU (see equation 13 supra).

Let $Y_t^i \equiv \left(\int_0^1 Y_t^i(j)^{\frac{\chi-1}{\chi}} d_j\right)^{\frac{\chi}{\chi-1}}$ denote aggregate output. Thus, the goods market clearing condition satisfies:

$$Y_t^i = C_{i,t}^i + I_{i,t}^i + G_{i,t}^i + EX_t^i \tag{38}$$

where $EX_t^i = a_1^i \left(\frac{P_{i,t}^i}{P_t^k}\right)^{-\theta} AB_t^k + a_2^i \left(\frac{P_{i,t}^i}{S_t P_t^w}\right)^{-\theta} AB_t^w$

The variable EX_t^irepresents total exports and AB_t^i stands for absorption.

Then the domestic economy's aggregate resource constraint can be rewritten as:

$$Y_t^i = \left(\frac{P_{i,t}^i}{P_t^i}\right)^{-\theta} \left[(1 - a_1^i - a_2^i)AB_t^i + a_1^i \left(\frac{P_t^i}{P_t^k}\right)^{-\theta} AB_t^k + a_2^i \left(\frac{P_t^i}{S_t P_t^w}\right)^{-\theta} AB_t^w\right] \tag{39}$$

where AB_t^i, AB_t^k and AB_t^w are, respectively, absorption in the domestic economy, RoU and the RoW. We have:

$$AB_t^i = C_t^i + I_t^i + G_t^i \tag{40}$$

$$AB_t^k = C_t^k + I_t^k + G_t^k \tag{41}$$

and AB_t^w is an exogenous process.

The internationally traded bonds market is in equilibrium when the positions of the export and importing firms vis-à-vis the RoW equals the households' choice of internationally traded bonds holdings. The evolution of net foreign assets NFA (net cross-border loans plus households' internationally traded bonds holdings) at the aggregate level can be expressed as:

$$S_t B_{w,t}^i + (1-\zeta^i) L_{G,t}^i - (1-\zeta^k) L_{G,t}^k$$
$$= S_t R_{w,t-1} \Psi_{b,t-1}^i \left(b_{t-1}^i, Z_{t-1}^i\right) B_{w,t-1}^i + R_{L,t-1}^i \Psi_{l,t-1}^k \left(l_{t-1}^i, l_{t-1}^k\right)(1-\zeta^i) L_{G,t-1}^i$$
$$- R_{L,t-1}^k \Psi_{l,t-1}^i \left(l_{t-1}^i, l_{t-1}^k\right)(1-\zeta^k) L_{G,t-1}^k + EX_t^i - \left(IM_{k,t}^i + IM_{w,t}^i\right) \qquad (42)$$

where $IM_{k,t}^i$ and $IM_{w,t}^i$ are imports of country i originating from country k (of the RoU) and from the RoW, respectively.

Noting that the definitions of b_t^i , l_t^i and l_t^k are $b_t^i \equiv \frac{S_t B_{w,t}^i}{Y_t^i P_t^i}$, $l_t^i \equiv \frac{L_{Gt}^i}{Y_t^i P_t^i}$ and $l_t^k \equiv \frac{L_{Gt}^k}{Y_t^k P_t^k}$, we can rewrite the evolution of total real NFA position in percentage of steady-state output as:

$$b_t^i + (1-\zeta^i) l_t^i - (1-\zeta^k) l_t^k \frac{P_t^k Y_t^k}{P_t^i Y_t^i}$$
$$= \frac{R_{w,t-1} \Psi_{b,t-1}^i}{\pi_t^i} b_{t-1}^i + \frac{R_{L,t-1}^i \Psi_{l,t-1}^k}{\pi_t^i} (1-\zeta^i) l_{t-1}^i \frac{Y_{t-1}^i}{Y_t^i}$$
$$- \frac{R_{L,t-1}^k \Psi_{l,t-1}^i}{\pi_t^i} (1-\zeta^k) l_{t-1}^k \frac{P_{t-1}^k Y_{t-1}^k}{P_{t-1}^i Y_t^i} + \left(\frac{P_{i,t}^i}{P_t^i} - \frac{C_t^i}{Y_t^i} - \frac{I_t^i}{Y_t^i} - \frac{G_t^i}{Y_t^i}\right) \qquad (43)$$

$\forall\, i, k \in \{h, f\}$ and $i \neq k$.

We assume that the RoW is fully exogenous and its variables follow an autoregressive process AR(1).

3. Simulations

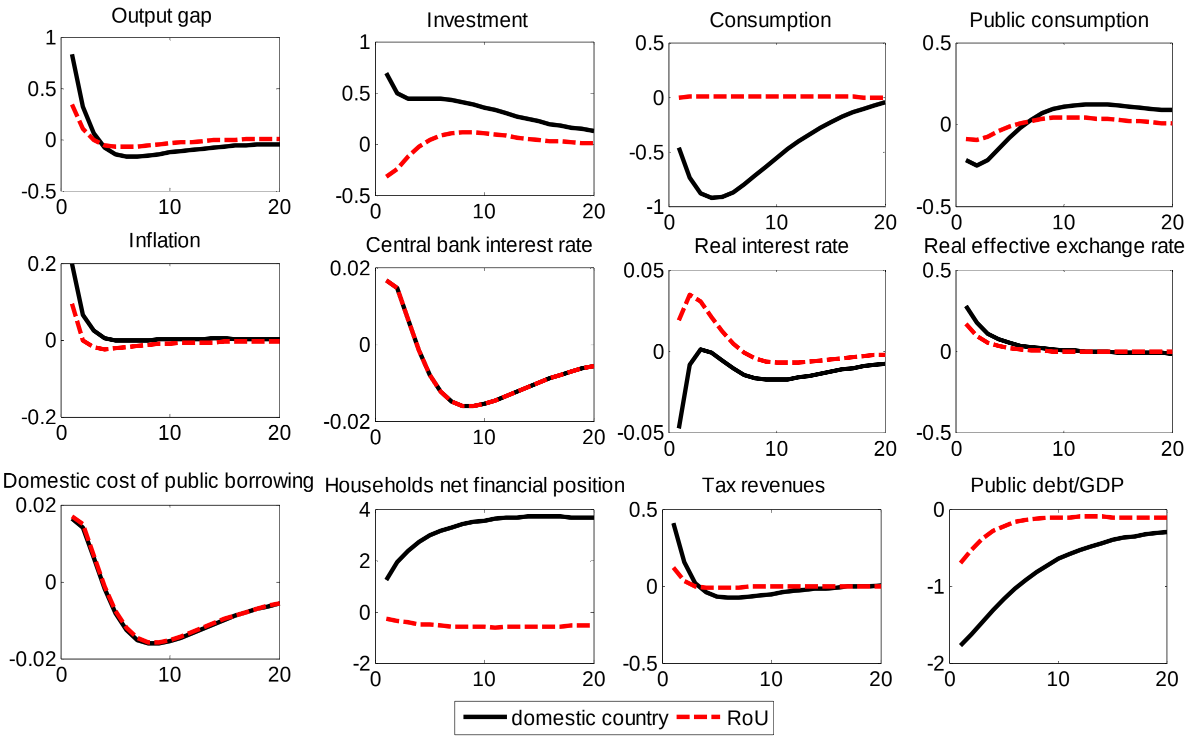
The equations of the model are log-linearized around the steady state. For the simulations, we used the software Dynare. We calibrated the model (see Table 1 in appendix) by following the literature on DSGE models applied to the euro area or by doing our own computations based on data from the European Commission, the OECD or the ECB. We simulated a 1% positive asymmetric shock on savings in one country of the union. We chose an average value of 0.75 for the autoregressive coefficient (ρ_ε) in order to account for the gradual process of deleveraging in some countries. Figure 1 displays the effects of the shock on the main macroeconomic aggregates of the domestic country hit by the shock (straight line) and of the RoU (dotted line). All variables are defined in deviation from the steady-state level.

Due to the shock, private consumption is below its steady-state level. The demand for final goods from households to retailers declines. But the demand for intermediate/capital goods increases, because entrepreneurs expect higher future demand from the RoW.[13] This is so, because there is a real effective depreciation of the currency of the union. In the interest rate parity, the effect of a lower real interest rate is stronger than the effect of a lower nation-wide risk premium (the NFA position is positive as far as households are now net lenders). The domestic real interest rate is

[13] Specifically, entrepreneurs demand more capital to capital producers in order to sell more wholesale goods to retailers who export those goods. And capital producers demand more investment goods to retailers in order to produce more capital goods.

lower than its steady-state level because the common central bank does not raise the nominal interest rate as much as the increase in the domestic inflation rate. Indeed, the common nominal interest rate is determined according to a Taylor rule whereby union-wide aggregates of output gap and inflation are key variables. Yet, output growth and inflation are smaller in the RoU than in the domestic economy.

Figure 1. Positive asymmetric shock on savings



Labour supply decreases but labour demand increases. Hours worked and the real wage rate increase. The rental rate of capital and capital price increase also.[14] As a result, tax revenues become higher: the increase in the receipts from the tax on factor income exceeds the loss of receipts from the tax on consumption. Primary public expenditures decrease because public consumption is assumed to be counter-cyclical.[15] The government enjoys a primary budget surplus. But interest rate payments do not decline. Indeed, the cost of public borrowing is higher due to a higher reference rate (the risk-free interest rate). This effect is negligible because, at the same time, the sovereign risk premium is lower. Thanks to a positive output growth, higher inflation and a primary budget surplus, the ratio of public debt-to-GDP start going under the 100% level (the assumed steady-state level).

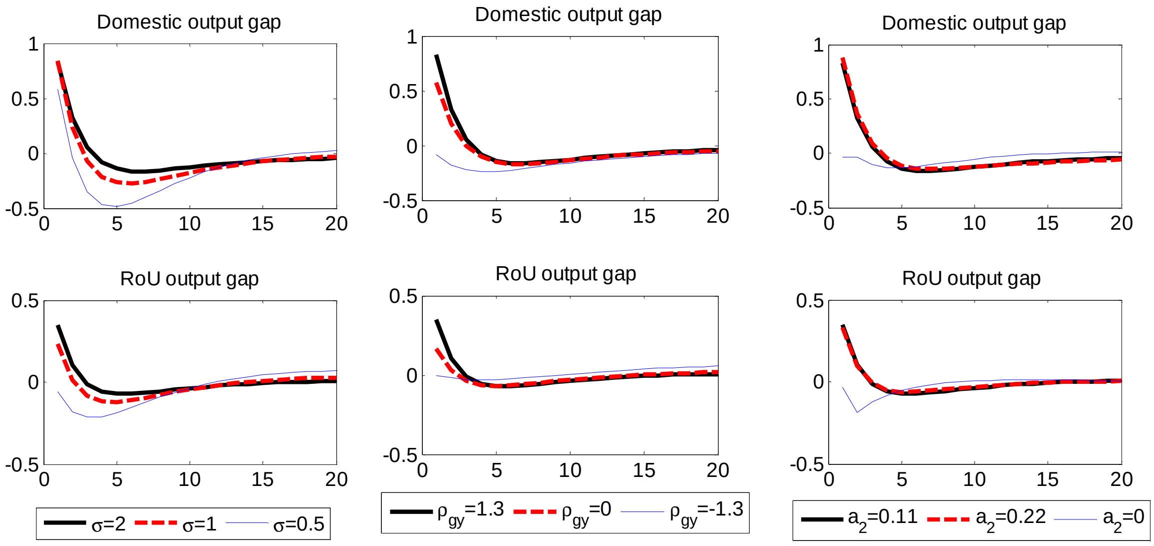
[14] Firms need to produce more with a given stock of capital. Investment is driven by a higher expected future demand from the RoW. Since the adjustment of capital is gradual, there is an excess demand for capital.

[15] Transfers are exogenous.

The shock in the domestic economy spills over the RoU. There are negative (but small) effects on consumption and investment. Yet, output growth is still positive thanks to higher net exports. As a matter of fact, the RoU is affected by higher real interest rates, since the common central bank raises the nominal interest rate more than the increase in inflation in the RoU. However, there is a real effective depreciation not only with regard to the domestic country (where producer prices increase) but also with regard to the RoW (the NFA position of the RoU is negative – hence a higher nation-wide risk premium – because the government borrows more funds from banks of the domestic country and the cost of public borrowing increases due to a higher risk-free interest rate). Thus, retailers in the RoU can export more goods. Hours worked and the real wage rate can increase. But since investment is falling, the capital price and the rental rate of capital decrease. As a consequence, tax revenues increase only a bit (taxes on wages increase but taxes on capital income and consumption decline). Since public consumption is counter-cyclical, there is a small primary budget surplus and a small decline in the ratio of public debt-to-GDP.

For robustness checks, we did the simulations again assuming different values of the following parameters for both the domestic country and the RoU: *i*) the inverse intertemporal elasticity of substitution (σ); *ii*) the cyclical behaviour of fiscal policy (ρ_{gy}); and *iii*) the degree of openness to trade with the RoW (a_2). For each parameter, Figure 2 displays the effects on domestic output and on the output in the RoU.

Figure 2. Robustness checks



First, when the intertemporal elasticity of substitution is higher (sigma below unity), households are more willing to substitute future consumption for current consumption. The effect of a lower real interest rate is weaker. As a result, following the positive shock on household savings in the domestic country, domestic current consumption decreases more and domestic output increases less than in the case where sigma is higher. This adversely affects the economy in the RoU (lower net exports).

Second, if public consumption is procyclical (ρ_{gy} being negative), then the effect of the shock on domestic output is negative, because the increase in domestic investment is lower than the decrease in domestic private consumption. Since domestic output is lower, public consumption decreases, which worsens the negative effect of the shock on output. Thus, it is not advisable to implement a restrictive fiscal policy in a context of a decline in household consumption. Furthermore, such a restrictive procyclical fiscal stance would not help economic recovery in both the domestic economy and the RoU. This has recently been the difficult position of some euro area countries.

Third, if the monetary union were not open to the RoW (a_2 being nul), then the positive shock on household savings would not have a positive effect on output. Thus, in our model, output growth is critically dependent on net exports to the RoW.

Conclusion

In the literature about the consequences of a future probable increase in household savings in some European countries in a context of household deleveraging, the work of Cuerpo et al. (2013) is the closest to ours. They showed that household deleveraging would cause a significant fall in housing investment, consumption, investment in capital and output. In their model, the main economic mechanisms are the following. A negative shock on credit availability and on house prices leads to a fall in consumption, which has a direct negative effect on output. Falling house prices translate into deflation and the latter makes it harder to reduce debt (the Fisherian debt-deflation spiral). Positive real interest rates lower investment in capital. Labour supply increases (due to the negative income shock) and labour demand falls. As a consequence, real wages fall. The negative impact of the shock on macroeconomic aggregates leads to a government budget deficit and an increase in the public-debt-to-GDP ratio.

On the contrary, in our model, output growth can be positive (on some conditions). This is so, because the nature of the shock and the mechanisms are different. The shock is an increase in savings. It leads to a decline in consumption but investment increases. The real interest rate is lower than its steady-state level because the common central bank does not raise the nominal interest rate as much as the increase in inflation in the domestic country (given that the increase in inflation and output in the RoU is smaller). Moreover, a real effective depreciation of the single currency helps to sustain aggregate demand via higher net exports to the RoW. Besides, hours worked increase and the real wage rate as well. Tax revenues are higher thanks to higher labour and capital income. The government primary budget balance improves (all the more since public consumption is assumed to be counter-cyclical) and the ratio of public debt-to-GDP decreases. In this respect, positive inflation helps reducing this ratio.

One has to be cautious with the results. The saving shock could cause a contraction in economic activity in the following cases: the extent of the shock is large (Eggertsson and Krugman, 2012), output growth in the RoW is not sufficient to enable net exports to increase both in the domestic country and in the RoU, there is government deleveraging and public consumption is procyclical. Our conclusion is simply that household deleveraging does not necessarily impair economic recovery and fiscal consolidation should not occur at the same time. In this respect, according to the latest forecast of the European Commission, positive economic growth would slightly resume in the southern countries of the euro area (Greece, Italy, Portugal, and Spain) in 2014, and these positive economic trends would mainly rely on exports of goods and services. As a matter of fact, the growth of final public consumption and public investment will still be negative in these countries, and in Spain, private investment will even continue declining.

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Appendix: Table 1. Calibration of the model

Description	Parameter	Value	References
Inverse intertemporal elasticity of substitution	σ	2	Literature on the EA
Inverse of the Frisch elasticity of labour supply	η	1	Literature on the EA
Subjective discount factor	β	0.99	Literature on the EA
Working time	N	1/3	Literature on the EA
Habit persistence coefficient	h	0.85	Literature on the EA
Share of imported goods from the rest of the union	a_1^i	0.21	AMECO database
Share of imported goods from the rest of the world	a_2^i	0.11	AMECO database
Elasticity of substitution domestic/imported goods	θ	1.5	Coenen et al. (2008)
Elasticity of the risk premium with respect to NFA position	ψ_b^i	0.001	Schmitt-Grohé & Uribe (2003)
Capital contribution to production	α	0.36	OECD database
Capital depreciation rate	δ	0.03	Literature on the EA
Internal capital adjustment costs parameter	ψ_I	0.25	Literature on the EA
Fraction of retailers keeping their prices unchanged	ϕ_i	0.8	Literature on the EA
Elasticity of the external finance premium (EFP) with respect to firm's leverage ratio	γ	0.005	[a] See Notes
Quarterly factor for the external finance premium for firms	Ψ_E^i	1.005	[b] See Notes
Firms' probability of leaving the economy	$1-\nu$	0.0272	Bernanke et al. (1999)
"Home bias" in the banking loans provided to governments	ζ^i	0.7	ECB database
Elasticity of risk premium with respect to government debt	ψ_l^i	0.001	Coenen et al. (2008)
Steady-state ratios			
Consumption/GDP ratio	C/Y	0.6	AMECO database
Investment /GDP ratio	I/Y	0.2	AMECO database
Public expenditures/GDP ratio	G/Y	0.2	AMECO database
Transfers/GDP ratio	Tr/Y	0.13	AMECO database
Loans to Governments /GDP ratio	l^i	1	[c] See Notes
Public debt/GDP ratio	$DY^i = l^i$	1	Steady-state analytical solution
Macroeconomic policy			
Smoothing coefficient in the monetary rule	β_0	0.8	Literature on the EA
Inflation stabilizing coefficient in the monetary rule	β_1	2	Literature on the EA
Output stabilizing coefficient in the monetary rule	β_2	0.1	Literature on the EA
Smoothing coefficient in the public expenditure rule	ρ_g	0.8	Coenen et al. (2008)
Output stabilizing coefficient in the public expenditure rule	ρ_{gy}	1.3	[d] See Notes
Debt stabilizing coefficient in the public expenditure rule	ρ_{gl}	0.01	Christoffel et al. (2011)
Tax rate on consumption	τ_c	0.20	EC data
Tax rate on wages (*labor income*)	τ_w	0.33	EC data
Tax rate on capital income	τ_k	0.25	EC data

Notes:[a] Corresponding to a steady-state leverage NW/K=0.4, as in the literature on the EA. [b] Corresponding to a 2% average annual EFP for firms as in Bernanke et al. (1999). [c] The ratio of average total bank assets to GDP is close to 300% in Europe, with a share of banking loans to the private sector amounting to 67% of total banking loans (ECB database). Thus, the share of banking loans to the private sector is approximately 200% of GDP and the share of banking loans to governments is 100% of GDP. [d] In the literature on the cyclicality of the government budget balance, an estimated coefficient on the output gap above unity means that fiscal policy is highly counter-cyclical (as in the United States or the United Kingdom in the early 2000s).