# Structural asymmetries and financial imbalances in the eurozone

Ivan Jaccard and Frank Smets*

August 3, 2017

**Abstract**

Many southern European economies experience large capital inflows during periods of expansion that are followed by abrupt reversals when recessions hit. This paper studies the dynamics of capital flows between the North and the South of Europe in a two-country DSGE model. We show that the dynamics of capital flows observed in the eurozone can be explained by introducing differences in the degree of financial frictions between regions. Combining financial frictions in domestic credit environments with habit formation generates asymmetries in the propagation mechanism of shocks that are common to both regions. This mechanism provides an explanation for the procyclicality of net capital inflows observed in the South of Europe and generates a higher welfare cost of business cycle fluctuations in the region most affected by financial frictions.

- *Keywords:* Cross-border financial markets, eurozone crisis, incomplete international asset markets, structural reforms.
- *JEL:* F32, F20, G17.

*European Central Bank. The views expressed in this paper are those of the authors and do not necessarily reflect the views of the European Central Bank or the Eurosystem. A previous version of this paper has circulated under the title: "Capital flows, intermediation frictions and the adjustment to common shocks". This project has benefited from comments and suggestions from M. Ehrmann, S. Schmitt-Grohé, M. Onofri, D. Krueger, C. Tille, M. Aguiar, M. Chang, G. Gopinath, B. Eichengreen, M. Hoffmann, U. Jermann, D. Lopez-Salido, V. Quadrini, P. Bacchetta, J. Gali, D. Sandri, R. Wouters, L. Dedola, G. Dlugoszek, R. Kollmann and from conference/seminar participants at the DNB, the 2015 Bank of Korea International Conference, The 2015 Bank of Spain/Banque de France conference on Structural reforms, T2M 2015, Humboldt University, the University of Nottingham, the ECB and the NY Fed/Banque de France workshop on cross-border capital flows.

# 1 Introduction

As illustrated by Figure A.1, a main characteristic of the eurozone business cycle is that the current account of Germany vis-à-vis the South of Europe is positively correlated with GDP in Germany.[1] By contrast, and as illustrated by Figure A.2, in the South, the region's current account vis-à-vis Germany is strongly negatively correlated with output.[2] As shown in Figure A.3, there is also a high degree of output synchronization between the North and the South of Europe. The dynamics of current accounts between the North and the South of Europe therefore implies that net capital inflows are procyclical in the South and countercyclical in the North.

The main objective of this paper is to develop and study a simple model mechanism that could explain the dynamics of capital flows observed at business cycle frequency in the eurozone. Our goal is to develop a two-region dynamic general equilibrium model that could broadly reproduce the stylized facts documented above. The proposed theoretical framework is then used to study the welfare implications of cross-border capital flows.

Our main thesis is that differences in the degree of financial frictions between the North and the South of Europe are a key driver of cross-border capital flows in the eurozone. Our main hypothesis can firstly be motivated by the fact that Southern European economies are considerably more reliant on bank credit than Germany. This difference is illustrated in Figure A.4, which reports the average loan-to-output ratios observed in the two regions, where Southern Europe consists of Italy, Spain and Portugal. A second key structural difference between the two regions is that contracts are typically more difficult to enforce in the South than in Germany. As illustrated by Figure A.5, the evolution of the rule of law index, which is an indicator of the ease at which contracts can be enforced, demonstrates that the quality of institutions is an important dimension along which the two regions have failed to converge. Other measures of contract enforcement, such as the strength of legal right index, confirm that differences in legal systems across Europe remain a key source a cross-country heterogeneity.[3]

[1] Over the period from 1995 to 2016, the HP-filtered correlation between the current account of Germany vis-à-vis South Europe and output in Germany is 0.55.

[2] The HP-filtered correlation between the current account and GDP in the South in Figure A.2 is -0.74.

[3] In 2014 the strength of legal right index was about 3 times higher in Germany than in Italy, which are two of the largest eurozone economies. Source: World Development Indicators. Differences in these indicators reflect structural factors such as the time needed to enforce a contract. As an average over the period from 2003 to 2014, it took about 400 days to enforce a contract in Germany. In Italy, over the same

In the model economy that is envisioned, these structural differences are accounted for by introducing two structural parameters measuring the degree of financial frictions. First, the extent to which credit is needed to finance production is determined by a loan-in-advance constraint, which is a standard way to introduce a role for financial intermediation. This constraint measures the degree of dependence of the economy on its domestic banking sector. The second main departure from the frictionless benchmark is that we interact this loan-in-advance constraint, which creates a demand for bank loans in each region, with an incentive compatibility constraint. The aim of this second constraint is to formalize the idea that the legal structure of an economy is likely to play a key role in a debitor's decision to potentially default on its loan. This effect is captured by introducing a structural parameter that affects the tightness of this incentive compatibility constraint. Since in the model this parameter value affects the default decision by modifying the payoff from walking away, we interpret it as reduced form proxy for the quality of a country's institutions.

Agents in our economy accumulate two types of assets: physical capital and a safe financial asset that is purchased from abroad. The stock of domestic physical capital is immobile whereas the financial asset is a one period risk-free bond that can be traded across borders. A country's net foreign asset position depends on the net outstanding amount of safe financial assets purchased and issued on the international financial market. The structure of our model therefore allows us to study fluctuations in current account balances from the perspective of international capital flows. While domestic lending between entrepreneurs and bankers is subject to the two frictions discussed above, a key assumption is that financial markets are frictionless in the sense that the asset that is traded across borders is risk-free.

Our main finding is that introducing a higher degree of financial frictions in the South provides an explanation for the dynamics of capital flows observed in the eurozone. This result is obtained in a model able to broadly reproduce a set of macroeconomic moments that characterize business cycle fluctuations in the North and the South of Europe. Introducing a higher value for the loan-in-advance parameter in the South allows our model to match the difference in loan-to-output ratios shown in Figure A.4. The sign of the correlation coefficients between output and the current account in each region can be reproduced if the incentive compatibility constraint in tighter in the South, which is in line with the evidence on contract enforcement discussed above. Introducing differences in contract enforcement

period, the average number of days required to enforce a contract was higher than 1'200 days.

and in the extent to which bank credit is needed to finance production also allows this model to explain why consumption is more volatile in the South. Firms in the South need more credit than firms in the North to operate and credit in the South is more difficult to obtain because contracts are more difficult to enforce. These two effects work in the same direction and both contribute to make financial frictions more costly in the South than in the North. The procyclicality of net capital inflows in the South is therefore explained by introducing differences in these two structural parameters that characterize the degree of financial frictions in each region.

Interacting differences in the degree of financial frictions with a particular habit motive (e.g., Jaccard 2014) is the key mechanism that allows our two-region model to quantitatively reproduce the main difference in business cycle dynamics observed across the two regions. With a standard preference specification, a model with common shocks and different degrees of financial frictions generates business cycle dynamics that are very similar across regions and fluctuations in current account balances of a much smaller magnitude. When combined with habits, the key is that tighter financial frictions in the South strengthen the internal propagation mechanism of shocks in that region. Although shocks are common, this difference in propagation mechanisms allows our model to generate the difference in business cycle dynamics that is needed to match the set of business cycle moments shown in Table 2.

The model main mechanism relies on the fact that financial frictions introduce an endogenous wedge that distorts the allocation of resources by altering the marginal productivity of production factors. Relative to a frictionless model, the size of this wedge critically depends on the two financial friction parameters. The distorsion caused by financial frictions is larger in the South because credit is more difficult to obtain and firms in that region need larger quantities of credit in order to finance production. In terms of the main equations of the model, this difference in the degree of financial frictions implies that the size of the wedge that distorts the marginal product of factors is larger in the South than in the North.

Introducing a habit motive amplifies the propagation mechanism of shocks and the magnitude of this effect depends on the degree of financial frictions. The intuition for this result is that financial frictions hurt agents because they make consumption smoothing more difficult to achieve. This effect is amplified by this preference specification because habits create a strong consumption smoothing motive and the time-varying distorsion caused by financial frictions makes this consumption smoothing objective more difficult to achieve. Since a

higher degree of financial frictions increase the desire to transfer consumption across times, the key is that this mechanism creates an intertemporal smoothing motive that is stronger in the region most affected by the distorsion. In good times, agents in the most affected region therefore devote a larger share of output to investment, which in turn stimulates capital accumulation. In boom periods, the larger increase in capital accumulation induced by this stronger consumption smoothing motive has a larger stimulative effect on production and profits in the most affected region. A stronger increase in southern firm value in turn generates a credit boom of a larger magnitude in that region. Since an increase in the discounted value of future profits relaxes the incentive compatibility constraint, this effect is therefore larger in the South than in the North.

Given this stronger intertemporal smoothing motive, whether our mechanism generates an improvement or a deterioration in the current account in the South depends on the asset that agents choose to achieve consumption smoothing. If agents choose to accumulate net foreign assets, the current account improves and a deterioration of the current account is obtained if agents reduce net foreign asset accumulation in response to a positive shock. Since capital only depreciates slowly over time, physical capital accumulation is a better hedge than the short-term financial asset. Given that physical capital is the preferred asset to achieve consumption smoothing, the key is that agents in the South choose to use the financial asset to finance an increase in capital accumulation in good times. The deterioration in the current account in the South that occurs in good times therefore reflects that agents in that region use the cross-border asset market to finance domestic capital accumulation. In other words, in boom periods, the South increases its net issuance of financial assets and the resulting decline in net foreign asset accumulation provides a source of revenue that can be used to increase the economy's stock of physical capital. The dynamics of capital accumulation induced by this stronger intertemporal smoothing motive therefore leads to a net capital inflow that is used to finance a current account deficit in the South during periods of economic expansion.

**Literature review.** The starting point of our analysis is the basic two-country version of the standard one-sector stochastic growth model with complete asset markets (e.g, Backus et al. 1992; Baxter 1995). The first key departure from the baseline model is the introduction of restrictions in the extent to which international capital markets permit to pool risk across economies. Following Cole (1988), Baxter (1995), Baxter and Crucini (1995),

Kollmann (1996), Arvanitis and Mikkola (1996), Boileau (1999), Heathcote and Perri (2002) and Corsetti et al. (2008) among others, we develop a model in which individuals have incomplete access to international risk-sharing.

Our work also builds on the literature that studies the dynamics and long-run determinants of global imbalances between countries with heterogeneous financial markets. In Mendoza et al. (2009), financial integration between two countries in different stages of financial development generates the evolution of imbalances between the United States and China observed over the last decades. In their model, differences in the degree of financial development are captured by two structural parameters characterizing the degree of contract enforcement and the extent to which limited liability is applied. In Caballero et al. (2008), the main mechanism relies on differences in countries' ability to generate financial assets from real investments. They show that a collapse in asset market in one region leads to an increase in the demand for foreign assets, which in turn generates an improvement in the country's net foreign asset position.

Relative to these two influential studies, the main difference is that in our model the effects of structural asymmetries are amplified by introducing a particular habit formation motive into the analysis (e.g., Jaccard 2014). As in Jaccard (2017), interacting this particular specification of habit formation with financial frictions strengthens the model's endogenous propagation mechanism. In the context of two-country DSGE models, precautionary motives and risk considerations also play a central role in the analysis of Gourio et al. (2013) and Fogli and Perri (2015). When differences in contract enforcement are the only source of cross-country heterogeneity, our model predicts that the volatility of output and consumption should be higher in the region experiencing procyclical net capital inflows, which is in line with the stylized facts on emerging market economies documented in Aguiar and Gopinath (2007).[4]

This paper also contributes to the literature initiated by the euro area crisis. Reis (2013) emphasizes the role played by frictions leading to a misallocation of resources (see also Mongelli et al. 2016). Gopinath et al. (2017) document a significant loss in total factor productivity in South Europe and develop a small open economy model with heterogeneous firms that is able to rationalize these novel empirical findings. In their model, the decline in total factor productivity is due to a misallocation of resources that is caused by a capital

[4]See also Schmitt-Grohé and Uribe (2016) for a more recent overview of the stylized facts.

wedge. Gilchrist et al. (2015) study imbalances in the eurozone in a model in which financial frictions affect the pricing behaviour of firms. Their approach also emphasizes the importance of introducing differences in degrees of financial market distortions across the North and South of Europe. Kollmann et al. (2014) estimate a three country DSGE model and explain the boom-bust cycle in Spain by combining financial frictions with risk premium shocks. Rubio (2014) studies the implications of cross-country housing-market heterogeneity for the transmission mechanism of shocks in a monetary union.

Fernández-Villaverde and Ohanian (2015) argue that the stagnation observed in some European economies can be attributed to sluggish productivity growth originating from political economy distortions (see also Fernandez-Villaverde et al. 2013). Using a large panel of countries, Challe et al. (2016) document that persistent capital inflows are systematically followed by a decline in the quality of domestic institutions and develop a model in which government intervention plays a role in allocating resources to the private sector. Martin and Phillipon (2017) develop a model that can be used to study the nexus between fiscal policy, credit and current account dynamics and conclude that stronger fiscal discipline during the boom would have made the recession less severe in some Southern European economies (see also Gourinchas et al. 2016).

Another strand of the literature studies the contribution of expectations about long-run growth in driving current account dynamics (e.g., Hoffmann et al. 2013). Following a related approach, Siena (2014) explains imbalances in the eurozone by estimating the contribution of anticipated shocks, whereas Bonam and Goy (2017) study imbalances in a monetary union by introducing a home bias in expectations.

Finally, concerns that diverging economic structures could lead to asymmetries in the monetary policy transmission mechanism were documented in the early stages of the euro area's existence.[5] In Cecchetti (1999) for instance, differences in financial structure across European economies are attributed to their dissimilar legal structure (see also Danthine et al. 1999). This argument, which also draws on the work of La Porta et al. (1997, 1998), is motivated by a series of empirical facts demonstrating the impact of the legal system of a country on the structure of financial intermediation. In the same vein, Cacciatore et al. (2016) focus on product and labor market deregulation and study the implications of asymmetric deregulation for the conduct of optimal monetary policy in the eurozone

[5] Differences in the transmission mechanism of monetary policy are for instance documented by Ehrmann (1998)

# 2 The model

The economy is composed of two regions, the North and the South, that are linked by a financial market that can be used to trade securities. International markets are incomplete and each domestic economy is composed of a representative agent, a financial intermediary, and a representative firm. A role for banks is introduced by assuming that in each region the non-financial sector needs to obtain a loan to pay workers and foreign as well as domestic capital owners in advance. The extent to which external financing is needed is determined by the tightness of the loan-in-advance constraint. Institutional differences are captured by introducing a "walk away" constraint that links the amount of external financing that non-financial corporations can obtain to the quality of the country's institutional framework.

**The competitive equilibrium in the North**

The notation $\widetilde{y}$ is adopted to denote variables, such as output, that represent prices or quantities in the South and $y$ will be the corresponding counterpart in the North. Technology and preferences are consistent with balanced growth and stationary variables are denoted using capital letters. Small letters are used to denote detrended variables and the deterministic growth rate along the balanced growth path is denoted by $\gamma$. Since the market structure across the two blocks is identical, we focus the analysis on the Northern economy.

**The non-financial corporate sector**

In period $t$, profits in the non-financial sector are given as follows:

$$\pi_{Ft} = y_t - r_{Kt}k_t - w_t N_t - r_{Lt}l_t, \tag{1}$$

The final output good, which is denoted by $y$, is produced by firms in the non-financial corporate sector using hours worked $N$ and domestic capital $k$. Domestic capital and hours worked are both supplied by the domestic household. $r_K$ is the cost of renting domestic capital from the domestic consumers, $w$ is the wage paid to workers. The total cost from obtaining external finance from the domestic banking sector is denoted by $r_L l$, where $r_L$ is the cost of borrowing funds from the domestic financial intermediary.

The production function takes a Cobb-Douglas form with constant returns to scale:

$$y_t = A_t k_t^{\alpha} N_t^{1-\alpha}, \tag{2}$$

where $k$ is the quantity of domestic capital allocated to the production of the final output good, and where the labor share is denoted by $1-\alpha$. The technology shock that is common to both regions is denoted by $A_t$ and follows an autoregressive process of order one:

$$\log A_t = \rho_A \log A_{t-1} + \varepsilon_{At},$$

where $\varepsilon_{At}$ is a random disturbance that is normally distributed and $\rho_A$ is the autoregressive parameter. Technology shocks are the only source of business cycle fluctuations and are common to both country blocks.

A role for banks is introduced by assuming that firms need to obtain a loan to pay inputs in advance. The loan-in-advance constraint can be expressed as follows:

$$l_t \geq \eta \left( w_t N_t + r_{Kt} k_t \right), \tag{3}$$

where $\eta$ is the parameter that determines the tightness of the constraint. The model reduces to a frictionless economy when $\eta$ is set to 0. In the South, the tightness of the loan-in-advance constraint is denoted by $\widetilde{\eta}$.

The impact of the legal system on credit is captured by assuming that entrepreneurs in the final-good sector default and run away with the funds borrowed from banks, if the value of their debt exceeds the net present value from operating the firm for a sufficiently long period of time (e.g., Jermann and Quadrini 2012). Bankers understand this incentive structure and make sure that entrepreneurs always have the incentive to reimburse the loan so that default never occurs in equilibrium. This incentive compatibility constraint, which is internalized by entrepreneurs, implies that the maximum amount that firms can borrow is given as follows:

$$\mu l_t \leq V_t, \tag{4}$$

where $V$ denotes the present value from operating the firm. For simplicity, $V$ is expressed as the infinite discounted sum of future profits, which can be expressed in recursive form as follows:

$$V_t = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left[ \pi_{Ft+1} + V_{t+1} \right], \tag{5}$$

Since firms in the final-good sector are owned by the representative agent, managers use the

stochastic discount factor of the agent, which is denoted by $\beta E_t \lambda_{t+1}/\lambda_t$ to discount future profits. The impact of the country's institutional framework on agents' access to credit is captured by the parameter $\mu$. A lower value for $\mu$ decreases the payoff from defaulting and therefore makes it less likely that the case $\mu l > V$ will occur. A lower value for this parameter therefore corresponds to an improvement in the country's institutional framework and reduces debtors' incentives to walk away with the loan. By lowering the payoff from defaulting, a lower value for $\mu$ implies that for a given value of $V$, more credit will be extended to firms. Our interpretation of this parameter is therefore that it captures the ease at which contracts can be enforced.

Managers in the final goods-producing sector maximize the discounted value of future dividends:

$$\max_{N_t, k_t, l_t} E_0 \sum_{t=0}^{\infty} \widehat{\beta}^t \frac{\lambda_t}{\lambda_0} \pi_{Ft},$$

subject to equations (1) to (4) and where $\widehat{\beta}$ is the modified discount factor (e.g., Kocherlakota 1990).

**Households**

The period $t$ budget constraint of the representative household is given by the following equation:

$$\pi_{Tt} + r_{Kt} k_t + r_{Dt} d_t + w_t N_t + p_{St} \gamma s_{t+1} + \widetilde{s}_t = c_t + i_t + \kappa d_t + s_t + \varsigma s_t + \widetilde{p}_{St} \gamma \widetilde{s}_{t+1}, \quad (6)$$

and the representative agent divides his or her time between leisure activities $L$, and hours worked in final goods-producing sector $N$ :

$$L_t = 1 - N_t, \quad (7)$$

The wage rate received by workers is denoted by $w$ and total income also consists of a revenue from depositing funds in the banking sector, $r_D d$, where $r_D$ denotes the rate at which deposits are remunerated. The representative agent owns the domestic intermediary as well as firms in the final goods-producing sector and total dividend income is denoted by $\pi_T$. Consumption expenditures are denoted by $c$, and $k$ is the stock of domestic capital accumulated by the agent. Households incur a monitoring cost when supplying deposits to

the banking sector. The monitoring cost takes the form of a fixed cost that is proportional to the amount deposited and is denoted by $\kappa$. With this structure, the supply of deposit will therefore be completely elastic.

The presence of a cross-border financial market also allows households in the North to share risk by issuing a domestic risk-free asset that is purchased by agents in the South. In period $t$, the revenue from selling a domestically issued risk-free asset to consumers in the South is denoted by $p_S s$, where $p_S$ denotes the asset price. On the expenditures side, the coupon paid in period $t$ by domestic agents to remunerate bondholders who purchased the quantity of safe asset issued in $t-1$ is denoted by $s$. To ensure that the problem is well-behaved, we further assume that issuing financial assets is costly and that issuers incur a fixed cost that is proportional to the stock of safe asset available at time $t$. The fixed cost of issuing debt is denoted by $\varsigma$.

Similarly, agents in the North have access to a one-period risk-free bond that is issued by agents in the South. On the expenditure side, the quantity of foreign bonds purchased at time $t$ is denoted by $\widetilde{s}$, where $\widetilde{p}_S$ is the price of the bond issued by agents in the South. On the revenue side, $\widetilde{s}$ denotes the payment received from holding the quantity of foreign bonds that was purchased in period $t-1$. The issue of steady state indeterminacy is avoided by assuming that agents in each country derive utility from holding the stock of safe asset issued by consumers in the other region. In the North, a demand for safe assets is therefore obtained by introducing $\widetilde{s}$ directly into the utility function. We simplify the analysis by abstracting from domestic issuance of bonds purchased by domestic agents, since domestic flows have no effect on the current account.

Following Baxter and Crucini (1993) among others, we assume that capital accumulation is subject to an adjustment cost and adopt the following functional form:

$$\gamma k_{t+1} = (1-\delta)k_t + \left(\frac{\theta_1}{1-\epsilon}\left(\frac{i_t}{k_t}\right)^{1-\epsilon} + \theta_2\right)k_t, \tag{8}$$

where $i$ denotes investment and $\delta$ is the depreciation rate of capital. The parameter that determines the elasticity of Tobin's Q with respect to changes in the investment to capital ratio is denoted by $\epsilon$. The two constant $\theta_1$ and $\theta_2$ are calibrated to ensure that the introduction of adjustment costs has no effect on the deterministic steady state of the model.

Relative to the specification of preferences studied in Jaccard (2014), we assume that habits are formed over a composite good consisting of consumption, the stock of safe asset

and leisure. The law of motion for the habit stock is given as follows:

$$\gamma x_{t+1} = m x_t + (1-m) c_t^{\varkappa} \widetilde{s}_t^{1-\varkappa} (\psi + L_t^{\upsilon}), \tag{9}$$

where $m$ is the habit parameter that controls the speed at which the habit stock depreciates. The share of consumption in utility is denoted by $\varkappa$. Each period, the representative household chooses optimally consumption, hours worked, the quantity of deposits to allocate to the banking sector, investment and controls the evolution of its capital stock, its habits stock, its stock of foreign asset and the stock of safe asset issued to foreigners by maximizing lifetime expected utility,

$$\max_{c_t, N_t, d_t, i_t, k_{t+1}, x_{t+1}, s_{t+1}, \widetilde{s}_{t+1}} E_0 \sum_{t=0}^{\infty} \widehat{\beta}^t \log \left[ c_t^{\varkappa} \widetilde{s}_t^{1-\varkappa} (\psi + L_t^{\upsilon}) - x_t \right],$$

subject to constraints (6) to (9).

**Banks**

In each country block, the provision of credit is undertaken by a regional banking sector that simply channels funds from households to firms in its domestic non-financial sector. Profits in the banking sector are given as follows:

$$\pi_{Bt} = r_{Lt} l_t - r_{Dt} d_t,$$

We assume that the technology used by banks to transform deposits into loans is linear in deposits:

$$l_t = z d_t,$$

where $z$ is an exogenous technology parameter measuring the efficiency of the financial intermediation sector.

**Market equilibrium**

A competitive equilibrium in the economy is a sequence of prices:

$$w, \widetilde{w}, r_L, \widetilde{r}_L, r_D, \widetilde{r}_D, \lambda, \widetilde{\lambda}, V, \widetilde{V}, \varpi, \widetilde{\varpi}, \psi, \widetilde{\psi}, p_S, \widetilde{p}_S$$

where $\varpi$ and $\widetilde{\varpi}$ denote the Lagrange multipliers associated with the loan-in-advance con-

straints in the two regions, $\psi$ and $\widetilde{\psi}$ are the Lagrange multipliers associated with the incentive compatibility constraints in each region, $\lambda$ and $\widetilde{\lambda}$ marginal utility, and quantities:

$$l, \widetilde{l}, y, \widetilde{y}, c, \widetilde{c}, i, \widetilde{i}, d, \widetilde{d}, N, \widetilde{N}, k, \widetilde{k}, s, \widetilde{s}$$

that satisfy households and firms efficiency conditions as well as the two resource constraints:

$$y_t + \widetilde{s}_t + \gamma p_{St} s_{t+1} = c_t + i_t + \kappa d_t + (1+\varsigma)\, s_t + \gamma \widetilde{p}_{St} \widetilde{s}_{t+1},$$

$$\widetilde{y}_t + s_t + \gamma \widetilde{p}_{St} \widetilde{s}_{t+1} = \widetilde{c}_t + \widetilde{i}_t + \widetilde{\kappa} \widetilde{d}_t + (1+\widetilde{\varsigma})\, \widetilde{s}_t + \gamma p_{St} s_{t+1},$$

for all states, for t=1...$\infty$, and given initial values for the six endogenous state variables $k, \widetilde{k}, x, \widetilde{x}, s$ and $\widetilde{s}$.[6]

**Financial imbalances**

In the context of our model, the current account in the North is given by domestic absorption, which can be defined as follows:

$$ca_t = y_t - c_t - i_t - \kappa d_t - \varsigma s_t,$$

Similarly, in the South, the current account is given as follows:

$$\widetilde{ca}_t = \widetilde{y}_t - \widetilde{c}_t - \widetilde{i}_t - \widetilde{\kappa} \widetilde{d}_t - \widetilde{\varsigma} \widetilde{s}_t,$$

and the aggregate market clearing condition implies that:

$$ca_t = -\widetilde{ca}_t,$$

From the perspective of international capital flows, the current account can equivalently be expressed as the change in net foreign asset position[7] minus the income received from holding the foreign asset:

$$ca_t = (\gamma \widetilde{p}_{St} \widetilde{s}_{t+1} - \gamma p_{St} s_{t+1}) - (\widetilde{s}_t - s_t),$$

[6] In each country, the aggregate resource constraint is obtained by substituting the expressions for profits in the budget constraint of the households, who owns the domestic banking and corporate sectors.

[7] where we have assumed that the international foreign assets are one period assets, *i.e.* assets that depreciate fully after one period.

$$\widetilde{ca}_t = (\gamma p_{St} s_{t+1} - \gamma \widetilde{p}_{St} \widetilde{s}_{t+1}) - (s_t - \widetilde{s}_t),$$

# 3 Calibration

Whenever possible, we use available empirical evidence to calibrate the main structural parameters of the model. A first set of parameters is chosen to match long-run steady state ratios following standard practice in the real business cycle literature. As second set of parameters is calibrated to maximize the model's ability to reproduce a series of key stylized facts characterizing the dynamics of the main business cycle aggregates in the North and South of Europe.

**Labor supply, subjective discount factor and capital share**

To our knowledge, differences in labor supply characteristics or capital intensities are not significant sources of cross-country heterogeneity in the eurozone. We therefore assume that these parameters are identical across country blocks and calibrate them using values that are considered standard in the real business cycle literature (e.g., King, Plosser and Rebelo 1988; King and Rebelo 1999). The two labor supply parameters, $\upsilon$ and $\psi$ in the North and $\widetilde{\upsilon}$ and $\widetilde{\psi}$ in the South, are set to ensure that the Frisch elasticity of labor supply is approximately equal to 3 in each country block and that agents spend on average 20% of their time on work related activities. The capital share parameters $\alpha$ and $\widetilde{\alpha}$ are set to 1/3. We also assume that the subjective discount rates of time preference $\beta$ and $\widetilde{\beta}$ are identical across country blocks and set this parameter value to 0.99, which is a standard choice.

**Cross-border asset market**

The introduction of a cross-border market for safe assets adds four structural parameters into the analysis. The fixed cost of issuing the safe asset and the utility share of the safe asset stock in the North and South are denoted by $\varsigma$ and $\widetilde{\varsigma}$, and $1-\varkappa$ and $1-\widetilde{\varkappa}$, respectively. In the absence of evidence suggesting otherwise, we assume that the structure of the cross-border asset market is symmetric across country blocks. In each country, the fixed cost of issuance is set to 0.02, which implies that a cost amounting to two percent of the total stock of debt must be paid each period to issue debt internationally. The consumption share in the utility function is set to 0.99, implying a utility weight for the safe asset stock of 0.01 in each country.

**Deterministic growth rates**

Over the period from 1996 to 2016, the average quarterly growth rate of output stood at 0.35% and 0.27% in North and in the South, respectively. Once uncertainty is taken into account, it is not possible to reject the null hypothesis that the estimated mean growth rates are equal across country blocks. We therefore assume a common deterministic trend rate $\gamma$ and set this parameter value to 1.003, which is in line with these estimates.

**Financial intermediation**

Given that lending and borrowing costs are a potentially important source of cross-country heterogeneity, we use harmonized data on lending and borrowing rates to calibrate the set of parameters associated with the structure of financial intermediaries across the two regions. Real rates are obtained by deflating the nominal values computed for each country using the corresponding harmonized index of consumer prices.

Given the simplifying assumption that deposit rates in each region are determined by monitoring costs, the two parameters $\kappa$ and $\widetilde{\kappa}$ can be used to calibrate the average cost of funding in each country block, that is $E(r_D)$ and $E(\widetilde{r}_D)$, respectively, and we use data on deposit rates to calibrate these two parameter values.[8] As an average over the period from 2000 to 2016, the average real rate paid on deposits with maturity of less than a year to non-financial corporations, households and non-profit institutions serving households stood at 0.08%, 0.15%, 0.11% and 0.43% in Germany, Italy, Spain and Portugal, respectively. Using GDP weights to compute a weighted average, we obtain an average deposit rate of 0.16% in the South vs. 0.08% in the North. The 95% confidence interval for the estimated mean ranges from -0.19% to 0.36 in the North and from -0.09% to 0.40% in the South. Given that the difference in average deposit rates across the two country blocks is not statistically significant, we set $\kappa$ equal to $\widetilde{\kappa}$. Setting the common monitoring cost parameter to 0.0003 implies a value for the steady state annualized deposit rate in the two regions of 0.12%.

Since the financial efficiency parameters $z$ and $\widetilde{z}$ drive a wedge between deposit and lending rates, we use data on short-term loans to non-financial corporations to calibrate these two parameters. As an average over the period from 2003q1 to 2016q3, the real interest rate paid by non-financial corporations for loans with a maturity of less than a year stood at 1.64%, 1.57%, 1.55% and 3.41% in Germany, Italy, Spain, and Portugal, respectively. Using country weights to compute an aggregate measure of the cost of lending

[8] See data appendix.

in the South of Europe, we obtain an average borrowing rate in that region of 1.68%. Given that the difference in average short-term real lending costs is not statistically significant, i.e. 1.66% in Germany vs. 1.68% in the South, we assume that the two parameters capturing the efficiency of financial intermediation are identical across the two regions. Setting this parameter to 0.0659 implies a steady state borrowing cost of 1.67%.

**Moment matching procedure**

The remaining parameters are calibrated to maximize the model's ability to jointly reproduce a series of stylized facts characterizing the dynamics of the main business cycle aggregates in both regions. This first set of empirical facts consists of the standard deviation of output, consumption, investment and of the correlation between the current account and output in each country. The corresponding twelve empirical moments are reported in Table 2, where the 95% confidence intervals for the estimated means and standard deviation have been added in brackets.

TABLE 1: BENCHMARK CALIBRATION

| $\sigma_A$ | $\rho_A$ | $\epsilon$ | $\widetilde{\epsilon}$ | $m$ | $\widetilde{m}$ | $\mu$ | $\widetilde{\mu}$ | $\eta$ | $\widetilde{\eta}$ | $\delta$ | $\widetilde{\delta}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0074 | 0.95 | 0.02 | 0.1 | 0.3 | 0.982 | 2 | 8 | 1.4 | 3.0 | 0.012 | 0.055 |

The twelve remaining parameters to calibrate include the two habit and adjustment costs parameters, which are denoted by $m$, $\widetilde{m}$, $\epsilon$ and $\widetilde{\epsilon}$ and which affect the volatility of output, consumption, investment and the correlation between the trade balance and output. In each country block, the ease at which contracts can be enforced is captured by the two parameters $\mu$ and $\widetilde{\mu}$. For any given values of $V$ and $\widetilde{V}$, a weaker institutional environment, which in this model implies higher values for $\mu$ and $\widetilde{\mu}$, makes it less likely that the incentive compatibility constraint will be satisfied. A tighter incentive compatibility constraint not only reduces the equilibrium quantity of loans that firms will obtain but also affects the volatility of all business cycle aggregates. Whereas it is difficult to associate these two parameters with one moment in particular, the two contract enforcement parameters will mainly be identified by the two output-current account correlation coefficients.

In equilibrium, the loan to output ratios also critically depend on the value of the two financing-in-advance parameters $\eta$ and $\widetilde{\eta}$, which we also include in the set of parameters to calibrate using this moment matching procedure. The extent to which non-financial

corporations rely on bank lending is an important source of structural heterogeneity across the two regions. This is accounted for by choosing values for $\eta$ and $\widetilde{\eta}$ that maximize the model's ability to match the average loan to output ratios observed in the data (*i.e.*, 1.35 in the North and 2.32 in the South). The depreciation rate parameters $\delta$ and $\widetilde{\delta}$ are calibrated to ensure that the average investment to output ratios observed in the data can be matched. As an average over the period from 1996 to 2016, the average investment to output ratios stood at 0.20 in the North and 0.22 in the South. Finally, the shock standard deviation and shock persistence parameters $\sigma_A$ and $\rho_A$ are the last two degrees of freedom that can be exploited to match this set of moments. The outcome of this moment matching procedure is shown in Table 2, which reports the combination of parameter values that maximizes the model's ability to reproduce these stylized facts.

Table 2: Business Cycle Moments (HP-filtered Statistics)

| | Data | | | Data | |
|---|---|---|---|---|---|
| | Estimated [95% CI] | Model | | Estimated [95% CI] | Model |
| $\sigma_{\log y}$ | 1.53 [1.33, 1.80] | 1.36 | $\sigma_{\log \widetilde{y}}$ | 1.22 [1.02, 1.43] | 1.41 |
| $\sigma_{\log c}$ | 0.50 [0.44, 0.59] | 0.50 | $\sigma_{\log \widetilde{c}}$ | 1.02 [0.88, 1.20] | 0.91 |
| $\sigma_{\log i}$ | 5.02 [4.37, 5.92] | 4.48 | $\sigma_{\log \widetilde{i}}$ | 3.79 [3.30, 4.47] | 3.83 |
| $\rho(\log y_t, ca_t)$ | 0.55 [0.39, 0.68] | 0.62 | $\rho(\log \widetilde{y}_t, \widetilde{ca}_t)$ | -0.74 [-0.63, -0.82] | -0.49 |
| Steady state ratios | | | | | |
| $E(i/y)$ | 0.20 [0.20, 0.21] | 0.20 | $E(\widetilde{i}/\widetilde{y})$ | 0.22 [0.21, 0.22] | 0.22 |
| $E(l/y)$ | 1.35 [1.32, 1.37] | 1.35 | $E(\widetilde{l}/\widetilde{y})$ | 2.32 [2.23, 2.41] | 2.32 |

Note. $\sigma$ denote the HP-filtered standard deviation, $\rho()$ is the correlation coefficient, and $E()$ denotes the unconditional expectation.

**Are the constraints always binding?**

We verified that the constraints are always strictly binding by checking that in both regions the Lagrange multipliers associated with the financing-in-advance and walk away constraints (see equations 3 and 4 for the Northern economy) are always strictly positive in a large sample of simulated data. We also solved a version of the model without the financing-in-advance constraints, without the walk away constraints, and without both constraints and verified that the constraints are always strictly binding.

# 4 Results

As illustrated in Table 2, the model with one single aggregate technology shock is able to broadly reproduce the 12 moments that were targeted. It is possible to reproduce the significant difference in consumption and investment volatilities observed across the two regions in a model able to jointly match long-term ratios, such as the investment to output or loan to output ratios.

The lower consumption volatility observed in the North can be reproduced by setting the habit parameter in the North to 0.3 vs. 0.982 in the South, implying a stronger habit formation motive in the surplus region. Similarly, the lower investment volatility and higher consumption volatility in the South can be replicated by introducing adjustment costs that are higher in the South. In a model with one single source of shocks, it would not be possible to generate differences in investment and consumption volatilities of this magnitude without introducing heterogeneity in the extent to which contracts can be enforced. As illustrated in Table 1, a higher value for $\widetilde{\mu}$ is required in order to generate the higher volatility of consumption and lower volatility of investment observed in the South, implying an institutional framework that is weaker in the South than in the North.

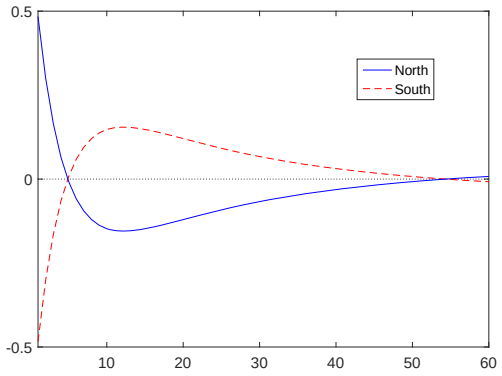


Figure 1. Response of the trade balance in the North and South to a positive shock. y axis: Level deviation from steady state normalized by steady state level. x axis: quarters after the shock.

Figure 1 shows the response of the current account in both regions to a positive technology shock. In response to a positive technology shock, this illustrates that the model generates net capital flows from the North to the South. In terms of financial flows, the increase in current account deficit in the South that occurs during periods of booms implies that $(\widetilde{p}_{St}\gamma\widetilde{s}_{t+1} - \widetilde{s}_t)$

must exceed $(p_{St}\gamma s_{t+1} - s_t)$, and therefore that the South finances its current account deficit by issuing debt that is purchased by agents in the North. The presence of a cross-border financial market therefore allows households in the South to consume and invest in excess of what can be produced domestically. Similarly, production exceeds domestic absorption in the North during boom periods, as the quantity of capital exported by the region increases.

Since the current account can take negative values, the impulse responses in Figure 1 are shown in deviation from steady state level, *i.e.* $(ca_t - ca)/ca$ in the North. The magnitude of the variation reported in Figure 1 illustrates that this mechanism generates fluctuations in current account balances that can be very large. Table 3 below compares the volatility of the current account to output ratio in the North obtained in the model with the one observed in the data and reports in bracket the 95% confidence interval for the estimated standard deviation. To allow comparability, we normalize the data to ensure that the simulated and actual series have the same mean. The statistics reported in Table 3 illustrate that the large volatility of the current account generated by this mechanism is not inconsistent with the available evidence.

TABLE 3: STANDARD DEVIATION
CURRENT ACCOUNT

| | Data | Model |
|---|---|---|
| $\sigma_{ca_t/y_t}$ | 0.17 [0.15, 0.20] | 0.20 |

Table 3. Standard deviation $ca_t/y_t$. Normalized data.

**Main quantitative limitation**

Since our main objective is to study a mechanism that generates differences in internal propagation mechanisms, these results are obtained with one single aggregate technology shock as the only source of business cycle fluctuations. This simple shock structure also implies that this model will fail to match some other dimensions of the data that are not reported in Table 1. The main quantitative limitation of this model is its inability to generate the large fluctuations in credit observed in the data.

Tighter financial frictions in the South lead to a stronger internal propagation mechanism in that region. This in turn allows the model to generate fluctuations in credit that are

about 1.3 times as volatile in the South than in the North. In the data, credit in the South is about 1.2 times as volatile as in the North. This mechanism is therefore able to generate differences in the relative standard deviation of credit across regions that are broadly in line with the available evidence. A main quantitative limitation is that this model however fails to reproduce the high standard deviation of credit observed in each region.

# 5 Deconstructing the mechanism

In the case of common shocks and without any source of cross-country heterogeneity, the two country blocks are perfectly symmetric. In this special case, since shocks are common, the current account is constant. This property of the model can be exploited to gain intuition into how structural asymmetries affect the cyclicality of financial imbalances. Figure 2 below shows the response of net foreign asset positions, output and credit to a common technology shock in the case in which differences in financial frictions are the only source of cross-country heterogeneity. Relative to the benchmark calibration shown in Table 1, all other sources of heterogeneity are eliminated by considering the case in which the depreciation rates, habit formation and adjustment costs parameters are identical across regions.[9] As illustrated by the bottom right panel, which shows the dynamics of net foreign asset positions, *i.e.* $\log(\widetilde{s}/s)$ in the North and $\log(s/\widetilde{s})$ in the South, relative to the symmetric benchmark, introducing differences in contract enforcement is sufficient to explain the cyclical behaviors of capital flows observed in the eurozone. By implying that financial frictions have a more distorting impact in the South, this asymmetry generates a positive correlation between the trade balance and output in the North, which implies procyclical net capital inflows in the South. The larger distorsion in the South reduces the potential for intertemporal smoothing and makes consumption smoothing more difficult to achieve. As illustrated in the top right panel of Figure 2, this mechanism also explains the higher volatility of consumption observed in the South. Differences in the degree of financial frictions also generate a larger increase in credit in the South than in the North. In qualitative terms, the dynamics of credit implied by this mechanism is therefore consistent with the fact that credit growth increased more

[9] This case $\mu < \widetilde{\mu}$ and $\eta < \widetilde{\eta}$ corresponds to the following calibration:

| $\sigma_A$ | $\rho_A$ | $\epsilon$ | $\widetilde{\epsilon}$ | $m$ | $\widetilde{m}$ | $\mu$ | $\widetilde{\mu}$ | $\eta$ | $\widetilde{\eta}$ | $\delta$ | $\widetilde{\delta}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0074 | 0.95 | 0.1 | 0.1 | 0.982 | 0.982 | 2 | 8 | 1.4 | 3.0 | 0.055 | 0.055 |

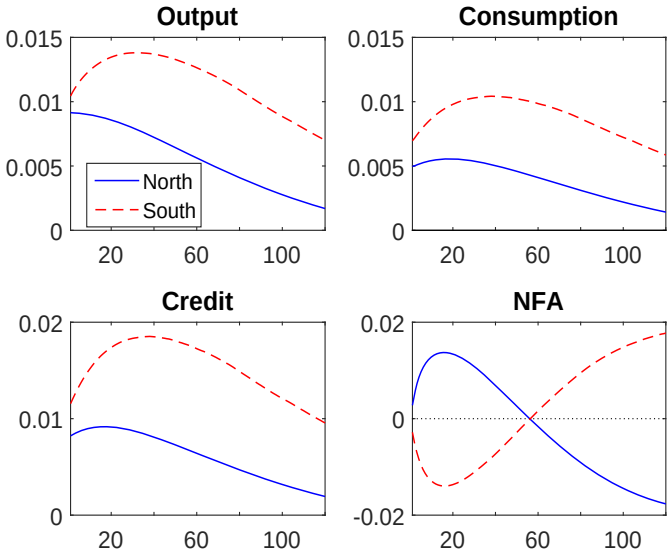


Figure 2. Response of output, consumption, credit and net foreign asset accumulation to a positive technology shock in log deviation from steady state in the case in which $\mu < \widetilde{\mu}$ and $\eta < \widetilde{\eta}$ are the only source of cross-country heterogeneity.

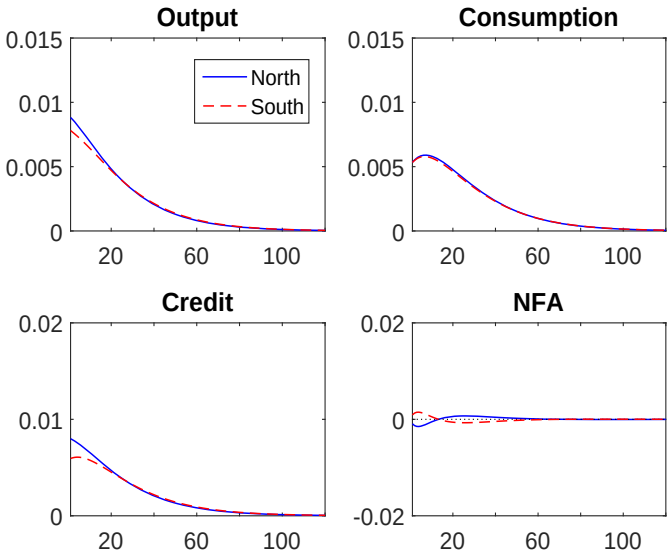


Figure 3. Case $\mu < \widetilde{\mu}$ and $\eta < \widetilde{\eta}$ as the only source of heterogeneity, and no habit formation, i.e. $m = \widetilde{m} = 1$.

rapidly in the South of Europe than in Germany during the boom phase that preceded the financial crisis.[10]

This exercise illustrates that introducing differences in habit formation motives or capital adjustment costs is not essential in order to explain the cyclicality of capital flows in the eurozone. The results shown in Figure 2 are also obtained using a low degree of habit formation, *i.e.* $m = \widetilde{m} = 0.982$. Introducing a small deviation from the log utility case is sufficient to generate a plausible degree of business cycle asymmetries between the two regions.

**The mechanism without habits**

Figure 3 shows the same impulse response in the case in which we abstract from habit formation by setting $m = \widetilde{m} = 1$. As can be seen by comparing Figures 2 and 3, which have the same scale, without habit formation, the model looses much of its ability to generate asymmetric responses to common shocks. The dynamics of output and credit becomes very similar across regions and the lower volatility obtained in this case reflects that the model's endogenous propagation mechanisms in the two regions are considerably weaker in this case. Moreover, as can be seen from the bottom right panel of Figure 3, the symmetric response of consumption and output to common shocks leads to cross-border capital flows of a much smaller magnitude in the model without habits.

**A stronger intertemporal smoothing motive in the South**

Why is the intertemporal smoothing motive stronger in the South? Habit formation induces a stronger consumption smoothing motive, while financial frictions make this objective more difficult to achieve. As documented in the asset pricing literature (e.g., Jermann 1998), combining frictions that reduce the potential for intertemporal smoothing with habit formation increases the volatility of marginal utility. In terms of the consumption and saving decision, theses larger fluctuations in marginal utility create a stronger demand for capital in good times, since accumulating capital when consumption is high allows agents to transfer wealth from today to tomorrow, which is how consumption smoothing is achieved in this class of models.

[10] Between 2003 and 2008 which corresponds to a period of expansion in the eurozone, credit to non-financial corporations increased by 142%, 46% and 52% in Spain, Portugal and Italy, respectively. In Germany by contrast, credit to non-financial corporations only increased by 16% over this period. Source: ECB.

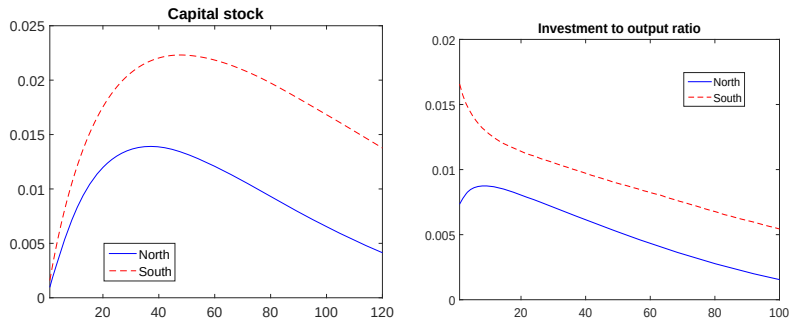


Figure 4. Response of marginal utility and the investment to output ratio to a positive technology shock. Case $\mu < \widetilde{\mu}$ and $\eta < \widetilde{\eta}$ are the only source of cross-country heterogeneity.

The intuition for this result is that the financing-in-advance and incentive compatibility constraints distort the allocation of resources by introducing a time-varying wedge into the marginal productivity of production factors. This wedge, in turn, creates a deadweight loss that reduces the effectiveness of the different margins of adjustment that agents use to insure themselves against shocks. Since international asset markets are incomplete, marginal utility can differ across countries and a positive shock leads to a decline in marginal utility that is larger in the South than in the North. As illustrated in the left panel of Figure 4, this stronger intertemporal smoothing motive implies that capital will accumulate faster in the South than in the North. In other words, the stronger intertemporal smoothing motive induced by our mechanism generates an increase in the share of output that is devoted to investment that is larger in the South than in the North. This effect is illustrated in the right panel of Figure 4, which shows how the investment to output ratios respond to a positive technology shock in each region.

**Capital accumulation and the discounted value of future profits**

The larger increase in capital stock in the South increases output in that region. Since profits in each country in turn depend on the quantity of output produced by the non-financial sector, the larger increase in capital in the South also has a positive impact on the value of the firm, which is determined by the discounted sum of future profits (see equation 5 in the North). An increase in households' propensity to invest therefore has a positive effect on capital accumulation and profits. The incentive compatibility constraint (see equation 4 in the North) also implies that the amount of credit that is extended to firms in turn

depends on the value of the firm. As illustrated by the left panel of Figure 5 below, since capital accumulates faster in the South than in the North, a positive technology shock has a larger effect on the value of the firm in that region. This effect of capital accumulation on the value of the firm therefore explains the larger magnitude of the credit boom in the South. As illustrated by the right panel of Figure 5, the larger increase in firm value induced by this mechanism generates a decline in the Lagrange multiplier associated to the incentive constraint that is larger in the South than in the North. The mechanism therefore generates a relaxation of the incentive compatibility constraint that is stronger in the South than in the North.

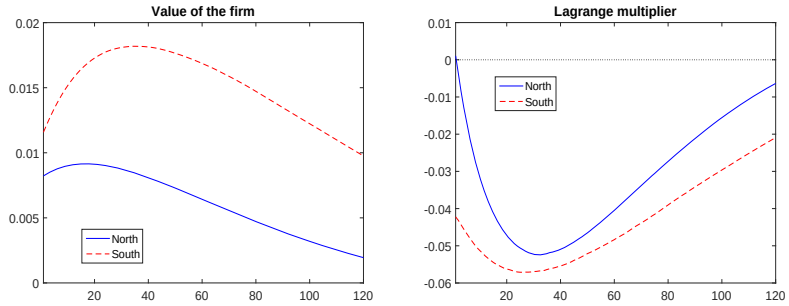


Figure 5. Response of the value of the firm and the Lagrange multiplier associated with the IC constraint to a positive technology shock. Case $\mu < \widetilde{\mu}$ and $\eta < \widetilde{\eta}$ are the only source of cross-country heterogeneity.

**The effect of financial frictions on capital accumulation**

Figure 6 shows the response of the financial wedge, *i.e.* $\varpi/\lambda$ and $\widetilde{\varpi}/\widetilde{\lambda}$ to a positive technology shock in the North and South in the case in which $\mu < \widetilde{\mu}$ and $\eta < \widetilde{\eta}$ are the only source of cross-country heterogeneity. As explained above, the effect of capital accumulation on profits generates an increase in the firm value that is more pronounced in the South. As shown by Figure 6, this also affects the dynamics of the two financial wedges, which declines in the South on impact whereas it increases in the North.

Given the different impact of common shocks on the two financial wedges, the dynamics of capital accumulation can be better understood by studying the link between the return of capital in each region and financial frictions. When $\mu < \widetilde{\mu}$ and $\eta < \widetilde{\eta}$ are the only source of heterogeneity, and given the low degree of adjustment costs needed to account for the

data, the difference in capital accumulation observed across countries is mainly driven by the dynamics of $\varpi/\lambda$ and $\widetilde{\varpi}/\widetilde{\lambda}$. As illustrated by the two Euler equations below, everything else equal, a fall in $\widetilde{\varpi}/\widetilde{\lambda}$ in the South increases the expected return on capital, while the increase in $\varpi/\lambda$ in the North reduces the expected return on capital in this region.

$$1 = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left( \frac{q_{t+1}\left( (1-\delta) + \frac{\theta_1}{1-\epsilon}\left(\frac{i_{t+1}}{k_{t+1}}\right)^{1-\epsilon} + \theta_2 - \theta_1 \left(\frac{i_{t+1}}{k_{t+1}}\right)^{1-\epsilon} \right) + \alpha \frac{y_{t+1}}{k_{t+1}} \frac{1}{1+\eta \frac{\varpi_{t+1}}{\lambda_{t+1}}}}{q_t} \right)$$

$$1 = \widetilde{\beta} E_t \frac{\widetilde{\lambda}_{t+1}}{\widetilde{\lambda}_t} \left( \frac{\widetilde{q}_{t+1}\left( \left(1-\widetilde{\delta}\right) + \frac{\widetilde{\theta}_1}{1-\widetilde{\epsilon}}\left(\frac{\widetilde{i}_{t+1}}{\widetilde{k}_{t+1}}\right)^{1-\widetilde{\epsilon}} + \widetilde{\theta}_2 - \widetilde{\theta}_1 \left(\frac{\widetilde{i}_{t+1}}{\widetilde{k}_{t+1}}\right)^{1-\widetilde{\epsilon}} \right) + \widetilde{\alpha} \frac{\widetilde{y}_{t+1}}{\widetilde{k}_{t+1}} \frac{1}{1+\widetilde{\eta} \frac{\widetilde{\varpi}_{t+1}}{\widetilde{\lambda}_{t+1}}}}{\widetilde{q}_t} \right)$$

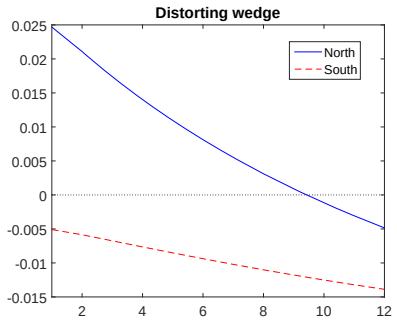


Figure 6. Response of the financial wedge to a positive technology shock.

Everything else equal, this difference in the dynamics of the financial wedges would therefore lead to a higher return on capital in the South than in the North. For this non-arbitrage condition to hold, capital should therefore accumulate faster in the South than in the North, as illustrated in the left panel of Figure 4. In response to a positive shock, the faster increase in capital in the South reduces the marginal productivity of capital, *i.e.* $\widetilde{\alpha}\widetilde{y}_{t+1}/\widetilde{k}_{t+1}$. This decline in the marginal productivity of capital component of total return compensates for the increase in the financial wedge component, *i.e.* $1/\left(1+\widetilde{\eta}\frac{\widetilde{\varpi}_{t+1}}{\widetilde{\lambda}_{t+1}}\right)$. The response of capital therefore ensures that expected discounted returns are always equalized

despite the difference in the dynamics of $\varpi/\lambda$ and $\widetilde{\varpi}/\widetilde{\lambda}$ induced by the higher degree of financial frictions in the South.

**Why differences in financial frictions to explain the eurozone stylized facts?**

Given that our mechanism relies on generating a stronger intertemporal smoothing motive in the South, a natural question to ask is whether combining habit formation with capital adjustment costs (e.g, Jermann 1998) would have been sufficient to generate the desired result. Figure 7 below shows the response to a common technology shock in the case in which higher capital adjustment costs in the South is the only source of cross-country heterogeneity.[11]

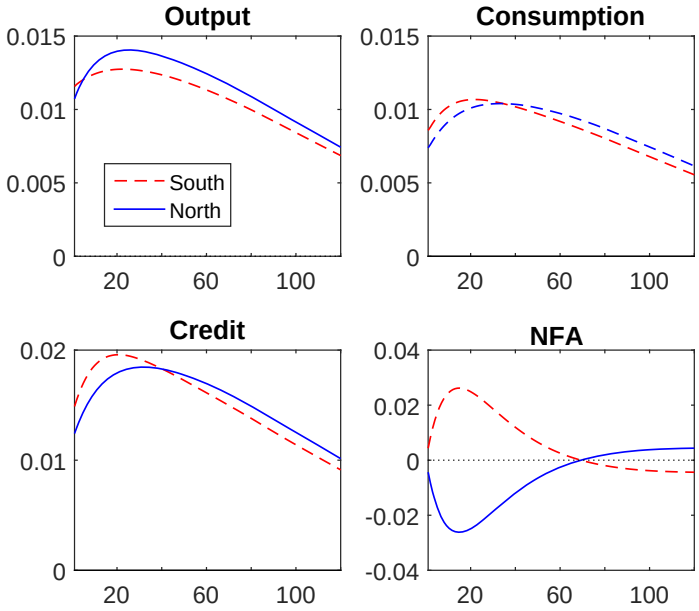


Figure 7. Case $\widetilde{\epsilon} > \epsilon$ as the only source of cross-country heterogeneity.

For the calibration that we are considering, the key is that investment is the preferred adjustment margin that agents in the South use to achieve their consumption smoothing objective. In response to a positive shock, consumption increases and since the increase in

[11] The case $\epsilon < \widetilde{\epsilon}$ corresponds to the following calibration:

| $\sigma_A$ | $\rho_A$ | $\epsilon$ | $\widetilde{\epsilon}$ | $m$ | $\widetilde{m}$ | $\mu$ | $\widetilde{\mu}$ | $\eta$ | $\widetilde{\eta}$ | $\delta$ | $\widetilde{\delta}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0074 | 0.95 | 0.1 | 2 | 0.982 | 0.982 | 8 | 8 | 3.0 | 3.0 | 0.055 | 0.055 |

domestic production is not sufficient to finance the desired level of investment, the optimal choice is to borrow from abroad to finance part of the increase in domestic capital.

Whether the current account in the South increases or decreases in response to a positive shock depends on the intensity of capital adjustment costs. For the case under consideration, a low degree of capital adjustment costs is needed to match the volatility of investment in the South. Low capital adjustment costs imply that the capital stock is an effective hedge against business cycle fluctuations. In this case, agents in the South find it optimal to reduce their net foreign asset position to finance an increase in domestic investment in good times. In response to a positive shock, domestic capital accumulation is therefore financed by running a current account deficit and the country's net foreign asset position deteriorates.

It would not be possible to obtain the same result by simply introducing higher capital adjustment costs in the South instead of a higher degree of financial frictions. To illustrate this point, we also studied a version of the model with similar degrees of financial frictions but higher adjustment costs in the South. With similar degrees of habit intensity across regions, higher capital adjustment costs in the South would indeed create a stronger intertemporal smoothing motive in that region, since marginal utility would be more volatile. However, high capital adjustment costs in the South also reduce the effectiveness of the investment margin. As a result, increasing the region's net foreign asset position in good times to compensate for the insufficient increase in domestic capital is the most effective strategy to achieve consumption smoothing in this case. As shown in the bottom right panel of Figure 7, the net foreign asset position in the South increases in this case and this leads to a net outflow of capital, which in turn generates a surplus of the current account balance. Introducing higher adjustment costs in the South instead of a higher degree of financial frictions would therefore generate procyclical fluctuations in the current account in that region, which is the opposite from what we observe in the data.

**The welfare cost of business cycle fluctuations**

The first column of Table 4 reports the welfare cost of uncertainty obtained in each country by comparing average welfare in the economy subject to business cycle fluctuations with the case in which the shock standard deviation is set to zero. In the North, welfare at time $t$ is given by the discounted sum of future utility, which can be expressed recursively as follows:

$$wf_t = \log\left[c_t^{\varkappa}\widetilde{s}_t^{1-\varkappa}(\psi + L_t^{\upsilon}) - x_t\right] + \widehat{\beta}E_t wf_{t+1}$$

Relative to a deterministic economy without shocks, with this preference specification, welfare is lower in a world subject to exogenous shocks (e.g., Jaccard 2017). The difference between welfare in the stochastic and deterministic economies, *i.e.* $E(wf)$ vs. $wf$ therefore provides a measure of the welfare cost of business cycle fluctuations (e.g., Lucas 2003, Cho et al. 2015).[12]

As illustrated in Table 4, for the calibration that matches the moments shown in Table 2, the welfare cost of uncertainty is about ten times higher in the South than in the North. In the South, the procyclicality of net capital inflows implies that agents borrow by issuing debt in good times and therefore that they need to close their current account deficits during periods of recession. The cyclical behavior of net capital flows in that region therefore implies that borrowing needs to be reduced precisely when marginal utility is high and the desire to consume most pressing. The dynamics of net financial flows therefore creates an additional source of risk that exacerbates the welfare cost of business cycle fluctuations in the region that experiences procyclical net inflows. In the North, by contrast, the cross-border financial market provides a margin of adjustment that allows agents to self-insure against unexpected shocks since it implies that borrowing can increase during periods of recession. This favorable cyclical property of net financial flows facilitates consumption smoothing in the North and implies a welfare cost of business cycle fluctuations in that region that is close to zero, despite the fact that a much stronger habit motive is needed to match the moments reported in Table 2.

Table 4: Welfare cost

| | Benchmark | Structural reforms $\mu = \widetilde{\mu} = 2$ |
|---|---|---|
| Welfare loss, North | 0.04 | 0.03 |
| Welfare loss, South | 0.39 | 0.16 |

Table 4. Welfare cost of business cycle fluctuations in percent.

[12] It is necessary to use higher-order perturbation techniques in order to compute the welfare cost of business cycle fluctuations. We use the techniques developed by Adjemian et al. (2014).

Relative to the benchmark calibration, the second column of Table 4 reports the case in which $\mu = \widetilde{\mu} = 2$, *i.e.* a case in which the degree of contract enforcement is similar across regions. The fact that the cost of business cycle fluctuations in the South is cut by more than half when the structural asymmetry due to contract enforcement is eliminated illustrates the potential effect that structural reforms could have on the welfare cost of business cycle fluctuations (e.g., Blanchard and Giavazzi 2003). As discussed in the introduction, the degree of contract enforcement remains a major source of structural heterogeneity in the eurozone. These results suggest that a harmonization of legal systems that would raise the quality of contract enforcement in the South would significantly attenuate the welfare cost of business cycle fluctuations in that region by reducing the procyclicality of net capital inflows.

# 6 Conclusion

A key characteristic of the eurozone business cycle is that the South borrows from the North in good times. Given the high degree of output synchronization across eurozone economies, the cyclicality of capital flows implies that the South needs to reduce borrowing when recessions hit, precisely when marginal utility of consumption is highest. In the North by contrast, the fact that agents in that region can afford to reduce lending to the South during periods of recession provides a margin of adjustment that acts as a shock absorber. In our model, the cyclicality of capital flows observed in the data therefore makes consumption smoothing more difficult to achieve in the South than in the North, which is consistent with the higher volatility of consumption in the South.

Given that the procyclicality of capital flows in the South is due to a higher degree of financial frictions, our model predicts that the welfare cost of business cycle fluctuations should be higher in the region that experiences procyclical net capital inflows. One possible interpretation of this admittedly reduced-form mechanism is that differences in the quality of institutions, which affect the ease at which contracts can be enforced, amplifies the effects of financial frictions in the region most affected by the distorsion.

Given the close interaction between our two financial friction parameters, another interpretation is that the higher degree of financial frictions in the South is caused by a higher dependence on bank credit in that region. One possible explanation is that firms in the South have less access to market-based financing than firms in the North. Policies aimed

at diversifying the source of financing, especially for small and medium sized enterprises, could therefore reduce the dependence of southern European economies on their domestic banking sector (see also ECB 2014, De Fiore and Uhlig 2015). In the context of our model, a reduction in the economy's dependence on bank credit would attenuate the distorsion caused by weaker contract enforcement, which in turn would lower the welfare cost of business cycle fluctuations in the most affected region.

# 7 References


Adjemian, Stephane & Bastani, Houtan & Karame, Frederic & Juillard, Michel & Maih, Junior & Mihoubi, Ferhat & Perendia, George & Pfeifer, Johannes & Ratto, Marco & Villemot, Sebastien, (2014). "Dynare: Reference Manual Version 4," Dynare Working Papers 1, CEPREMAP.

Aguiar, Mark and Gopinath, Gita (2007). "Emerging Market Business Cycles: The Cycle Is the Trend," *Journal of Political Economy*, vol. 115, pages 69-102.

Arvanitis, Athanasios V. & Mikkola, Anne (1996). "Asset-Market Structure and International Trade Dynamics," *American Economic Review*, vol. 86(2), pages 67-70, May.

Backus, David K. & Kehoe, Patrick J. & Kydland, Finn E., (1992). "International Real Business Cycles," *Journal of Political Economy*, vol. 100(4), pages 745-75, August.

Baxter, Marianne & Crucini, Mario J., (1993). "Explaining Saving-Investment Correlations," *American Economic Review*, vol. 83(3), pages 416-36, June.

Baxter, Marianne, (1995). "*International trade and business cycles*," Handbook of International Economics, in: G. M. Grossman & K. Rogoff (ed.), Handbook of International Economics, edition 1, volume 3, chapter 35, pages 1801-1864

Baxter, Marianne & Crucini, Mario J., (1995). "Business Cycles and the Asset Structure of Foreign Trade," *International Economic Review*, vol. 36(4), pages 821-54, November.

Bernanke, S. Ben (2015). "Germany's trade surplus is a problem", Brooking Institute, April 3, 2015.

Blanchard, Olivier & Francesco Giavazzi, (2002). "Current Account Deficits in the Euro Area: The End of the Feldstein Horioka Puzzle?," *Brookings Papers on Economic Activity*, vol. 33(2), pages 147-210.

Blanchard, Olivier & Francesco Giavazzi, (2003). "Macroeconomic Effects of Regulation and Deregulation in Goods and Labor Markets," *The Quarterly Journal of Economics*, vol. 118(3), pages 879-907.

Boileau, Martin, (1999). "Trade in capital goods and the volatility of net exports and the terms of trade," *Journal of International Economics*, vol. 48(2), pages 347-365, August.

Bonam, Dennis & Gavin Goy, (2017). "Home biased expectations and macroeconomic imbalances in a monetary union," DNB Working Papers 556, Netherlands Central Bank, Research Department.

Boissay, Frederic & Collard, Fabrice & Smets, Frank (2016). "Booms and Banking Crises." *Journal of Political Economy,* vol. 124 no. 2.

Cacciatore, Matteo & Fiori, Giuseppe & Ghironi, Fabio, (2016). "Market deregulation and optimal monetary policy in a monetary union," *Journal of International Economics*, vol. 99(C), pages 120-137.

Challe, Edouard and Lopez, Jose Ignacio and Mengus, Eric, (2016). "Southern Europe's Institutional Decline". HEC Paris Research Paper No. ECO/SCD-2016-1148.

Cecchetti, Stephen G. (1999). "Legal structure, financial structure, and the monetary policy transmission mechanism," *Economic Policy Review*, issue Jul, pages 9-28.

Cho, Jang-Ok & Thomas Cooley & Hyung Seok Kim, (2015). "Business Cycle Uncertainty and Economic Welfare," *Review of Economic Dynamics*, vol. 18(2), pages 185-200, April.

Chinn, Menzie D. and Hiro Ito (2006). "What Matters for Financial Development? Capital Controls, Institutions, and Interactions," *Journal of Development Economics*, Volume 81, Issue 1, Pages 163-192 (October).

Cole, Harold, (1988). "Financial Structure and International Trade," *International Economic Review*, vol. 29(2), pages 237-59, May.

Corsetti, Giancarlo & Luca Dedola & Sylvain Leduc, (2008). "International Risk Sharing and the Transmission of Productivity Shocks," *Review of Economic Studies*, vol. 75(2), pages 443-473.

Danthine, Jean-Pierre, Grancesco Giavazzi, Xavier Vives, and Ernst-Ludwig von Thadden. (1999). The Future of European Banking. London: Centre for Economic Policy Research.

Draghi, Mario (2014). "Recovery and Reform in the euro area", Brookings Institution, Washington, 9 October 2014.

De Fiore, Fiorella & Harald Uhlig, (2015). "Corporate Debt Structure and the Financial Crisis," *Journal of Money, Credit and Banking*, vol. 47(8), pages 1571-1598, December.

ECB (2014). "SME access to finance in the euro area: barriers and potential policy remedies", ECB Monthly Bulletin, July 2014.

Ehrmann, Michael (1998). "Will EMU Generate Asymmetries? Comparing Monetary Policy Transmission Across European Countries". Working Paper European University Institute, 1998/2.

Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" *American Economic Review*, 105(10), 3150-3182.

Fernandez-Villaverde, Jesus & Luis Garicano & Tano Santos, (2013). "Political Credit Cycles: The Case of the Eurozone," Journal of Economic Perspectives, vol. 27(3), pages 145-66

Fernandez-Villaverde, Jesus and Ohanian, Lee (2015). "The Political Economy of European Economic Stagnation", mimeo University of Pennsylvania.

Fogli, Alessandra & Fabrizio Perri, (2015). "Macroeconomic Volatility and External Imbalances," *Journal of Monetary Economics,* Volume 69, January 2015, p. 1–15.

Gopinath, Gita, Sebnem Kalemli-Ozcan, Loukas Karabarbounis, and Carolina Villegas-Sanchez (2017). "Capital Allocation and Productivity in South Europe", *Quarterly Journal of Economics*, forthcoming.

Gourinchas, Pierre-Olivier & Thomas Philippon & Dimitri Vayanos, (2016). "The Analytics of the Greek Crisis," NBER Working Paper No. 22370.

Gourio, Francois & Siemer, Michael & Verdelhan, Adrien, (2013). "International risk cycles", *Journal of International Economics*, vol. 89(2), pages 471-484.

Heathcote, Jonathan & Perri, Fabrizio, (2002). "Financial autarky and international business cycles," *Journal of Monetary Economics*, vol. 49(3), pages 601-627, April.

Hoffmann, Mathias & Krause, Michael U. & Laubach, Thomas, (2013). "The expectations-driven US current account," Discussion Papers 10/2013, Deutsche Bundesbank, Research Centre.

IMF (2014). "IMF Country Report No. 14/217 ", Selected Issue on Germany, June 2014.

Jaccard, Ivan (2014). "Asset returns and labor supply in a production economy", *Journal of Money, Credit and Banking*, Volume 46, Issue 5, pages 889–919, August 2014.

Jaccard, Ivan (2017). "Asset Pricing and the Propagation of Macroeconomic Shocks". *Journal of the European Economic Association,* forthcoming.

Jermann, Urban J., (1998). "Asset pricing in production economies," *Journal of Monetary Economics*, vol. 41(2), pages 257-275, April.

Jermann, Urban & Vincenzo Quadrini, (2012). "Macroeconomic Effects of Financial Shocks," *American Economic Review*, vol. 102(1), pages 238-71, February.

King, Robert G., Plosser, Charles I. and Rebelo, Sergio T., (1988). "Production, growth and business cycles", *Journal of Monetary Economics,* vol. 21(2-3), pages 195-232.

King, Robert G. and Rebelo, Sergio T., (1999). "Resuscitating real business cycles," *Handbook of Macroeconomics*, J. B. Taylor & M. Woodford (ed.), edition 1, volume 1, chapter 14, pages 927-1007.

Kocherlakota, Narayana R. (1990). "On the 'Discount' Factor in Growth Economies." *Journal of Monetary Economics*, vol. 25(1), pages 43-47.

Kollmann, Robert, (1996). "Incomplete asset markets and the cross-country consumption correlation puzzle," *Journal of Economic Dynamics and Control*, vol. 20(5), pages 945-961, May.

Kollmann, Robert & Pataracchia, Beatrice & Ratto, Marco & in't Veld, Jan & Roeger, Werner, (2014). "International capital flows and the boom-bust cycle in Spain," *Journal of International Money and Finance*, vol. 48(PB), pages 314-335.

La Porta, Rafael, Lopez-de-Silanes, Florencio, Shleifer, Andrei, and Vishny, Robert W (1997). "Legal Determinants of External Finance". *Journal of Finance* 52, no. 3: 1131-1150.

La Porta, Rafael Lopez de Silanes, Florencio, Shleifer, Andrei, and Vishny, Robert (1998). "Law and Finance" *Journal of Political Economy* 106 (1998): 1113-1155.

Lane, Philip R. (2013). "Capital Flows in the Euro Area," European Economy - Economic Papers 2008 - 2015 497, European Commission.

Robert E. Lucas Jr., (2003). "Macroeconomic Priorities," *American Economic Review*, vol. 93(1), pages 1-14, March.

Mark, C. Nelson (2001). "International Macroeconomics and Finance: Theory and Econometrics", Blackwell Publishers.

Martin, Philippe & Thomas Philippon, (2017). "Inspecting the Mechanism: Leverage and the Great Recession in the Eurozone," *American Economic Review*, vol. 107(7), pages 1904-1937, July.

Masuch, Klaus & Moshammer, Edmund, Pierluigi, Beatrice (2016). "Institutions, Public Debt and Growth in Europe". ECB Working Paper No. 1963.

Mendoza, Enrique G. & Quadrini, Vincenzo & Rios-Rull, Jose-Victor (2009a). "Financial Integration, Financial Development, and Global Imbalances," *Journal of Political Economy*, vol. 117(3), pages 371-416, 06.

Milesi-Ferretti, Gian-Maria & Cedric Tille, (2011). "The Great Retrenchment: International Capital Flows During the Global Financial Crisis," Working Papers 382011, Hong Kong Institute for Monetary Research.

Mongelli, Francesco Paolo & Reinhold, Elisa & Papadopoulos, Georgios, (2016). "What's so special about specialization in the euro area?," ECB Occasional Paper Series 168.

Reis, Ricardo (2013). "The Portugese Slump and Crash and the Euro Crisis," *Brookings Papers on Economic Activity*, vol. 46 (1 (Spring), pages 143-210.

Rubio, Margarita, (2014). "Housing-market heterogeneity in a monetary union," *Journal of International Money and Finance*, vol. 40(C), pages 163-184.

Siena, Daniele (2014). "The European Monetary Union and Imbalances: Is it an Anticipation Story?", Working papers 501, Banque de France.

Gilchrist, Simon & Raphael Schoenle & Jae Sim & Egon Zakrajsek (2015). "Financial Heterogeneity and Monetary Union," 2015 Meeting Papers 1327, Society for Economic Dynamics.

Schmitt-Grohe, Stephanie & Uribe, Martin, (2016). "Open Economy Macroeconomics", Textbook Manuscript (forthcoming Princeton University Press).

Wyplosz, Charles (2010). "Germany, Current Accounts and Competitiveness", VOX CEPR's Policy Portal,

# 8 Appendix A

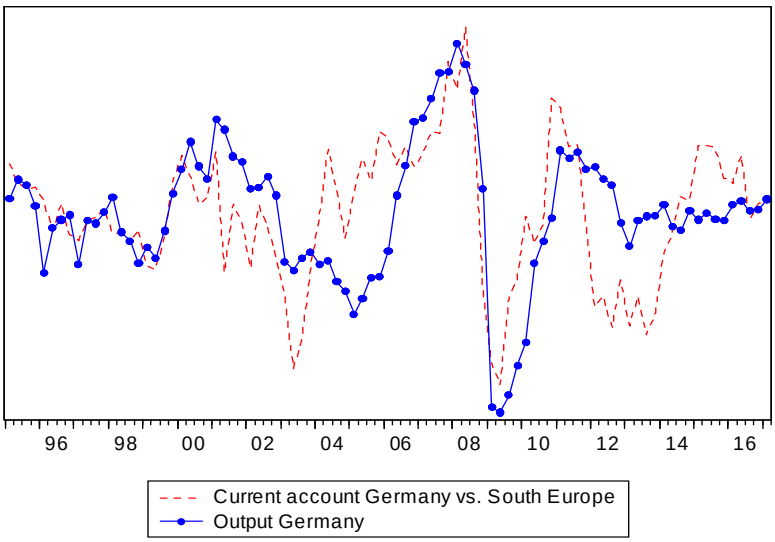


Figure A.1: Current account Germany vs. South Europe and output Germany in logs, HP-filtered data. The series have been normalized to have the same scale.

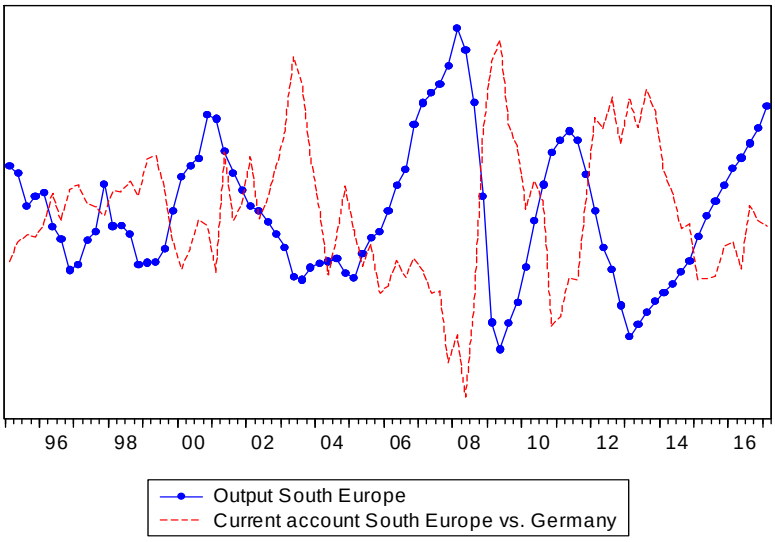


Figure A.2: Current account South Europe vs. Germany and output South Europe in logs, HP-filtered data. South Europe consists of Italy, Spain and Portugal. The series have been normalized to have the same scale.

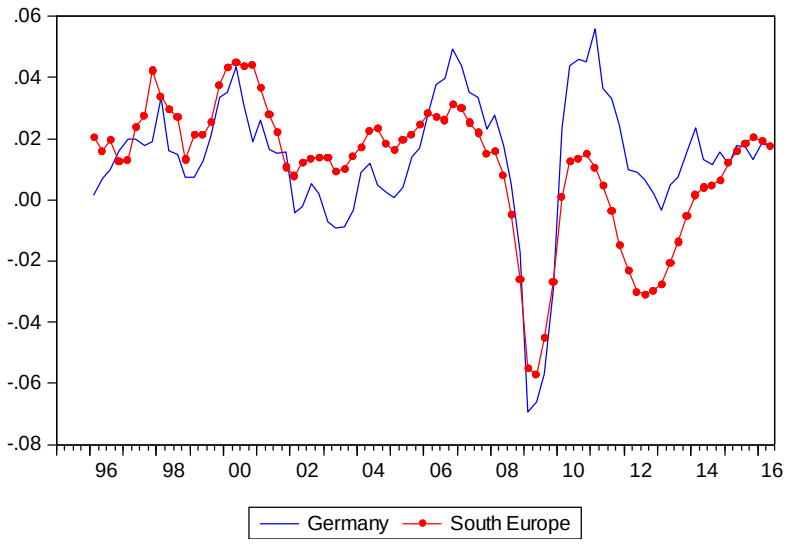


Figure A.3: Year-over-year change in output, quarterly data. South Europe consists of Portugal, Spain and Italy.

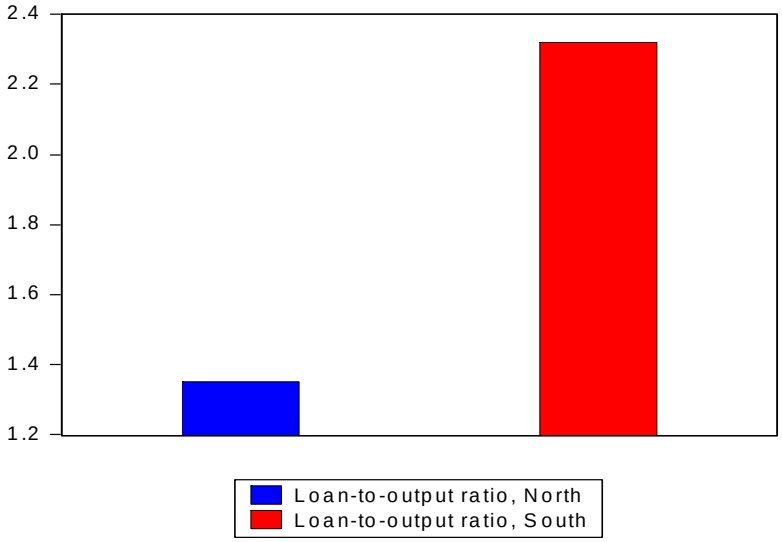


Figure A.4: Loan-to-output ratios, average over the period from 2003 to 2016. South Europe consists of Portugal, Spain and Italy.

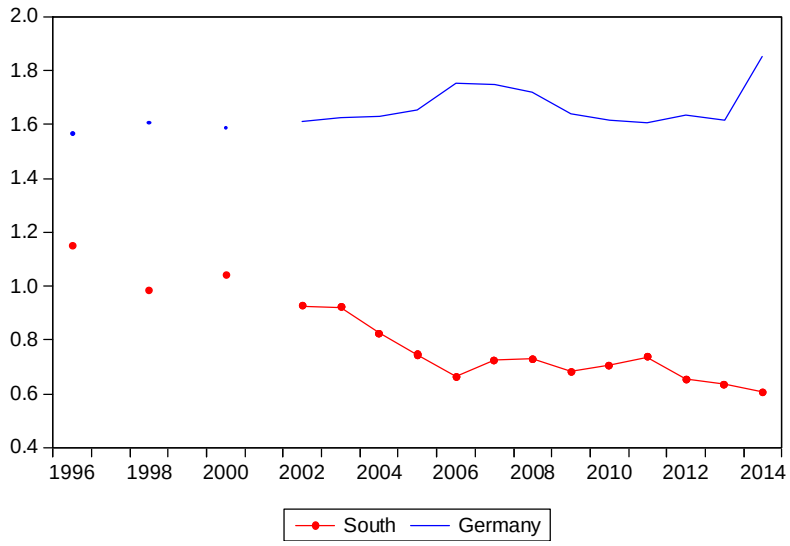


Figure A.5: Rule of law index. Weighted average of Italy, Portugal and Spain for the South.

# 9 Appendix B: Data description

| Variable | Data description | Data source |
|---|---|---|
| Current account ($ca$) | Current account balance Germany vs. Italy, Spain and Portugal | Bundesbank |
| Real GDP ($y$) | Mio of chained 2010 euros. | Statistical Office of the European Communities. |
| Rule of law index ($\mu$) | Proxy for quality of contract enforcement.[13] | World Bank/NRGI /Brookings. |
| Loans ($l$) | Loans to Non-financial corporations. adjusted for sales and securitization. | ECB. |
| Deposit rates ($r_D$) | New business, maturity less than a year Non-financial corporations, Households and NPISHs. | ECB |
| Lending rates ($r_L$) | New business, maturity less than a year Loans to non-financial corporations. | ECB |
| | Real rates computed using the Harmonized index of consumer prices(overall index). | ECB |

[13]The rule of law index captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.