Interest rates, Eurobonds and intra-European exchange rate misalignments: The challenge of sustainable adjustments in the Eurozone

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Interest rates, Eurobonds and intra-European exchange rate misalignments: The challenge of sustainable adjustments in the eurozone

Vincent Duwicquet[*] Jacques Mazier[**] Jamel Saadaoui[***]

Abstract: The euro crisis shed lights on the nature of alternative adjustment mechanisms in a monetary union characterized by a large heterogeneity. Exchange rate adjustments being impossible, it remains very few efficient alternative mechanisms. At the level of the whole eurozone the euro is close to its equilibrium parity. But the euro is strongly overvalued for Southern European countries, France included, and largely undervalued for Northern European countries, especially Germany. This paper gives a new evaluation of these exchange rate misalignments inside the eurozone, using a FEER approach, and examines the evolution of competitiveness. In a second step, we use a two-country SFC model of a monetary union with endogenous interest rates and Eurobonds issuance. Three main results are found. Firstly, facing a competitiveness loss in southern countries due to exchange rates misalignments, increasing intra-European financing by banks of northern countries or other institutions could contribute to reduce the debt burden and induce a partial recovery but public debt would increase. Secondly, the implementation of Eurobonds as a tool to partially mutualize European sovereign debt would have a rather similar positive impact, but with a public debt limited to 70 percent of GDP. Finally, Eurobonds could also be used to finance large European projects which could impulse a stronger recovery in the entire zone with stabilized current account imbalances. However, the creation of a European institution in charge of the issuance of the Eurobonds would face strong political obstacles.

JEL Classification: F31, F32, F37, F41, E12.

Key words: Euro Crisis, Exchange Rate Misalignments, Eurobonds, Interest Rate.

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1. Introduction

"The second implication of the absence of fiscal transfers is that countries need to invest more in other mechanisms to share the cost of shocks. Even with more flexible economies, internal adjustment will always be slower than it would be if countries had their own exchange rate. Risk-sharing is thus essential to prevent recessions from leaving permanent scars and reinforcing economic divergence."

Mario Draghi (2015).

The euro crisis shed lights on the nature of alternative adjustment mechanisms in a monetary union characterized by a large heterogeneity. Adjustment mechanisms are defined in a broad sense as mechanisms that ensure a return to the initial situation or, possibly, to recover towards full employment after a slowdown. It remains very few efficient alternative mechanisms in the absence of exchange rate flexibility as underlined by the quotation of Mario Draghi. Budgetary policy could play a major role. In the United States, budgetary policy stabilizes 20 percent of shocks on the GDP (Italianer and Pisani-Ferry, 1992). But there is no equivalent in the European case. Well integrated capital markets, with portfolio diversification and intra-zone credit, have been proposed as a powerful adjustment mechanism by the "international risk sharing" approach. Intra-zone credit and capital income from international portfolio would have stabilization coefficients around 20-30 percent each (Asdrubali and Kim, 2004). These results have been used during the 2000 by proponents of liberal economic policies in the EU to promote deeper financial integration instead of having to develop a federal budget (European Commission, 2007; Trichet, 2007)[1]. This approach is still present in the last Action Plan of the European Commission (2015) on the Capital Market Union with the goal of creating one single

[1] Mario Draghi (2015) acknowledges the crucial role of budgetary policies and that this approach "the less public risk-sharing we want, the more private risk-sharing we need" could be insufficient in case of financial storms in the future. However, he concludes that Members States should achieve structural reforms to have sound public finances in order to be able to deal with periods of financial and economic turmoil.

market for shares, bonds and securitized bank loans. However, the theoretical basis, the empirical methodology and the results appear highly questionable (Clévenot and Duwicquet, 2011).

Consequently, relative wage and price flexibility are proposed in order to take place, at least partially, of exchange rate adjustments. Actually, these mechanisms allow only a very slow and partial return to equilibrium with an important cost in terms of growth and employment and with large differences between countries, due to huge structural specificities. They are more inefficient when they are implemented simultaneously in interdependent countries, as it is the case in the eurozone, especially in the Southern European countries. They are more efficient in a largely opened economy like Ireland than in rather closed ones like Greece or even Portugal (Mazier and Saglio, 2008).

This situation reflects a rather simple diagnosis. At the level of the whole eurozone, the current account is close to equilibrium and the fiscal deficit is smaller than in many other OECD countries. The euro is close to its equilibrium parity. But intra-European imbalances are huge. The euro is strongly overvalued for Southern European countries, France included, and largely undervalued for Northern European countries, especially Germany (Jeong *et al.*, 2010). These overvaluations slow growth and induce fiscal and current deficits in the South while undervaluations boost growth in the North via exports, especially towards the rest of the eurozone, and deficits are reduced. This situation is equivalent to implicit positive transfers in favor of the North and negative transfers at the detriment of the South, which are largely ignored in the public debate.

In order to investigate these issues, Duwicquet et al. (2013) have used a two-country SFC model of a monetary union along the lines of Godley and Lavoie (2006, 2007a, 2007b), Lavoie (2003) and Duwicquet and Mazier (2010, 2011). The model described the real sector and assets and liabilities of economic agents in order to analyze financial integration in a consistent manner.

A federal budget has been introduced with federal expenditures and social transfers financed by federal taxes and Eurobonds issuance. Three results have been found. The stabilizing role of such a federal budget has been confirmed facing asymmetric shocks or exchange rate misalignments within the monetary union. Similarly, the stabilizing role of Eurobonds, used to finance European investment projects, has been illustrated. But the model was limited to exogenous interest rates, which can only be regarded as a preliminary step, as we have assisted to large movements of interest rates in Southern European countries since the onset of the euro crisis.

This paper is organized as follow. In a first part, we give a new evaluation of these exchange rate misalignments inside the eurozone, using a FEER approach, and we discuss the structural heterogeneity of the eurozone. In a second part, we introduce an extended version with endogenous interest rates of an SFC model of a monetary union. With this model, we examine to what extent asymmetric evolutions due to intra-European misalignments can be adjusted. Interest rates on public bonds are now endogenous. Fiscal policy is partially endogenous and reacts to financial markets evolution with the implementation of budget cuts. The possibility to increase intra-zone financing allows a reduction of the pressure on interest rates. Eurobonds are introduced and used in two ways, on the one hand, in order to pool a part of the European public debts and, in the other hand, to finance European investments in growth sectors. A combination of tax rebate and budget cuts is also investigated.

2. Intra-European exchange rates misalignments and structural heterogeneity

Since the beginning of the 2000s, a surge of current account imbalances within the eurozone has been observed in spite of a rather balanced current account for the whole area. On the one side, Northern European countries have accumulated huge current account surpluses and on the other side, Southern European countries have run important current account deficits. After 2009, current account deficits of Southern European countries have been reduced mainly

because of restrictive policies and internal devaluations. These evolutions reflect, at least partially, the increasing exchange rate misalignments inside the eurozone. By using a FEER approach, introduced by Williamson (1983), Jeong et alii (2010) and Duwicquet et alii (2013) have shown a split within the eurozone between some countries increasingly undervalued (like Germany, Austria, Netherlands and Finland) and others increasingly overvalued (like Greece, Portugal, Spain and France). As we can see in table 1, on average between 2005 and 2010, Germany, Austria, Netherlands and Finland have been undervalued by 13 percent while Greece, Portugal, Spain and France have been overvalued by 23 percent.

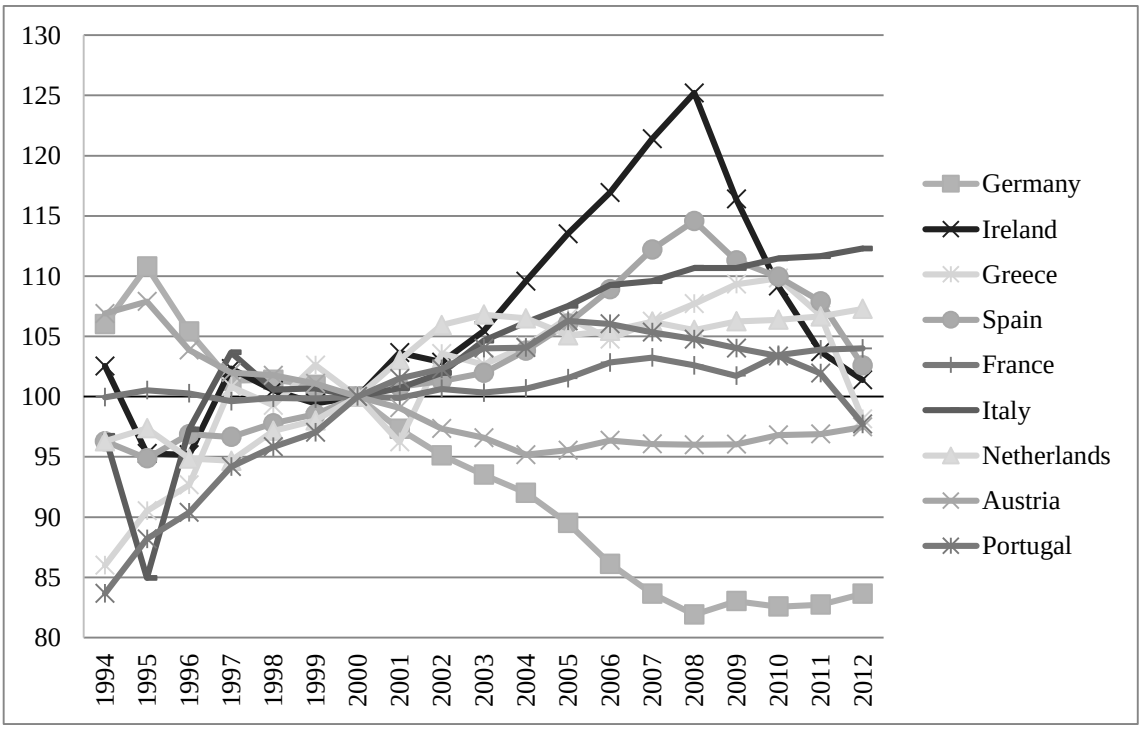
Table 1: Misalignments in real effective terms (in percent)

	EU	FRA	GER	ITA	SPA	AUT	FIN	IRL	NLD	PRT	GRC
1994	-3.4	3.1	-10.5	9.2	0.6	-3.1	-1.7	3.8	0.8	4.3	13.9
1995	1.2	1.4	-9.4	11.2	8.8	-8.3	7.2	3.8	0.8	7.0	1.3
1996	4.2	3.9	-4.8	9.4	-4.6	-9.2	9.3	0.8	0.4	-11.3	-12.5
1997	3.5	15.2	-3.2	8.2	-0.8	-8.8	16.9	0.6	1.8	-19.3	-12.7
1998	0.6	15.4	-5.2	5.1	-1.4	-3.5	17.4	-0.8	-2.2	-18.5	-8.4
1999	2.0	19.5	-8.1	1.8	-6.9	-2.9	17.6	0.4	-0.7	-23.7	-17.8
2000	0.1	7.4	-8.4	-0.7	-10.0	1.1	21.4	-2.2	-3.7	-28.7	-25.2
2001	6.9	7.6	-3.5	-1.2	-13.0	-3.5	22.2	-5.4	-6.4	-34.3	-24.3
2002	6.6	2.4	3.5	-4.2	-12.9	9.8	23.0	-6.2	-8.2	-27.4	-22.4
2003	2.2	-3.0	2.2	-6.9	-13.6	2.9	12.0	-6.8	-3.0	-23.8	-11.8
2004	6.6	-5.7	9.0	-1.9	-22.0	1.2	12.7	-7.2	-1.1	-33.8	1.0
2005	1.8	-11.2	11.6	-1.2	-30.7	3.8	5.5	-7.3	1.6	-44.2	-4.6
2006	0.3	-8.8	16.5	-0.7	-34.0	7.9	9.4	-5.1	6.1	-42.5	-5.1
2007	0.1	-12.8	18.4	-0.3	-42.0	10.4	11.5	-11.1	3.1	-33.8	-7.4
2008	-2.6	-19.8	14.3	-5.7	-46.7	12.6	4.5	-14.1	0.0	-45.9	-10.1
2009	0.6	-11.6	16.3	-2.0	-21.4	7.2	-0.4	-2.5	2.1	-35.4	-0.4
2010	1.6	-8.9	20.2	-3.2	-21.5	9.8	3.4	8.1	8.4	-26.8	-11.5
2011	8.2	-15.4	16.9	-4.1	-19.5	6.9	-7.3	3.9	6.6	-22.1	-46.2
2012	14.1	-14.1	19.9	4.3	-1.3	7.8	-5.2	13.0	7.1	2.7	-15.9

Notes: Forecasts for 2012 based on IMF WEO October 2013; See Jeong *et al.* (2010) for a complete description of the model of world trade and the methodology used to compute ERMs. Source: authors' calculations. A positive (negative) number indicates an undervaluation (overvaluation) expressed in percent of the observed value. See appendix A for details about the methodology used to correct current account balances from the effect of differences between output gaps in the eurozone. This correction, especially important after the crisis (due to a de-synchronization of business cycles in the euro area), is based on Bayoumi and Faruqee (1998).

These intra-European exchange rate misalignments reflect a strong structural heterogeneity between European countries at several levels (nature of the international specialization, size and productivity of the firms, R&D effort and qualification of the labor force). They are at the heart of the current problems of the eurozone. However, since the onset of the euro crisis in 2010, a reduction of misalignments has been observed for most of the Southern European countries. Irish, Spanish, Italian and even Portuguese euros seemed no more overvalued in 2012. But Greek and French euros remained overvalued by around 15 percent and German euro undervalued by around 20 percent. These movements have been mainly driven by large real effective devaluations in Ireland, Spain, Portugal and Greece, as shown in figure 1 with the evolutions of the relative unit labor cost (RULC) i.e. the real effective exchange rates based on ULC. These politics of internal devaluation have been very painful and has led to a deep recession in Greece, as in other Southern European countries, with a reduction of current deficits mainly due to the shrink of imports, but with limited improvement of public finances.

Figure 1: Real effective exchange rates based on unit labor cost

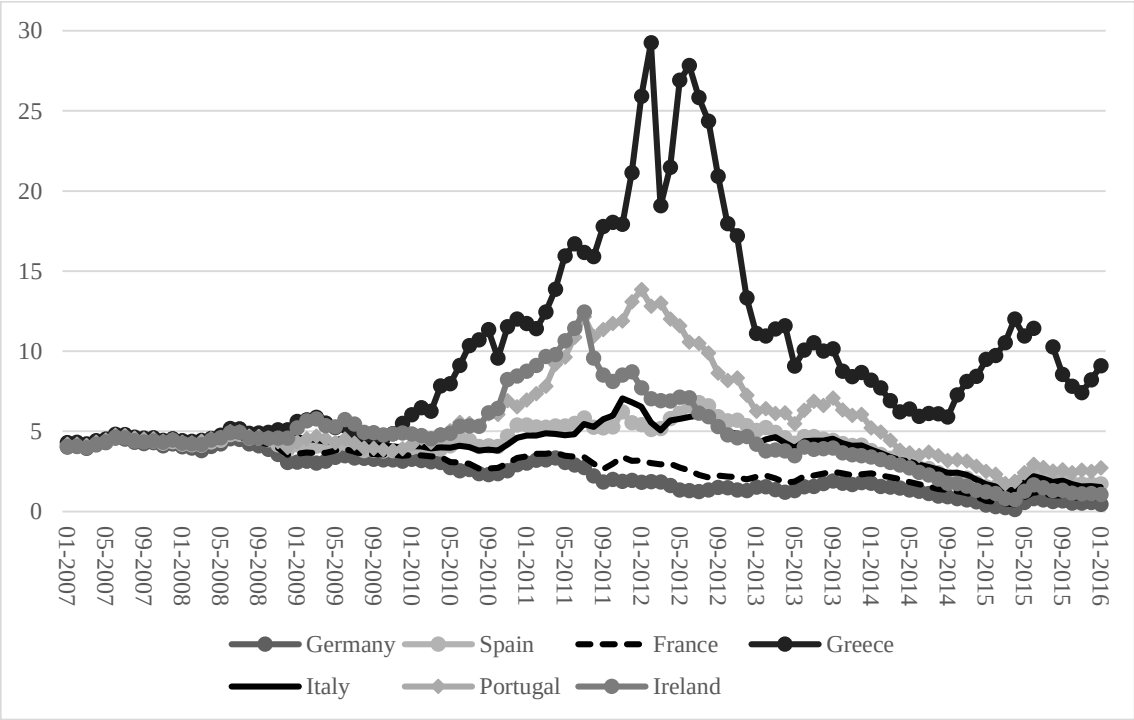


Source: authors' calculations based on European Commission data (AMECO), basis 100 in 2000.

The financial crisis of 2008 was, in any case, due to a rise of public deficits and debts. Nevertheless, it has led to a huge increase in the government deficits and debts due to measures implemented to rescue banks and support the economic activity and also to the fall of tax incomes induced by the recession. Monetary policy also became expansionary with a decline of the interest rate of the European Central Bank (ECB). But the weakest European countries faced difficulties to finance their deficits as the financial markets feared sovereign debt default. As they could not attack national currencies thanks to the monetary union, the financial markets concentrated their attacks on the public bonds. Interest rates soared, first, in Ireland and in Greece, then in other Southern European countries while they remained very low in Germany, but also in France. The existence of the monetary union was at stake and a reversal only took place after the announcement of the ECB in September 2012 to intervene without restriction on the public bonds secondary markets in case of necessity (see figure 2).

But this ECB intervention was accompanied by very restrictive fiscal policies in the framework of the Fiscal Pact and by structural reforms in favor of more liberalization.

Figure 2: 10-years government real interest rates in percent



Source: European Central Bank's Statistical Data Warehouse.

On the whole, results have been uneven amongst member states. Real devaluation has been inefficient in Greece and, to a large extent, in Portugal due to their limited degree of trade openness and the social cost has been high. Combined with restrictive fiscal policies, it has led to a deep recession which has limited the improvement of public finances. The public debt ratio has increased massively. In Ireland and, to a less extent, in Spain the real devaluation has been more operational thanks to the role played by the export sector but the initial negative shock has not been offset and the rate of unemployment remained high (in January 2016, the unemployment rate was 8.9 percent in Ireland and 20.5 percent in Spain). In Germany, between 2000 and 2008, sharp wage and productivity adjustments have led to a large reduction of the German relative unit labor cost which has been preserved during the crisis.

On the opposite, in France, the successive governments have been reluctant to implement cost adjustments and the euro remained overvalued. The strategy adopted has been since 2013 to reduce costs through tax rebates (around 1.5 percent of GDP). The target of these measures is not clear and they raise, at least, two questions. If the government wants to improve the competitiveness, this measure is inaccurate as all the firms, including those of the non-tradable sector like banks and retailers, can benefit of the tax rebates. Consequently, the transfer in favor of the tradable sector is too limited, compared with the cost disadvantage which prevails actually. A larger transfer would be necessary but could not be supported by public finances. If the target is to improve employment, as it seems to be more the case with the "Pacte de responsabilité et de solidarité", the past experiences show that efficiency is not warranted and the problem of cost-competitiveness, which cannot be ignored, is not solved. The government is aware of these limits and has completed his array of measures by re-launching industrial policy measures (major industrial projects, innovation policy, etc.) to improve non-price competitiveness. This is welcome but this kind of measures takes a long time (around 10 years) to be fully operational.

The risk is therefore that any target can be reached. The competitiveness problem will remain and financing the current deficit might become more difficult. Tax rebates could have a limited impact on employment, at least as the profit margins have been reduced during the crisis, especially for the export sector. The financing of the tax rebates will imply public expenditures cuts with a negative impact on activity. The more likely outcome would be a long lasting period of stagnation.

In this context, it is worthwhile, using a SFC model of a monetary union, to assess various alternative economic policies scenarios which try to tackle this problem of intra-European misalignments.

3. SFC modeling of adjustment mechanisms in a monetary union

3.1. The structure of the model

An asymmetric two-country SFC model of a monetary union allows a consistent description of assets and liabilities of all associated real and financial flows. The monetary union is composed of two countries (n and s) with an asymmetry of size. The country n is five times larger than the country s. This configuration facilitates analyzing the adjustment mechanisms of the country s facing the rest of the monetary union.

We introduce in this model the possibility of public federal expenditures and Eurobonds. This will open the road to investigate stabilizing effects of Eurobonds. Firms can accumulate both real and financial capital. They can finance their investments by non-distributed profits, bank loans or equities. Commercial banks are able to supply credit and to ration credit. The single central bank (ECB) refinances the commercial banks. Households hold banking deposits, bonds and equities. The two national governments issue bonds and Treasury bills.

In table 2, we describe the balance sheet in terms of assets (written with a positive sign) and liabilities (written with a negative sign) of each sector: households, firms, government, commercial banks, the single central bank and a federal budget.

Table 2: Balance sheet of a monetary union

	Country n						*Country* s				
	HH	F	G	B	FB	ECB	HH	F	G	B	Σ
C		$+k_n$						$+k_s$			0
D	$+bd_n$			$-bd_n$			$+bd_s$			$-bd_s$	0
Cs	$+hh_n$			$+h_n$		$-h$	$+hh_s$			$+h_s$	0
Cr		$-l_n$		$+l_n^n$						$+l_s^n$	0
				$+l_n^s$				$-l_s$		$+l_s^s$	
R				$-rf_n$		$rf_n + rf_s$				$-rf_s$	0
Bd	$+pb_n b_n^n$		$-pb_n b_n$				$+pb_n b_s^n$				0
	$+pb_s b_n^s$						$+pb_s b_s^s$		$-pb_s b_s$		
E				$+bte_n$	$-bte_n$					$+bte_s$	0
Bi			$-bt_n$	$+bt_n^n$						$+bt_s^n$	0
				$+bt_n^s$					$-bt_s$	$+bt_s^s$	
Eq	$+pe_n eh_n^n$	$+pe_n ee_n^n$					$+pe_n eh_s^n$	$+pe_n ee_s^n$			0
		$-pe_n e_n$									
	$+pe_s eh_n^s$	$+pe_s ee_n^s$					$+pe_s eh_s^s$	$+pe_s ee_s^s$			0
								$-pe_s e_s$			
W	$-vh_n$	$-v_n$	$-d_n$	$-vb_n$	$-de_n$		$-vh_s$	$-v_s$	$-d_s$	$-vb_s$	0
Σ	0	0	0	0	0	0	0	0	0	0	

Notes: For the agents in the economy, HH stands for households, F for firms, G for national government, B for private banks and FB stands for federal budget or a federal institution in charge of the emission of Eurobonds. For the type of financial assets held and issued in the economy, C stands for physical capital, D for deposits, Cs for cash, Cr for credit, R for advances of the central bank, Bd for bonds, E for Eurobonds, Bi for bills, Eq for equities and W stands for wealth.

Beyond physical capital (k), eight kinds of monetary or financial assets are distinguished[2]: bank deposits (bd) held by households, bonds issued by governments ($pb.b$) and held by households of both countries, loans (l) supplied by each commercial bank to firms of the two countries, equities issued by firms ($pe.e$) and held by households and firms of both countries, Treasury bills issued by each State (bt) and held by commercial banks of both countries, high

[2] When there are two symbols (n and s), the subscript denotes the country where the asset is held, the superscript the country where the asset is issued. For example, bt_n^s represents the amount of bills held by country n and issued by the country s.

powered money (h) held by households (hh) as well as by commercial banks (mandatory reserves), advances supplied by the central bank to commercial banks (rf) and finally Eurobonds (bte) issued by a federal authority and held by banks.

Our model relies on the main features of the contributions of Duwicquet and Mazier (2010, 2011) and Duwicquet et al. (2013). Nevertheless, several crucial changes are included to examine current developments in the eurozone crisis:

- Interest rates on Treasury bills supplied by the State are endogenous. The demand of Treasury bills by private banks is an increasing function of interest rate. Thus, in case of an insufficient demand, this mechanism induces upward pressures on interest rates.
- Budgetary policy is partially endogenous and is linked to financial markets. When interest rates on sovereign debt increase, the national government can reduce public expenditures in reaction.
- The possibility to increase intra-zone financing is introduced in order to reduce the pressure on interest rates. This can be achieved through foreign banks purchases of public bonds or Treasury bills, through the European Stability Mechanism or even through direct intervention of the central bank on the public bond market.
- The role of Eurobonds is examined in two ways. On the one hand, Eurobonds are aimed at pooling a part of sovereign debt in the eurozone. On the other hand, Eurobonds could be used to finance European investment projects in various sectors namely education, health and innovation.
- Last the rather traditional policy mix combining tax rebates and expenditures cuts (roughly the French government strategy) is also discussed.

The main equations are presented below. The model has been calibrated to represent the structure of the European Monetary Union. The value of coefficients and the entire model are given in appendix B and C[3].

The demand side

The model dynamics relies essentially on the investment function. As we can see below, investment reacts positively to the rate of profit and to variation of aggregate demand. It responds negatively to the debt structure and to credit costs.

$$g_n = k_{0n} + k_{1n}\frac{up_n(-1)}{k_n(-2)} + k_{2n}\frac{\Delta y_n}{y_n(-1)} - k_{3n}\frac{l_n(-1)}{k_n(-1)} - k_{4nn}rl_n - k_{4sn}rl_s \qquad [1]$$

where g stands for the rate of accumulation of physical capital; up represents the amount of undistributed profits; l is the firms' indebtedness; rl is the credit cost and y is the gross domestic product.

At the macroeconomic level, an increase in investment spending will generate more profits. These profits will be, on the one hand, distributed in part to shareholders (here, households and other firms) and, on the other hand, retained.

The household consumption function includes a positive wealth effect. This wealth effect describes the behavior of households which target a constant ratio between wealth and disposable income.

$$c_n = a_{0n} + a_{1n}yh_n + a_{2n}vh_n(-1) \qquad [2]$$

where vh stands for the households' wealth and yh for the disposable income with capital gains.

[3] The EViews codes used for the numeric simulations are available from the authors upon request.

The disposable income of households is defined as the sum of after-tax labor incomes (wages) and after-tax capital incomes (interest rates and dividends). A part of disposable income augmented with capital gains is consumed whereas the residual saving corresponds to bank deposits, money holdings and to financial assets (bonds supplied by the State and equities supplied by private firms). The financial wealth covers a large array of financial assets (bank deposits, cash money, equities and bonds).

The government receives taxes from households and banks, spends and pays interests. The public deficit is financed by issuance of bonds and Treasury bills. Supply of Treasury bills balances the gap between public deficit and bonds issuance thus:

$$\Delta bt_n = gn_n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n + ps_n - cl_n - tf_n \quad [3]$$

where bt is the amount of T-bills; gn stands for the national public expenditures; r is the interest rate on T-bills; b represents the amount of bond issued; t are the taxes paid by the households; tb are the taxes paid by commercial banks; teb are the taxes paid by the ECB; tf are the taxes paid by firms; ps stands for social benefits and cl for firms' social contributions.

The banking sector

The central bank supplies money and provides an unlimited amount of refinancing to private banks at the key interest rate (ib) acting as the lender of last resort. The interest rate on bank deposit (id) is simply determined with a margin on the key interest rate of the central bank.

$$\Delta rf_n = \Delta h_n + \Delta l_n^n + \Delta l_n^s + \Delta bt_n^n + \Delta bt_n^s - bp_n - \Delta bd_n \quad [4]$$

$$id = ib - m_{2b} \quad [5]$$

The central bank does not make any profit as in Godley and Lavoie (2007). Thus interests paid to the Central Bank are equal to taxes paid to the State. This is in line with the practice of most modern central banks in the world economy.

Commercial banks supply the entire amount of demanded credit:

$$\Delta l_n = inv_n - up_n - pe_n \Delta e_n + pe_n \Delta ee_n^n + pe_s \Delta ee_n^s \quad [6]$$

The credit market is open to foreign banks. We suppose that banks of the smaller country (country s) do not lend to firms of the larger country n ($l_s^n = 0$). Bank loans are allocated between domestic and foreign firms relatively to their respective trade openness. The interest rate on bank loans is endogenous and depends on the lagged value of Treasury bills' rate of each country and on their own lagged value.

$$rl_n = (1-a) rl_n(-1) + a.r_n(-1) \quad [7]$$

$$rl_s = (1-a) rl_s(-1) + a.r_s(-1) \quad [8]$$

Treasury bills play a key role in the model resolution. Banks purchase a limited amount of Treasury bills with a demand which depends positively on the rate of interest. Thus interest rates become endogenous, as they adjust supply of Treasury bills determined by the public deficit (which has to be financed) and private demand of Treasury bills in each country.

Bills issued by the southern country and domestically held in the private sector (bt_s^s) as well as bills held in the rest of the union (bt_n^s) depends on the interest rates differential between the two countries:

$$\frac{bt_s^s}{y^s} = a_{1ss} r_s - a_{2ss} r_n$$

$$\frac{bt_n^s}{y^n} = a_{1ns} r_s - a_{2ns} r_n$$

By summing demands of these two countries, we obtain the global demand for Treasury bills issued by the southern country:

$$bt_s = \left(a_{1ss} r_s - a_{2ss} r_n\right) y_s + \left(a_{1ns} r_s - a_{2ns} r_n\right) y_n$$

The interest rate on Treasury bills issued by the southern country becomes endogenous and we can write:

$$r_s = \frac{bt_s + \left[a_{2ss} r_n y_s\right] + \left[a_{2ns} r_n y_n\right]}{\left[a_{1ss} y_s\right] + \left[a_{1ns} y_n\right]} \qquad [9]$$

Regarding the rest of the union (the northern country), we assume that the southern country does not hold bills issued by the northern country which finances its public deficit only domestically:

$$bt_s^n = 0$$

$$bt^n = bt_n^n$$

The global demand for Treasury bills issued by the northern country depends on the level of interest rate (r_n) and the national income (y_n):

$$bt_n^n = \frac{\left(r_n - a_{1nn}\right) y_n}{b_{2nn}}$$

Consequently, we have the following interest rate determination for the northern country:

$$r_n = a_{1nn} + \frac{b_{2nn} bt_n}{y_n} \qquad [10]$$

After an increase of public deficit, the public deficit remains financed by commercial banks. However, the level of interest rates is higher. This tightening of financial conditions is partially transmitted to rates on bank loans granted to firms and to interest rates on public bonds which are supposed to be equal to interest rates on Treasury bills.

Baseline scenario

Our model represents a monetary union characterized by a sluggish growth in the baseline scenario (around 1 percent per year). The entire model and main characteristics of the baseline scenario are given in appendix C. Sensitivity tests have been conducted on the most relevant parameters. They are also available in the appendix D. They show a rather good robustness of the results. From this baseline scenario, we simulate an asymmetric loss of competitiveness in the southern country due to an exchange rate misalignment. This can be seen as a shortcut as the current imbalances in the eurozone have various origins (wage policies, debt-led growth in the non-tradable sector, etc.) as underlined by Belabed et alii (2013). Within the monetary union price re-alignments are not possible via exchange rates, leading to exchange rate misalignments, as they have been estimated. To illustrate the loss competitiveness, the term ti is equal to 10 between periods 10 and 45 in the import equations:

$$\log(im_n) = \mu_{0n} + \mu_{1n}\log(y_n) + \mu_2 \log\left(\frac{w_n - ti}{y_n}\right) - \mu_2 \log\left(\frac{w_s + ti}{y_s}\right) \quad [11]$$

$$\log(im_s) = \mu_{0s} + \mu_{1s}\log(y_s) + \mu_2 \log\left(\frac{w_s + ti}{y_s}\right) - \mu_2 \log\left(\frac{w_n - ti}{y_n}\right) \quad [12]$$

This shock deteriorates the current account of the southern country and improves external trade of the northern country. Consequently, we observe a decline of national income in the South and an increase of national income in the North. In order to investigate the current developments of the eurozone crisis, we compare the effect of this shock in different versions of the model. In addition to the baseline scenario, five versions of the model will be examined.

3.2. Alternative scenarios of economic policies

Scenario 1: Budget cuts

In this first scenario, public expenditures become endogenous and react to rising interest rates on Treasury bills:

$$gn_n = a_{gg1} gn_n(-1) - a_{gg2} r_n bt_n(-1) \quad [13]$$

In line with the objectives of the revised Stability and Growth Pact as well as aims of the Fiscal Compact, we assume that the government targets to reach a debt-GDP ratio of 70 percent in period 45. To achieve this challenge, the government progressively reduces its public expenditures. The speed of public expenditures reduction is governed by the evolution of interest rates. The year of the shock, public expenditures decrease by 0.2 percent of GDP relatively to the baseline scenario. In the baseline scenario, publics expenditures amount to 19.5 percent of GDP in period 45. In the first scenario, they drop to 12 percent of GDP in period 45.

Scenario 2: Intra zone financing

We investigate, here, implications of financial support granted by the northern country to the southern country. In the wake of a loss of competitiveness in the southern country, the issuance of public securities will rise to finance an increasing deficit. We assume that private banks of the northern country will sustain a supplementary demand to bring down interest rates. This scenario can also be seen as an illustration of the European Stability Mechanism where northern countries grant loans with low rates of interest to southern countries. Similar effects are also expected if the Central Bank purchases directly Treasury bills of southern countries. In each case, the southern country receives financial aid to reduce the debt burden substantially.

Scenario 3: Issuance of Eurobonds

In this scenario, Eurobonds are issued in order to mutualize partially sovereign debt of southern countries. We assume that there is threshold (a debt-GDP ratio of 60 percent) from which Eurobonds are issued to finance public debt in the eurozone as a substitute to national debt.

Nevertheless, national governments have to pay interest on issued Eurobonds. Southern countries must be committed to stabilize their public debt.

$$If \quad \frac{d_n}{y_n} < 60\% \quad then$$
$$\Delta bt_n = \left(g_n^n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n + ps_n - cl_n - tf_n \right) + reuro.bte_n(-1) \quad [14]$$

$$If \quad \frac{d_s}{y_s} < 60\% \quad then$$
$$\Delta bt_s = \left(g_s^s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s + ps_s - cl_s - tf_s \right) + reuro.bte_s(-1) \quad [15]$$

Each government may appeal the issuance of Eurobonds (bte_n for the northern government and bte_s for the southern government).

$$If \quad \frac{d_n}{y_n} > 60\% \quad then$$
$$\Delta bte_n = \left(g_n^n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n + ps_n - cl_n - tf_n \right) + ge_n \quad [16]$$

$$If \quad \frac{d_s}{y_s} > 60\% \quad then$$
$$\Delta bte_s = \left(g_s^s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s + ps_s - cl_s - tf_s \right) + ge_s \quad [17]$$

The global offering of Eurobonds is obtained by the sum of the two countries

$$bte = bte_n + bte_s \quad [18]$$

Demand for Eurobonds simply depends on the interest rate ($reuro$) and the level of GDP of the entire eurozone ($y_e = y_n + y_s$).

$$bte = \frac{\left(reuro - a_{0e} \right) y_e}{a_{1e}}$$

In the model, we use the following determination of interest rates:

$$reuro = a_{0e} + a_{1e} \left(\frac{bte}{y_e} \right) \quad [19]$$

Scenario 4: Issuance of Eurobonds and European projects

To complete the previous scenario, Eurobonds are used as a tool to finance European projects in growth sectors. Southern countries as well as northern countries can use Eurobonds in order to stimulate their economic growth.

Scenario 5: Tax rebate and public expenditures cuts

In this scenario describing roughly the French "Crédit d'impôt pour la compétitivité et l'emploi (CICE)" and the "Pacte de responsabilité et de solidarité" the government reduces the social contributions paid by the firms to partly compensate the competitiveness loss due to the overvaluation ($trs = 1.5$ for $ti = 10$ in period 10 in scenario 5). To avoid an increase of the public debt, public expenditures are cut in the same proportion ($gs_s = a_{gg1} gs_s(-1) - trs$ in period 10 in scenario 6). However, these measures are not sufficiently devoted to the tradable sector and the effect on employment, which is the other main target, is uncertain. That is why the government toolkit includes also industrial policy measures such as innovation and technology policy or relocation policy. These measures are complex to design and to manage and their effects are only in the long run. As an illustration and in an optimistic way, it is assumed that after period 30 the non-price competitiveness of country s is improved (the import income elasticity of country s, μ_{1s} declines from 1 to 0.98 while the import income elasticity of country n, μ_{1n} increases from 1 to 1.02 in scenario 7).

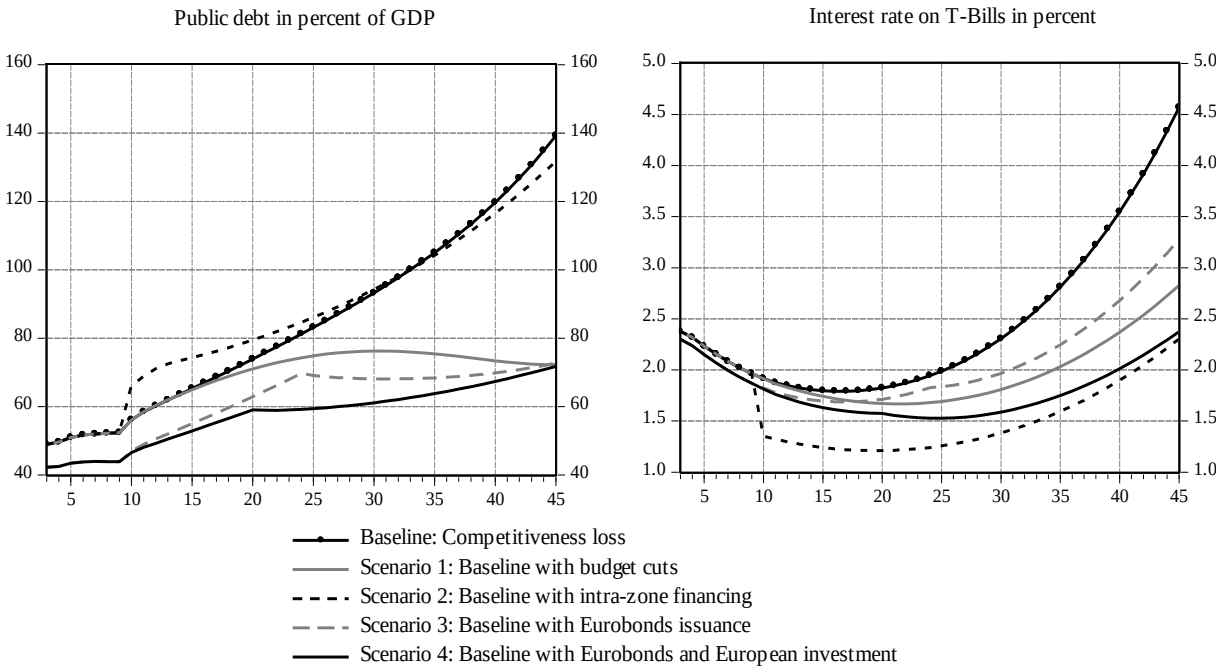
3.3. Adjustments in the monetary union and economic policies

In figure 3, we can observe the evolution of interest rates and public debt in the southern country in the baseline scenario (competitiveness loss in the southern country) and in the first four versions of the model.

In the baseline scenario, we assume that any adjustment mechanism is implemented to face the competitiveness loss. Thus, this competitiveness loss widens the external deficit and in the same time increases the need of external financing. In addition, the negative impact of trade deficit

on the GDP implies a diminution of taxes collected by the government and thus an increase of the public deficit. On Treasury bills market, interest rates increase alongside the debt increase and the slowdown of GDP. This "snowball" effect implies a tremendous increase in debt levels (140 percent of GDP in period 45) and of interest rates (4.5 percent in period 45).

Figure 3: Evolutions of public debt and interest rate in the southern country

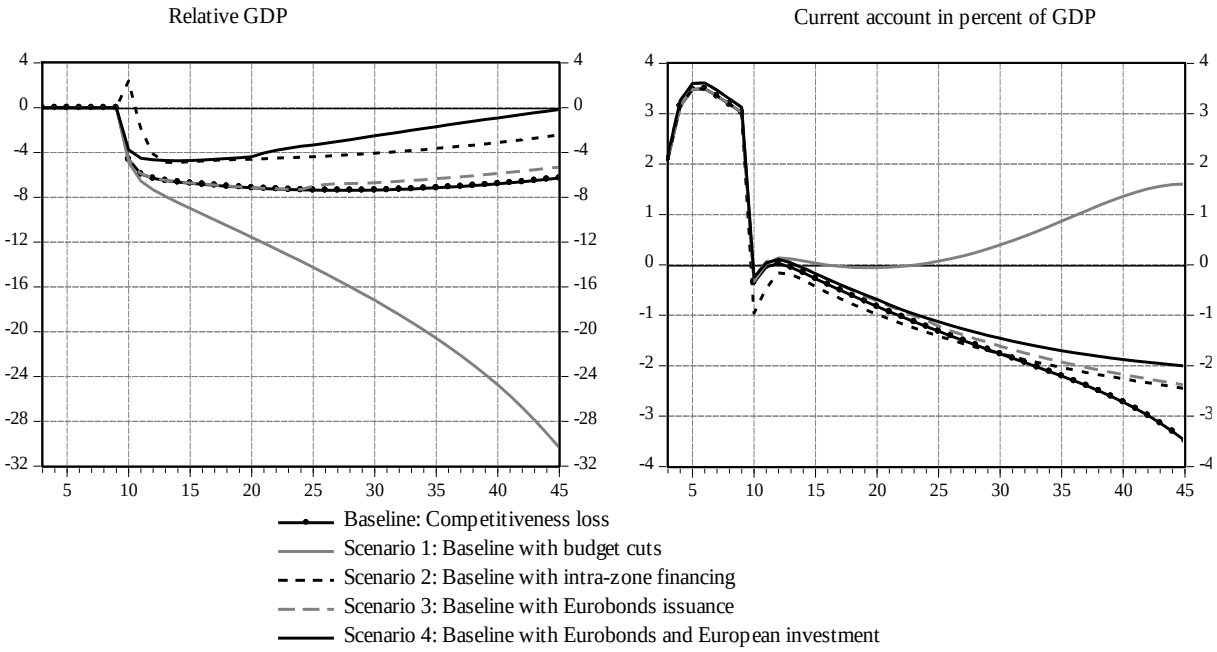


Source: authors' calculations.

In order to eschew another "Greek drama", European authorities can react by implementing various economics policies to achieve more sustainable adjustments.

In the first scenario, the government tries to reduce its public expenditures in order to prevent an increase of interest rates. The long run purpose of this policy is to reach a debt-to-GDP ratio limited to 70 percent. However, due to the Keynesian multiplier effect, public expenditures reduction puts a huge strain on economic activity as we can see in figure 4. Interest rates are reduced compared with the baseline scenario but still rise in the medium run and reach 2.8 percent in period 45 due to a smaller demand of Treasury bills induced by the decline of the activity.

Figure 4: Relative GDP and current account in the southern country

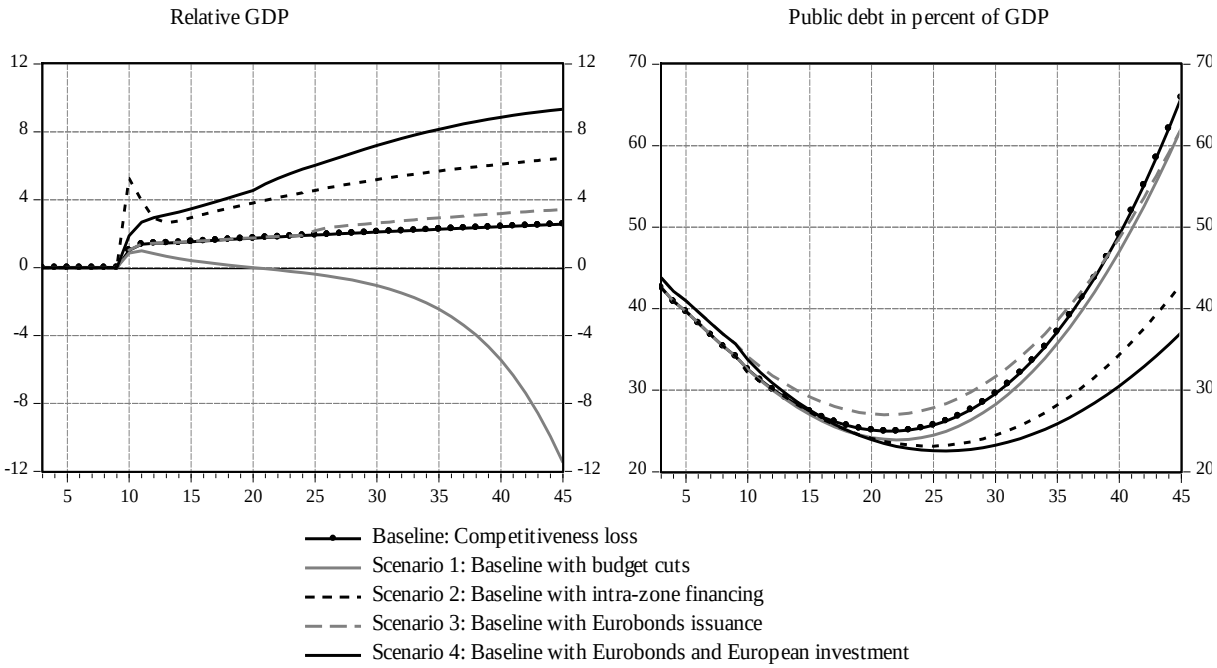


Source: authors' calculations.

In the second scenario, we assume that intra-zone financing is large thanks to an eased demand from private banks of the Northern countries or to the implementation of a European Stability Mechanism. This allows to keep interest rates at low level (2.4 percent in period 45) in spite of a huge increase of public debt-to-GDP ratio (130 percent in period 45). The negative impact on economic growth is largely offset in the long run but the competitiveness problem is not solved (see figure 4). We can notice that the Treaty ratified in March 2012 which gives an institutional background to the European Stability Mechanism stipulates that members States must reach a debt-to-GDP ratio of 60 percent in the medium run. The results of the second scenario will be greatly affected if the objective fixed by the European Stability Mechanism was respected. In such a case the result in terms of relative growth rates would be largely similar to those of the first scenario.

The third and the fourth scenario analyze the impact of an issuance of Eurobonds in the eurozone. We can observe that interest rates increase less rapidly in the fourth scenario than the third scenario. In the fourth scenario, Eurobonds finance investments in growth sectors therefore economic growth is stronger and upward pressures on interest rates are weaker.

Figure 5: Relative GDP and current account in the northern country



Source: authors' calculations.

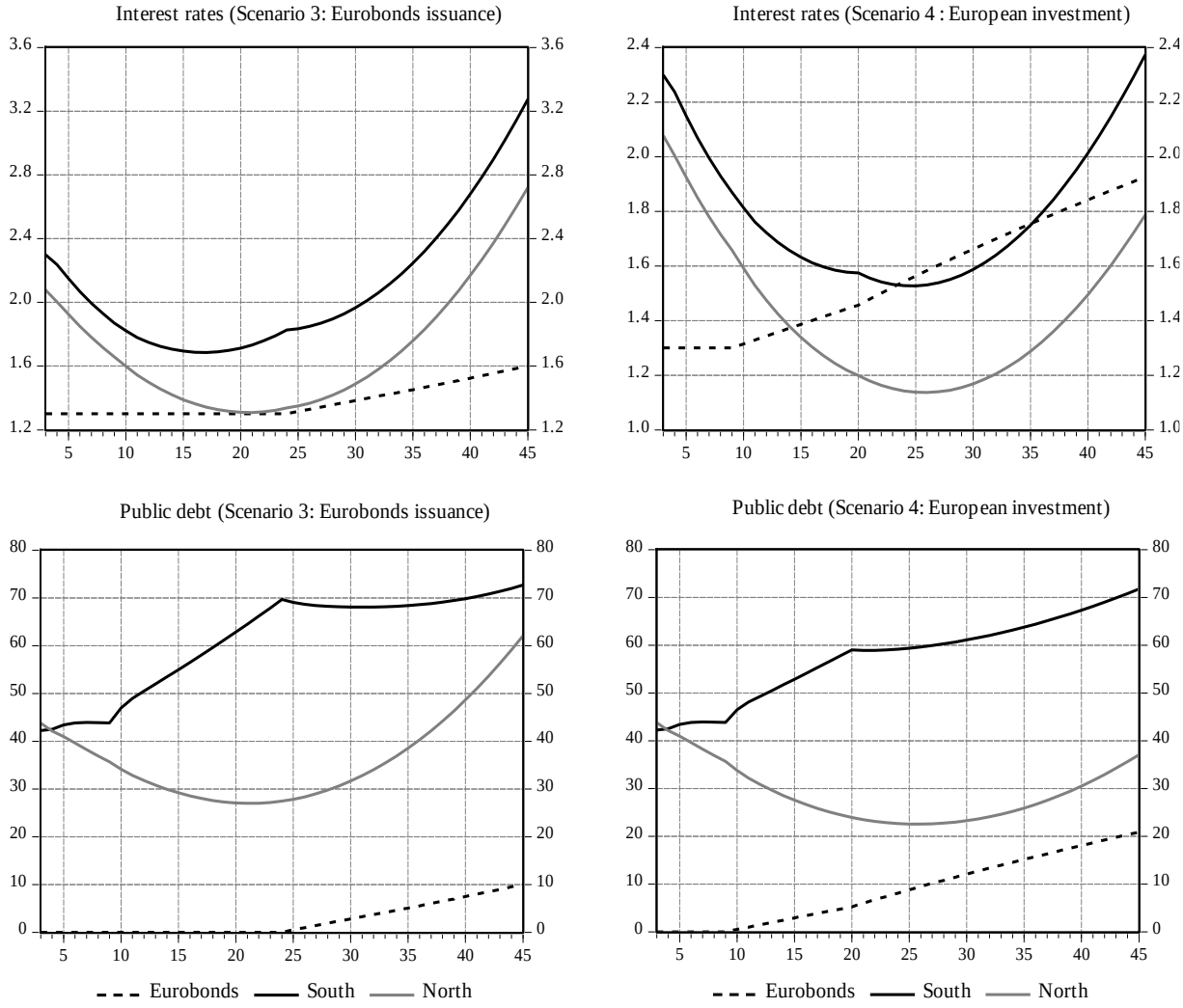
These growth gaps can be observed in the figure 4. We compute adjustments on GDP thanks to the following formula:

$$Relative\,GDP = \frac{GDP_{competitiveness\ loss\ with\ adjustment} - GDP_{competitiveness\ loss\ without\ adjustment}}{GDP_{competitiveness\ loss\ without\ adjustment}}$$

Initially, the GDP drops after the negative competitiveness shock. The implementation of European projects financed by Eurobonds (scenario 4) absorbs completely the competitiveness loss in the long run as GDP returns to its value before the shock in period 45. Eurobonds issuance to mutualize partially sovereign debt (scenario 3) induces a partial adjustment. We can notice that intra-zone financing (scenario 2) appears to be more efficient than Eurobonds issuance alone (scenario 3). The implementation of a European Stability Mechanism aimed at providing low interest rates to governments and firms stimulates investment. In terms of relative growth, the worst case is the first scenario where governments implement drastic budget cuts in order to achieve a debt-to-GDP ratio of 70 percent in the long run. The GDP drops by 30 percent in relative terms in period 45. The slowdown of economic activity induces a decrease of imports and then a massive adjustment of the current account balance. Without any policy

reactions (baseline scenario) after the competitiveness loss, external deficits of the southern country steadily increase and reach 3.5 percent of GDP in period 45. In other scenarios, we observe a stabilization of the external deficit around 2 percent in the long run.

Figure 6: Interest rate and public debt in scenario 3 and 4



Source: authors' calculations.

In figure 5, we can analyze the consequences of the various scenarios in the northern country in terms of growth and public debt. Again, drastic budget cuts in the southern country have negative impact on economic activity even in the northern country. In the long run, the fall of GDP will bring public debt to 65 percent of GDP. In other scenarios, public debt increases less thanks to a stronger growth, particularly in the fourth scenario.

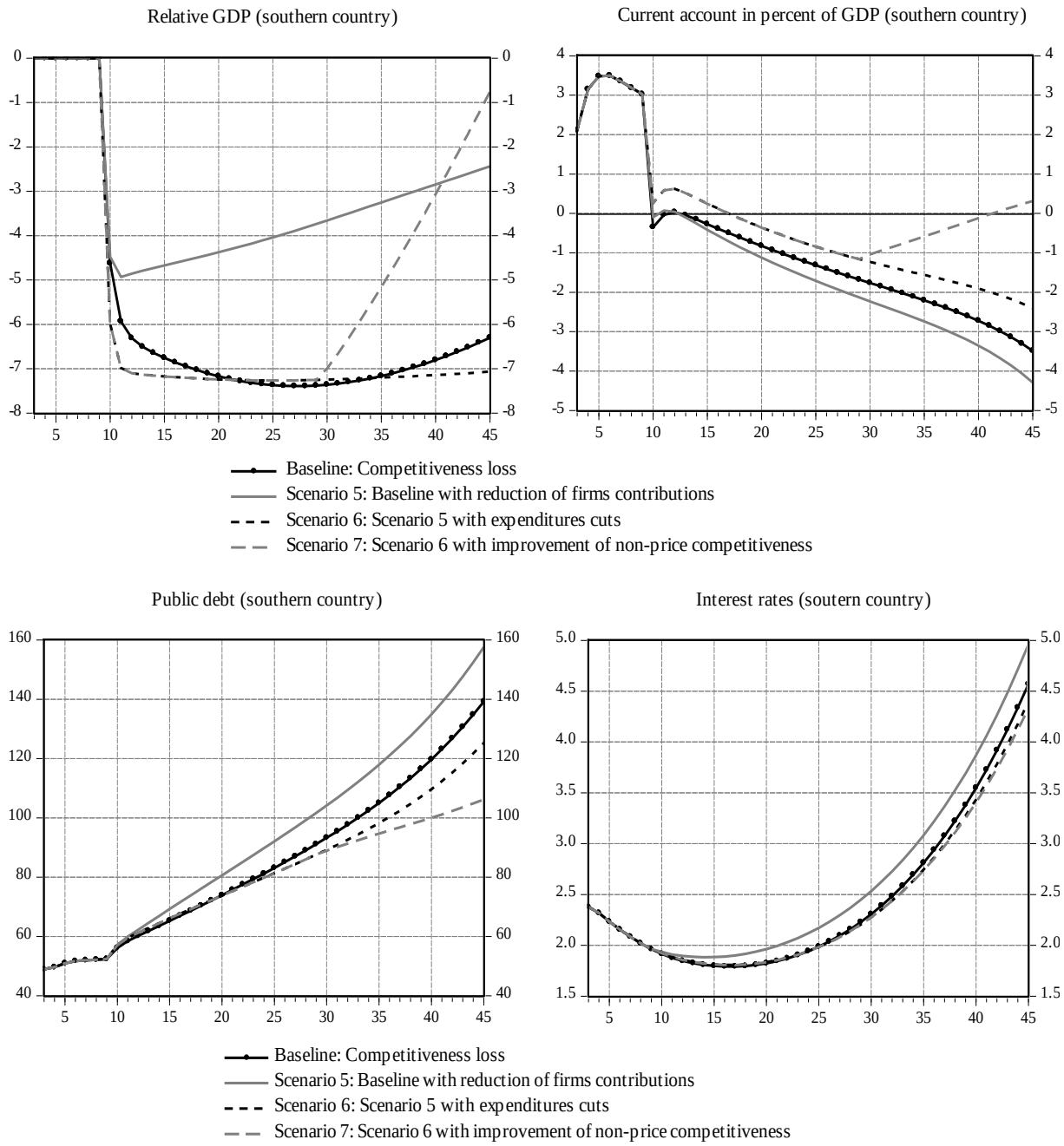
According to our numerical simulations, the emission of Eurobonds constitutes a useful tool to

reignite growth in the entire eurozone. Figure 6 shows levels of public debt and evolution of interest rates on Treasury bills and Eurobonds in the third and the fourth scenario.

As growth is stronger in the fourth scenario, interest rates on national T-bills are lower when Eurobonds play a role in financing the real economy. Conversely, the interest rate on Eurobonds is slightly higher in the fourth scenario (1.9 percent) than in the third scenario (1.6 percent). Regarding levels of public debt, again, European debt in Eurobonds is higher in the fourth (20 percent of GDP) relatively to the third scenario (10 percent of GDP). Nevertheless, European indebtedness remains sustainable as well as national indebtedness in spite of the fact that national governments have to pay interests on these issued Eurobonds.

We now move towards the last scenarios with tax rebate and public expenditures cuts. In scenario 5, the reduction of the social contributions paid by firms partly offsets the effect of overvaluation of the euro for southern countries and their loss of competitiveness. The GDP fall is less pronounced but the balance trade deterioration remains while the public deficit and debt increase a lot, inducing a substantial increase of interest rates (see figure 7). To avoid this unsustainable worsening of the public finance, public expenditures are cut of an amount equivalent to the tax rebate (scenario 6). This limits partly the rise of the public debt and of the interest rate but at the detriment of the GDP growth which returns to the depressed baseline scenario. This strategy of the French "Pacte de responsabilité et de solidarité" uses simultaneously the accelerator and the brake and can have only a limited effect. The initial tax rebate represents a high cost for the public finances without being targeted on the tradable sector, mainly due to European competition rules. The only way of escape would be the success of industrial and innovation policies able to improve at medium term the non-price competitiveness, as it is illustrated in the scenario 7. This can be seen as a relevant perspective but it would face many institutional and political obstacles.

Figure 7: Tax rebate and public expenditures cuts (scenarios 5 to 7)



Source: authors' calculations.

4. Conclusion

If European authorities do not react by implementing new economic policies to achieve sustainable adjustments, the intra-European exchange rates misalignments and the competitiveness loss in southern countries induce stagnation in southern countries, diverging current account imbalances and public debt increases with rising interest rates. Restrictive fiscal policies, as they have been implemented in southern countries, can contain interest and public

indebtedness but at the cost of a deeper recession. This policy-mix based on tax rebate to improve competitiveness and public expenditures cuts, illustrated by the French "Pacte de responsabilité et de solidarité", has only a limited effect.

Increasing intra-European financing by banks of northern countries or by the European Stability Mechanism or even by the intervention of the ECB itself could contribute to reduce the debt burden and induce a partial recovery. But the problem of competitiveness of the southern countries would not be solved and public debt would increase (scenario 2).

Implementation of euro-bonds as a tool to partly mutualize European sovereign debt would have a rather similar positive impact, but with a public debt limited to 70 percent of GDP, which could be considered as an important advantage (scenario 3). Furthermore, Eurobonds could also be used to finance large European projects which could impulse a stronger recovery in the entire eurozone with stabilized current account imbalances (scenario 4). To improve non-price competitiveness, it could (and should) be completed by more structural policies (industrial and innovation policies) which are complicated to implement and effective only in the long run.

However, the creation of a European institution in charge of the emission of Eurobonds would face strong political obstacles. The northern countries fear that Eurobonds would give to the southern countries the opportunity to continue irrelevant policies. They would ask that the launching of Eurobonds would be accompanied by more restrictive fiscal policy in the respect of the Stability pact and by a stricter monitoring of national fiscal policies. This could generate numerous political tensions between Member States. Actually, the European Stability Mechanism organizes the rescue of countries facing difficulties only under the condition of a strict control of the public finance. In such a configuration, Eurobonds as tool to mutualize the debt would not be of a large help compared with the present institutional framework. On the opposite the southern countries could argue that a part of the debt induced by the overvaluation of their euro could be financed by Eurobonds without being subjected to tougher constraints.

Finally, the efficiency of these institutional innovations inside the monetary union could be compared with an alternative framework where the possibility of intra-European exchange rate adjustments would be reintroduced thanks to a new type of monetary regime (cohabitation of a global euro with national euros, new European Monetary System with a euro reduced to a simple ECU, exit of the Germany or of southern countries). These various monetary regimes are a more straightforward solution to the problem of competitiveness of southern countries and allow a more efficient adjustment at short term, with a more balanced growth regime at medium term (Mazier and Valdecantos, 2015). They could also be completed by structural policies to improve non-price competitiveness. However, the main difficulty raised by this alternative strategy is the transition period which would be difficult to manage with the risk of capital flights and multiple bank crises.

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Appendix A: Methodological note on the underlying current account

A simple foreign trade model is used for all the countries with export and import equations for goods and services related to real exchange rates, domestic output gap for import and foreign output gap for export. The interested reader could consult the IMF occasional paper 167 in which this correction is completely described (Bayoumi and Faruqee, 1998). Lagged effects of exchange rate variations are spread on three years (t : 0.6; $t+1$: 0.25 and $t+2$: 0.15). Export price in domestic currency is independent from the real exchange rate while on the contrary import price in domestic currency depends immediately and completely of the exchange rate variation. The current account in percentage of GDP can be written as:

$$CA/Y = \alpha + \left[(M/Y)\beta_m + (X/Y)\beta_x\right](0,6R + 0,25R_{-1} + 0,15R_{-2}) - (M/Y)R$$
$$-(M/Y)\psi_m YGAP + (X/Y)\psi_x YGAPF$$

where $YGAPF$ is the average output gap of the main partners; R, the logarithm of the real exchange rate (*an increase of* R *indicates a depreciation*); β_x, β_m, the long run export and import price elasticities, respectively; ψ_x, ψ_m, long run export and import volume elasticities, respectively.

In case of real appreciation (*a decrease of* R), import in volume increases while exports decreases with lagged effects of the exchange rate variations but current account is improved thanks to cheaper imports. Last rising domestic output gap has a negative impact on current account while foreign output gap has an opposite effect. The underlying current account is the current account corrected by the effects of past and present exchange rate variations and by the effects of the domestic and foreign output gaps:

$$CA/Y_{UND} = \alpha + \left[(M/Y)\beta_m + (X/Y)\beta_x\right]R - (M/Y)R$$

By substitution, we obtain:

$$CA/Y_{UND} = CA/Y + \left[(M/Y)\beta_m + (X/Y)\beta_x\right](0,4\Delta R + 0,15\Delta R_{-1})$$
$$+(M/Y)\psi_m YGAP - (X/Y)\psi_x YGAPF$$

Appendix B: Main parameters

Table B1. Value of the parameters for the model of a monetary union

Main parameters				
Investment made by firms of country N(S)				
k_{0n}	k_{0s}	Autonomous component	0.055	0.057
k_{1n}	k_{1s}	Marginal impact of firms' profit	0.525	0.525
k_{2n}	k_{2s}	Accelerator effect	0	0
k_{3n}	k_{3s}	Marginal impact of firms' indebtedness	0.1	0.1
k_{4nn}	k_{4ss}	Marginal impact of rate on loans granted by country N(S) banks	0.375	0.475
k_{4sn}	k_{4ns}	Marginal impact of rate on loans granted by country S(N) banks	0.125	0.025
δ_n	δ_s	Rate of depreciation	0.05	0.05
External trade of country N(S)				
μ_{0n}	μ_{0s}	Autonomous component	-1.39	-3
μ_{1n}	μ_{1s}	Income elasticity	1	1
μ_2	μ_2	Price elasticity	0.5	0.5
Consumption				
a_{1n}	a_{1s}	Marginal propensity to consume out of disposable income	0.75	0.75
a_{2n}	a_{2s}	Marginal propensity to consume out of wealth	0.04	0.04
Cash money held by households				
λ_{0n}	λ_{0s}	Cash to consumption ratio	0.15	0.15
Rate of interest on T-bills issued by country N(S)				
a_{1nn}	-	Autonomous component (country N)	0.3	-
a_{1ss}	-	Marginal impact of growth (country S)	0.3	-
b_{2nn}	-	Marginal impact of supply of T-bills in percent of GDP (country N)	0.2	-
a_{1ns}	-	Marginal impact of growth of country N on rate of country S	1	-
a_{2ss}	a_{2ns}	Marginal impact of rates of country N on rate of country S	1.3	1
Eurobonds				
a_{1e}	-	Autonomous component	0.2	-

a_{2e}	-	Marginal impact of supply of T-bills in percent of GDP	0.15	-
Rate of interest on bank loans				
a	-	Marginal impact of rate on T-bills	0.1	-
High powered money (HPM)				
λ_n	λ_s	HPM-bank deposit ratio	0.05	0.05
m_{2b}	-	Banks margin	0.005	-
Tax rates				
θ_{bn}	θ_{bs}	Banks	0.176	0.176
θ_n	θ_s	Personal income tax rate	0.13	0.13
θ_{nf}	θ_{sf}	Firms tax rate	0.35	0.35
χ_n	χ_s	Social contributions rate	0.36	0.36
sf_n	sf_s	Rate of undistributed firms' profit	0.419	0.419
r_{0n}	r_{0s}	Wage share	0.646	0.646

Demand of country N bonds by households of country N		
v_{0nnb}	Autonomous demand	0.047
v_{1nnb}	Marginal impact of rate on country N bonds	2
v_{2nnb}	Marginal impact of rate on country S bonds	2
v_{3nnb}	Marginal impact of rate on bank deposits	0.2
v_{4nnb}	Marginal impact of rate on return of country N equities	0.1
v_{5nnb}	Marginal impact of rate on return of country S equities	0.1
Demand of country S bonds by households of country N		
v_{0nsb}	Autonomous demand	0.047
v_{1nsb}	Marginal impact of rate on country S bonds	2
v_{2nsb}	Marginal impact of rate on country N bonds	2
v_{3nsb}	Marginal impact of rate on bank deposits	0.2
v_{4nsb}	Marginal impact of rate on return of country N equities	0.1
v_{5nsb}	Marginal impact of rate on return of country S equities	0.1
Demand of country S bonds by households of country S		
v_{0ssb}	Autonomous demand	0.081

ν_{1ssb}	Marginal impact of rate on country S bonds	2
ν_{2ssb}	Marginal impact of rate on country N bonds	2
ν_{3ssb}	Marginal impact of rate on bank deposits	0.2
ν_{4ssb}	Marginal impact of rate on return of country N equities	0.1
ν_{5ssb}	Marginal impact of rate on return of country S equities	0.1
Demand of country N equities by households of country N		
ν_{0nne}	Autonomous demand	0.476
ν_{1nne}	Marginal impact of rate on country N bonds	0.01
ν_{2nne}	Marginal impact of rate on country S bonds	0.01
ν_{3nne}	Marginal impact of rate on bank deposits	0.2
ν_{4nne}	Marginal impact of rate on return of country N equities	0.02
ν_{5nne}	Marginal impact of rate on return of country S equities	0.02
Demand of country S equities by households of country N		
ν_{0nse}	Autonomous demand	0.213
ν_{1nse}	Marginal impact of rate on country N bonds	0.01
ν_{2nse}	Marginal impact of rate on country S bonds	0.01
ν_{3nse}	Marginal impact of rate on bank deposits	0.2
ν_{4nse}	Marginal impact of rate on return of country N equities	0.02
ν_{5nse}	Marginal impact of rate on return of country S equities	0.02
Demand of country S equities by households of country S		
ν_{0sse}	Autonomous demand	0.625
ν_{1sse}	Marginal impact of rate on country N bonds	0.01
ν_{2sse}	Marginal impact of rate on country S bonds	0.01
ν_{3sse}	Marginal impact of rate on bank deposits	0.2
ν_{4sse}	Marginal impact of rate on return of country N equities	0.02
ν_{5sse}	Marginal impact of rate on return of country S equities	0.02
Demand of country N equities by households of country S		
ν_{0sne}	Autonomous demand	0.0315
ν_{1sne}	Marginal impact of rate on country N bonds	0.01

v_{2sne}	Marginal impact of rate on country S bonds	0.01
v_{3sne}	Marginal impact of rate on bank deposits	0.2
v_{4sne}	Marginal impact of rate on return of country N equities	0.02
v_{5sne}	Marginal impact of rate on return of country S equities	0.02
f_{3ss}	Marginal impact of firms' profit	0.6
Price of firms' equities		
σ_n, σ_s	Growth rate	1.003
Government expenditures		
a_{gg1}	Growth rate	1.018
a_{gg2}	Marginal impact of debt service	0

Appendix C: Entire model and baseline

Table C1. Variables involved in the model of a monetary union

Variable	Name
Endogenous Variables	
y_n, y_s	National income, in real terms
ydh_n, ydh_s	Real disposable income
cl_n, cl_s	Firm's social contributions
ps_n, ps_s	Social benefits
yh_n, yh_s	Haig–Simons real disposable income
t_n, t_s	Personal income tax
tf_n, tf_s	Taxes on firms
c_n, c_s	Households consumption
bd_n, bd_s	Bank deposit held by households
cgh_h, cgh_s	Households' capital gains
vh_n, vh_s	Households' wealth
b_n^n	Demand of country N bonds by households of country N
b_n^s	Demand of country S bonds by households of country N
b_s^s	Demand of country S bonds by households of country S
eh_n^n	Demand of country N equities by households of country N
eh_n^s	Demand of country S equities by households of country N
eh_s^s	Demand of country S equities by households of country S
eh_s^n	Demand of country N equities by households of country S
hh_n, hh_s	Cash money held by households
up_n, up_s	Firms' retained earnings
g_n, g_s	Accumulation rate
inv_n, inv_s	Investment made by firms
k_n, k_s	Firms' fixed capital stock
l_n, l_n	Loans supplied by private banks to firms
ee_n^n	Demand of country N equities by firms of country N
ee_n^s	Demand of country S equities by firms of country N

Variable	Name
ee_s^n	Demand of country N equities by firms of country S
ee_s^s	Demand of country S equities by firms of country S
re_n, re_s	Rate on return of equities
e_n, e_s	Number of equities
v_n, v_s	Firms' wealth
cge_n, cge_s	Firms' capital gains
w_n, w_s	Wage share
div_n, div_s	Dividends distributed by firms
$dive_n^n$	Dividends distributed by country N firms to country N firms
$divh_n^n$	Dividends distributed by country N firms to country N households
$dive_s^n$	Dividends distributed by country N firms to country S firms
$divh_s^n$	Dividends distributed by country N firms to country S households
$dive_s^s$	Dividends distributed by country S firms to country S firms
$divh_s^s$	Dividends distributed by country S firms to country S households
$dive_n^s$	Dividends distributed by country S firms to country N firms
$divh_n^s$	Dividends distributed by country S firms to country N households
bt_n, bt_s	Treasury bills held by banks
b_n, b_s	Bonds held by households
pb_n, pb_s	Price of bonds held by households
d_n, d_s	Public debt
l_n^n	Loans supplied by country N banks to country N firms
l_s^s	Loans supplied by country S banks to country S firms
bt_n^n	T-bills issued by country N government held by country N banks
bt_s^s	T-bills issued by country S government held by country S banks
bp_n, bp_s	Banks' profit
tb_n, tb_s	Taxes on banks
rf_n, rf_s	Central bank advances made to private banks
h_n, h_s	Cash money held by private banks
vb_n, vb_s	Private banks' wealth

Variable	Name
teb, teb_n, teb_s	Taxes on Central bank advances made to private banks
im_n, im_s	Imports
x_n, x_s	Exports
l_s^n	Loans supplied by country S banks to country N firms
l_n^s	Loans supplied by country N banks to country S firms
bt_n^s	T-bills issued by country S government held by country N banks
h	High powered money (HPM)
rl_n, rl_s	Interest rate on loans
id	Interest rate on bank deposit
r_n, r_s	Interest rate on Treasury bills
bte, bte_n, bte_s	Eurobonds
$reuro$	Interest rate on Eurobonds
Exogenous variables	
gn_n, gn_s	National government expenditures
ge_n, ge_s	Federal government expenditures
trs	Reduction of firm's social contributions
pe_n, pe_s	Price of equities
m_{2b}	Private banks' margin on banks deposit
ib	Rate of interest on central bank advances
ti	Competitiveness loss parameter (currency overvaluation)

Baseline model

$$y_n = c_n + inv_n + g_n^n + x_n - im_n \quad [20]$$

$$y_s = c_s + inv_s + g_s^s + x_s - im_s \quad [21]$$

$$ydh_n = id_n bd_n(-1) + b_n^n(-1) + b_n^s(-1) + divh_n^n + divh_n^s - t_n + ps_n - cl_n \quad [22]$$

$$ydh_s = id_s bd_s(-1) + b_s^s(-1) + b_s^n(-1) + divh_s^s + divh_s^n - t_s + ps_s - cl_s \quad [23]$$

$$cl_n = \chi_n w_n \quad [24]$$

$$cl_s = \chi_s w_s \quad [25]$$

$$\Delta ps_n = \Delta t_n + \Delta tf_n \quad [26]$$

$$\Delta ps_s = \Delta t_s + \Delta tf_s \quad [27]$$

$$yh_n = ydh_n + cgh_n \quad [28]$$

$$yh_s = ydh_s + cgh_s \quad [29]$$

$$t_n = \theta_n \left[w_n + b_n^n(-1) + b_n^s(-1) + id_n bd_n(-1) + divh_n^n + divh_n^s \right] \quad [30]$$

$$t_s = \theta_s \left[w_s + b_s^s(-1) + b_s^n(-1) + id_s bd_s(-1) + divh_s^s + divh_s^n \right] \quad [31]$$

$$tf_n = \theta_{nf} \left[y_n(-1) - w_n(-1) - rl_n l_n^n(-2) - rl_s l_s^n(-2) - div_n + dive_n^n + dive_n^s \right] \quad [32]$$

$$tf_s = \theta_{sf} \left[y_s(-1) - w_s(-1) - rl_s l_s^s(-2) - rl_n l_n^s(-2) - div_s + dive_s^s + dive_s^n \right] \quad [33]$$

$$c_n = a_{0n} + a_{1n} yh_n + a_{2n} vh_n(-1) \quad [34]$$

$$c_s = a_{0s} + a_{1s} yh_s + a_{2s} vh_s(-1) \quad [35]$$

$$\Delta bd_n = ydh_n - c_n - pb_n \Delta b_n^n - pb_s \Delta b_n^s - pe_n \Delta eh_n^n - pe_s \Delta eh_s^s - \Delta hh_n \quad [36]$$

$$\Delta bd_s = ydh_s - c_s - pb_s \Delta b_s^s - pb_n \Delta b_s^n - pe_s \Delta eh_s^s - pe_n \Delta eh_n^n - \Delta hh_s \quad [37]$$

$$cgh_h = \Delta pb_n b_n^n(-1) + \Delta pb_s b_n^s(-1) + \Delta pe_n eh_n^n(-1) + \Delta pe_s eh_n^s(-1) \quad [38]$$

$$cgh_s = \Delta pb_s b_s^s(-1) + \Delta pb_n b_s^n(-1) + \Delta pe_s eh_s^s(-1) + \Delta pe_n eh_s^n(-1) \quad [39]$$

$$vh_n = bd_n + pb_n b_n^n + pb_s b_n^s + pe_n eh_n^n + pe_s eh_n^s + hh_n \quad [40]$$

$$vh_s = bd_s + pb_s b_s^s + pb_n b_s^n + pe_s eh_s^s + pe_n eh_s^n + hh_s \quad [41]$$

$$b_n^n = \frac{\left[\left(v_{0nnb} + v_{1nnb} rb_n - v_{2nnb} rb_s - v_{3nnb} id - v_{4nnb} re_n - v_{5nnb} re_s\right) vh_n\right]}{pb_n} \quad [42]$$

$$b_n^s = \frac{\left[\left(v_{0nsb} + v_{1nsb} rb_s - v_{2nsb} rb_n - v_{3nsb} id - v_{4nsb} re_n - v_{5nsb} re_s\right) vh_n\right]}{pb_s} \quad [43]$$

$$b_s^s = \frac{\left[\left(v_{0ssb} + v_{1ssb} rb_s - v_{2ssb} rb_n - v_{3ssb} id - v_{4ssb} re_n - v_{5ssb} re_s\right) vh_s\right]}{pb_s} \quad [44]$$

$$eh_n^n = \frac{\left[\left(v_{0nne} - v_{1nne} rb_n - v_{2nne} rb_s - v_{3nne} id + v_{4nne} re_n - v_{5nne} re_s\right) vh_n\right]}{pe_n} \quad [45]$$

$$eh_n^s = \frac{\left[\left(v_{0nse} - v_{1nse} rb_n - v_{2nse} rb_s - v_{3nse} id - v_{4nse} re_n + v_{5nse} re_s\right) vh_s\right]}{pe_s} \quad [46]$$

$$eh_s^s = \frac{\left[\left(v_{0sse} - v_{1sse} rb_n - v_{2sse} rb_s - v_{3sse} id - v_{4sse} re_n + v_{5sse} re_s\right) vh_s\right]}{pe_s} \quad [47]$$

$$eh_s^n = \frac{\left[\left(v_{0sne} - v_{1sne} rb_n - v_{2sne} rb_s - v_{3sne} id + v_{4sne} re_n - v_{5sne} re_s\right) vh_s\right]}{pe_n} \quad [48]$$

$$hh_n = \lambda_0 c_n \quad [49]$$

$$hh_s = \lambda_0 c_s \quad [50]$$

$$up_n = \left[y_n - w_n - rl_n l_n^n(-1) - rl_s l_s^n(-1) - div_n + dive_n^n + dive_n^s - t_{nf}\right] \quad [51]$$

$$up_s = \left[y_s - w_s - rl_s l_s^s(-1) - rl_n l_n^s(-1) - div_s + dive_s^s + dive_s^n - t_{sf} + trs\right] \quad [52]$$

$$g_n = k_{0n} + k_{1n} \frac{up_n(-1)}{k_n(-2)} + k_{2n} \frac{\Delta y_n}{y_n(-1)} - k_{3n} \frac{l_n(-1)}{k_n(-1)} - k_{4nn} rl_n - k_{4sn} rl_s \quad [53]$$

$$g_s = k_{0s} + k_{1s} \frac{up_s(-1)}{k_s(-2)} + k_{2s} \frac{\Delta y_s}{y_s(-1)} - k_{3s} \frac{l_s(-1)}{k_s(-1)} - k_{4ss} rl_s - k_{4ns} rl_n \quad [54]$$

$$inv_n = g_n k_n(-1) \quad [55]$$

$$inv_s = g_s k_s(-1) \quad [56]$$

$$\Delta k_n = inv_n - \delta_n k_n(-1) \quad [57]$$

$$\Delta k_s = inv_s - \delta_s k_s(-1) \quad [58]$$

$$\Delta l_n = inv_n - up_n - pe_n \Delta e_n + pe_n \Delta ee_n^n + pe_s \Delta ee_n^s \quad [59]$$

$$\Delta l_s = inv_s - up_s - pe_s \Delta e_s + pe_s \Delta ee_s^s + pe_n \Delta ee_s^n \quad [60]$$

$$ee_n^n = \frac{\left[\left(f_{1nn} re_n - f_{2nn} re_s + f_{3nn} \frac{up_n}{k_n(-1)} + f_{0nn} \right)\left(k_n + pe_n ee_n^n + pe_s ee_n^s \right)\right]}{pe_n} \quad [61]$$

$$ee_n^s = \frac{\left[\left(f_{1ns} re_s - f_{2ns} re_n + f_{3ns} \frac{up_n}{k_n(-1)} + f_{0ns} \right)\left(k_n + pe_n ee_n^n + pe_s ee_n^s \right)\right]}{pe_s} \quad [62]$$

$$ee_s^n = \frac{\left[\left(f_{1sn} re_n - f_{2sn} re_s + f_{3sn} \frac{up_s}{k_s(-1)} + f_{0sn} \right)\left(k_s + pe_n ee_s^n + pe_s ee_s^s \right)\right]}{pe_n} \quad [63]$$

$$ee_s^s = \frac{\left[\left(f_{1ss} re_s - f_{2ss} re_n + f_{3ss} \frac{up_s}{k_s(-1)} + f_{0ss} \right)\left(k_s + pe_n ee_s^n + pe_s ee_s^s \right)\right]}{pe_s} \quad [64]$$

$$pe_n = \sigma_n pe_n(-1) \quad [65]$$

$$pe_s = \sigma_s pe_s(-1) \quad [66]$$

$$re_n = \frac{\Delta pe_n}{pe_n(-1)} + \frac{div_n}{pe_n(-1)e_n(-1)} \quad [67]$$

$$re_s = \frac{\Delta pe_s}{pe_s(-1)} + \frac{div_s}{pe_s(-1)e_s(-1)} \quad [68]$$

$$e_n = eh_n^n + ee_n^n + eh_s^n + ee_s^n \quad [69]$$

$$e_s = eh_s^s + ee_s^s + eh_n^s + ee_n^s \quad [70]$$

$$v_n = k_n + pe_n ee_n^n + pe_s ee_n^s - l_n - pe_n e_n \quad [71]$$

$$v_s = k_s + pe_n ee_s^n + pe_s ee_s^s - l_s - pe_s e_s \quad [72]$$

$$cge_n = \Delta pe_n ee_n^n(-1) + \Delta pe_n ee_n^s(-1) \quad [73]$$

$$cge_s = \Delta pe_s ee_s^n(-1) + \Delta pe_s ee_s^s(-1) \quad [74]$$

$$w_n = r_0 y_n \quad [75]$$

$$w_s = r_0 y_s \quad [76]$$

$$div_n = (1-sf)\left[y_n(-1) - w_n(-1) - rl_n l_n^n(-2) - rl_s l_s^n(-2) \right] \quad [77]$$

$$div_s = (1-sf)\left[y_s(-1) - w_s(-1) - rl_s l_s^s(-2) - rl_n l_n^s(-2) \right] \quad [78]$$

$$dive_n^n = div_n \left(\frac{ee_n^n(-1)}{e_n(-1)} \right) \quad [79]$$

$$divh_n^n = div_n \left(\frac{eh_n^n(-1)}{e_n(-1)} \right) \quad [80]$$

$$dive_s^n = div_n \left(\frac{ee_s^n(-1)}{e_n(-1)} \right) \quad [81]$$

$$divh_s^n = div_n \left(\frac{eh_s^n(-1)}{e_n(-1)} \right) \quad [82]$$

$$dive_s^s = div_s \left(\frac{ee_s^s(-1)}{e_s(-1)} \right) \quad [83]$$

$$divh_s^s = div_s \left(\frac{eh_s^s(-1)}{e_s(-1)} \right) \quad [84]$$

$$dive_n^s = div_s \left(\frac{ee_n^s(-1)}{e_s(-1)} \right) \quad [85]$$

$$divh_n^s = div_s \left(\frac{eh_n^s(-1)}{e_s(-1)} \right) \quad [86]$$

$$\Delta bt_n = gn_n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n + ps_n - cl_n - tf_n \quad [87]$$

$$\Delta bt_s = gs_s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s + ps_s - cl_s - tf_s + trs \quad [88]$$

$$\Delta b_n = \Delta b_n^n + \Delta b_s^n \quad [89]$$

$$\Delta b_s = \Delta b_s^s + \Delta b_n^s \quad [90]$$

$$pb_n = \frac{1}{rb_n} \quad [91]$$

$$pb_s = \frac{1}{rb_s} \quad [92]$$

$$d_n = bt_n + pb_n b_n \quad [93]$$

$$d_s = bt_s + pb_s b_s \quad [94]$$

$$\Delta l_n^n = \Delta l_n - \Delta l_s^n \quad [95]$$

$$\Delta l_s^s = \Delta l_s - \Delta l_n^s \quad [96]$$

$$\Delta bt_n^n = \Delta bt_n - \Delta bt_s^n \quad [97]$$

$$\Delta bt_s^s = \Delta bt_s - \Delta bt_n^s \quad [98]$$

$$bp_n = (1-\theta_{bn})\left[rl_n l_n^n(-1) + rl_n l_n^s(-1) + r_n bt_n^n(-1) + r_s bt_n^s(-1) - id_n bd_n(-1) - ib.rf_n(-1) \right] \quad [99]$$

$$bp_s = (1-\theta_{bs})\left[rl_s l_s^s(-1) + rl_s l_s^n(-1) + r_s bt_s^s(-1) + r_n bt_s^n(-1) - id_s bd_s(-1) - ib.rf_s(-1) \right] \quad [100]$$

$$tb_n = \theta_{bn}\left[rl_n l_n^n(-1) + rl_n l_n^s(-1) + r_n bt_n^n(-1) + r_s bt_n^s(-1) - id_n bd_n(-1) - ib.rf_n(-1) \right] \quad [101]$$

$$tb_s = \theta_{bs}\left[rl_s l_s^s(-1) + rl_s l_s^n(-1) + r_s bt_s^s(-1) + r_n bt_s^n(-1) - id_s bd_s(-1) - ib.rf_s(-1) \right] \quad [102]$$

$$\Delta rf_n = \Delta h_n + \Delta l_n^n + \Delta l_n^s + \Delta bt_n^n + \Delta bt_n^s - bp_n - \Delta bd_n \quad [103]$$

$$\Delta rf_s = \Delta h_s + \Delta l_s^s + \Delta l_s^n + \Delta bt_s^s + \Delta bt_s^n - bp_s - \Delta bd_s \quad [104]$$

$$h_n = \lambda_n bd_n \quad [105]$$

$$h_s = \lambda_s bd_s \quad [106]$$

$$\Delta vb_n = bp_n \quad [107]$$

$$\Delta vb_s = bp_s \quad [108]$$

$$teb = ib\left[rf_n(-1) + rf_s(-1)\right] \quad [109]$$

$$teb_n = teb\left(\frac{y_n}{y_n + y_s}\right) \quad [110]$$

$$teb_s = teb\left(\frac{y_s}{y_n + y_s}\right) \quad [111]$$

$$\log(im_n) = \mu_{0n} + \mu_{1n}\log(y_n) + \mu_2\log\left(\frac{w_n - ti}{y_n}\right) - \mu_2\log\left(\frac{w_s + ti}{y_s}\right) \quad [112]$$

$$\log(im_s) = \mu_{0s} + \mu_{1s}\log(y_s) + \mu_2\log\left(\frac{w_s + ti}{y_s}\right) - \mu_2\log\left(\frac{w_n - ti}{y_n}\right) \quad [113]$$

$$x_n = im_s \quad [114]$$

$$x_s = im_n \quad [115]$$

$$l_s^n = 0 \quad [116]$$

$$l_n^s = \left(\frac{x_s}{y_s}\right) l_s \quad [117]$$

$$bt_s^n = 0 \quad [118]$$

$$bt_n^s = \left(a_{1ns}r_s - a_{2ns}r_n\right) y_n \quad [119]$$

$$h = hh_n + hh_s + h_n + h_s \quad [120]$$

$$rl_n = (1-a)rl_n(-1) + a.r_n(-1) \quad [121]$$

$$rl_s = (1-a)rl_s(-1) + a.r_s(-1) \quad [122]$$

$$id = ib - m_{2b} \quad [123]$$

$$r_s = \frac{bt_s + \left[a_{2ss} r_n y_s\right] + \left[a_{2ns} r_n y_n\right]}{\left[a_{1ss} y_s\right] + \left[a_{1ns} y_n\right]} \quad [124]$$

$$r_n = a_{1nn} + \frac{b_{2nn} bt_n}{y_n} \quad [125]$$

$$rb_n = r_n \quad [126]$$

$$rb_s = r_s \quad [127]$$

$$gn_n = a_{gg1} gn_n(-1) - a_{gg2} r_n bt_n(-1) \quad [128]$$

$$gs_s = a_{gg1} gs_s(-1) - a_{gg2} r_s bt_s(-1) \quad [129]$$

Model with Eurobonds issuance

$$y_n = c_n + inv_n + g_n^n + x_n - im_n + ge_n \quad [130]$$

$$y_s = c_s + inv_s + g_n^n + x_s - im_s + ge_s \quad [131]$$

$$y_e = y_n + y_s \quad [132]$$

$$If \quad \frac{d_n}{y_n} < 60\% \quad then$$
$$\Delta bt_n = \left(g_n^n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n + ps_n - cl_n - tf_n\right) + reuro.bte_n(-1) \quad [133]$$

$$If \quad \frac{d_n}{y_n} > 60\% \quad then$$
$$\Delta bte_n = \left(g_n^n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n + ps_n - cl_n - tf_n\right) + ge_n \quad [134]$$

$$If \quad \frac{d_s}{y_s} < 60\% \quad then$$
$$\Delta bt_s = \left(g_s^s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s + ps_s - cl_s - tf_s\right) + reuro.bte_s(-1) \quad [135]$$

$$If \quad \frac{d_s}{y_s} > 60\% \quad then$$
$$\Delta bte_s = \left(g_s^s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s + ps_s - cl_s - tf_s\right) + ge_s \quad [136]$$

$$bte = bte_n + bte_s \quad [137]$$

$$bp_n = (1-\theta_{bn})\begin{bmatrix} rl_n l_n^n(-1) + rl_n l_n^s(-1) + r_n bt_n^n(-1) + r_s bt_n^s(-1) \\ +reuro.bte_n(-1) - id_n bd_n(-1) - ib.rf_n(-1) \end{bmatrix} \quad [138]$$

$$bp_s = (1-\theta_{bs})\begin{bmatrix} rl_s l_s^s(-1) + rl_s l_s^n(-1) + r_s bt_s^s(-1) + r_n bt_s^n(-1) \\ +reuro.bte_s(-1) - id_s bd_s(-1) - ib.rf_s(-1) \end{bmatrix} \quad [139]$$

$$tb_n = \theta_{bn}\begin{bmatrix} rl_n l_n^n(-1) + rl_n l_n^s(-1) + r_n bt_n^n(-1) + r_s bt_n^s(-1) \\ +reuro.bte_n(-1) - id_n bd_n(-1) - ib.rf_n(-1) \end{bmatrix} \quad [140]$$

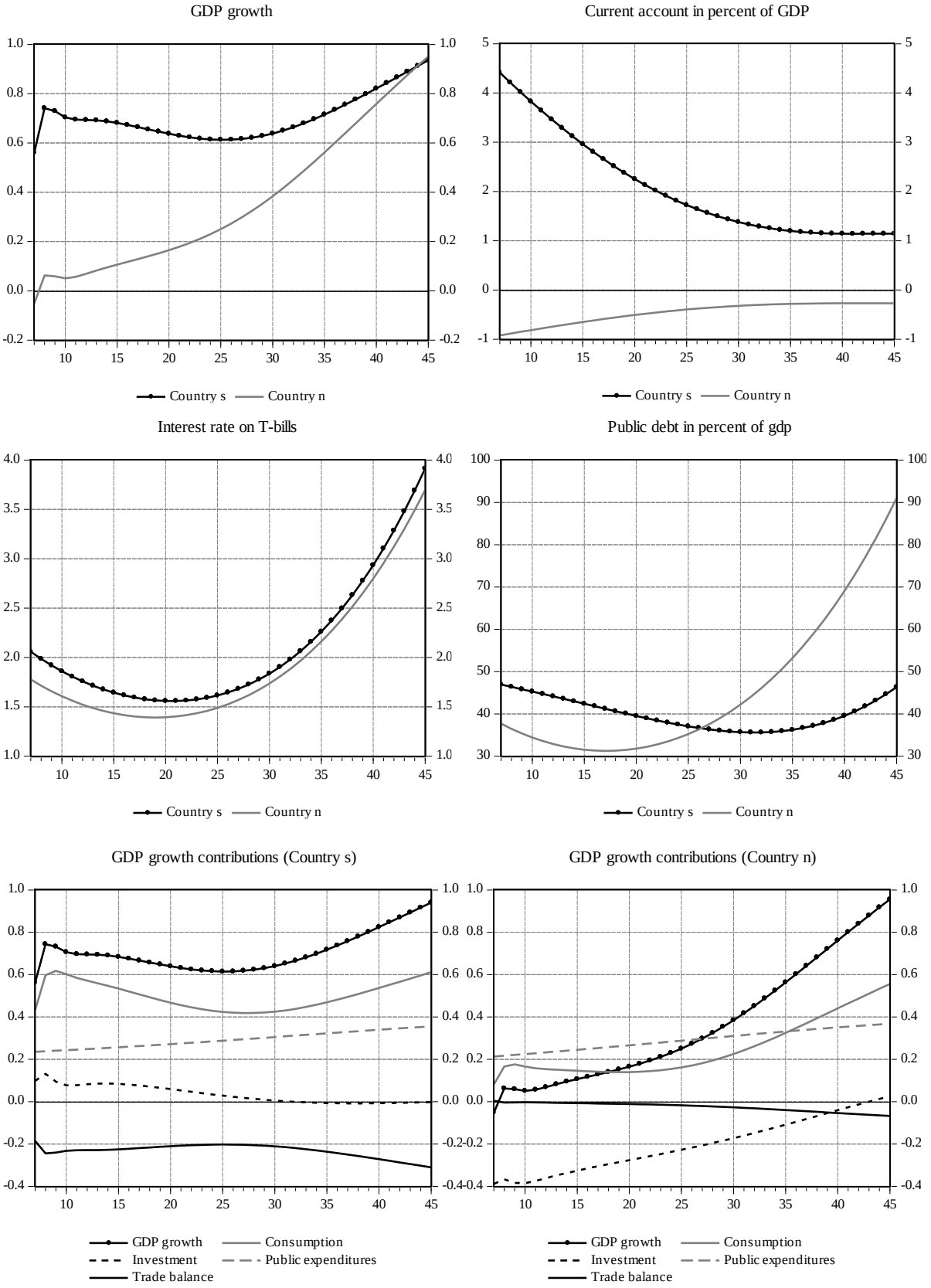
$$tb_s = \theta_{bs}\begin{bmatrix} rl_s l_s^s(-1) + rl_s l_s^n(-1) + r_s bt_s^s(-1) + r_n bt_s^n(-1) \\ +reuro.bte_s(-1) - id_s bd_s(-1) - ib.rf_s(-1) \end{bmatrix} \quad [141]$$

$$\Delta rf_n = \Delta h_n + \Delta l_n^n + \Delta l_n^s + \Delta bt_n^n + \Delta bt_n^s + \Delta bte_n - bp_n - \Delta bd_n \quad [142]$$

$$\Delta rf_s = \Delta h_s + \Delta l_s^s + \Delta l_s^n + \Delta bt_s^s + \Delta bt_s^n + \Delta bte_s - bp_s - \Delta bd_s \quad [143]$$

$$reuro = a_{0e} + a_{1e}\left(\frac{bte}{y_e}\right) \quad [144]$$

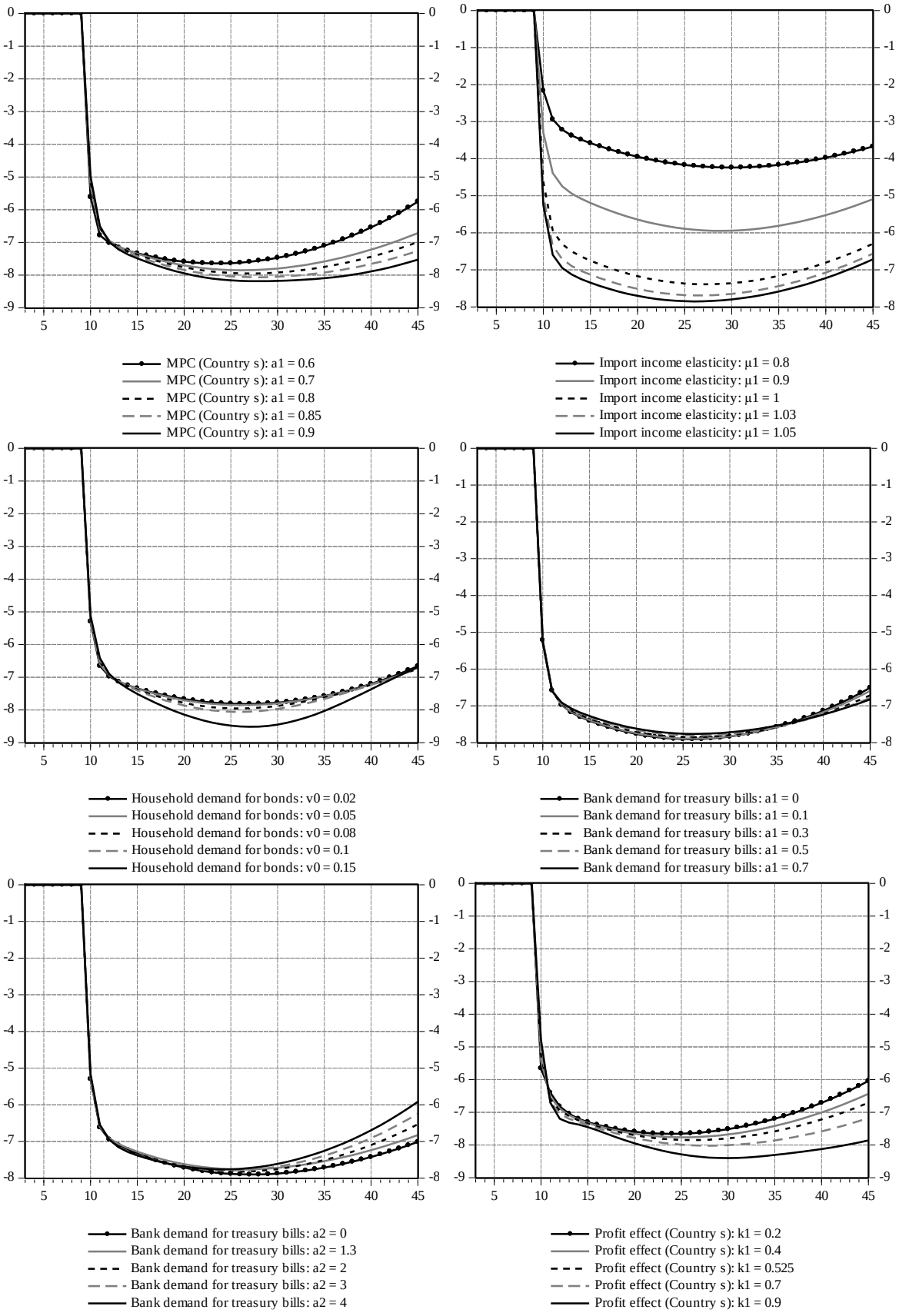
Figure C1. Baseline simulations without competitiveness loss

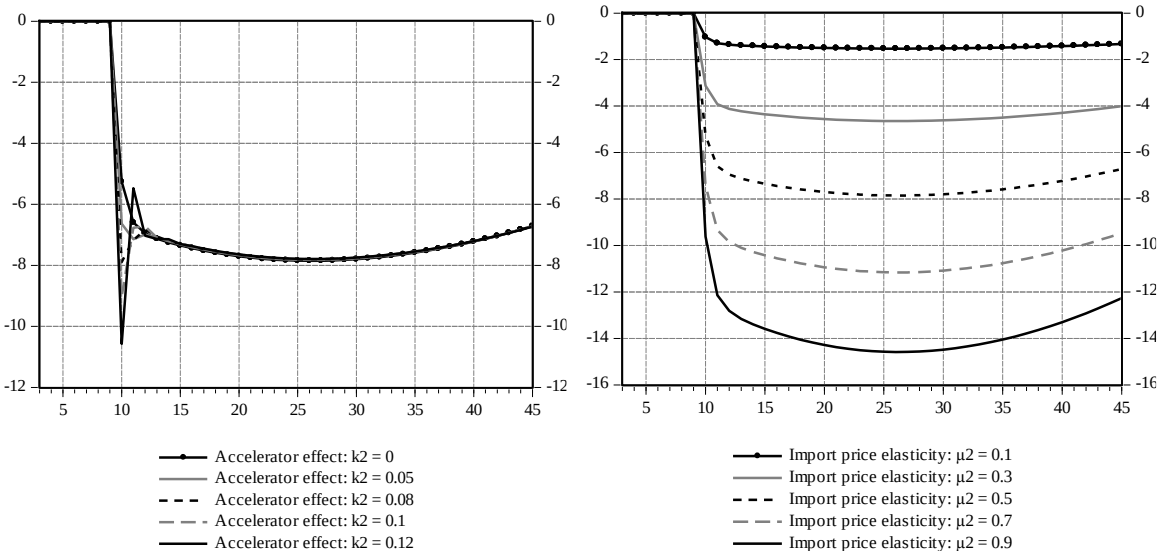


Source: authors' calculations.

Appendix D: Sensitivity analysis

Figure D1. Impact of a competitiveness loss on country S GDP (in percent relative to the baseline)





Source: authors' calculations.