Capital flows, intermediation frictions and the adjustment to common shocks

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Abstract

In the euro area, aggregate consumption is more volatile in countries where the procyclicality of net capital inflows is stronger. Moreover, real short-term interest rates are on average lower and bank lending rates higher in countries where aggregate consumption is more volatile. We ask whether a two-country business cycle model in which common shocks are the main source of business cycle fluctuations can reproduce the main features of the cross-country heterogeneity observed in the data. We find that the welfare cost of business cycle fluctuations is substantially higher in the region that experiences procyclical net capital inflows and our results suggest that the direction of capital flows depends on the relative efficiency of financial intermediation.

- *Keywords:* Two-country models, cross-border capital flows, international asset markets.
- *JEL: F32, F44, F11*

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1 Introduction

The divergence in trade balances between countries of the euro area "core" and countries of the euro area "periphery" observed since the introduction of the common currency and the sudden convergence triggered by the crisis has put the spotlight on the policy implications of intra-euro area imbalances (e.g., Tesar and Dominguey 2013). The main challenge is to explain why despite a high degree of synchronization of output fluctuations, the dynamics of trade balances observed between country blocks remains a major source of cross-country heterogeneity (see Figure 5 and 6).

This negative co-movement between trade balances and the resulting dynamics of capital flows was particularly striking during the crisis years. While some "core" countries reduced their trade surplus, many "periphery" countries experienced large capital outflows and had to close their trade deficits in the middle of one of the worst financial crisis on record. The empirical evidence that we present in section 2 also suggests that consumption is more volatile in periphery countries, where net capital inflows are generally more procyclical than in the rest of the euro area.

To shed light on the link between risk sharing and financial imbalances, this paper develops a two-country general equilibrium model to study the dynamics of international adjustments when the economy is hit by a global shock. Our first objective is to develop a model that could reproduce some of the most salient features of the cross-country heterogeneity observed in the euro area. We then use our quantitative model to address the following questions: Is it possible to generate synchronized business cycle fluctuations across country blocks in a model in which trade balances move in opposite directions? If shocks are common to all countries, what determines the direction of net capital flows? And how does the cyclicality of net capital flows affect the welfare cost of business cycle fluctuations?

Given the particular structure of the euro area economy, we address this question in a framework that departs from the existing literature on business cycles in two-country models with complete markets (e.g., Backus, Kehoe and Kydland 1992, 1995) in several respects. First, given that the euro area's financial system is predominantly bank-based, we develop a model in which the allocation of savings between the domestic and the foreign sectors is undertaken by financial intermediaries. Second, we introduce frictions in international asset markets (e.g., Cole 1988, Baxter and Crucini 1995, Kollmann 1996, Arvanitis and Mikkola 1996, Boileau 1999, Heathcote and Perri 2002) and consider an intermediate case in which exchanges of an intermediate good between

the domestic and the foreign financial intermediary is the only channel of international trade.

We show that a two-country model that matches the differences in short-term market and bank lending rates across country blocks can explain the direction of capital flows as well as the magnitude of financial imbalances observed in the data. The key ingredient is cross-country differences in the structure of financial intermediation. In particular, we show that tighter intermediation frictions generate higher bank lending rates, procyclical net capital inflows and a trade deficit in the region whose financial sector is relatively less efficient.

The steady state magnitude of financial imbalances can be explained by the effect of differences in the relative efficiency of financial intermediation on cross-border capital flows (e.g., Niepmann 2013). In a model with international linkages, the presence of a cross-border capital market leads to a reallocation of households' savings in both countries towards the most efficient financial sector. Relative to a closed economy, agents living in the region with less efficient finance take advantage of the more efficient technology available abroad by selling domestic capital to the foreign financial intermediary. Since agents living in the most efficient region allocate the majority of domestic savings to their domestic financial sector, this asymmetry in cross-border flows is reflected in net foreign asset holdings. The region with the most efficient financial sector accumulates net foreign assets. By contrast, the less efficient region finances its trade deficit by selling domestic capital to the more efficient financial intermediaries located abroad. On average, differences in financial structure therefore create a trade surplus in the region in which intermediation frictions are relatively less severe and a corresponding trade deficit abroad.

In our economy, the dynamics of net capital inflows is amplified by fluctuations in the price at which capital is traded across borders. Since the price of capital is procyclical, these valuation effects increase the revenue from selling domestic capital abroad during boom periods. Given that a country with a trade deficit is a net seller of domestic capital, this valuation effect aggravates the economy's trade deficit during periods of expansion. By contrast, fluctuations in relative prices improve the trade surplus of countries that are net buyers of foreign capital and help explain the diverging trade balances observed in the data during periods of expansion. By generating net capital flows from the periphery to the core during periods of recession, differences in financial structure therefore explain why consumption is more volatile in countries that experience procyclical net capital inflows (e.g., Kaminsky, Reinhart and Vegh 2005).

Our second main result is that the direction of net capital flows between trading partners has a significant effect on the welfare cost of business cycle fluctuations. By generating an increase in savings precisely when households' desire to consume is the most pressing, procyclical net capital inflows exacerbate the welfare cost of business cycle fluctuations, which in our environment is considerably larger in the economy with less efficient financial intermediaries.

Following King and Plosser (1984), Mehra, Piguillem and Prescott (2011) and Greenwood, Sanchez and Wang (2013), financial services are modelled as an intermediate good that enters as an input in the production of the final output good. Relative to this literature, we consider an economy in which the production of financial services is subject to a technological constraint that is meant to capture institutional factors that are likely to affect the efficiency of financial intermediation (e.g., Cecchetti 1999, La Porta, Lopez-de-Silanes, Shleifer and Vishny 1997, 1998, Danthine, Giavazzi, Vives and von Thadden 2000). In our environment, a less efficient financial sector needs a larger number of loan officers per unit of capital to produce a given quantity of financial services. By reducing the quantity of financial services that can be produced in the long-run, total output is lower and the borrowing costs of final goods-producers are therefore higher in the region where intermediation frictions are relatively more severe.

Relative to a standard neoclassical growth model (e.g., Kydland and Prescott 1982, King, Plosser and Rebelo 1989), the introduction of a financial intermediation sector affects the model propagation mechanism by amplifying the effects of technology shocks. In our environment, this propagation mechanism depends on the shadow price of financial services, whose volatility can be amplified by combining habit formation with capital adjustment costs (e.g., Jermann 1998, Jaccard 2014). When asset prices are sufficiently volatile, these endogenous fluctuations exacerbate boom-and-bust lending cycles by amplifying the effects of shocks on the production of financial services. Without this financial accelerator mechanism, it would be difficult to generate business cycle asymmetries of the magnitude observed in the data in a model in which common shocks play a predominant role.

The remainder of this paper is organized as follows. The main stylized facts are documented in section 2. The competitive economy is described in section 3 and the parameter selection procedure is discussed in section 4. Section 5 discusses the response to common shocks and the main mechanism is deconstructed in section 6. The effects on the welfare cost are studied in section 7 and section 8 concludes.

2 Data description

The objective of this section is to document the main commonalities and specificities between euro area countries by presenting a series of stylized facts that characterize the euro area business cycle. Table 1 reports HP-filtered standard deviation of output for 11 euro zone countries (see Appendix A for a description). The HP-filtered standard deviation of consumption, investment and hours relative to output, where all variables are expressed in logarithms, which are denoted σ_c/σ_y, σ_N/σ_y, σ_x/σ_y respectively, is reported in columns two to four. The fifth column reports for each country the correlation between the logarithm of real output and the trade balance, $\rho(tb, y)$.

The first striking empirical regularity that emerges from the statistics presented below is that there are important differences in consumption volatility across euro area economies. Relative to output, consumption volatility is particularly high in Portugal, Spain, Ireland and Greece, while it is significantly lower in countries like Austria and Germany. As shown in column 5, the European business cycle is also characterized by significant differences in the cyclicality of the trade balance. Austria, Finland, Germany and the Netherlands are the only countries in which the correlation between the trade balance and output is positive. And as illustrated by Figure 1 in the appendix, the positive co-movement between the trade balance and output is stronger in countries in which the volatility of consumption is lower.

Financial and banking statistics are reported in Table 2. First, column 6 reports the average real lending rates, which is denoted $E(r_L)$, and that correspond to maturities shorter than a year. Real rates are computed as the difference between average lending rates and CPI inflation. In column 7, $E(r_D)$ is the corresponding deposit rates, expressed in real terms. The real risk-free rate, which is shown in column 8, is the difference between the 3-month euribor rate, which is common to all countries, and the inflation rate.

As shown by column 6 and 7, differences in average real lending rates and in intermediation margins are an important source of cross-country heterogeneity. As illustrated by Figure 2 below, firms located in countries in which aggregate consumption is more volatile are likely to face higher average lending rates. The positive relationship between mean lending rates and the volatility of aggregate consumption suggests that credit conditions have an effect on agents' ability to smooth consumption. As shown in Figure 3, the relationship between real interest rates and consumption volatility is clearly negative, suggesting that real interest rates are on average lower in countries in

which aggregate consumption is more volatile.

TABLE 1: EURO AREA CYCLE 1999-2013

	σ_y	σ_c/σ_y	σ_N/σ_y	σ_x/σ_y	$\rho(tb,y)$
	(1)	(2)	(3)	(4)	(5)
Austria	1.43	0.28	0.59	1.84	0.17
Belgium	1.13	0.56	0.83	2.97	-0.25
Finland	2.35	0.60	0.51	1.82	0.30
France	1.14	0.52	0.68	2.74	-0.54
Germany	1.74	0.36	0.55	2.31	0.52
Greece	1.82	1.38	n.a.	5.66	-0.60
Ireland	2.45	0.96	1.14	3.70	-0.40
Italy	1.45	0.69	0.63	1.90	-0.26
Netherlands	1.40	0.61	0.74	3.13	0.32
Portugal	1.24	1.11	0.94	2.82	-0.60
Spain	1.18	1.13	1.20	3.49	-0.83

TABLE 2

	$E(r_L)$	$E(r_D)$	$E(r_F)$	$E(WGI)$
	(6)	(7)	(8)	(9)
Austria	1.62	0.12	0.6	1.77
Belgium	0.9	-0.32	0.4	1.43
Finland	1.71	-0.15	0.56	2.06
France	1.81	0.38	0.76	1.39
Germany	2.8	0.33	0.93	1.64
Greece	2.89	0.31	-0.42	0.58
Ireland	2.48	-0.11	0.23	1.62
Italy	2.03	-0.13	0.24	0.54
Netherlands	1.62	-0.22	0.3	1.88
Portugal	3.87	0.08	0.06	1.06
Spain	1.72	-0.22	-0.24	1.18

Comparison with Backus et al. (1994)

Relative to the stylized facts reported by Backus, Kehoe and Kydland (1994), an interesting difference is that the sign of the output trade balance correlation in Germany

and Finland has changed over time. The Table below reports this correlation for various subperiods. As reported by Backus et al. using data until the beginning of the 1990s, the output trade balance correlation is negative in both Finland and Germany in the pre-1991 sample. By contrast, this correlation is positive for the 1991-2013 sample period and is highest from 1999 to 2009, which corresponds to the euro area period excluding the sovereign debt crisis episode.

	Before 1991q1	1991q2-2013q2	1995q1-2013q2	1999q1-2009q4
Finland	-0.58	0.18	0.25	0.36
Germany	-0.23	0.27	0.46	0.50

For Germany, one natural explanation is that the German reunification has been an important structural change. The structural changes brought about by the banking crisis of the early 1990's could also potentially explain why this relationship has changed in Finland.

Potential sources of cross-country heterogeneity

In the literature initiated by the creation of the single currency, differences in financial structure were identified as one of the most important causes of cross-country heterogeneity. According to Cecchetti (1999) for instance, differences in financial structures are the proximate cause for national asymmetries in the monetary policy transmission mechanism. When it comes to the determinants of this heterogeneity, the evidence reported by Cecchetti suggests that differences in legal structures could play an important role. As established by the work of La Porta, Lopez-de-Silanes, Shleifer and Vishny (1997, 1998), the structure of finance in a country depends on the rights accorded to shareholders and creditors. The structure of financial intermediation is therefore a product of the country's legal structure. As argued by Danthine, Giavazzi, Vives and von Thadden (2000), if these disparities in legal structure depend on country's historical heritage, they are likely to generate differences in financial structure that could be very persistent.

Given the close relationship between the legal structure of a country and the quality of economic governance, column 9 in Table 2 reports a broad measure of economic governance for each 11 countries. Drawing on the work of Cecchetti (1999), Lopez-de-Silanes et al. (1997,1998), and Danthine et al. (1999), we construct a broad indicator that includes factors that are likely to affect the efficiency of financial intermediation such as the quality of contract enforcement, the quality of regulation, the extent to

which agents abide by the rules of society, and the ability of the government to permit and promote private sector development.[1] Figure 4 below, which plots the relationship between consumption volatility and our composite indicator provides suggestive evidence that consumption is likely to be more volatile in countries in which the financial sector is less efficient and therefore that differences in financial structure could be an important source of cross-country heterogeneity.

TABLE 3

	σ_y	σ_c/σ_y	σ_x/σ_y	σ_N/σ_y	$\rho(nco, y)$	$E(nco/y)$
	(1)	(2)	(4)	(3)	(4)	(5)
Periphery	1.29	0.81	2.53	0.81	-0.74	-2.27
Core	1.43	0.35	2.4	0.57	0.20	3.02

	$E(r_L)$	$E(r_D)$	$E(rr)$	$E(WGI)$
	(6)	(7)	(8)	(9)
Periphery	2.60	-0.01	-0.03	1.0
Core	1.74	0.02	0.59	1.70

Aggregate statistics

To simplify the theoretical analysis, we now divide the countries listed in Table 1 and 2 in two different groups, namely the core and the periphery, and report a series of aggregate statistics that will be used to calibrate the DSGE model that will be developed in the next section. Since one of the primary objectives of the paper is to understand the determinants of consumption volatility, we base our classification on the statistics reported in columns 2. The economies in which the volatility of consumption is highest are in decreasing order of magnitude Greece, Spain, Portugal, Ireland and Italy. We include this five countries in the periphery, which leaves Austria, Belgium, Finland, France, Germany and the Netherlands in the core. Finally, we use the trade balance as a measure of net capital outflow (e.g., Mankiw 2011) and report the correlation between net capital outflow and output, *i.e.* $\rho(nco, y)$ as well as the average net capital outflow to output ratio, *i.e.* $E(nco/y)$.

The main aggregate stylized facts to reproduce are therefore that consumption is more volatile, average bank lending rates are higher, short term risk-free rates are lower,

[1] where our index of governance is computed as follows:
WGI= (government effectiveness+ regulatory quality+rule of law+control of corruption)/4.

and the trade balance is more countercyclical in the periphery than in the core. Core countries have been running a trade surplus, and therefore have a positive net capital outflow position, while countries in the periphery are running a trade deficits and have a negative net capital outflow position. Finally, our aggregate index of financial structure suggests that economic governance is on average weaker in the periphery.

3 The model

The economy is composed of two countries that are linked by an international capital market that give rises to cross-border flows between the two financial sectors. International markets are incomplete and each domestic economy is composed of a representative agent, a financial intermediary, and a representative firm. Lending and borrowing of capital between the two financial intermediaries is the only source of trade. International linkages between the two financial sectors are introduced by assuming that in each country, financial intermediation requires a financial input that is produced abroad. The imperfect substitutability between domestic and foreign capital gives rise to an optimal portfolio allocation decision between funds collected from the domestic household and funds obtained on the international capital market. The financial services produced by the financial intermediaries are then rented to the firms in the final good sector.

3.1 The competitive equilibrium

The notation $\widetilde{y}$ is adopted to denote variables that represent prices or quantities in the periphery countries and y will be the corresponding counterpart in the core countries. The market structure of the core and of the periphery economies is similar. Differences in structural parameters across the two blocks will be the only source of cross-country heterogeneity. Technology and preferences are consistent with balanced growth and stationary variables are denoted using capital letter. Small letters are used for detrended variables and the deterministic growth rate along the balanced growth path is denoted γ. Since the market structure across the two blocks is identical, we focus the analysis on the core economy.

The final-goods producing sector in the core economy

The optimization problem of the firm is static and its objective is to maximize total profits, π_F, by optimally choosing the number of hours worked to hire from the

representative agent, N_F, and the quantity of financial services, y_L, that is obtained from the financial sector, where r_L is the lending rate. The final output good of the firm, which is denoted y, is produced via a Cobb-Douglas production function:

$$y_t = A_t y_{Lt}^{\alpha} N_{Ft}^{1-\alpha}, \tag{1}$$

where α is the capital share. The state of technology, which is denoted A, and which is common across countries, is subject to random disturbances that capture the effects of aggregate supply shocks. Managers in the final-goods producing sector maximize profits

$$\max_{N_{Ft}, y_{Lt}} \pi_{Ft} = y_t - w_t N_{Ft} - r_{Lt} y_{Lt}, \tag{2}$$

subject to (1), and taking as given the exogenous state of technology, which evolves according to the following stochastic process:

$$\log A_t = \rho_A \log A_{t-1} + \varepsilon_{At}, \tag{3}$$

The financial intermediaries

The key assumption is that the production of financial services is determined by a production function that relates the quantity of output that financial intermediaries can produce to factors of production. The quantity of new loans that is supplied by the financial sector, *i.e.* $\gamma y_{Lt+1} - (1-\delta_L) y_{Lt}$, cannot exceed a fraction μ of the financial intermediary's capital stock, k :

$$\gamma y_{Lt+1} - (1-\delta_L) y_{Lt} \leq \mu_t k_t, \tag{4}$$

where μ is the financial multiplier.

The financial intermediary capital stock has a domestic and a foreign component:

$$k_t = (d_t - b_t)^{\xi} \widetilde{b}_t^{1-\xi} \tag{5}$$

The capital deposited by the domestic household in the domestic financial sector is denoted d, and b is the amount that the domestic financial sector invests abroad. $d-b$ is therefore the share of domestic capital that is allocated to the domestic economy. The quantity of capital that the domestic financial intermediary receives from abroad is denoted $\widetilde{b}$, where $0 \leq \xi \leq 1$ is a technology parameter that measures the degree of

financial openness.

The financial multiplier, μ, is endogeneized by assuming that the production of financial services depends on the number of hours worked that loan officers spend on the allocation of the intermediary's production of financial services to prospective borrowers. The number of hours worked by loan officers is denoted, N_B. To keep the analysis tractable, we assume that the interaction between μ, k and N_B is given by the following relationship:

$$\mu_t = \left(\frac{N_{Bt}}{k_t}\right)^{1-\phi} \tag{6}$$

where $0 \leq \phi \leq 1$ is a parameter that measures the efficiency of financial intermediation.[2] The financial intermediation process is less efficient the lower the value of ϕ. A less efficient financial sector needs a higher number of loan officers per unit of capital in order to produce a given quantity of financial services and this lower productivity affects the steady state quantity of financial services that the intermediary can produce. As will be discussed in section 4, the value of the financial multiplier and therefore of the quantity of financial services that will be produced critically depends on the parameter ϕ, which provides a measure of the economy's financial structure.

Revenues of the financial intermediary consist of two distinct components. First, the financial intermediation activity generates a revenue from lending y_L to the domestic firms, where r_L is the interest rate on loans. Second, the domestic bank receives a revenue from selling its domestic capital abroad, *i.e.* $p_B b$, where p_B is the price at which it sells domestic capital to the foreign financial intermediary.

The costs associated with loan production are firstly given by the remuneration of household capital, d, that the domestic household deposits with the financial sector, where the deposit rate is denoted r_D. The production of financial services requires labor and w is the wage rate paid to workers in the financial sector. The cost of obtaining foreign capital is given by $\widetilde{p}_B\widetilde{b}$, and $\widetilde{p}_B$ is the price of foreign capital that is paid to the foreign financial intermediary. So at periods t, profits in the financial sector are given as follows

$$\pi_{Bt} = r_{Lt}y_{Lt} + p_{Bt}b_t - w_t N_{Bt} - r_{Dt}d_t - \widetilde{p}_{Bt}\widetilde{b}_t, \tag{7}$$

Each period, bank managers optimally choose production factors and the level of

[2]This implies a production function with capital and labor as inputs that follows a Cobb-Douglas form.

production to maximize shareholder value, which is given by the infinite discounted sum of future cash-flows:

$$\max_{y_{Lt+1},d_t,b_t,\widetilde{b}_t,N_{Bt}} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \pi_{Bt},$$

subject to constraints (4) to (7), where $\beta^t \frac{\lambda_t}{\lambda_0}$ is the stochastic discount factor of the domestic representative agent, who owns the banks.

Households

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

$$\pi_{Tt} + w_t N_{Bt} + w_t N_{Ft} + r_{Dt} d_t = c_t + x_t, \tag{8}$$

and the representative agent divides his or her time between leisure activities, L, hours worked in final goods-producing sector, N_F, and time spent working as a loan officer in the financial intermediation sector, N_B :

$$L_t = 1 - N_{Bt} - N_{Ft}, \tag{9}$$

where agents total labor income is denoted $wN_B + wN_F$.

Total income also consists of revenue from depositing capital in the banking sector, $r_D d$. The representative agent owns the domestic intermediary and the final goods-producing firms and total dividend income is denoted π_T. Total revenue is allocated between consumption expenditures, c, and the amount invested in capital deposited with the financial intermediary, which we denote x.

The law of motion governing the accumulation of capital is subject to adjustment costs:

$$\gamma d_{t+1} = d_t + \left(\frac{\theta_1}{1-\epsilon} \left(\frac{x_t}{d_t} \right)^{1-\epsilon} + \theta_2 \right) d_t, \tag{10}$$

where ϵ is the parameter controlling the supply elasticity of household capital, and where θ_1 and θ_2 are parameters that are calibrated to ensure that adjustment costs have no impact on the deterministic steady state of the economy (e.g., Baxter and Crucini 1993, Jermann 1998). This assumption implies that adjustment costs will not generate any direct resource costs and will only affect the elasticity of the investment

to capital ratio to changes in Tobin's Q. Finally, we assume that agents' habit stock is slow moving and that its dynamics evolves according to the following law of motion:

$$\gamma h_{t+1} = mh_t + (1-m)c_t\left(\psi + L_t^{\upsilon}\right), \tag{11}$$

where h denotes the habit stock and m is a parameter that governs the speed at which the habit stock depreciates (e.g., Campbell and Cochrane 1999). The labor supply parameter υ controls the Frisch elasticity of labor supply, while ψ determines the steady state time allocation.[3] The representative household decides optimally how to divide his or her time and how to allocate resources between the two domestic sectors by maximizing lifetime expected utility

$$\max_{c_t, N_{Bt}, N_{Ft}, x_t, d_{t+1}, h_{t+1}} E_0 \sum_{t=0}^{\infty} \beta^t \log\left(c_t(\psi + L_t^{\upsilon}) - h_t\right),$$

subject to constraints (8) to (11).

Market equilibrium

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

$$w, \widetilde{w}, r_L, \widetilde{r}_L, p_B, \widetilde{p}_B, r_D, \widetilde{r}_D, \lambda, \widetilde{\lambda}, q_D, \widetilde{q}_D, q_L, \widetilde{q}_L, \varphi, \widetilde{\varphi}$$

where q_D and $\widetilde{q}_D$ denote the price of capital in the core and periphery countries, λ and $\widetilde{\lambda}$ is marginal utility, q_L and $\widetilde{q}_L$ is the shadow price of financial services, φ and $\widetilde{\varphi}$ is the Lagrange multiplier associated with habit accumulation equation, and quantities:

$$y, \widetilde{y}, c, \widetilde{c}, h, \widetilde{h}, x, \widetilde{x}, d, \widetilde{d}, b, \widetilde{b}, N_B, \widetilde{N}_B, N_F, \widetilde{N}_F$$

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

$$A_t y_{Lt}^{\alpha} N_{Ft}^{1-\alpha} + p_{Bt} b_t = c_t + x_t + \widetilde{p}_{Bt}\widetilde{b}_t,$$

$$A_t \widetilde{y}_{Lt}^{\alpha} \widetilde{N}_{Ft}^{1-\alpha} + \widetilde{p}_{Bt}\widetilde{b}_t = \widetilde{c}_t + \widetilde{x}_t + p_{Bt} b_t,$$

for all states, for t=1...∞, and given initial values for the four endogenous state variables $h, \widetilde{h}, d$ and $\widetilde{d}$.

[3] All parameters in the utility function are calibrated to ensure that consumption and leisure are always normal goods.

Savings and net capital outflows

A measure of net capital outflows, which we denote nco, can be defined to study the dynamics of financial imbalances. In the core countries, the difference between the cost of obtaining capital from banks in the periphery, *i.e.* $\widetilde{p}_B\widetilde{b}$ and the income from selling domestic capital abroad, $p_B b$, can be expressed as follows:

$$nco_t = \widetilde{p}_{Bt}\widetilde{b}_t - p_{Bt}b_t = y_t - c_t - x_t$$

A positive net capital outflow position is equivalent to a trade surplus and corresponds to the case in which domestic income is greater than domestic spending, *i.e.* $y > c + x$. Savings, which we denote s, can then be defined as:

$$s_t = nco_t + x_t$$

Since a positive net capital outflow position implies that the country is saving more than it is investing, *i.e.* $s > x$, it must be sending some of its saving abroad. A trade surplus in the core economy therefore corresponds to the case in which the amount of capital that is sent abroad by the core countries is greater than the revenue they receive from selling their capital abroad.

In our general equilibrium analysis, a trade surplus in the core needs to be compensated by a trade deficit in the periphery economy, *i.e.* $\widetilde{nco} < 0$. Similarly, a negative net capital outflow position in the periphery implies that the payment received by banks in the periphery from the core is greater than the amount they send abroad and therefore that they invest more than they save.

Short-term rates

Assuming that international asset markets are incomplete implies that short-term risk-free rates will differ across regions. The discrepancy between these two rates can be interpreted as a measure of market fragmentation. In each case, the stochastic discount factor of the representative agent can be used to derive real interest rates. For the core consumers, the one period risk-free rate is determined by the following condition:

$$\frac{1}{1 + r_{Ft}} = \beta E_t \frac{\lambda_{t+1}}{\lambda_t}$$

while in the periphery, the risk-free rate is given by:

$$\frac{1}{1+\widetilde{r}_{Ft}} = \widetilde{\beta} E_t \frac{\widetilde{\lambda}_{t+1}}{\widetilde{\lambda}_t}$$

4 Calibration and results

The structure of the model can be used to identify the main sources of heterogeneity between the two different blocks by estimating the key structural parameters of the model using the simulated method of moments. The structure of the model allows us to consider three main sources of cross-country heterogeneity. On the household side, differences in attitudes towards risk (m, $\widetilde{m}$) are the two main sources of demand-side heterogeneity. As for the financial intermediation process, differences in the cost of adjusting the stock of capital deposited in the banking sector ($\epsilon, \widetilde{\epsilon}$) and differences in financial structure ($\phi, \widetilde{\phi}$) are the two main sources of supply-side heterogeneity.

These parameters are estimated by selecting six empirical moments that best characterize the heterogeneity observed between the two country blocks. The sources of heterogeneity are then identified by estimating these key structural parameters using a procedure that minimizes the distance between the data and the corresponding theoretical moments. First, we make use of the fact that lending rates are on average higher in the periphery, *i.e.* $E(\widetilde{r}_L) = 2.60\%$ vs. $E(r_L) = 1.74\%$ to calibrate the two financial structure parameters, ϕ and $\widetilde{\phi}$. Second, since differences in real interest rates provide a measure of market fragmentation, the fact that short-term rates are on average higher in the core, *i.e.* $E(r_F) = 0.59\%$ vs. $E(\widetilde{r}_F) = -0.03\%$, can be used to quantify the strength of precautionary saving motives across the two regions. In our environment, this dimension of the data will be captured by the two habit parameters, m and $\widetilde{m}$. Finally, the two adjustment costs parameters, ϵ and $\widetilde{\epsilon}$ are pinned down by including data on investment, *i.e.* $std(x)/std(y) = 2.4$ and $std(\widetilde{x})/std(\widetilde{y}) = 2.53$ into the loss function.

To keep the analysis tractable, we assume that the remaining parameters are identical across country blocks. The production technology of the final output good is homogenous across countries and the first technology parameter α, which represents the output share of the financial intermediation sector, is calibrated to reproduce the fact that in the euro area as a whole financial intermediation broadly defined represents about one third of total value added.[4] Given the lack of precise estimates on bank ex-

[4]See ECB Monthly Bulletin, Table 5.2. Financial intermediation regroups information and communication, finance and insurance, real estate (but not construction), professional business and support

posures to foreign capital, the degree of financial openness parameter, ξ, is set to 0.5, which implies an average leverage ratio for the euro area as a whole, *i.e.* $E(\widetilde{b}/d + b/\widetilde{d})$ of 50%. The fact that average deposit rates across country blocks are almost identical, *i.e.* $E(r_D) = 0.02\%$ vs. $E(\widetilde{r}_D) = -0.01\%$ implies that differences is subjective discount factors cannot be an important source of cross-country heterogeneity. Setting $\beta = \widetilde{\beta} = 0.999$ ensures that the aggregate investment share of output $E(x/y + \widetilde{x}/\widetilde{y})$ will be approximately equal to 20%, which is the average value observed for the euro area as a whole, and implies that deposit rates across the two country blocks will be equalized. Finally, we set the share of non-performing loans, $\widetilde{\delta}_L = \delta_L$ to 0.025.

To highlights the effects of differences in economic structure, we consider the case of common shocks that affect the two blocks equally. The common factor takes the form of technology shocks in the final good sectors. Setting the shock standard deviation σ_A to 0.01 and the persistence parameter, ρ_A, to 0.979 allows the model to match the observed volatility of output in the euro area.

Results

The loss function is minimized for the following combination of parameter values:

TABLE 4

ϵ	$\widetilde{\epsilon}$	ϕ	$\widetilde{\phi}$	m	$\widetilde{m}$
3.77	4.48	0.70	0.62	0.81	0.64

As illustrated by the significant difference between the two habit and adjustment costs parameters, this selection procedure explains the lower mean risk-free rate observed in the periphery by attributing a lower value to the habit parameter of the periphery consumer, $\widetilde{m}$, and a higher value to the peripheral adjustment cost parameter, $\widetilde{\epsilon}$. By strengthening the precautionary motive, together with a higher degree of capital adjustment costs, the higher intensity of habits in the periphery creates the necessary increase in the volatility of marginal utility that is needed to lower the mean risk-free rate (e.g., Weil 1989, Jermann 1998). Differences in the cost of adjusting capital are also key to simultaneously explain the small difference in investment volatility across the two country blocks. Intuitively, the values that we obtain for m and $\widetilde{m}$ imply a lower elasticity of intertemporal substitution (EIS) in consumption in the periphery. Without differences in the cost of adjusting capital, this lower EIS would make investment in the periphery more volatile than in the core, and consumption less volatile, which is the opposite from what is observed in the data.

services.

TABLE 5

	Data	Model
$E(r_F)$	0.59	0.58
$E(\widetilde{r}_F)$	-0.03	0.0
$E(r_L)$	1.74	1.73
$E(\widetilde{r}_L)$	2.60	2.61
$std(x)/std(y)$	2.40	2.40
$std(\widetilde{x})/std(\widetilde{y})$	2.53	2.52

TABLE 6

	Output volatility		Consumption volatility		Hours volatility	
	Data	Model	Data	Model	Data	Model
Periphery	1.29	1.28	0.81	0.76	0.81	0.78
Core	1.43	1.44	0.35	0.64	0.57	0.63

	Cyclicality trade balance		Mean trade balance	
	Data	Model	Data	Model
Periphery	-0.74	-0.99	-2.27	-3.5
Core	0.20	0.99	3.02	2.87

Finally, as illustrated by the significant difference between ϕ and $\widetilde{\phi}$ that is needed to match the data, according to this procedure, differences in financial structure are an important source of cross-country heterogeneity. In terms of efficiency of the financial intermediation sector, the case $\widetilde{\phi} < \phi$ corresponds to a situation in which the financial multiplier is on average smaller in the periphery than in the core:

$$E(\widetilde{\mu}) = 0.09,\ E(\mu) = 0.12$$

For any given unit of capital stock, relative to what the financial sector in the periphery is able to achieve, financial intermediaries in the core are therefore on average able to transform a higher fraction of capital into new loans. Within the context of our model, the case $\widetilde{\phi} < \phi$ therefore corresponds to a situation in which intermediation frictions are less severe in the core than in the periphery.

A higher degree of intermediation frictions also affects the size of the economy by reducing the equilibrium quantity of output that financial intermediaries will be able

to produce. As a result, the marginal utility of financial services, and therefore the interest rate charged to firms, is higher in countries in which intermediation frictions are more severe.

5 The adjustment to common shocks

In Figure 1 below, the blue continuous line shows the impulse response of output, y, consumption, c, the amount of capital that is sold abroad, b, the financial multiplier, μ, financial services, y_L, and the trade balance, nco, in the countries composing the core to a positive technology shock. The dashed line shows the same impulse response for the periphery countries. As illustrated by the dynamics of financial imbalances induced by common shocks, the model is able to generate the positive (negative) correlation between output and the trade balance or net capital outflows observed in the core (periphery) countries.

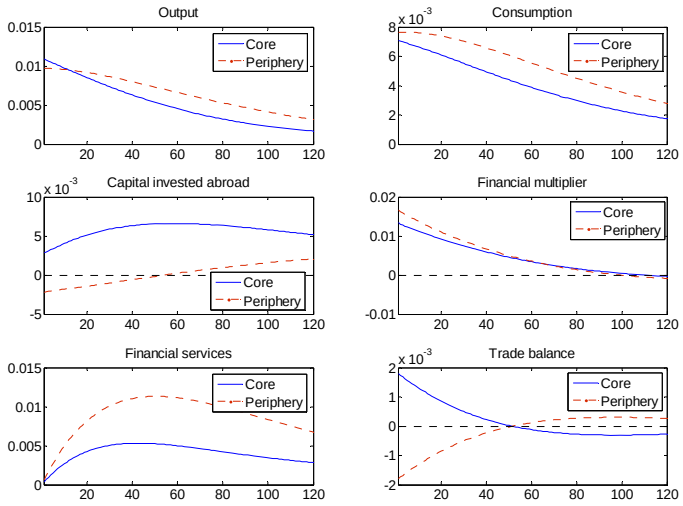

Figure 1: Impulse response to a common technology shock. Except for the trade balance which is shown in levels, all variables are expressed in logs.

The response of capital that is invested abroad by financial intermediaries in the two blocks, which is shown in the middle left panel, is a main source of business cycle asymmetry in this model. In response to a positive shock, financial intermediaries in the core increase their exposure to the periphery, while the quantity of capital invested

abroad by the periphery declines. As illustrated by the lower left panel, the fact that banks in the core choose to allocate a larger fraction of their domestic savings to the foreign sector creates a lending boom in the periphery, which, as shown by the upper left panel, leads to a more persistent increase in output. The smaller magnitude of the lending boom in the core illustrates that during periods of expansion agents in this economy find it optimal to use the international capital market to channel deposits from households in the core countries to firms in the periphery.

A financial accelerator mechanism

Our specification of the production function of financial services, which in the core takes the following form:

$$\gamma y_{Lt+1} - (1-\delta_L) y_{Lt} \leq \mu_t k_t$$

gives rise to an endogenous amplification mechanism that works through the effect of the shadow price of financial services, q_L, on the demand for production factors. The dynamics of q_L is characterized by the following optimality condition[5]:

$$q_{Lt} = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left[(1-\delta_L) q_{Lt+1} + r_{Lt+1} \right]$$

which expresses the price of the financial sector's stock of financial services as the infinite discounted sum of future lending rates that the financial intermediary will charge to firms, and where $\beta E_t \lambda_{t+1}/\lambda_t$ is the stochastic discount factor of the agent, who owns the financial intermediary.

Changes in q_L affect the real economy by amplifying the fluctuations in the financial multiplier μ_t, which depends on the quantity of loan officer per unit of capital, N_B/k, chosen by managers in the financial sector. After rearranging terms, the dynamics of the labor to capital ratio is determined by the following optimality condition, which characterizes the financial sector optimal demand for labor:

$$\frac{N_B}{k} = \left(\frac{(1-\phi) q_{Lt}}{w_t} \right)^{1/\phi}$$

[5]For the periphery, the shadow price of financial services is given as follows:

$$\widetilde{p}_{Lt} = \widetilde{\beta} E_t \frac{\widetilde{\lambda}_{t+1}}{\widetilde{\lambda}_t} \left[(1-\delta_L) \widetilde{p}_{Lt+1} + \widetilde{r}_{Lt+1} \right]$$

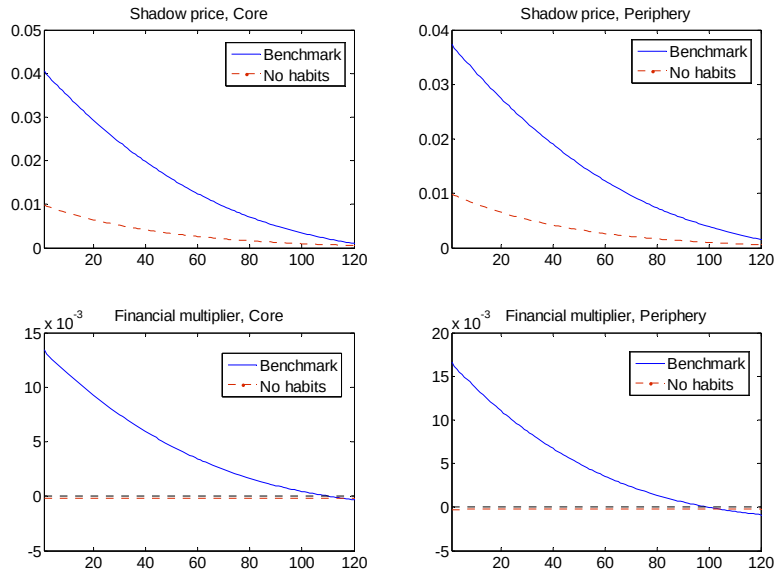

Figure 2: Impulse response to a positive technology shock. Benchmark model vs. model without habits.

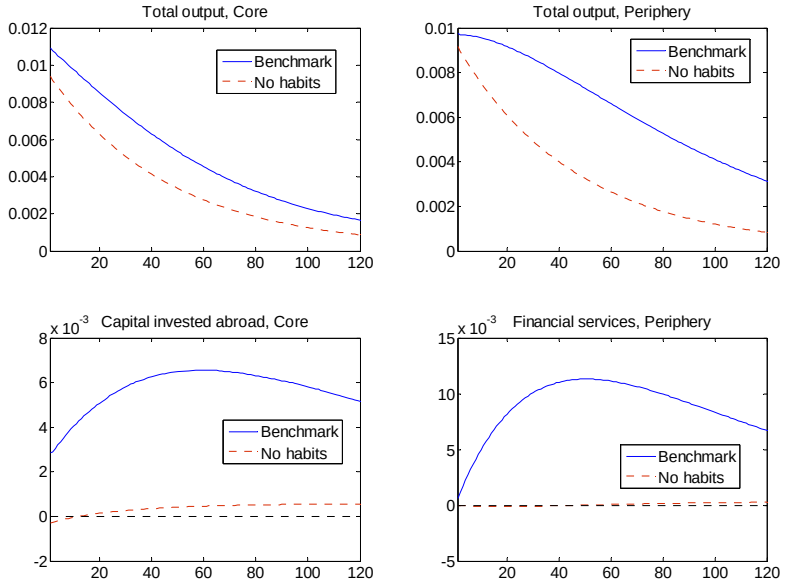

Figure 3: Impulse response to a positive technology shock. Benchmark model vs. model without habits.

This condition illustrates that the intermediary's desired labor to capital ratio, N_B/k, increases with the shadow price of financial services, q_L, and decreases with the cost of labor, w. If q_L is sufficiently volatile, a positive shock that raises the value of the stock of financial services therefore leads to an increase in the quantity of hours worked by loan officers, which in turn increases the value of the financial multiplier, μ. The increase in μ further stimulates the creation of credit by increasing the quantity of output that can be produced for each given unit of capital, which in turn raises production in the final good sector and therefore total output in the economy.

As documented in the asset pricing literature (e.g., Jermann 1998), in standard production economy models, an increase in the volatility of asset prices can be achieved by combining habit formation with capital adjustment costs. To illustrate the quantitative magnitude of this financial accelerator mechanism, Figure 2 below compares the impulse responses of $q_L, \widetilde{q}_L, \mu$ and $\widetilde{\mu}$ obtained in the benchmark model with a case in which the effects of habit formation in both countries are switched off by setting $m = \widetilde{m} = 1$. Without habits, as shown in the upper panel of Figure 2, the impact of technology shocks on q_L and $\widetilde{q}_L$ are of several orders of magnitude smaller. If asset prices are not sufficiently volatile, a positive technology shock only has a small impact on the financial multiplier (see the lower panels of Figure 2) because in this case, the effect of the shadow price on the labor to capital ratio is offset by the increase in wages triggered by the shock. Without habits, the multipliers μ and $\widetilde{\mu}$ hardly react and this financial accelerator mechanism can no longer amplify the effects of technology shocks.

Figure 3 compares the response of output, capital sent abroad in the core and bank lending in the periphery in the benchmark model with a version of the model without habits. As shown by the response of the quantity of capital sent abroad by financial intermediaries in the core and lending to firms in the periphery in the two cases, the role played by this amplification mechanism is quantitatively important. This mechanism also affects the dynamics of output, which becomes less volatile in the model without habits.

The smaller volatility of asset prices that is obtained when this propagation mechanism is turned off decreases the quantity of cross-border capital flows. As a result, the response of output in the core and in the periphery becomes very similar, which illustrates that in the case of common shocks, cross-border capital flows are the main source of business cycle asymmetry in this model.

6 What explains the level and the cyclicality of financial imbalances?

The structure of the model allows for many differences in structural parameters. In this section, we study how the following sources of cross-country heterogeneity affect financial imbalances: (i) differences in attitudes towards risk, (ii) differences in adjustment costs, and (iii) differences in financial structures. 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, the trade balance is equal to zero both in the steady state and over the business cycle.[6] This property of the model can be exploited to gain intuition into how these different sources of heterogeneity affect the level and the cyclicality of financial imbalances. The level of financial imbalances and the ouput-trade balance correlation obtained in the symmetric case are reported in column 2 of Table 7 and corresponds to the following calibration:

$$\epsilon = \widetilde{\epsilon} = 3.77,\ \phi = \widetilde{\phi} = 0.7,\ m = \widetilde{m} = 0.81$$

Columns 3 to 5 in Table 7 below show the marginal contribution of each of these three sources of cross-country heterogeneity relative to the symmetric benchmark.

Differences in attitudes towards risk

Model 1 (see column 3 in Table 7) reports the model implications in the case in which $m = 0.81$ and $\widetilde{m} = 0.64$ is the only source of cross-country heterogeneity. The results obtained in this case demonstrate that differences in attitudes towards risk, while needed to explain the lower risk-free rate observed in the periphery, cannot explain the cyclicality nor the level of net capital outflows observed in the euro area. When the habit parameter is the only source of cross-country heterogeneity, the model generates a trade deficit in the core and, as reported in Table 7, predicts that net capital inflows in the periphery should be countercyclical, which is the opposite from what is observed in the data. Intuitively, the case $\widetilde{m} < m$ corresponds to a situation in which agents' elasticity of intertemporal substitution in consumption is lower in the periphery than in the core. By making agents' desire to smooth consumption more pressing in the periphery and less pressing in the core, differences in habits therefore

[6] Without asymmetries, the assumption that $\xi < 1$ still implies that capital is traded but in this case shocks have no effects on the level or the cyclicality of net capital outflows because $\widetilde{p}_{Bt}\widetilde{b}_t = p_{Bt}b_t$ for all t.

generate countercyclical net capital inflows in the periphery, which reduce consumption volatility in this region. By contrast, since it generates procyclical net capital inflows in the core, the resulting cyclicality of capital flows increase consumption volatility in this region, which becomes more volatile than in the periphery when $\widetilde{m} < m$ is the only source of cross-country heterogeneity.

By raising the volatility of marginal utility, the second main effect of an increase in risk aversion for consumers in the periphery is to strengthen precautionary saving motives. Relative to the symmetric case, this stronger precautionary motive in the periphery stimulates capital accumulation, which in this environment can be achieved either by accumulating a larger quantity of foreign asset, *i.e.* b in this case, or by decreasing the quantity of domestic capital that is sold abroad. In the case $\widetilde{m} < m$, the periphery therefore becomes a net saver and runs a small trade surplus in the steady state.

TABLE 7

	Data	Symmetric case	Model 1 $m > \widetilde{m}$	Model 2 $\epsilon < \widetilde{\epsilon}$	Model 3 $\phi > \widetilde{\phi}$
	(1)	(2)	(3)	(4)	(5)
$\rho(tb, y)$	0.20	0	-0.99	-0.99	0.99
$\rho(\widetilde{tb}, \widetilde{y})$	-0.74	0	0.99	0.99	-0.99
$E(tb/y)$	3.03	0	-0.06	-0.2	3.16
$E(\widetilde{tb}/\widetilde{y})$	-2.25	0	0.06	0.2	-3.90

Table 7: $\rho(tb, y)$ and $\rho(\widetilde{tb}, \widetilde{y})$ is the correlation between the trade balance and output in the core and in the periphery. $E(tb/y)$ and $E(\widetilde{tb}/\widetilde{y})$ is the average trade surplus/deficit in the core and periphery.

Differences in capital adjustment costs

Model 2 shows what happens to financial imbalances when we move from the perfectly symmetric case to the case in which $\epsilon = 3.77$ and $\widetilde{\epsilon} = 4.48$ is the only source of cross-country heterogeneity. As shown by the results reported in column 4, the effects of higher adjustment costs in the periphery are qualitatively similar to the effects obtained under Model 1. This result illustrates that the increase in precautionary saving motives obtained within this class of models is due to the combination of habits and adjustment costs (e.g., Jermann 1998). Everything else equal, a higher degree of

adjustment costs or an increase in the intensity of habits increases the volatility of marginal utility. In an open economy, and if differences in habits and adjustment costs are the only source of cross-country heterogeneity, a stronger precautionary motive increases aggregate savings and generates a steady state surplus in the region in which marginal utility is most volatile.

The final effect on the dynamics of net capital flows can be better understood by decomposing the total effect into a price and a quantity effect. In the core, the trade balance or net capital outflow position is given by:

$$nco_t = \widetilde{p}_{Bt}\widetilde{b}_t - p_{Bt}b_t$$

Given that with the assumptions regarding the sources of cross-country heterogeneity that were made the dynamics of $\widetilde{p}_{Bt}$ and p_{Bt} are identical,[7] without loss of generality we firstly set $\widetilde{p}_{Bt} = p_{Bt}$, and to gain intuition into the main model mechanism, we then linearize this condition around the model's deterministic steady state.[8] Up to a first-order approximation, the dynamics of the trade balance in the core is approximately equal to:

$$\widehat{nco}_t = \frac{p_B\widetilde{b}}{nco}\widehat{\widetilde{b}}_t - \frac{p_B b}{nco}\widehat{b}_t + \frac{\left(\widetilde{b} - b\right)p_B}{nco}\widehat{p}_{Bt} \tag{12}$$

where variables with a hat are expressed in percentage deviation from steady state, and $\widetilde{b}, b, p_B$ and nco denote steady state values. This expression illustrates that variations in the price of capital, $\widehat{p}_{Bt}$, will not affect the dynamics of net capital flows as long as the condition $\widetilde{b} = b$ holds. Therefore, since up to a first-order approximation, the introduction of habits and adjustment costs do not affect $\widetilde{b}$ and b, the dynamics of the trade balance is solely driven by quantities when differences in these two parameters are the only source of cross-country heterogeneity.[9]

Without any significant impact of $\widehat{p}_{Bt}$, the dynamics of capital flows can be explained by the ratio of marginal utilities $\lambda/\widetilde{\lambda}$, which provides a measure of relative "hunger". If, as in the case studied under Model 1 and 2, marginal utility in the pe-

[7] The parameters $\mu, \widetilde{\mu}$ and $\beta, \widetilde{\beta}$ are similar across country blocks.

[8] All the moments reported in the paper are computed using a second-order approximation. A first-order approximation is nevertheless sufficient to illustrate what are the main drivers of trade balance dynamics.

[9] The effects of habit formation and adjustment costs only affect $E(b)$ and $E(\widetilde{b})$ through higher-order terms and have no effects on b and $\widetilde{b}$, which denote steady state values in the case without uncertainty.

riphery is more volatile than in the core, a positive shock will raise $\lambda/\widetilde{\lambda}$. Intuitively, this generates a trade deficit in the core because consumers will satisfy this increase in relative "hunger" either by selling a larger fraction of their domestic capital abroad, and increase $\widehat{b}_t$, or by accumulating less foreign capital, which leads to a reduction in $\widehat{\widetilde{b}}_t$. Selling domestic capital abroad or reducing foreign capital accumulation allows them to trade future income for current consumption, and if differences in habits or adjustment costs were the only source of cross-country heterogeneity, net capital inflows would be procyclical in the core and countercyclical in the periphery, which, again, is the opposite from what is observed in the data.

Differences in financial structure

Model 3 shows what happens to the level and cyclicality of financial imbalances when we move from the perfectly symmetric case to the case in which $\phi = 0.7$ and $\widetilde{\phi} = 0.62$ is the only source of cross-country heterogeneity. The results shown in column 5 of Table 7 illustrate that differences in intermediation frictions are the key source of heterogeneity that allow the model to explain the direction of capital flows as well as the magnitude of financial imbalances observed in the data.

Financial structure and steady state imbalances

Relative to the symmetric benchmark, and as illustrated by the first two rows of Table 8 below, more severe intermediation frictions in the periphery reduce the value of the financial multiplier, and lower the steady state quantity of financial services that can be produced. This reduces the long-run potential of the economy and lowers the relative size of the periphery economy, *i.e.* $E(\widetilde{y}) < E(y)$. Furthermore, by increasing the relative scarcity of financial services, tighter intermediation frictions in the periphery increase the cost of lending by raising the marginal productivity of financial services, leading to $E(\widetilde{r}_L) > E(r_L)$. In the steady state, the lower competitiveness of financial intermediaries in the periphery leads to a reallocation of domestic savings towards the financial sector of the core countries. The presence of a cross-border capital market allows agents in the periphery to take advantage of the more efficient technology available in the core by selling a large fraction of their domestic capital stock abroad. Similarly, agents in the core allocate most of the domestic savings to their relatively more efficient domestic financial system and only send a small fraction of domestic deposits abroad. In equilibrium, the region with a less efficient financial sector therefore attracts lower quantities of foreign capital and sends a larger share of domestic savings abroad than its counterpart. The resulting assymmetry in cross-border capital flows,

i.e. $E(\widetilde{b}) > E(b)$, generates a trade deficit in the region whose financial sector is relatively less efficient and a corresponding surplus in the country where intermediation frictions are relatively less severe.

TABLE 8: STEADY STATE EFFECTS

	Symmetric Case $\phi = \widetilde{\phi} = 0.7$	Diff. Fin. Structure $\phi = 0.7$, $\widetilde{\phi} = 0.62$
$E(\mu)/E(\widetilde{\mu})$	1	1.40
$E(y_L)/E(\widetilde{y}_L)$	1	1.90
$E(y)/E(\widetilde{y})$	1	1.24
$E(r_L)/E(\widetilde{r}_L)$	1	0.65
$E(b)/E(\widetilde{b})$	1	0.74

Financial structure and the dynamics of net capital flows

Compared to the results obtained under Model 1 and 2, the main difference is that changes in the price at which countries are trading capital affect the dynamics of net capital flows in the case $\widetilde{\phi} < \phi$. As shown in Table 8, the fact that in this case $\widetilde{b}$ and b are different creates valuation effects, reflecting the fact that changes in the price at which agents sell or buy capital has a direct impact on their net exposure to the international market when they are either net buyers or net sellers of capital.

To gain intuition into the main determinants of trade balance dynamics, and using equation (12), it is useful to decompose the final effect into a quantity and a price effect. First, as discussed earlier, the dynamics of b and $\widetilde{b}$ can be linked to the behaviour of marginal utilities $\lambda/\widetilde{\lambda}$, which provides a measure of relative hunger. Like adjustment costs, an increase in the degree of intermediation frictions reduces the potential for intertemporal smoothing and raises the volatility of the marginal utility of consumption. Since intermediation frictions are more severe in the periphery, in response to a positive shock, marginal utility declines by less in core than in the periphery. In relative terms, marginal utility of the core consumers increases, and this increase in relative "hunger" is satisfied by selling a larger fraction of domestic capital abroad, or by reducing the quantity of capital accumulated from abroad. As discussed earlier, without valuation effects, the increase in b would have a dominating effect on the dynamics of the trade balance, and a positive shock that increased output in the two regions would create a trade deficit in the core, which would be inconsistent with the data.

In the case $\widetilde{\phi} < \phi$, the key is that these differences in the degree of intermediation frictions create steady state imbalances that generate valuation effects. Given that

the price of capital is procyclical, consumers in the core who are net buyers of foreign capital, *i.e.* $\widetilde{b} > b$ when $\widetilde{\phi} < \phi$, pay a higher price to accumulate foreign capital during expansion periods. Similarly, consumers in the periphery who are net sellers of domestic capital, receive a higher price during periods of economic boom. During expansion periods, this valuation effect therefore improves the trade surplus in the core and worsens the trade deficit in the periphery. Relative to Model 1 and 2, introducing differences in financial structure, which in turn give rise to steady state differences in cross-border capital flows and lending rates, therefore allows Model 3 to explain why net capital inflows are procyclical in the periphery and countercyclical in the core.

7 Heterogeneity in financial structure and the welfare cost of business cycle fluctuations

This section studies how the direction of capital flows induced by differences in intermediation frictions affect the welfare cost of business cycle fluctuations. As in section 6, the effects of heterogeneity in financial structures are isolated by firstly considering the case of perfect symmetry between the two blocks, which is obtained by setting:

$$\epsilon = \widetilde{\epsilon} = 3.77,\ \phi = \widetilde{\phi} = 0.7,\ m = \widetilde{m} = 0.81$$

Column 2 of Table 8 below reports the volatility of consumption, the mean lending rate, the mean risk-free rate, and a measure of the welfare cost of business cycle fluctuations that is generated by the model in this special case. Without asymmetry, and setting the values of the periphery parameters to the values that were estimated for the core countries, the risk-free rate would be equalized across country blocks, and equal to 0.42%. In terms of welfare cost of business cycle fluctuations, as shown by the last two rows of column 2, agents in this economy would be ready to abandon about 3% of their annual consumption or accept a 5.5% reduction in their annual wage to be able to live in a deterministic world that would not be subject to any business cycle fluctuations.

Column 3 shows what happens to the symmetric allocation when differences in financial structure of the magnitude that we estimated, *i.e.* $\phi = 0.62$ and $\widetilde{\phi} = 0.7$, is the only source of cross-country heterogeneity. As already explained in section 6, a higher degree of intermediation frictions in the periphery generates procyclical net capital inflows in the periphery and countercyclical net capital inflows in the core. As

can be seen by comparing the volatility of consumption in column 2 and 3, everything else equal, a higher degree of intermediation frictions in the periphery makes consumption smoothing more difficult to achieve. Similarly, consumption volatility in the core decreases, and as in the data, the model with differences in intermediation frictions can explain why consumption is more volatile in the periphery than in the core.

Table 8

	(1) Data		(2) Symmetric		(3) $\widetilde{\phi} < \phi$		(4) Benchmark	
	Periph.	Core	Periph.	Core	Periph.	Core	Periph.	Core
$corr(tb, y)$	-0.74	0.20	0	0	-0.99	0.99	-0.99	0.99
σ_c/σ_y	0.81	0.35	0.66	0.66	0.74	0.63	0.76	0.64
$E(r_L)$	2.60	1.74	1.71	1.71	2.52	1.73	2.61	1.73
$E(rr)$	-0.03	0.59	0.42	0.42	0.37	0.63	0	0.58
$E(\frac{c_t - c}{c})$	-	-	3.13	3.13	5.6	1.62	7.7	0.63
$E(\frac{w_t - w}{w})$	-	-	5.56	5.56	8.43	3.76	11.1	2.7

Procyclical net capital inflows in the periphery means that savings decrease in good times and therefore that savings will have to increase during periods of recession. The cyclical behaviour of aggregate savings in the periphery makes the economy riskier by forcing agents to increase savings precisely when their desire to consume is the most pressing. By reducing the potential for intertemporal smoothing in the periphery, the dynamics of net capital flows therefore creates an additional source of risk that exacerbates the welfare cost of business cycle fluctuations in this region.

For consumers living in the core countries, by contrast, the cyclical behaviour of capital flows provides an additional source of insurance against unexpected shocks since this additional margin allows them to use accumulated savings to smooth the decline in consumption during periods of recession. The insurance provided by the dynamics of capital flows attenuates the effects of shocks, and relative to the symmetric case shown in column 2, this reduction in risk is reflected by a decline in the two measures of the welfare cost of business cycle fluctuations.

Finally, column 4 reports the results in the case in which all three sources of cross-country heterogeneity are introduced, which corresponds to the calibration discussed in section 4. A model that matches mean interest rates and investment volatilities across country blocks therefore predicts that the welfare cost of uncertainty is significantly higher in the region that experiences procyclical net capital inflows.

8 Conclusion

This study develops a dynamic general equilibrium model in which differences in financial structure compete with several other sources of cross-country heterogeneity. Our quantitative analysis suggests that introducing differences in financial structure is necessary in order to replicate the main features of the data. We find that a two-country model in which common shocks are the only source of fluctuations can replicate the cyclicality of the trade balance as well as the difference in short-term and bank lending rates observed between country blocks. At the same time, explaining the large difference in consumption volatility across the two regions remains a challenge for a model in which technology shocks are the only source of business cycle fluctuations.

In our environment, introducing differences in financial structure increases the welfare cost of business cycle fluctuations in the region that experiences procyclical net capital inflows. If, as suggested by the early literature on the monetary policy transmission mechanism (e.g., Cecchetti 1999, Danthine, Giavazzi, Vives and von Thadden 2000), these differences in financial structure across euro area economies are a product of their dissimilar legal structures, they are likely to generate imbalances that could be very persistent. One interpretation of our results is that pursuing structural reforms in the financial sector aimed at reducing these disparities may attenuate the procyclicality of net capital inflows in peripheral euro area countries and could reduce the magnitude of these financial imbalances.

These results are obtained in a relatively stylized version of the two-country neoclassical growth model and abstract from many potentially important aspects. In particular, they depend on a series of assumptions concerning the structure of international asset markets, including the assumption that capital can flow across borders only through financial intermediaries. In addition, the model does not contain a fiscal block and thus abstracts from cross-country heterogeneity resulting from differences in fiscal policy.

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10 Appendix A: Data description

Data source
OECDMEI/Haver for gross domestic product (y), consumption (c), investment (x), and the trade balance (nco or tb), 1999-2013
OECDNAQ/Haver for hours worked (N), 1999-2013
ECB/Haver for bank lending rates (r_L). Loans to nonfinancial corporations, new business, amount less or equal to 1mio, maturity less than a year, 2003-2013
ECB/Haver for bank deposit rates (r_D).Nonfinancial corporations, households and NPI new business, amount less or equal to 1mio, maturity less than a year, 2003-2013
OECDMEI/Haver for short term risk-free rates (r_F), 1999-2013
World Bank/Haver for Worldwide governance indicators ($Index$)

Note: For Greece the data source is ELSTAT/Haver for gross domestic product, consumption and investment. A time series for hours worked is not available. For Ireland, r_D refers to deposit rates of households, nonfinancial corporation and NPI with agreed maturity.

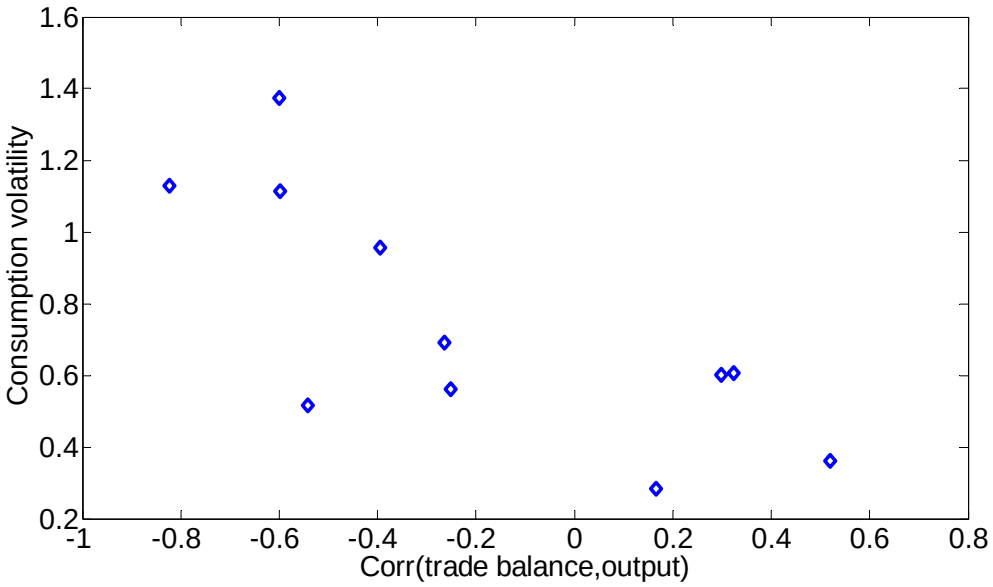

FIG. 1-y axis: Relative standard deviation of consumption, σ_c/σ_y. x axis: correlation between output and the trade balance.

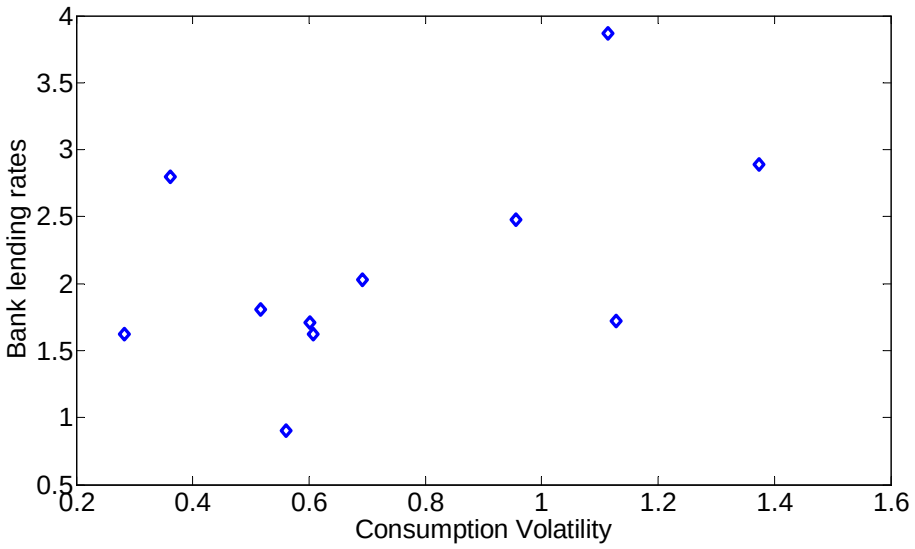

FIG. 2-y axis: Lending rates, $E(r_L)$. x axis: Relative standard deviation of consumption, σ_c/σ_y.

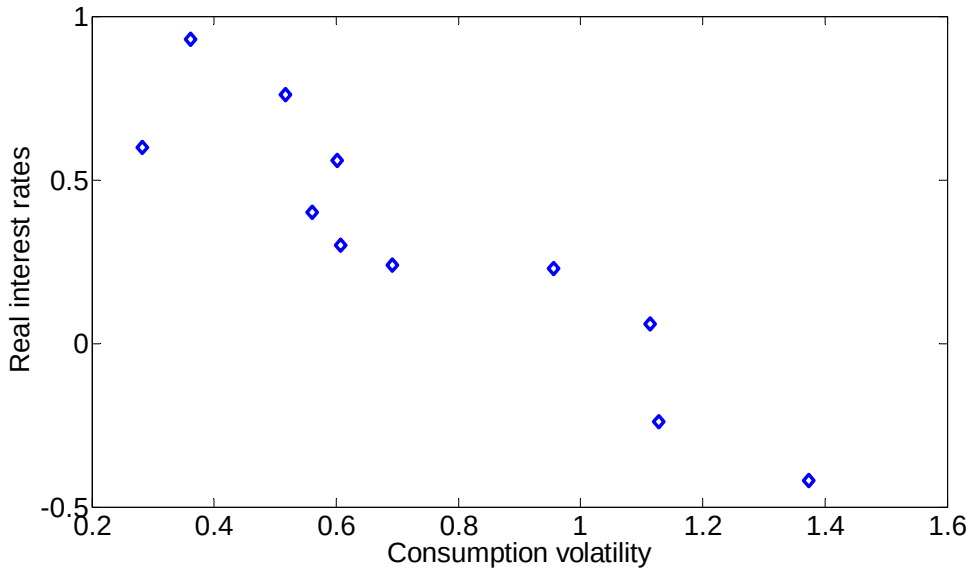

FIG. 3-y axis: Relative standard deviation of consumption, σ_c/σ_y. x axis: Real interest rates, $E(rr)$.

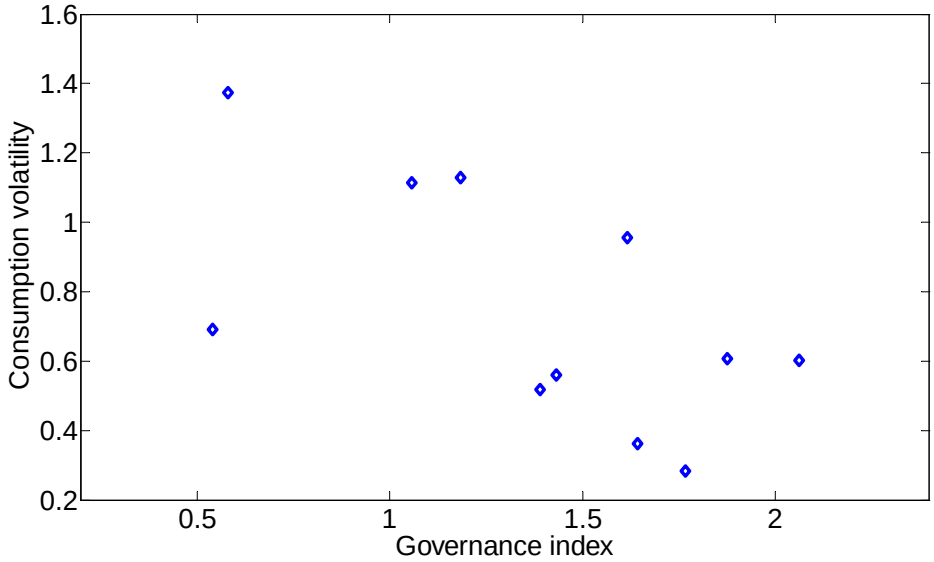

FIG. 4-y axis: Relative standard deviation of consumption, σ_c/σ_y. x axis: Governance indicator, $E(WGI)$.

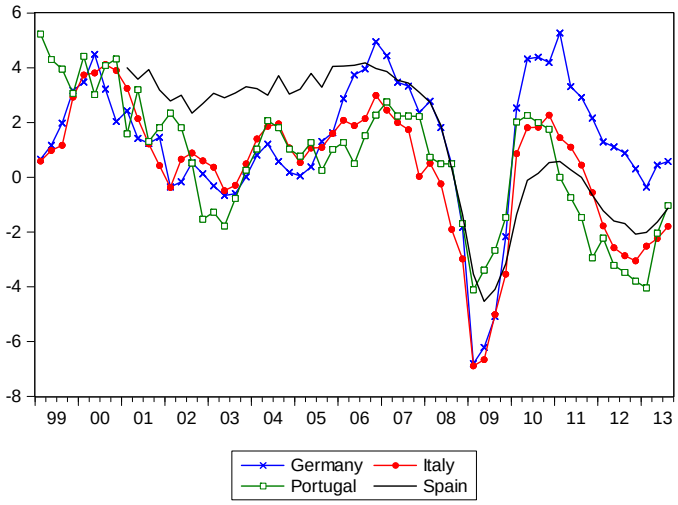

FIG. 5-Annualized output growth: Germany, Italy, Spain and Portugal.

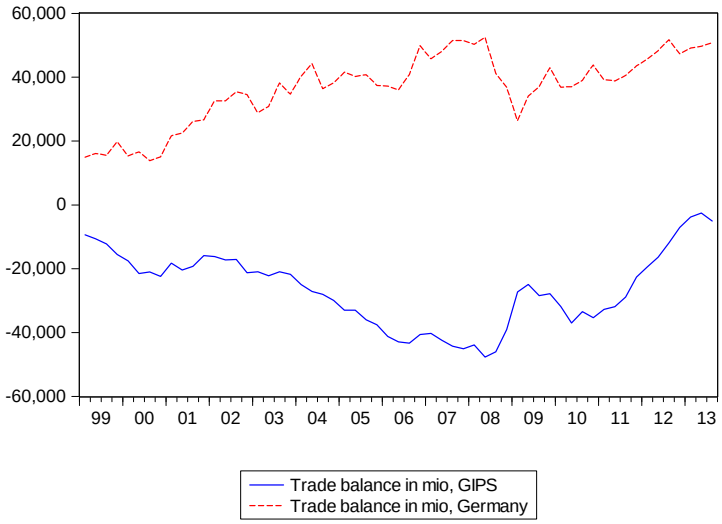

FIG. 6- Trade balance in mio, 1999-2013. GIPS vs. Germany. GIPS includes Greece, Italy, Portugal and Spain.