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## On the brink? Intra-euro area imbalances and the sustainability of foreign debt

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Intra-euro area imbalances and the  
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# **On the brink? Intra-euro area imbalances and the sustainability of foreign debt**

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## **Abstract**

In this paper we study the intra-euro area imbalances based on a dynamic general equilibrium model. We show that European financial integration and the introduction of the euro might have contributed to the development of imbalances. Interest rate convergence following EMU accession led to net foreign debt positions, which prove difficult to reverse. Simulation results for the euro area suggest that current account imbalances and foreign debt positions of today's crisis countries have significantly diverged from a sustainable path. Increasing investment in the EMU core and productivity in crisis countries may permit a return to sustainable foreign debt levels and correct macroeconomic imbalances in the euro area.

**Keywords:** Current account imbalances, euro area, foreign debt, sustainability, general equilibrium model

**JEL-Codes:** E44, F32, F34, G15

\* This article reflects the author's personal opinions and not those of his employer.

## 1. Introduction

Prior to the current crisis, diverging current account imbalances in the euro area have significantly changed the net investment positions of the euro area's member countries. While in particular Germany accumulated substantial net foreign assets, southern European countries and Ireland heavily increased their net foreign debt positions. The common view links these macroeconomic imbalances to diverging wage growth, unit labour costs and inflation rates as well as national differences in investment and consumption (e.g. European Commission 2010). As a general policy implication, today's crisis countries are being asked to readjust their wages and prices to regain international competitiveness and to reduce their net foreign debt by future current account surpluses.

Another strand of the literature links the emergence of current account imbalances to changed conditions on financial markets (Caballero et al. 2008, Körner 2011). Thereby, European financial market integration has been a positive credibility shock for the southern European countries. The attractiveness of southern Europe's financial markets improved relatively to the euro area core countries, such as Germany. This asymmetric change in financial market attractiveness might explain initial capital flows from the euro area core to the southern periphery as well as persistent current account deficits in the euro periphery and surpluses in the core of the euro area. If this setting describes a new equilibrium situation, then Europe might not need to worry about current account (im)balances.

Such a conclusion has been stated by Caballero et al. (2008) in their paper on US–Asia imbalances. Based on a dynamic general equilibrium model Caballero et al. (2008) showed that the Asian crisis was a negative credibility shock reducing the relative attractiveness of Asian financial markets against US financial markets. As a result, capital has persistently flowed from Asia to the US financial market. These flows created the observed divergence of current account balances between Asia and the US. Moreover the authors conclude that US current account deficits can be sustained via any of the three rebalancing channels i) future trade balance surpluses, ii) investment income from FDI or iii) a depreciation of the long run real exchange rate.

In this paper we adopt this theory for the euro area by using an augmented model that allows all three rebalancing channels to work in conjunction (Körner 2011). The European monetary and financial integration is assumed to have bestowed positive credibility on former high

inflation countries in southern Europe – a positive financial market shock from EMU participation. The simulated results are compared with actual data, which provides evidence that current account imbalances and in particular net foreign debt positions of crisis countries are far from sustainable. Alternative simulation scenarios with increasing investment or productivity allow to draw implications how today's crisis countries might adjust macroeconomic imbalances.

## **2. Macroeconomic imbalances in the euro area?**

### **2.1 The common views on intra-euro area imbalances**

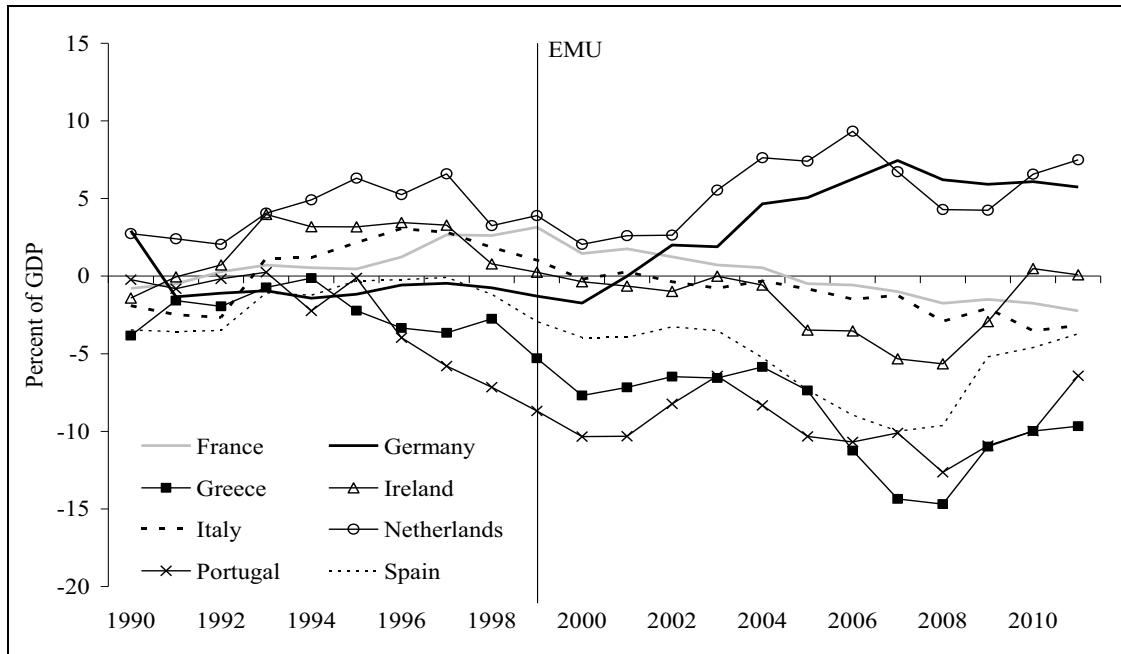
Since the introduction of the euro until the financial crisis, euro area countries experienced a build-up of significant macroeconomic imbalances (European Commission 2008, 2009, 2010). These imbalances became visible in divergent developments of current account balances and net foreign debt positions, as well as significant differences in growth rates of unit labour costs, consumer prices, investment and GDP.

Thereby, countries of the euro periphery (Greece, Ireland, Portugal, Spain, and Italy) have developed current account deficits leading to strong increases in their net foreign debt positions. Rising unit labour costs and consumer prices, credit expansion and strong GDP growth accompanied the process in these countries. In contrast, most core countries of the euro area (Benelux, Austria, Finland) but in particular Germany have accumulated high net foreign asset positions (or reduced their net debt position) by running persistently high current account surpluses after the year 2000. Moreover, consumer prices, GDP and unit labour costs grew moderately in surplus countries relative to the periphery. In Germany and Austria unit labour costs almost kept the level of 1999 in real terms. Figures 1 and 2 show the divergence of current account balances and net international investment positions in the euro area.

In general, changes of the current account balance of whatever sign are not necessarily an indication of imbalances. They may simply reflect inter-temporal saving as well as consumption and investment preferences of private enterprises, households and governments (Obstfeld and Rogoff 1994). Additionally, business cycles, demographic developments (De Santis and Lührmann 2006) and fiscal policy are important determinants of empirical realisations of the current account balance. Moreover, rising prices and unit labour costs and

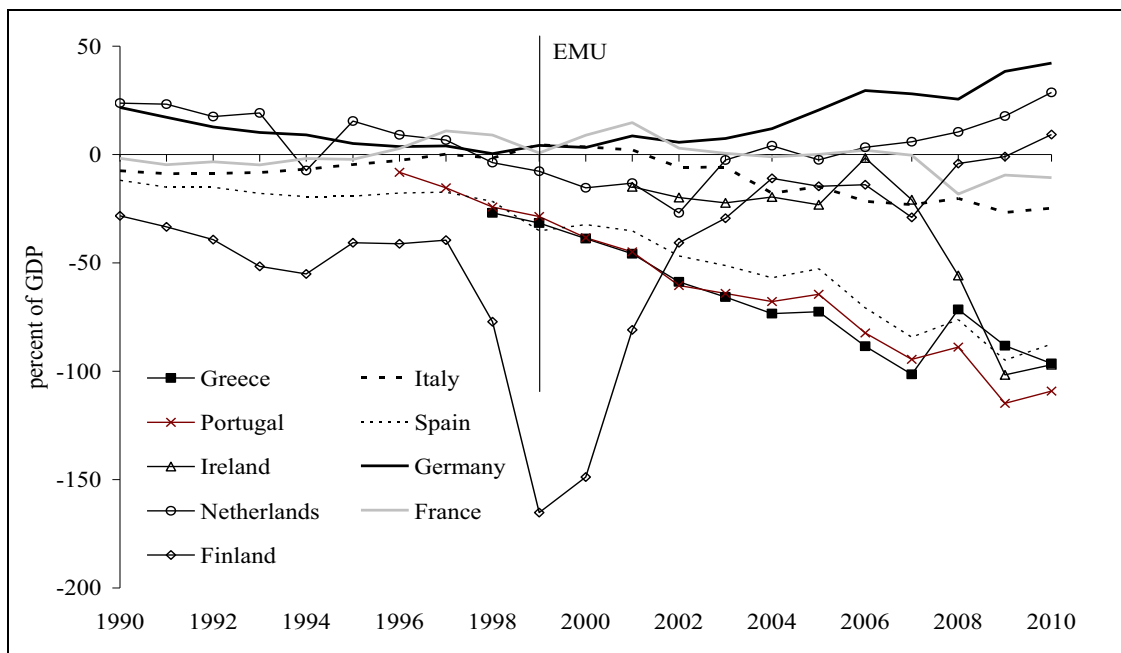
strong investment could be due to a catch-up of periphery countries within the euro area (Balassa 1964, Samuelson 1964).

Figure 1 Diverging current account balances after EMU accession



Source: IMF.

Figure 2 Net international investment positions



Source: IMF.

Blanchard and Giavazzi (2002) labelled intra-euro area capital flows from the euro core to the periphery, underlying the current account development, the end of the Feldstein-Horioka puzzle. Instead of savings being invested domestically as found by Feldstein and Horioka (1980), savings were invested abroad in countries with the largest expected marginal return on capital. Euro core's net savings were funnelled via integrated capital markets to periphery countries.<sup>1</sup> The elimination of the exchange rate risk and the common monetary policy conducted by the ECB improved macroeconomic conditions and therefore credit conditions in former high inflation countries of the periphery, such as Greece, Portugal, and Spain. EMU membership seemed to have nourished the notion of enhanced international capital allocation efficiency and international risk sharing (Schnabl and Zemanek 2011).

A more pessimistic explanation can be drawn from the theory of optimum currency areas. In a monetary union, relatively stronger growing consumer prices and unit labour costs in the euro periphery imply a real appreciation against the core countries, in particular Germany. From the perspective of the real exchange rate being a measure of cost and price competitiveness (Lipschitz and McDonald 1992; Arghyrou and Chortareas 2006, European Commission 2010), the euro periphery lost competitiveness vis-à-vis euro core countries. The periphery's products have become relatively expensive compared to goods from core countries. Imports increased, exports decreased and the current account balance worsened alongside the trade balance. A pattern of diverging current account balances appeared with current account surpluses in most core countries and current account deficits in periphery countries. Capital flows from the core to the periphery are not the offsetting factor in this process but rather the necessary consequence of current account differences.

The common monetary policy of the European Central Bank (ECB) was not able to counter these developments. It failed to steer against rising wages and inflation in the euro periphery as core countries' (in particular German) low wage and price growth kept average euro area inflation close to the central bank target of two per cent. The single nominal interest rate for the euro area in combination with dispersing national inflation rates (and inflation expectations) created too low real interest rates in high inflation countries and too high real interest rates in low inflation countries (Sturm and Wollmershäuser 2008, foreseen by Walters 1990). The one-size-fits-all monetary policy of the EMU further fuelled the asymmetric

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<sup>1</sup> This can be related to a European version of the savings glut/investment slump hypothesis by Bernanke (2005).

economic development by providing pro-cyclical investment incentives. The nominal differences in wage and price inflation translated into real divergences.

In addition, “*the long shadow of the fall of the wall*” (Gros 2010) further promoted the build-up of macroeconomic imbalances in the euro area. In the recession following the post-reunification boom German unemployment and public debt rocketed (Schnabl and Zemanek 2011). During the second half of the 1990s, public wage austerity, high unemployment and also the integration of the Central and Eastern European countries into the European Union kept private sector wage growth down (Schnabl and Zemanek 2011). In contrast, based on overoptimistic expectations (Lane and Pels 2011), citizens of the euro periphery anticipated or expected continuing future income growth consequently increasing their present consumption and investment in exchange for future income (Tobin 1967, Summers 1981). Capital inflows and rising consumption and investment entrenched current account deficits.

According to the theory of optimum currency areas (OCA) by Mundell (1961), real imbalances either triggered by an asymmetric shock or adverse economic developments constitute a disequilibrium and need to be adjusted via a realignment of the real exchange rate. As no nominal exchange rate exist between euro area countries, the real exchange rate alignment depends on changing relative wages and prices between the core and the periphery. However, low labour market flexibility in Europe (Bayoumi and Eichengreen 1992, European Commission 2008) has so far prevented timely real exchange rate realignment or large-scale labour migration. The latter seems to be on the rise as recent reports on a 25% drop in Greek nominal wages in 2011 and a 90% increase in migration of Greeks to Germany hint at (Rogers and Philippe 2012, Destatis 2012). Thus, the OCA theory implicates that macroeconomic imbalances are a failure of economies in a monetary union to readjust to the equilibrium. Mundell (2000) himself doubts that the euro area thus constructed would be able to overcome these impediments – rightly so in hindsight.

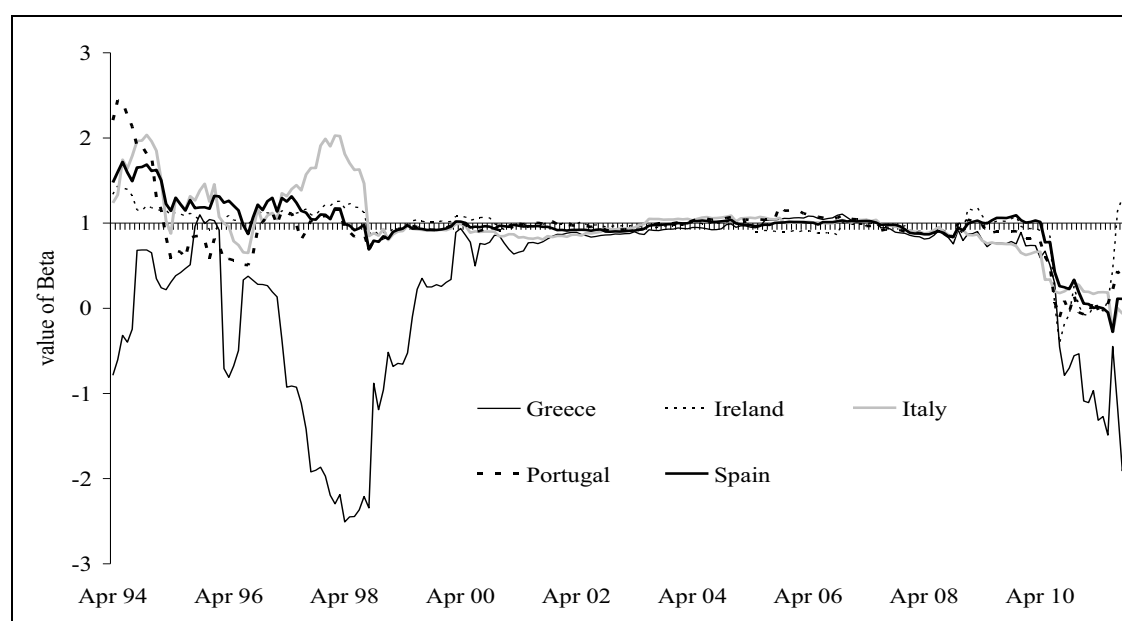
## **2.2 An equilibrium view on intra-euro area imbalances**

In contrast, Caballero et al. (2008) argue that persistent macroeconomic imbalances may constitute a new equilibrium following an external shock. They show for the example of US–Asia imbalances that the Asian crisis might have led to such a new equilibrium incorporating persistent current account deficits in the United States and reciprocate surpluses in Asia as well as a new debtor–creditor situation. Thereby, Caballero et al. (2008) argue that the Asian crisis of 1997 was a negative credibility shock reducing the relative attractiveness of Asian



financial markets against US financial markets. As a result, capital has persistently flowed from Asia to the US financial market creating the observed persistent divergence of current account balances between Asia and the US. Based on a dynamic general equilibrium model Caballero et al. (2008) show that the US may further sustain persistent current account deficits via any of the three channels i) future trade balance surpluses, ii) investment income from FDI or iii) a depreciation of the long run real exchange rate.<sup>2</sup>

Figure 3 Evolution of beta coefficients of euro periphery government bonds



Source: ECB. Based on monthly data.

Following the argumentation of Caballero et al. (2008), the European financial market integration in the 1990s can be interpreted as a positive shock for many euro periphery countries. In preparation of the monetary union, the development towards a single financial market was fostered. Barriers of entry were reduced, common standards as well as common clearing and payment transfers systems were introduced in addition to several financial market regulations harmonized at the European level. As a result financial market integration increased in the euro area as shown by highly synchronized financial integration indicators and market developments. For instance, financial market integration became clearly visible in

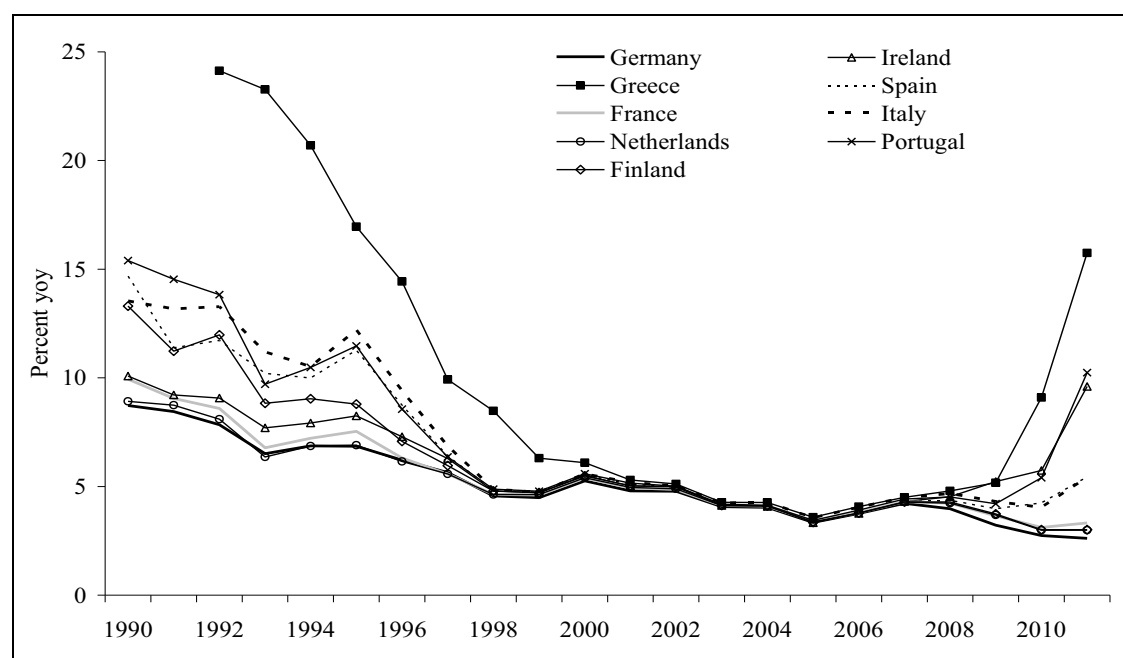
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<sup>2</sup> Caballero et al. (2008) assume that current account balances are financed by US-dollar denominated debt. The depreciation of the US-dollar reduces the value of the debt and provides external debt sustainability.

the relative market volatility of a government bonds expressed as beta value depicted in Figure 3.<sup>3</sup> With the start of EMU in 1999 (and Greece in 2001), beta values of periphery countries converged to a uniform value of one, indicating an almost perfect co-movement of government bond prices in the euro area.

In the course of financial market integration, formerly high interest rates of periphery countries significantly fell to the established low levels of core countries. This convergence is visible in Figure 4 showing government bond yields of euro area countries. Since the middle of the 1990s, government bond yields converged to relatively low rates of German government bonds. Private lending rates did also converge. Figure 5 illustrates the cross-country standard deviation of bank lending rates among euro area countries. Since 1999 bank-lending rates converged strongly as a result of financial market integration. The era of equal interest rates of core and periphery lasted for about one decade. During the current government debt crisis, government bond yields of periphery countries again increased significantly against the core's rates while bank-lending rates diverged only slightly.

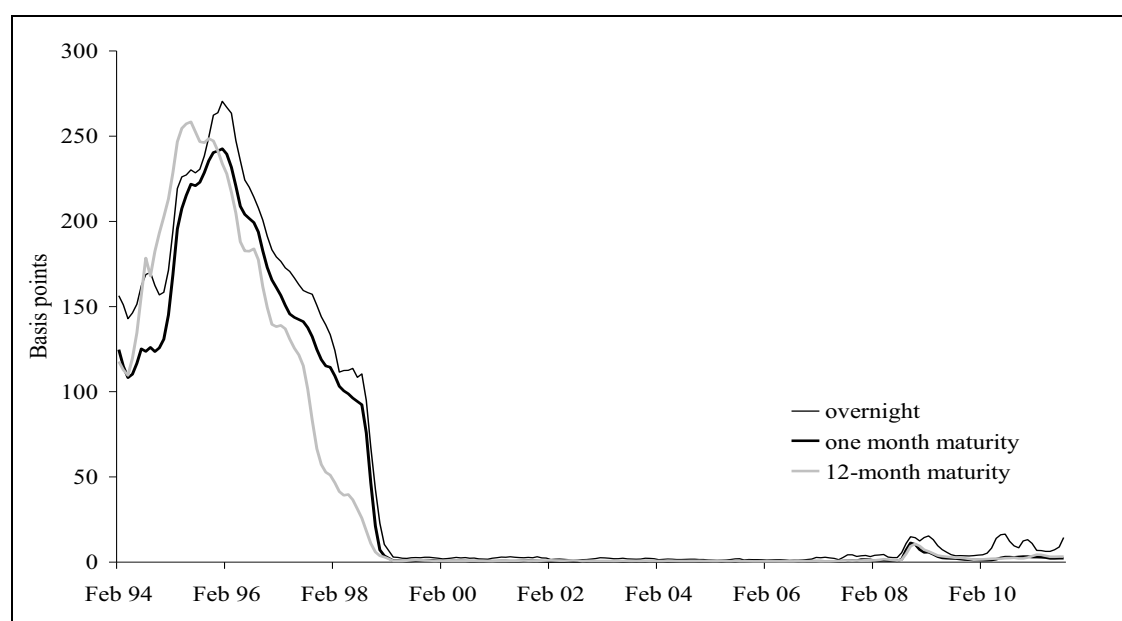
Figure 4 EMU convergence criterion bond yields, at yearend in per cent



Source: Eurostat

<sup>3</sup> In this case, beta is a number describing the risk of a bond relative to the market risk and is defined as  $\beta = \text{cov}(p_i, p_m) / \text{var}(p_m)$ . Variable  $p$  is the price of a bond with  $i$  indicating a specific country and  $m$  the average. A value of 1 indicates that the respective bond is as volatile as the average.

Figure 5 Cross-country standard deviation of lending rates among euro area countries



Source: ECB

In the context of Caballero et al. (2008), European financial market integration has been a positive credibility shock for the periphery countries relative to core countries in the 1990s. The attractiveness of the periphery's financial markets improved relatively to the core. This rise in attractiveness possibly explains initial capital flows from the euro area core to the periphery as well as persistent current account deficits in the euro periphery and surpluses in the core of the euro area. If this setting describes a new equilibrium situation, then Europe might not need to worry about the current account imbalances experienced so far and the sustainability of crisis countries foreign debt. A favourable outcome of this analysis would mean that a hair-cut as decided by Greece would not have to be the necessary consequence to reduce international debt in other European periphery countries. The significance of this hypothesis will be analysed based on an augmented general equilibrium model of intra-euro area imbalances.

### 3. A dynamic general equilibrium model of intra-euro area imbalances

#### 3.1 The Caballero et al. (2008) model revisited

The augmented model of global imbalances (Körner 2011) is expanding upon the model scenarios considered by Caballero et al. (2008) in their ‘equilibrium model of global imbalances’. It closes the gap between the so far unconnected parts of the dynamic general equilibrium model by fully integrating foreign direct investment and associated capital flows together with real exchange rates in a joint model. The key difference between the original Caballero et al. (2008) model and the augmented version is the property of all three rebalancing channels working in conjunction. The joint modelling pushes the model closer to reality by facilitating an interaction of net exports and the current account, capital flows and FDI, and real exchange rate adjustments all taking place at the same time. In addition, Körner (2011) uses a more realistic calibration of domestic and foreign investment costs enabling us to show that the trajectories of international indebtedness of countries are difficult to reverse in cases of extreme international investment positions. This is particularly true if the real exchange rate channel cannot be fully utilized to correct imbalances – as in the case of limited nominal exchange rate flexibility when all real exchange rate adjustment comes from price level changes. The last property links the model to the case of imbalances in the European monetary union.

#### 3.2 Model properties

The model applies a setup with two regions of the euro area countries, named *Periphery* (euro periphery, labelled with superscript  $P$ ) and *Core* (euro core, labelled with superscript  $C$ ), each standing for a representative set of countries.<sup>4</sup> Initially, both regions are assumed to be symmetric. In each of them stylized goods markets and more elaborate asset markets with investment, saving and production in assets in the tradition of Kiyotaki and Moore’s (1997) ‘trees’ are modelled. As both regions are assumed to be open economies, excess supply and demand are equilibrated via current account transactions. One of the regions, namely *periphery*, experiences an unexpected financial market credibility shock. The shock leads to the emergence of persistent imbalances between the two regions in the model (in our case

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<sup>4</sup> To reduce complexity in the model, we divide euro area countries into the two regions *Core* and *Periphery*. In the following, we will only refer to regions, although they imply separate countries.

within the euro area) in terms of interest rates, current accounts and the global asset portfolio allocation constituting a new equilibrium.

### *The goods market*

The goods market is modelled using CES preferences for a single country-specific good  $x$  produced in each region's country  $i$  at time  $t$ . The sum of all relative demands for the goods basket of each country  $i \neq j$  is equal to the country's gross national product. Aggregate demand is equal to aggregate production on a global scale so there is no demand deficiency (unemployment) in the model. Aggregate production  $X$ , the sum of all countries' relative demands  $C$  for country  $i$ 's good, has the following property:

$$\sum_i x_t^{ij} = \sum_i \gamma^{ij} C_t^i \left( \frac{q_t^j}{P_t^i} \right)^{-\sigma} = X_t^j, \forall i, j \in \{\text{Core}, \text{Periphery}\}$$

In this setting,  $\gamma^{ij}$  is the CES parameter defining relative demand of region  $j$  for region  $i$ 's good. For  $i = j$ , the value is the domestic demand elasticity given domestic consumption  $C$ . The variable  $q_t^j$  defines the terms of trade with country  $j$  as a function of the prices  $P_t^i$  for the goods demanded domestically and from the other region. The parameter  $\sigma$  defines the speed of adjustment of the terms of trade to changes in prices; the lower  $\sigma$ , the slower adjustment takes place, with  $\sigma = \infty$  signifying instantaneous adjustment and a value of nil showing no reaction to price changes.

Each region  $j$ 's aggregate production can be split into a scale ( $N$ ) and a productivity component ( $Z$ ) respectively, yielding  $X_t^j = N_t^j Z_t^j$ . Production's exogenously given rate of growth is  $\dot{X}_t^j / X_t^j \equiv g = g^n + g^z$  which may be region-specific. The terms of trade of one of the regions is set as numéraire, here  $q_t^C = 1$ . Consequently, total aggregate output  $X_t$  over all regions  $j \in \{\text{Core}, \text{Periphery}\}$  is the sum of individual regions. As countries of the *periphery* region experience a shock, their output before the financial market shock is  $X_{t=0}^{Po}$  while production thereafter is denoted by  $X_{t>0}^{Pn}$ . The real exchange rate  $\lambda_t^{CP}$  is defined as the inverse ratio of the two regions' price levels  $P_t^i$ . It brings about equilibrium in the goods market by equating relative demands for each region's basket of goods in relation to the price charged for it:

$$\lambda_t^{CP} = P_t^P / P_t^C \quad \text{using}$$

$$P_t^i = \left( \gamma q_t^{i(\sigma-1)} + (1-\gamma) q_t^{j(\sigma-1)} \right)^{1/(1-\sigma)}, \text{ with } i \neq j \text{ and } i, j \in \{Core, Periphery\}$$

Total demand is equal to total output being the sum of the individual regions' output. The *periphery's* output before and after the financial market shock is converted by the region's terms of trade:

$$X_t = X_t^C + q_t^P (X_t^{Po} + X_t^{Pn})$$

### *The asset market*

The asset market is the part of the model creating the dynamics from which imbalances arise after the financial market shock. It is assumed that a share  $\delta^j q_t^j X_t^j$  of the available assets used for production in the economy can be capitalized on financial markets, with parameter  $\delta^j$  defining the capability of these financial markets. The remainder  $(1-\delta^j) q_t^j X_t^j$  is unalienable and may be regarded as human capital.

The asset market is characterized by an overlapping generations setting determining asset supply and demand. Agents are not modelled individually but can be envisaged as being the multitude of constituents of the aggregate region's values. The instantaneous return on holding assets  $r_t V_t^j$  in any period  $t$  is the result of additions to the asset stock  $\delta^j q_t^j X_t^j$ , capital gains on existing assets  $\dot{V}_t^j$  and a deduction for keeping up the growth rate of assets  $g^n V_t^j$ . Asset supply is thus a positive function of financial market capabilities  $\delta^j$  and the terms of trade  $q_t^j$  while negatively reacting to increases in the interest rate  $r_t$  or the exogenous rate of growth of assets  $g^n$ :

$$r_t V_t^j = \delta^j q_t^j X_t^j + \dot{V}_t^j - g^n V_t^j$$

Asset demand arises from the inter-temporal balance of agents' wealth and the asset supply to be spent on. If a region's wealth exceeds its available asset supply, the surplus wealth is exported to and invested in more asset-abundant countries via the capital account. If the capital account is closed the interest rate serves as an equilibrator on the domestic market. Asset demand has three components: a return on accumulated wealth, additions from population growth and deductions for investment. Specifically, asset demand is domestically determined by the return on existing assets minus endowment for new generations  $(r_t - \vartheta) W_t^j$

with parameter  $\vartheta$  being the demographic parameter from the overlapping-generation component. To this, the uncapitalizable part of assets in production  $(1 - \delta^j)q_t^j X_t^j$ , or human capital, adds new assets while domestic investment costs  $g^n V_t^j - I_t^j$  reduce wealth. The dynamic change in a region's wealth is then defined by the following flow equation:

$$\dot{W}_t^j = (r_t - \theta)W_t^j + (1 - \delta^j)q_t^j X_t^j + g^n V_t^j - I_t^j$$

Investment  $I$  is a crucial component of the model. In order to sustain asset growth  $g^n N_t^j$  a share of the region's domestic output is required as investment:  $I_t^j = \kappa q_t^j X_t^j$ . The investment cost parameter  $\kappa$  is initially constant but can be made dynamic in simulations. A financial market shock may reduce the functioning of domestic financial markets so that investment becomes unprofitable for domestic investors. In this case, investment may still be profitably carried out by investors using capital of (deeper) financial markets from abroad via foreign direct investment (FDI). A bargaining price  $\kappa_p$  is paid by the investor to the shock region<sup>5</sup> for the right to carry out FDI. Total FDI costs  $P_t$  are determined by the amount of investment carried out and the FDI parameter  $\kappa_p$ , which is determined by the bargaining power of the investor and the investee. FDI costs for the investor in prices of the region invested in become:

$$P_t = \kappa_p q_t^j X_t^j$$

FDI takes place if there are bilateral private gains from trade. Private gains will occur if the discounted cash flow of future returns on investment exceeds the initial cost of investment. For investing agents from the *core* region, the following condition needs to be met to make FDI in the *periphery* region with lower financial market parameter  $\delta^p$  profitable:

$$g^n \frac{\delta^c}{r - g^z} > \kappa + \kappa_p > g^n \frac{\delta^p}{r - g^z}$$

Foreign investment can alternatively be thought of as an exporting process. Financial market 'know-how' is exported from the region holding this knowledge in abundance to the deprived region. In this sense, FDI resembles net exports of goods with the difference of affecting the financial account rather than the current account.

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<sup>5</sup> These FDI costs can be thought of as acquiring a public license for conducting FDI or the costs of carrying out a joint venture with a domestic firm. They are generalized by the catchall parameter  $\kappa_p$ .

### *Open economy properties*

Export between regions takes place if there is an imbalance of supply and demand on the domestic asset market. While the trade balance  $TB_t^j$  is defined as the domestic production less domestic absorption from consumption and investment, the current account balance  $CA_t^j$  is the difference between changes in asset demand and asset supply of a region:

$$\begin{aligned} TB_t^j &= X_t^j - \theta W_t^j - I_t^j \\ CA_t^j &= \dot{W}_t^j - \dot{V}_t^j \end{aligned}$$

The current account is the dual of the financial account. The current account may be equivalently written in national accounts as the sum of net exports and net investment income  $NINV_t^j$  from abroad. With the share of total assets of region  $j$  invested in region  $i$  being  $\alpha_t^{ji}$  the current account is:

$$\begin{aligned} CA_t^j &= X_t^j - \theta W_t^j - I_t^j + r_t (\alpha_t^{ji} V_t^i - \alpha_t^{ij} V_t^j) \\ &= TB_t^j + NINV_t^j \end{aligned}$$

The share of a region's total wealth invested in foreign assets  $\alpha_t^{ji}$  is given by the sum of past current account surpluses –source of changes in the net investment position. The main difference with FDI is the change in property rights taking place when acquiring assets via the current account while for FDI only the income stream from returns on investment abroad is repatriated. Foreign asset shares and the share of domestic assets in the global portfolio  $\square_t^{ji}$ , i.e. all wealth in all regions, is given by:

$$\begin{aligned} \alpha_t^{ji} &= \frac{W_t^j - V_t^j}{V_t^i} = \frac{\sum_{s=0}^{t-1} CA_s^j}{V_t^i} \\ \dot{\alpha}_t^{ji} &= \frac{\dot{W}_t^j - \dot{V}_t^j}{V_t^i} = \frac{CA_t^j}{V_t^i} \\ \square_t^{ji} &= \alpha_t^{ji} \frac{V_t^i}{W_t^j} = \frac{\sum_{s=0}^{t-1} CA_s^j}{V_t^i} \frac{V_t^i}{W_t^j} = \frac{\sum_{s=0}^{t-1} CA_s^j}{W_t^j} \end{aligned}$$

The global portfolio share will be one of the benchmarks for model dynamics. It captures the longer lasting effects of imbalances between regions resulting from a shock to financial markets in the *Periphery*-region.



### *The shock*

A shock to the financial markets in countries of the *Periphery*-region changes those countries' ability to convert assets used for production into capital assets tradable on financial markets. A negative shock may be envisaged as a decrease in the number of safe assets as a reliable store of value available on financial market of a region's countries. Alternatively, a sudden improvement of financial markets like entering the European Monetary Union may constitute a positive shock thereby improving the number of safe assets. The change of  $\delta^P$  (e.g. in the case of a positive shock indicated by  $\delta_{t=0^-}^P < \delta_{t=0^+}^P$  with  $t=0^-$  marking the period before the shock and  $t=0^+$  the time directly afterwards) affects the initial equilibrium that prevailed between asset supply and asset demand within countries of both regions and alters the dynamic allocation of assets between regions.

The shock to the financial market development parameter  $\delta$  is the main driver of this dynamic general equilibrium model. It affects all areas – nominal and real – of the economy of the respective region and has an additional impact upon the other region, too. In our two-region setting with a *Core* and a *Periphery*, markets are asymmetrically affected by a shock to the *Periphery*'s financial market development parameter. In the *Core*-region, a surplus in the trade balance ensues while the *Periphery* experiences a deficit in the trade balance and, most likely, also in the current account leading to a long-term change in the international allocation of assets and debt between both regions. The drivers of the international investment position of a region are the main focus in the model simulations.

### *Balance of payments and exchange rate dynamics*

The properties of the balance of payments and exchange rate dynamics in this two-region setting are such that any increase in a variable of one region causes a decrease in the other region. The following set of six indicators constitute the core of the analysis:

The *trade balance* reacts immediately. It adapts to changes in wealth induced by the financial market shock and dynamically adjusts to investment flow patterns:

$$\frac{TB_t^C}{X_t^C} = -\theta \frac{(1-\delta^C) + g^n (V_t^C + N_t^P v_t^{Pn}) / X_t^C - \kappa_P x_t^{Pn} / x_t^C - \kappa / x_t^C}{(g^z + \theta - r_t)} + (1-\kappa)$$

The *current account balance* is composed of the trade balance and net investment income:

$$\frac{CA_t^C}{X_t^C} = g^C \left( \frac{(1 - \delta^C) + g^n (V_t^C + N_t^P v_t^{Pn}) / X_t^C - \kappa_P x_t^{Pn} / x_t^C - \kappa (1 + x_t^{Pn} / x_t^C)}{(g^z + \theta - r_t)} + \frac{\delta^C}{r_t - g^z} \right)$$

The *international investment position* of the core or its amount of net foreign assets/debt:

$$NA_t^C = \alpha_t^{CP} V_t^P - \alpha_t^{PC} V_t^C \equiv W_t^C - V_t^C$$

The *real interest rate* is a variation on the golden-rule rate of interest accounting for real exchange rate changes, changing weights of the countries and costs of domestic and foreign investment:

$$r_t = g^z + \frac{\dot{q}_t^P}{q_t^P} (x_t^{Pn} + x_t^{Po}) + \frac{\theta}{1 - \kappa} \left[ \delta^C - (\delta^C - \delta^P) x_t^{Po} - g^n \hat{v}_t^{Po} x_t^R \left( \frac{\delta^C}{\delta^P} - 1 \right) \right]$$

The *terms of trade* from which the real exchange rate is calculated, are as follows:

$$\lambda_t^{CP} = P_t^P / P_t^C = \left( \gamma q_t^{P(\sigma-1)} + (1 - \gamma) \right)^{1/(1-\sigma)} / \left( \gamma + (1 - \gamma) q_t^{P(\sigma-1)} \right)^{1/(1-\sigma)}$$

The *long term share of assets* of the core in the overall number of capitalizable assets consists of a country's past current account balances with respect to current overall wealth:

$$\bar{\alpha}_t^{ij} = \alpha_t^{ij} \frac{V_t^j}{W_t^i} = \frac{\sum_{s=0}^{t-1} CA_s^i}{V_t^j} \frac{V_t^j}{W_t^i} = \frac{\sum_{s=0}^{t-1} CA_s^i}{W_t^i}$$

The dynamics of these six equations will be presented in the simulation results below.

### *Solving the non-linear dynamic system*

The system of equations constitutes a non-linear dynamic system which cannot be uniquely solved. The model contains four dynamic equations, which can be approximated using an iterative simulation procedure. Starting from a set of estimated initial parameters the model is iterated until all simulated values reach their equilibrium values and further iterations do not change the equilibrium found. Due to the design of the model, this equilibrium is unique so that the only solution to the model is found by solving the following dynamic equation system. It is comprised of the four dynamic equations for the share of wealth dynamics  $\dot{w}_t^C$ , the price levels  $P_t^i$ , the output share dynamics  $\dot{x}_t^C$ , and asset value dynamics  $\dot{\hat{v}}_t^{Po}$ . For more technical details see Körner (2011):

$$\begin{aligned}
\dot{w}_t^C &= (r_t - \theta - g^C) w_t + \left(1 - \delta^C - \frac{\kappa}{x_t}\right) + g^n \left[ \frac{(1 - \kappa)}{\theta x_t^C} + \hat{v}_t^{Po} \left( \frac{\delta^C}{\delta^P} - 1 \right) \right] - \kappa_P \frac{x_t^{Pn}}{x_t^C} \\
1 &= \theta \gamma w_t^C P_t^{C(\sigma-1)} + (1 - \gamma) \left( \frac{(1 - \kappa)}{x_t^C} - \theta w_t^C \right) P_t^{P(\sigma-1)} \\
\dot{x}_t^C &= x_t^C (1 - x_t^C) \left( g^C - g^P - \frac{\dot{q}_t^P}{q_t^P} \right) \\
\dot{\hat{v}}_t^{Po} &= \frac{\theta}{1 - \kappa} \left[ \delta^C (1 - x_t^{Po}) + \delta^P x_t^{Po} - g^n \hat{v}_t^{Po} x_t^{Po} \left( \frac{\delta^C}{\delta^P} - 1 \right) \right] \hat{v}_t^{Po} - \delta^P
\end{aligned}$$

The simulation consists of a building period ( $t=0^-$ ) before the shock, the time of the shock ( $t=0$ ), the immediate aftermath of the shock ( $t=0^+$ ) and a secession of periods following the shock ( $t>1$ ). After ( $t=0^+$ ) the regions in the model converge to a new steady-state-like equilibrium for which all parameters asymptotically converge to a new set of values.

The state variables of the model are not directly affected by the shock. They change in accordance with the new model dynamics and bring about the new equilibrium:

$$\begin{aligned}
r_t &= g^z + x_t^P \frac{\dot{q}_t^P}{q_t^P} + \frac{\theta}{1 - \kappa} \left[ \delta^C - (\delta^C - \delta^P) x_t^{Po} - g^n \hat{v}_t^{Po} x_t^P \left( \frac{\delta^C}{\delta^P} - 1 \right) \right] \\
\lambda_t^{CP} &= P_t^P / P_t^C \\
P_t^P &= \left( \gamma q_t^{P(\sigma-1)} + (1 - \gamma) \right)^{1/(1-\sigma)} \\
P_t^C &= \left( \gamma + (1 - \gamma) q_t^{P(\sigma-1)} \right)^{1/(1-\sigma)} \\
x_t^P &= 1 - x_t^C = x_t^{Po} + x_t^{Pn} \\
\dot{x}_t^P &= -\dot{x}_t^C = \dot{x}_t^{Po} + \dot{x}_t^{Pn}
\end{aligned}$$

The solution to the non-linear dynamic system of equations is obtained by initially guessing and/or calibrating the shock to the capital values on the financial market. This loss in capital values feeds into wealth, which then depresses consumption in favour of savings. Savings generate intra-country flows of funds. These flows are the result of the initial shock and feed into the parameter values in the post-shock periods. At the ‘end’ of simulation time, capital values, wealth and all dynamics reach a steady-state value without further change. The final value is then used to calculate the present value of capital assets, which is then applied to update the initial guess of the capital market shock. Consecutive iterations use updated values.

### 3.3 Calibration and data

The model is calibrated using the same techniques as in Caballero et al. (2008) and Körner (2011). The convergence in nominal interest rates and inflation rates in the run-up to the start of the euro in 1999 serves as financial market shock. The convergence of government bond yields from EMU membership was strongest in the euro zone accession countries from the periphery as depicted in Figure 3 , Figure 4 and Figure 5 . Interest rates have converged significantly before the start of the monetary union and continued to do so in the first years of EMU's existence. Asset values of euro area countries increased through higher present values from lower interest rate discounting. The increase in capital values from this positive shock in the periphery serves as the calibration factor for the financial market development parameter  $\delta$ . In this sense, EMU accession served as a promulgator of financial market development.

All other parameters are calibrated using real data or computed values. The size of core and periphery regions  $C$  and  $P$  are computed as the weights of their relative GDP values. Growth rates are past rates of GDP growth and investment and FDI costs are estimated using a moving window of past net investment over GDP ratios and net investment income measures. Data stem from Eurostat databases listed in the appendix. The baseline set of core parameters including the demographics parameter  $\phi$ , the CES adjustment parameter  $\sigma$  and starting values for the international investment positions is kept as in the theory papers:

Parameter	$\theta$	$g$	$\delta^C$	$\bar{\Pi}_{0-}^{PC}$	$NA_{0-}^C$	$\sigma$	$\gamma$	$g^z$	$g^n$	$K$	$K_P$	$r_{aut}$
<b>Caballero et al.</b>	0.25	0.03	0.24	0.05	0	4	0.9	0.0	0.03	0.0	0.12	0.06
<b>Calibrated</b>	0.79	0.036	0.09	0.05	0	4	0.9	0.0	0.036	0.065	0.05	0.078

The European core-periphery model is simulated for different sets of countries. The baseline simulation has the notorious GIPS countries (Greece, Ireland, Portugal, and Spain) in the periphery group. Simulations are also run for the GIIPS group including Italy and also for single countries like Spain and Italy versus a Northern core. The core is composed of the other euro area countries that started the euro in 1999, namely Austria, Belgium, Germany, Finland, France, Luxemburg and the Netherlands — and Italy, when applicable. All simulations are based on EMU-12. Those countries that joined the euro after 2001 do not alter the composition of EMU significantly due to their relatively small economies. In addition, they do not all have a full set of historic time-series available at Eurostat for the 1990s as a building period for calibration. The late euro entrants are hence excluded from our simulations without loss of generality in our view.

However, simulation results should be treated as a stylized picture alone. This is because only EMU-12 countries are included in the simulation but net international investments positions or current account balances comprise virtually all countries of the world.<sup>6</sup> Nevertheless, as intra-euro area trade accounts for a large share of overall trade by euro area countries and the euro area's current account is overall roughly balanced, results still provide valuable insights on the sustainability of current account positions and foreign debts related to intra-euro area imbalances.

Investment and FDI parameters  $\kappa$  and  $\kappa_p$  are of particular interest. Caballero et al. (2008) do not calibrate but simply assume values of 0% and 12% respectively. Calibrations show that these values are far from the European (and US) reality: the net investment share  $\kappa$  is around 6.5% in the euro area (6.2% in the core, 8.2% in the GIPS-periphery) for the run-up to EMU in 1999. The catchall FDI parameter  $\kappa_p$  captures the return on investment abroad as the weighted sum of countries' primary income from the rest of the world over the depreciated present value of past FDI. This value is found to be around 5% for European countries.

## 4. Simulations results for the euro area

### 4.1 Baseline results – core-periphery (GIPS)

The simulation results are shown in 0 depicting the course of actual and of estimated variables of periphery countries (GIPS) against the remaining EMU-12 countries (core). The 'baseline' scenario shows the equilibrium path of the periphery's current account, net foreign assets (debt if negative), interest rates and the real exchange rate given the financial market shock from lowered interest differentials after 1999. The 'actual' line shows the de facto development between 1997 and 2011 and serves as the frame of reference for all subsequent simulations.

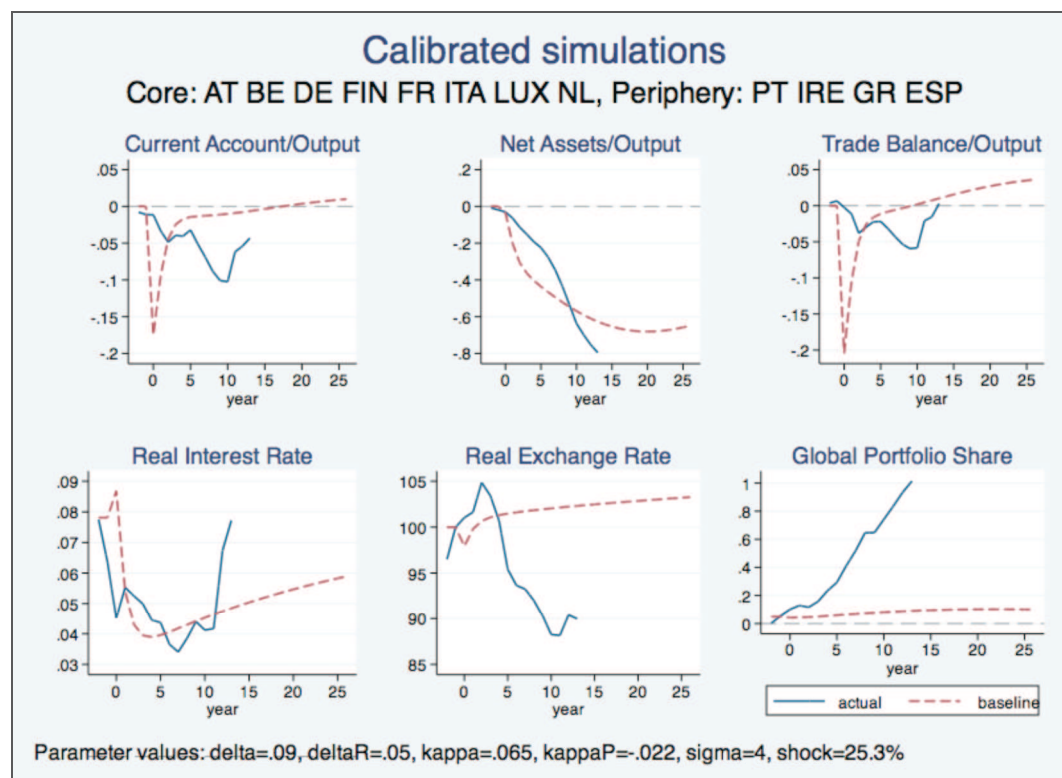
The financial market shock through EMU accession at time 0 (beginning of the two-year convergence period in 1997) has resulted in considerable current account deficits of the periphery. The development of the current account is shown by the line labelled actual, which

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<sup>6</sup> Eurostat publishes data on intra-European current account balances and investment positions only for the 2000s, not for the building period of model simulations in the years before EMU accession in 1999. The same applies to other data required for simulations for countries joining the euro area after 1999 (except Greece).

signals increasing deficits in the top left hand pane of 0. These deficits are due to trade deficits on the one hand as illustrated in the top right hand pane. In addition, the initial real depreciation of the exchange rate in the first five years has been reversed and turned into a strong appreciation depicted in the bottom centre pane favouring a negative current account.

Figure 6 Baseline simulation results for the PIGS-periphery



Source: own computations

The positive shock to periphery financial markets from lower real interest rates increased the present value of domestic capital assets by 25.3%.<sup>7</sup> Due to the wealth allocation at the time of the shock, a large part of these future discounted capital gains went to domestic owners of these assets whose perceived wealth increased accordingly. From the link between wealth and present and future consumption, a current account deficit ensued. The increased financial market capabilities led to an appreciation of the real exchange rate favouring increasing foreign indebtedness. These initial deficits should have been countered by a future depreciation and future trade balance surpluses in order to service international debt.

A comparison between simulations and the actual development of the benchmark parameters of periphery countries shows that this kind of rebalancing did not take place. To make matters

<sup>7</sup> See appendix 6.1 for the calibration of the financial market shock from EMU bond yield convergence.

worse, instead of countering initial current account deficits by real exchange rate depreciation and future trade balance surpluses, the opposite took place. Real exchange rate appreciation and an increase in trade balance deficits led to a further worsening of the current account and resulted in an unsustainable path of international debt.

The main problem of periphery countries today is, as our results suggest, the unsustainable path of international indebtedness. The top centre pane of 0 has net foreign assets of the PIGS countries reach the same level as predicted by the equilibrium model in 2007 (54%). The dynamics, however, is completely reversed. Instead of a converging and decreasing ratio of net foreign assets (negative assets are debt) over GDP, the actual line exhibits a strongly diverging pattern. While net assets over output in the reference simulation scenario peak at 68.1% (20 years after the shock), actual development has already surpassed this value by 2011 (79.6%). See appendix 6.2 for the full set of results for actual and simulated scenarios.

Neither current account surpluses nor a strong real depreciation are in view to change the current picture. Nonetheless, in 2011 the PIGS countries managed a weighted trade balance surplus of 0.3%. Yet real interest rates rose to a weighted 7.7% in 2011 and the disadvantageously high real exchange rate inhibits a reversal of the debt dynamics. And if a devaluation came about, rising real debt service would require an even stronger counter-reaction: Simulations hint at a required reduction of the trade balance over GDP ratio by five percentage points, and a real depreciation by at least 15 per cent to close the gap to simulated values. Only then would lower current account deficits lead to a convergence of the international investment positions of debtor countries.<sup>8</sup>

The main outcome of the baseline simulations is therefore the inability of periphery countries to reverse their accumulated current account positions by real exchange rate depreciations alone. Therefore, we present two alternative simulations, which might provide strategies for an adjustment leading to more sustainable net foreign debt levels.

## **4.2 Alternative 1: Increasing investment**

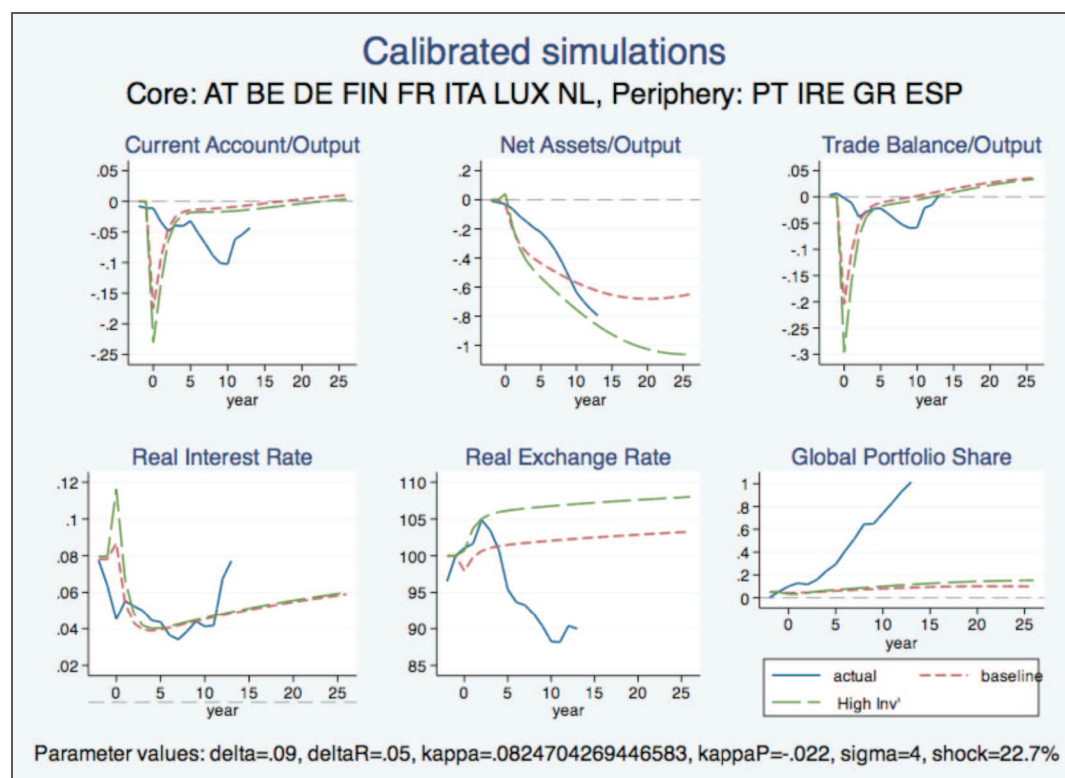
Investment in productive capital is a straightforward proposal to increase production and thus reduce the denominator of the debt-to-output ratio. More investment could be carried out in the core and periphery by increasing the net investment share  $\kappa$ . The average calibrated net investment parameter from gross capital formation less consumption of fixed capital

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<sup>8</sup> Simulations using the GIIPS countries as periphery yield similar, yet more attenuated results.

(depreciation) is found to be higher in the periphery (8.2%) than in the core (6.2%). It can be understood as the effort made to maintain the current capital stock and invest in new capital to sustain growth. If the overall level of investment were increased to the periphery's level, demand from core countries for periphery's capital goods would surge because of relatively lower investment costs in the periphery.

Figure 7 Simulation results for the PIGS-periphery assuming investment variation in the core countries



Source: own computations

The top center pane of Figure 7 shows a significantly higher sustainable debt level for the scenario labeled 'High Inv(estment)'. The sustainable debt level increases to 86.5% (year 13) while the current account can stay slightly more in deficit (1.4% instead of 0.6% for the baseline scenario). Capital exports to the core help decrease the real exchange rate in the periphery by five percentage points (107 rather than 102.3) fostering competitiveness relative to the centre and increasing demand. However, in reality periphery countries are far from achieving this degree of competitiveness: the weighted real exchange rate index is at 90.0 in 2011 and thus overvalued by 19% compared to the high investment scenario and 13% to the equilibrium calibrated baseline case. Unless this overvaluation is reduced, the FDI and net export channels in the model are blocked because they are unattractive to foreign buyers.



Additional demand from the core region for capital or production goods in the periphery cannot materialize.

### **4.3 Alternative 2: Increasing productivity**

Improving productivity and thus becoming more competitive internationally is an oft-heard demand for periphery countries. A variation in total factor productivity (TFP) does indeed improve the sustainability of current international debt positions. In Figure 8 a variation in TFP by an additional 1 or 2 percentage points respectively allows greater initial current account deficits. The average weighted current account deficit of the four PIGS countries has increased to a maximum of 10.2% in 2008. Strikingly, this value is higher than the one in the most optimistic “TFP+2%” scenario. It postulates a two percentage point increase in TFP from the financial market shock and goes along with a current account deficit of only 8.4% in year 10 after the shock (2008). In contrast to simulations, PIGS countries did not plunge into deficit after the shock; deficits rather built up over time. Net foreign debt is therefore currently only at a weighted 79.6% since 1999 — 16.9 percentage points higher than in the calibrated baseline scenario but within the range of realistic scenarios like a TFP increase by 0.5 percentage point (88.3%) or the above discussed rise in net investment.<sup>9</sup>

Debt levels can be sustained for longer when future productivity increases make up for current debt by over-proportionally increasing production. This positive link between higher TFP growth and debt sustainability is shown in the international investment position (Net Assets/Output) in the top center pane of Figure 8 . An increase in TFP by 1 percentage point would extend the sustainable debt level from 62.7% to 114% after 13 years (2011). A TFP increase of +0.5% would still allow for a maximum of over 100% of net foreign debt to be sustainable. However, in any case a future depreciation of the exchange rate and a turn-around in the current account position is required to return to the required equilibrium path.

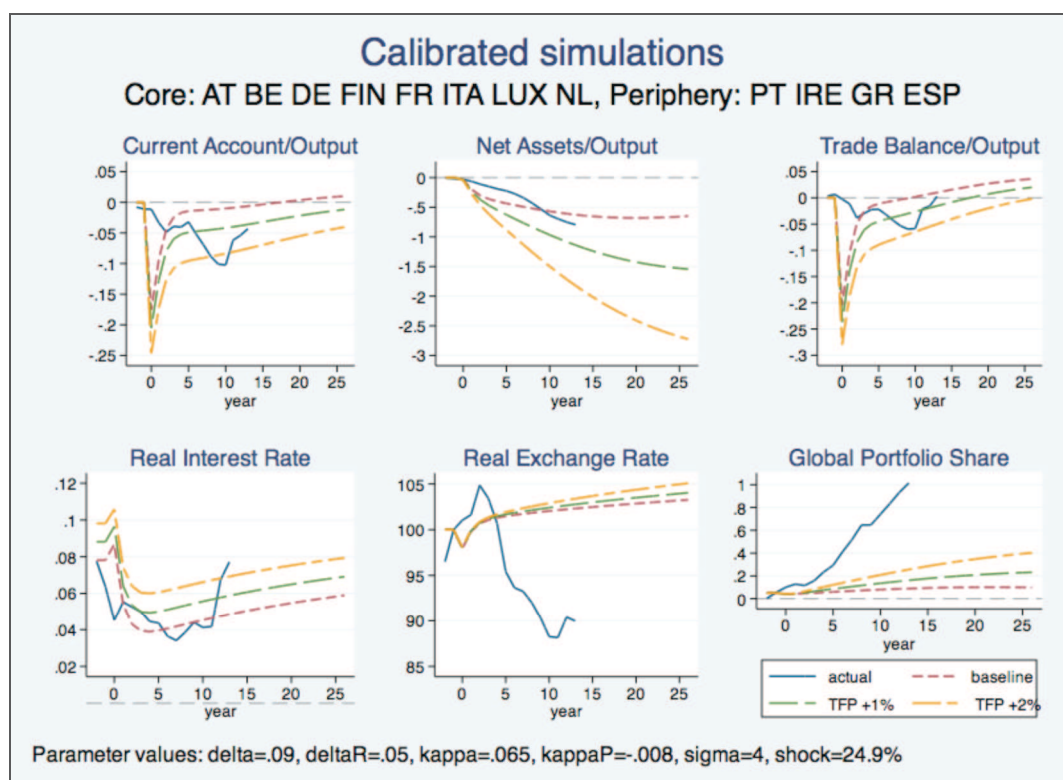
The actual path of the periphery’s current accounts has reversed in 2011 to a weighted deficit of 4.3%. Despite this reduction, values are still in the (highly unrealistic) range of the scenario with “TFP +2%” assuming productivity to have increased as a consequence of the financial market shock by two percentage points. Real appreciation in the bottom center pane has prevented debt levels from rising too much so far. However, a future depreciation, which equilibrium in the model calls for, might make current debt increasingly unsustainable.

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<sup>9</sup> See appendix 6.3 for simulation results of the 0.5% TFP variation not displayed in Figure 8 .

However, a lower real exchange rate is required to bring the balance of payments back towards sustainable levels. In its absence, the only alternative to considerable current account and trade balance surpluses to reduce foreign indebtedness would be lower domestic demand — currently to be seen in some periphery countries in recent times.

Figure 8 Simulations and TFP variation for core and PIGS-periphery model



Source: own computations

#### 4.4 Country case studies: Italy and Spain

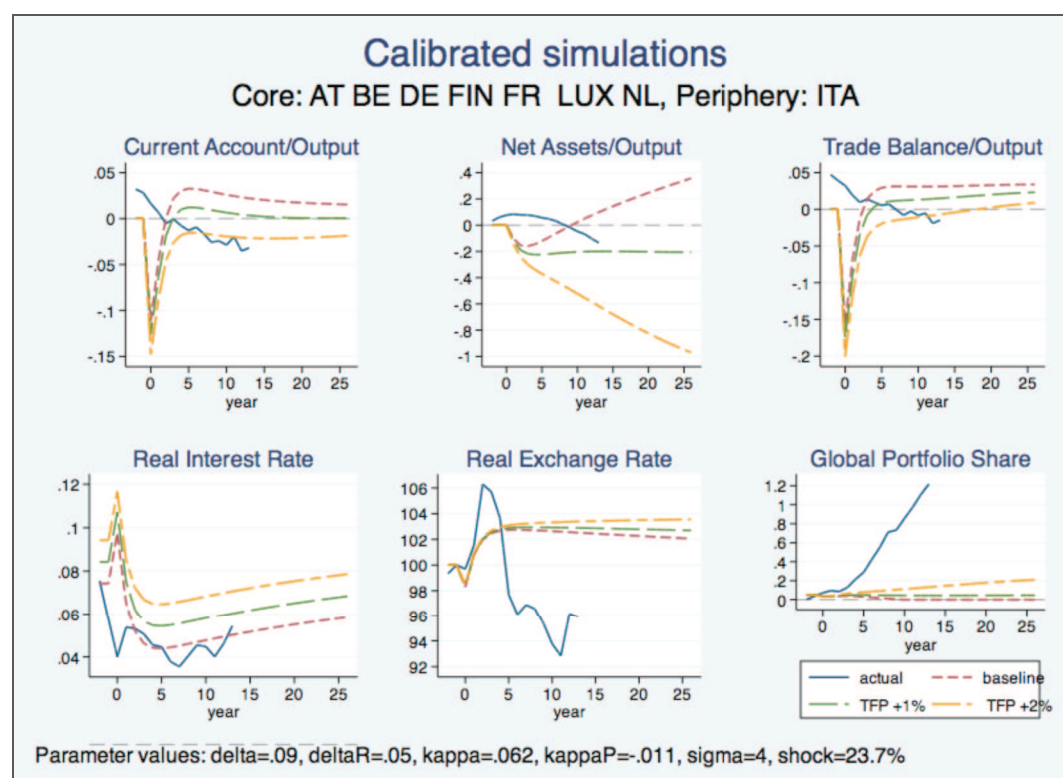
An application of the model to Italy as the single-country periphery and a Northern core highlights the versatility of the model. Italy's current problems are rather due to negative prospects from an uncompetitive real exchange rate stemming from low growth. In contrast to other periphery countries (and like France), Italy even had current account surpluses in the early years of the euro's existence. Only with time did the current account turn into deficit alongside the trade balance. Italy's net foreign asset position is almost balanced after 12 years.

In Italy, the financial market shock from convergence of interest rates did not lead to higher international debt but to domestic indebtedness. The income effect from lower interest rates is

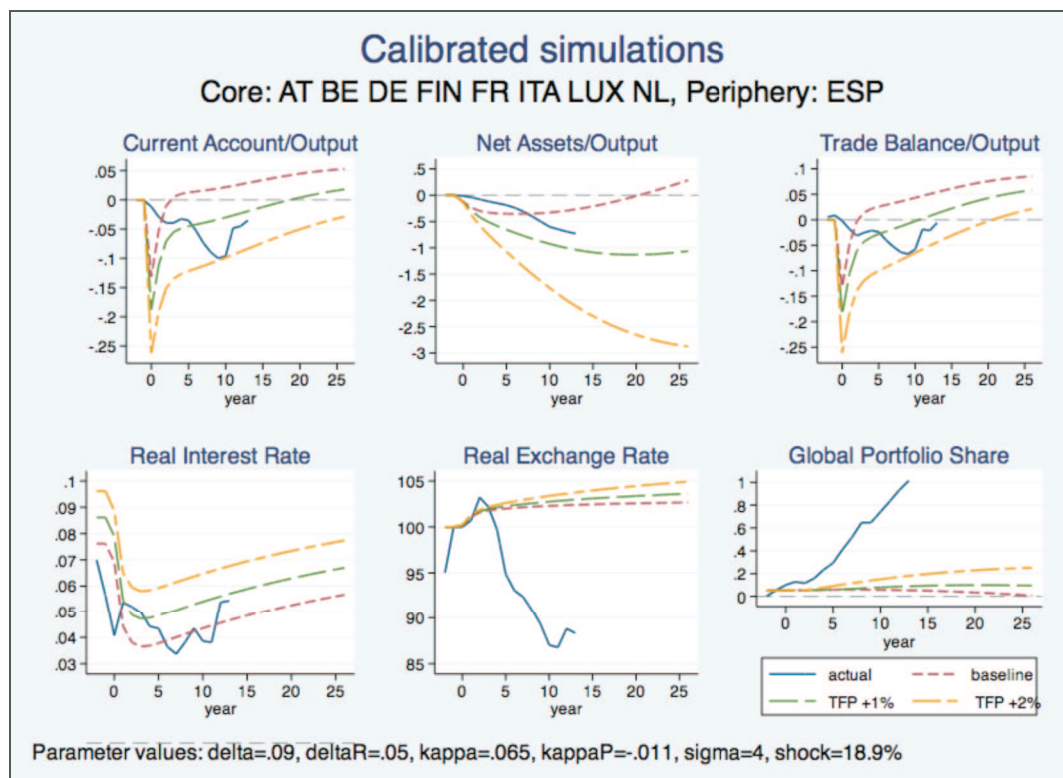
nonetheless visible in the real exchange rate: It increased by 7% since 1999 (year 0) and even 16% since 1997 as shown in the bottom centre pane of the upper part of Figure 9.<sup>10</sup> Italy needs to regain competitiveness by reducing the real exchange rate overvaluation and increasing growth prospects. The country's problems thus stem from a lack of international competitiveness visible in slowly deteriorating current account and trade balances.

For Spain, the picture is again a different one. The country has benefited from EMU accession and low interest rates and turned this advantage into a domestic demand boom. Current account deficits and capital inflows ensued, appreciating the real exchange rate by 13% compared to the rest of the euro zone. Since 1999, Spain has added 65.5% of its GDP to net foreign debt. However, recent turn-arounds in current account and trade balances look promising since they come close to equilibrium levels demanded in the 'TFP+1%' scenario, which only requires a feasible productivity increase by 1 percentage point. However, as for the other countries, the real exchange rate poses the main impediment to realignment of European imbalances.

Figure 9 Simulations and TFP variation for core countries and Italy and Spain



<sup>10</sup> Simulation results for the single-country simulations for Italy and Spain are not reported in the appendix but are available upon request from the authors.



Source: own computations

## 5. Economic policy implications

In this paper we study the intra-euro area imbalances based on a dynamic general equilibrium model. We show that the financial market shock, triggered by European financial integration and the introduction of the euro, might have contributed to the development of imbalances. The attractiveness of financial markets in southern Europe improved relatively to the core countries. Based on our model simulations, this explains capital flows from the euro area core to the periphery, persistent trade account and current account deficits in the euro periphery and surpluses in the core as well as diverging net foreign investment positions in the euro area.

More worrisome, our baseline simulation results for the euro area further suggest that foreign debt positions of the euro periphery countries are far from sustainable. Rising debt servicing costs would require a rather strong improvement of the trade balance and a real depreciation. Only then would lower current account deficits lead to a convergence of the international investment positions of debtor countries. However, future real depreciation would increase the real value of debt and might make current debt increasingly unsustainable. Alternative

scenarios, assuming rising investment and productivity, draw a less dramatic picture. The level of sustainability widens to a higher level of foreign debt.

Therefore, today's crisis countries will need to adjust to imbalances in current accounts and net foreign positions not only by real exchange rate depreciations alone. Our alternative simulation scenarios point at two possible strategies. First, investment in productive capital needs to be restarted and accelerated. To unburden the current account, capital needs to be accumulated by rising domestic savings in crisis countries. Second, raising crisis countries' productivity will add to their competitiveness and growth potential. Increasing production reduces the debt per GDP relation and provides income to serve debt.

A precondition is, however, to restore confidence in crisis countries and to solve their banking problems. Both continue to act as an opposite and thus negative financial market shock to the one experienced after EMU accession. Only after overcoming them will domestic savings stay in countries and can investments be allocated to productive sectors. On the other hand, crisis countries need to support investments by substantial structural reforms and enhancing investment conditions. Then foreign debt positions might – in the end – prove to be sustainable again.

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## 6. Appendix

### 6.1 Calibration and variable description

Data source: Eurostat, <http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home>

Time span: 1994 to 2011; building period for calibration: 1996 to 1998

Variable	Label	Variable abbreviation	Description	Unit/Formula
W	Wealth	NfaHnsh_EUR	Net financial assets Household sector	Millions of Euro
$\theta$	Financialization parameter	theta	Share of GDP over total capital assets	$1 / ('total\_wealth' / 'total\_gdp')$
$\delta^c$	Financial market development parameter	delta	Cost of transforming output into marketable capital assets	$('r\_aut')*(1-'kappa')^{\theta}$
		deltaR		$('r\_0plus')*(1-'kappa')^{\theta}$
X	Output	Gdpamp_EUR	Gross domestic product at market prices	Millions of Euro
$g$	Growth rate of output	g	Gross domestic product at market prices	Year-on-year in %
$g^z$	Productivity growth (TFP)	gz	$g^z = g - g^n$	as in Caballero et al. (2008)
$g^n$	Real growth less TFP	gn	$g^n = g - g^z$	as in Caballero et al. (2008)
CA	Current account balance	BoPCANAcotw_EUR	Balance of payments Current account. Net	Millions of Euro
TB	Trade balance	Ebogas_EUR	External balance of goods and services Net	Millions of Euro
NA	Net foreign assets	IipTNP_EUR	International investment position Total Net Position	Millions of Euro
$K$	Net investment share	Gcf_EUR	Gross capital formation	Millions of Euro
		Cofc_EUR	Consumption of fixed capital	Millions of Euro
$\kappa_P$	Rate of return on FDI	BoPFaDiNAcotw_EUR	Balance of Payments Financial account. Direct investment Net	Millions of Euro
		Npitwtrotw_EUR	Net primary income transfers with the rest of the world	Millions of Euro
	Rate of return on FDI (Alt.)	Bop_fdi_inc	FDI income and rates of return	Rate of return on FDI stocks
$r_{aut}$	Real interest rate	Eccby_index	EMU convergence criterion bond yields	At yearend in %
$\lambda_i^{CP}$	Real exchange rate	REER_index	Real Effective Exchange Rate	Index; deflator consumer price indices - 36 trading partners
$\sigma$	CES preference parameter	sigma	Speed of price level adjustment	as in Caballero et al. (2008)
$\gamma$	Cross-demand parameter	gamma	Strength of cross-border relative demand	as in Caballero et al. (2008)
Shock	Size of financial market shock	shock	Financial market shock from change in bond yields from EMU convergence	$1 - 'deltaR'/'delta'$

The shock is calibrated as the mean weighted spread of periphery countries' interest rates measured by EMU convergence criterion bond yields over the core's rate. Spreads are averaged over the last three years of the pre-convergence period (1994–96) and compared with the three-year average after two years of EMU's existence (2001–03). The shock translates into an increase in the net present value of the periphery's total capital assets of 24.9%.



## 6.2 Data for GIPS calibrated simulations (actual baseline and high investment scenarios)

		Actual							Baseline							High investment						
AD	year	CA	NFA	TB	IR	RER	RER2	GAS	CA	NFA	TB	IR	RER	RER2	GAS	CA	NFA	TB	IR	RER	RER2	GAS
1996	-2	-0.8	-0.8	0.4	7.8	100.0	96.5	0.2	0.0	0.0	0.0	7.8	0.8	100.0	5.0	0.0	0.0	0.0	8.0	0.8	100.0	5.0
1997	-1	-1.1	-1.9	0.7	6.4	103.6	100.0	5.5	0.0	0.0	0.0	7.8	0.8	100.0	5.0	0.0	0.0	0.0	8.0	0.8	100.0	5.0
1998	0	-1.1	-3.0	-0.3	4.5	104.7	101.0	10.0	-17.5	-3.4	-20.5	8.7	0.8	97.9	4.2	-23.0	4.2	-29.7	11.6	0.8	100.7	3.2
1999	1	-3.3	-6.4	-1.1	5.5	105.3	101.6	12.8	-9.4	-20.2	-10.5	5.4	0.8	99.8	4.5	-13.6	-18.3	-16.2	6.7	0.8	103.7	3.2
2000	2	-4.9	-11.2	-3.8	5.3	108.7	104.9	11.6	-4.4	-30.5	-4.9	4.3	0.8	100.7	4.6	-6.4	-33.5	-7.6	4.8	0.8	105.0	4.4
2001	3	-3.9	-15.2	-3.0	5.0	107.2	103.4	15.7	-2.4	-36.3	-2.6	3.9	0.8	101.1	5.0	-3.4	-42.3	-3.9	4.2	0.9	105.6	5.5
2002	4	-4.0	-19.2	-2.2	4.4	104.4	100.7	23.4	-1.7	-40.3	-1.6	3.9	0.8	101.3	5.5	-2.2	-48.4	-2.4	4.0	0.9	105.9	6.3
2003	5	-3.2	-22.4	-2.2	4.4	98.9	95.4	29.3	-1.4	-43.6	-1.1	4.0	0.8	101.5	6.0	-1.9	-53.5	-1.8	4.0	0.9	106.1	7.0
2004	6	-5.1	-27.6	-3.2	3.7	97.1	93.7	41.2	-1.3	-46.6	-0.8	4.1	0.8	101.6	6.4	-1.8	-58.2	-1.5	4.1	0.9	106.3	7.6
2005	7	-6.9	-34.5	-4.3	3.4	96.6	93.3	51.9	-1.3	-49.4	-0.6	4.2	0.8	101.7	6.9	-1.8	-62.7	-1.3	4.2	0.9	106.4	8.2
2006	8	-8.8	-43.3	-5.4	3.9	95.4	92.0	64.6	-1.2	-52.1	-0.3	4.3	0.8	101.8	7.3	-1.7	-67.1	-1.1	4.4	0.9	106.5	8.8
2007	9	-10.1	-53.4	-5.9	4.4	93.6	90.3	64.7	-1.1	-54.6	-0.1	4.4	0.8	101.9	7.6	-1.7	-71.4	-0.8	4.5	0.9	106.7	9.4
2008	10	-10.2	-63.7	-5.9	4.1	91.5	88.2	74.1	-1.0	-56.9	0.2	4.5	0.8	102.0	8.0	-1.7	-75.5	-0.6	4.6	0.9	106.8	10.0
2009	11	-6.2	-69.8	-2.1	4.2	91.4	88.1	83.5	-0.9	-59.1	0.5	4.6	0.8	102.1	8.3	-1.6	-79.4	-0.3	4.7	0.9	106.9	10.6
2010	12	-5.4	-75.2	-1.6	6.7	93.7	90.4	93.3	-0.8	-61.0	0.7	4.7	0.8	102.2	8.7	-1.5	-83.0	0.0	4.8	0.9	107.0	11.1
2011	13	-4.3	-79.6	0.3	7.7	93.2	90.0	101.4	-0.6	-62.7	1.0	4.8	0.8	102.3	8.9	-1.4	-86.5	0.3	4.9	0.9	107.0	11.6
2012	14								-0.5	-64.2	1.3	4.9	0.8	102.4	9.2	-1.2	-89.6	0.6	5.0	0.9	107.1	12.1
2013	15								-0.4	-65.4	1.5	5.0	0.8	102.5	9.4	-1.1	-92.5	0.9	5.1	0.9	107.2	12.6
2014	16								-0.2	-66.4	1.8	5.1	0.8	102.6	9.6	-1.0	-95.1	1.1	5.2	0.9	107.3	13.0
2015	17								-0.1	-67.2	2.1	5.2	0.8	102.6	9.8	-0.8	-97.4	1.4	5.3	0.9	107.4	13.4
2016	18								0.1	-67.7	2.3	5.3	0.8	102.7	9.9	-0.7	-99.5	1.7	5.4	0.9	107.5	13.7
2017	19								0.2	-68.0	2.5	5.4	0.8	102.8	10.0	-0.5	-101.2	2.0	5.5	0.9	107.5	14.0
2018	20								0.4	-68.1	2.7	5.5	0.8	102.9	10.1	-0.4	-102.7	2.2	5.6	0.9	107.6	14.3
2019	21								0.5	-68.0	2.9	5.5	0.8	102.9	10.1	-0.2	-103.9	2.4	5.6	0.9	107.7	14.5
2020	22								0.6	-67.7	3.1	5.6	0.8	103.0	10.1	-0.1	-104.8	2.7	5.7	0.9	107.7	14.7

CA: current account balance in % of GDP; NFA: net foreign assets in % of GDP; TB: trade balance in % of GDP; IR: interest rate in %; RER: real exchange rate/inverted terms of trade; RER2: real exchange rate index; GAS: global asset share in % of total assets

## 6.3 Data for GIPS calibrated simulations (Variation of total factor productivity)

		TFP + 0.5%							TFP +1%							TFP +2%						
AD	year	CA	NFA	TB	IR	RER	RER2	GAS	CA	NFA	TB	IR	RER	RER2	GAS	CA	NFA	TB	IR	RER	RER2	GAS
1996	-2	0.0	0.0	0.0	8.3	0.8	100.0	5.0	0.0	0.0	0.0	8.8	0.8	100.0	5.0	0.0	0.0	0.0	9.8	0.8	100.0	5.0
1997	-1	0.0	0.0	0.0	8.3	0.8	100.0	5.0	0.0	0.0	0.0	8.8	0.8	100.0	5.0	0.0	0.0	0.0	9.8	0.8	100.0	5.0
1998	0	-19.0	-3.5	-22.1	9.2	0.8	98.0	4.2	-20.5	-3.7	-23.7	9.6	0.8	98.0	4.3	-24.6	-4.1	-28.0	10.6	0.8	98.1	4.3
1999	1	-11.0	-21.9	-12.3	5.9	0.8	99.8	4.5	-12.7	-23.7	-14.0	6.4	0.8	99.9	4.5	-17.3	-28.4	-18.7	7.4	0.8	100.0	4.5
2000	2	-6.2	-34.0	-6.7	4.8	0.8	100.7	4.7	-7.9	-37.5	-8.5	5.3	0.8	100.8	5.2	-12.7	-47.0	-13.2	6.4	0.8	100.9	6.5
2001	3	-4.2	-41.7	-4.3	4.5	0.8	101.1	5.7	-6.0	-47.2	-6.1	5.0	0.8	101.2	6.5	-10.8	-62.0	-10.8	6.0	0.8	101.4	8.5
2002	4	-3.5	-47.8	-3.3	4.4	0.8	101.4	6.6	-5.2	-55.3	-5.0	4.9	0.8	101.5	7.6	-9.9	-75.5	-9.7	6.0	0.8	101.7	10.3
2003	5	-3.2	-53.1	-2.8	4.5	0.8	101.6	7.3	-4.9	-62.7	-4.5	5.0	0.8	101.7	8.6	-9.5	-88.5	-8.9	6.1	0.8	101.9	12.1
2004	6	-3.0	-58.2	-2.4	4.6	0.8	101.7	8.0	-4.7	-69.9	-4.1	5.1	0.8	101.8	9.6	-9.3	-101.3	-8.4	6.2	0.8	102.2	13.9
2005	7	-2.9	-63.1	-2.1	4.7	0.8	101.9	8.7	-4.6	-76.9	-3.7	5.2	0.8	102.0	10.6	-9.1	-113.8	-7.9	6.3	0.8	102.4	15.7
2006	8	-2.8	-67.8	-1.8	4.8	0.8	102.0	9.4	-4.5	-83.7	-3.4	5.3	0.8	102.1	11.6	-8.9	-126.1	-7.4	6.4	0.8	102.5	17.4
2007	9	-2.7	-72.4	-1.5	4.9	0.8	102.1	10.1	-4.3	-90.3	-3.0	5.5	0.8	102.3	12.6	-8.6	-138.2	-6.9	6.5	0.8	102.7	19.1
2008	10	-2.6	-76.7	-1.2	5.0	0.8	102.2	10.8	-4.2	-96.7	-2.6	5.6	0.8	102.4	13.5	-8.4	-149.9	-6.5	6.6	0.8	102.9	20.8

		TFP + 0.5%							TFP +1%							TFP +2%						
AD	year	CA	NFA	TB	IR	RER	RER2	GAS	CA	NFA	TB	IR	RER	RER2	GAS	CA	NFA	TB	IR	RER	RER2	GAS
2009	11	-2.4	-80.9	-0.9	5.2	0.8	102.3	11.4	-4.0	-102.8	-2.3	5.7	0.8	102.5	14.4	-8.1	-161.2	-6.0	6.7	0.8	103.1	22.5
2010	12	-2.3	-84.7	-0.6	5.3	0.8	102.4	12.0	-3.8	-108.6	-1.9	5.8	0.8	102.7	15.3	-7.8	-172.0	-5.5	6.8	0.8	103.2	24.1
2011	13	-2.1	-88.3	-0.3	5.4	0.8	102.5	12.6	-3.6	-114.0	-1.5	5.9	0.8	102.8	16.2	-7.5	-182.4	-5.0	6.9	0.8	103.4	25.6
2012	14	-1.9	-91.6	0.1	5.5	0.8	102.6	13.1	-3.4	-119.2	-1.2	6.0	0.8	102.9	17.0	-7.2	-192.4	-4.5	7.0	0.8	103.5	27.1
2013	15	-1.8	-94.6	0.4	5.6	0.8	102.7	13.6	-3.2	-124.0	-0.8	6.1	0.8	103.0	17.7	-7.0	-201.8	-4.1	7.1	0.8	103.7	28.5
2014	16	-1.6	-97.3	0.7	5.6	0.8	102.8	14.0	-3.0	-128.4	-0.5	6.2	0.8	103.1	18.4	-6.7	-210.7	-3.6	7.2	0.8	103.8	29.9
2015	17	-1.4	-99.7	0.9	5.7	0.8	102.9	14.4	-2.8	-132.4	-0.2	6.2	0.8	103.2	19.1	-6.4	-219.1	-3.2	7.3	0.8	104.0	31.2
2016	18	-1.2	-101.8	1.2	5.8	0.8	103.0	14.8	-2.6	-136.2	0.1	6.3	0.8	103.3	19.7	-6.1	-226.9	-2.8	7.4	0.8	104.1	32.5
2017	19	-1.1	-103.7	1.5	5.9	0.8	103.1	15.2	-2.4	-139.5	0.4	6.4	0.8	103.4	20.3	-5.8	-234.3	-2.4	7.4	0.8	104.2	33.6
2018	20	-0.9	-105.2	1.7	6.0	0.8	103.2	15.5	-2.2	-142.6	0.7	6.5	0.8	103.5	20.8	-5.5	-241.1	-2.0	7.5	0.8	104.4	34.8
2019	21	-0.7	-106.5	1.9	6.1	0.8	103.3	15.7	-2.0	-145.3	1.0	6.6	0.8	103.6	21.3	-5.2	-247.5	-1.6	7.6	0.8	104.5	35.8
2020	22	-1.8	-147.6	1.2	6.6	0.8	103.7	21.8	-5.0	-253.4	-1.3	7.7	0.8	104.6	36.8	-5.0	-253.4	-1.3	7.7	0.8	104.6	36.8

CA: current account balance in % of GDP; NFA: net foreign assets in % of GDP; TB: trade balance in % of GDP; IR: interest rate in %;  
RER: real exchange rate/inverted terms of trade; RER2: real exchange rate index; GAS: global asset share in % of total assets

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