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Sectoral allocation and macroeconomic imbalances in EMU*

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Abstract

In the decade following the introduction of the euro, many Southern EMU members experienced sizeable capital inflows. We document how, instead of contributing to convergence, these flows mainly fueled growth of the nontradable sectors. We rationalize these developments using a tractable two-sector, two-region ('North' and 'South') model of a monetary union. We show how the sharp fall in Southern interest rates that occurred in the run-up to EMU, leads to a consumption boom, wage growth, growth of the nontradable sector, and a deteriorating external position. In the North, an opposite process occurs. As such, both real exchange rates and external positions of the two regions diverge. Including a third country with a flexible exchange rate vis-à-vis the euro amplifies the effects of monetary integration in the South, while dampening them in the North. Using a panel-BVAR, we confirm empirically that the euro area countries experiencing a fall in interest rates relative to the euro area average, experienced faster growth of the nontradable sector and a deteriorating current account balance. We investigate various policy reforms to speed up the necessary rebalancing process. A deepening of the European market shows most promise, boosting GDP growth while facilitating a rebalancing towards tradables.

Keywords: EMU, monetary integration, current account imbalances, sectoral allocation.
JEL classifications: F32, F34, F36, F45.

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1 Introduction

In the run-up to the introduction of the euro, both real and nominal interest rates in the Southern members of the Economic and Monetary Union (EMU) decreased markedly. This induced major capital flows from the North to the South, which were initially considered to be largely benign.[1] In retrospect however, the inflow of capital mainly fueled a boom of domestic lending and construction, contributing little to productivity growth or business cycle convergence.[2] As the discrepancy between the external debt level and the capacity to repay the debt kept growing, eventually the solvency of the recipient regions came under pressure (see Giavazzi and Spaventa, 2010). Whereas there exists a fairly broad consensus regarding this narrative (see e.g. Baldwin and Giavazzi, 2015), less is known about how the sectoral allocation of capital came about. It is therefore also unclear whether the developments in the first decade of EMU where an unfortunate one-off or something that could have been been foreseen and possibly prevented.

In this paper, we first document empirically how the growth of the nontradable sector in Southern Europe was a broad-based phenomenon extending beyond the construction- and real estate sectors. We then proceed by constructing a tractable two-sector two-region general equilibrium model of a monetary union, which we use to simulate a permanent drop in the real interest rate similar to the one experienced by Southern Europe. The fall in the interest rate induces a regional demand boom, which increases demand for both tradable and nontradable goods. Whereas the nontradable sector is able to increase prices and output, the tradable sector faces foreign competition and thus has less room to increase prices. Therefore, in real terms, capital and labor are cheaper in the nontradable sector and are (re)allocated to this sector. In the North, Southern demand for tradables and upward pressure on the EMU-wide interest rate induce wage moderation and a shift of resources to the tradable sector. As such, cost competitiveness positions in the North and the South diverge, while Southern external debt accumulates. Absent a debt-elastic interest rate or a debt limit, there is nothing to stop this process.

Examining the robustness of this result, we show that the relocation of resources to the nontradable sector is largely invariant to the degree of competition in the nontradable sector and to differences in productivity across sectors and countries. When we extend the model to include a third region - the 'Rest of the World' - the effects of monetary integration in the Southern part of the union are amplified, while spillovers to the North are more muted.

Next, we validate our model predictions empirically using a reduced-form panel-BVAR for 10 euro area countries. The key model predictions hold up well: countries which experienced negative interest rate shocks (relative to the euro area average), experienced faster growth of the nontradable sector, whereas no such effect is found for the tradable sector. Negative interest rate shocks also contribute to a deteriorating current account balance.

[1] See for instance Feldstein (2012) who describes the large intra-EMU capital flows and the seminal paper of Blanchard and Giavazzi (2002) for a - at the time - common interpretation of these capital flows.

[2] Comunale and Hessel (2014) describe how the surge in domestic demand was the root cause behind the emergence of current account deficits. Fagan and Gaspar (2009) show that capital inflows fueled a consumption boom while Eichengreen (2010) and Holinski et al. (2012) show that the Southern countries became relatively less productive after monetary integration.

Our paper contributes to an emerging body of research that studies the allocation of incoming capital flows in Southern Europe, both across and within sectors, and the effects thereof on the external position and productivity.[3] Most related, Benigno and Fornaro (2014) and Piton (2015) show that in a small open economy framework an exogenous fall in the interest rate leads to (relative) growth of the nontradable sector. Piton (2015) suggests that higher mark-ups in the nontradable sector contribute to the relative growth of this sector, while Benigno and Fornaro (2014) show how - in a setting where only the tradable sector experiences productivity growth - the reallocation of labor to the nontradable sector contributes to stagnating productivity growth.

We show in a multi-country setting how falling interest rates induce a reallocation of resources to the nontradable sector that is qualitatively invariant to the degree of competition in the nontradable sector and to differences in productivity levels across sectors. Thus, the reallocation of resources also follows through when the nontradable sector is the less competitive and/ or less productive one. Accordingly, our results offer a structural explanation for the empirical findings documented by Borio et al. (2016), that credit booms like those experienced by Southern Europe after the introduction of the euro are associated with a productivity slowdown driven by a reallocation of resources towards less productive sectors. Finally, with the multi-region setting allowing us to capture both sides of EMU, we show how the fall in Southern interest rates endogenously leads to wage moderation in the North. In this way, we complement studies by Gadatsch et al. (2014) and Kollmann et al. (2015), who use large-scale New-Keynesian models to analyze drivers of the German current account surplus.

The results in this paper raise important policy issues, as to correcting external imbalances and preventing new ones. In our model, as in reality, investors 'waking up' and demanding a higher interest rate premium induces a sharp rebalancing process during which Southern GDP falls. We investigate various policy options that can accommodate a less disruptive rebalancing process. An increase in public savings in the South, by depressing demand, speeds up both the improvement of the external position as well as the reallocation of resources towards the tradable sector. This would have been useful during the built-up of the imbalances. However, higher public savings after the bust amplify the recession. A fiscal expansion in the North would speed up the current account adjustment but does not help to improve the sectoral allocation of resources in the South, as (relative) prices remain largely unaffected.

We conclude by focusing on product market reforms that have the potential to both boost growth and facilitate the rebalancing process. Firstly, we analyze the effects of a liberalization of the Southern nontradable sector, i.e., allowing for more domestic competition. Perhaps counter-intuitively, but in line with Cavelaars (2006), this does not improve the region's external position. As mark-ups and prices in the nontradable sector come down, demand for nontradable goods increases and the sector expands. Total output in the South grows, while the external position

[3]Reis (2013) focuses on financial frictions to show why relatively unproductive firms in the nontradable sector grow at the expense of the tradable sector. Gopinath et al. (2015) and Cecchetti and Kharroubi (2015) show that financial frictions can contribute to the misallocation of capital within sectors, as capital is allocated to firms that have higher net worth but are not necessarily more productive. Sy (2016) emphasizes how the interaction of a common monetary policy and heterogeneous inflation rates implies real rates that are lower in the South than in the North, contributing to growth of the Southern nontrable sector.

marginally deteriorates. Spillovers from liberalizing the Northern nontradable sector are limited. Secondly, we simulate a decrease in the mark-up on tradable goods (interpreted as a deepening of the European internal market). This induces a shift of productive resources towards the tradable sector and boosts growth. However, in the 3-region version of the model, in the short-term it does harm the external position of the union as whole, as demand for tradables increases faster than supply.

2 Stylized facts

In anticipation of the introduction of the euro, nominal interest rates in Southern Europe fell sharply. As this partly reflected falling inflation expectations, the drop of economically more relevant real interest rates was less extreme. Nevertheless, it was substantial: in the three years prior to the introduction of the euro, real one-year yields – the nominal one-year yield on government debt minus Consensus inflation expectations one-year hence – in Italy, Ireland, Portugal and Spain (the 'IIPS', with data for Greece being unavailable before 1998) fell by on average *four* percentage points, see Figure 1a. Over the same period, real rates in the rest of the euro area (REA) remained roughly constant.

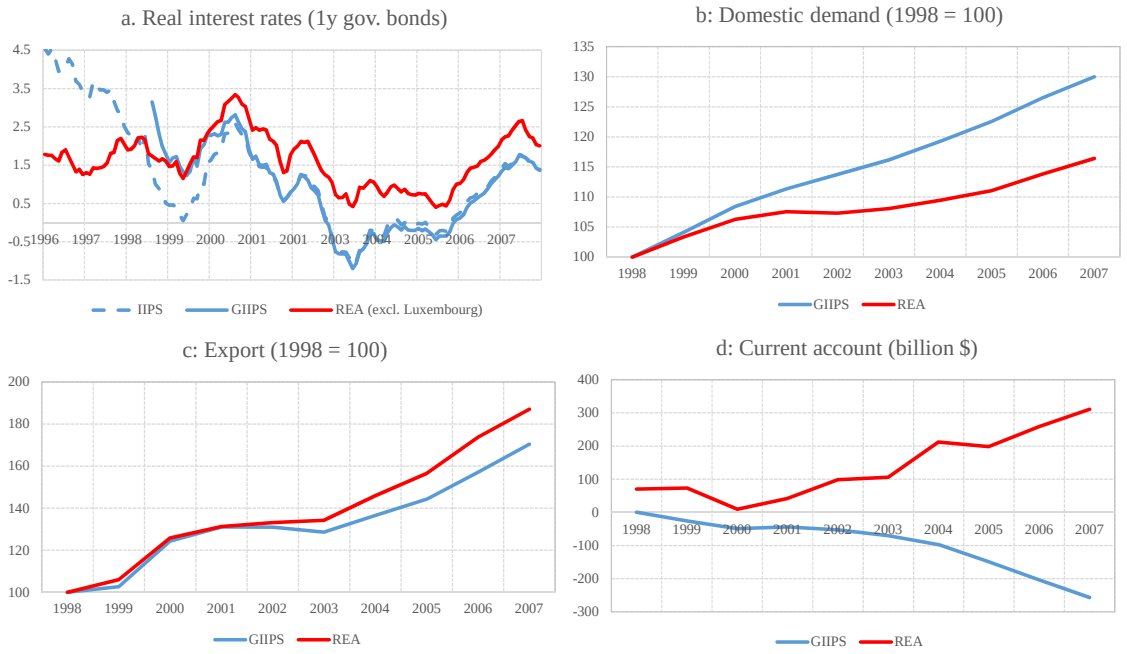
In the first years of EMU, interest rates in the entire euro area increased. Following the collapse of the dotcom bubble, interest rates came down again. However, inflation expectations and realized inflation in the GIIPS remained persistently above those in the REA. Consequently, real rates in the GIIPS remained below those in the REA up to the onset of the crisis.

Low and falling interest rates induced a domestic demand boom in the GIIPS (Figure 1b). Over 1999-2007, domestic demand in the GIIPS grew by on average 3% a year. In the REA, domestic demand increased by 1.7% a year. The demand boom in the GIIPS contributed to a surge in imports, but was not matched by a similar increase in exports. Export performance even somewhat lagged behind the REA (Figure 1c). As a result, the current account of the GIIPS – balanced at the onset of EMU – deteriorated sharply in the years thereafter. The GIIPS' current account deficit was matched by an increasing current account surplus in the REA (Figure 1d). Accordingly, the external position of the euro area as a whole remained close to balance.

In Figure 2 we plot value added in the nontradable sector to show that growth was mostly concentrated in the nontradable sector. To this end, we use data from the World Input Ouput Tables (Timmer et al., 2015) and estimate for each sector in each country the share of production that is absorbed domestically. We aggregate these results for all euro area countries, weighing each member by its share in total euro area output. Subsequently, we construct the nontradable sector by selecting those sectors that depend most heavily on domestic demand. Figure B.1 in the Annex shows for the year 1999 per sector the share of production that is absorbed domestically. In Figure 2a and b, we construct the nontradable sector by aggregating the 8 sectors that depend most heavily on domestic demand and which jointly produce 33% of total euro area output. In Figure 2c and d, we construct the nontradable sector by aggregating the 14 sectors that depend most heavily on domestic demand and which jointly produce 50% of total output.

Figures 2a and c show the growth rates of the nontradable sector. Irrespective of the threshold

Figure 1: Interest rates and macroeconomic imbalances



The IIPS contain Ireland, Italy, Portugal and Spain, the GIIPS includes Greece. The REA contains the other EMU-12 countries: Austria, Belgium, Finland, France, Germany, Luxembourg and the Netherlands. Figure 1a shows the real 1 year interest rate, calculated as the 1 year yield on government bonds minus inflation expectations over the same 1 year period (calculated using Consensus data). Figures 1b, d are based on data from the IMF WEO database October 2015, figure 1c uses AMECO data.

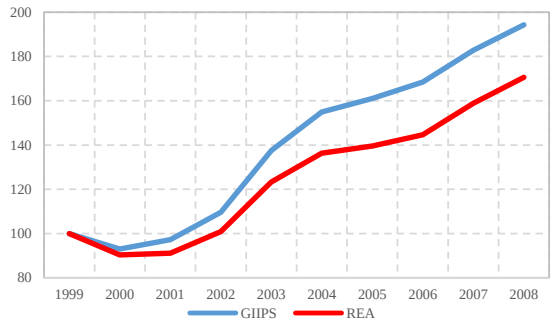
used, the nontradable sector in the GIIPS realized higher growth rates than the nontradable sector in the REA. This growth differential could be the result of higher GDP growth rates in the GIIPS, i.e., higher growth in both the nontradable and tradable sectors, potentially reflecting catch-up growth. However, Figures 2b and d show that this is not the dominant factor. Value added in the nontradable sector as percentage of GDP grows in the GIIPS countries, while it decreases in the REA. Hence, these latter countries realized mostly export led growth, as their GDP growth rate is higher than their nontradable sector growth rate. In the GIIPS, the reverse process can be witnessed: the nontradable sector grew faster than the tradable sector.

Numerous country or sector specific reasons can be identified to explain the allocation of capital inflows. One popular explanation focuses on excessive growth in the real estate sector. Housing bubbles have certainly been an important factor driving current account imbalances in countries such as Spain and Ireland. However, the nontradable boom was not limited to real estate and construction. Figures 2e and f show the growth rate and share of GDP of value added in the nontradable sector *excluding* the construction and real estate sector. Although growth rates are a bit lower than in Figure 2a, the overall pattern is the same. Thus, the rapid growth of the nontradable sector appears more broad-based than is sometimes suggested.[4]

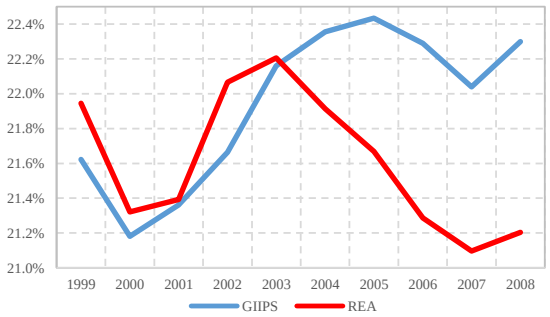
[4]The financial sector, another sector typically mentioned as a fast growing (closed) 'services' sector, is too open to be part of our nontradable sector and thus not driving the growth thereof.

Figure 2: Nontradable sector growth and as percentage of GDP

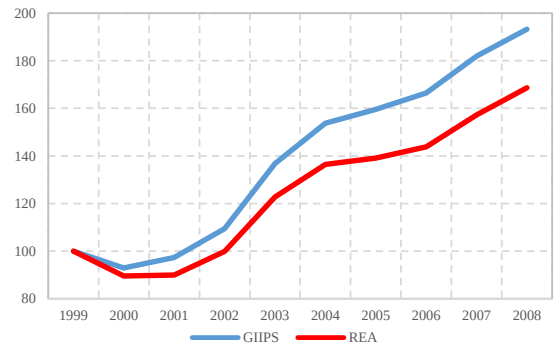
a: Value added nontradable sector (33% of output)



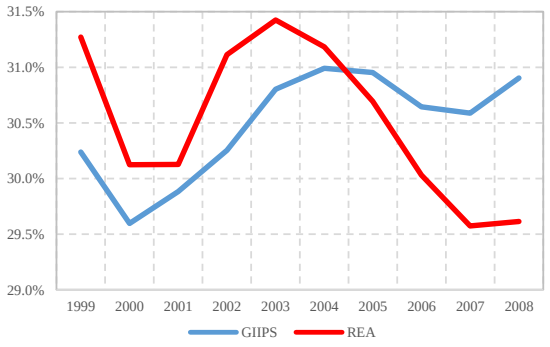
b: Value added nontradable sector as percentage of GDP (33% of output)



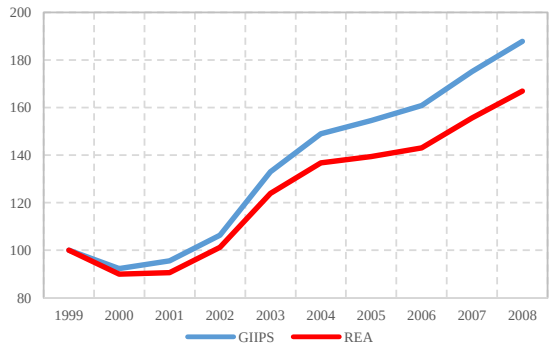
c: Value added nontradable sector (50% of output)



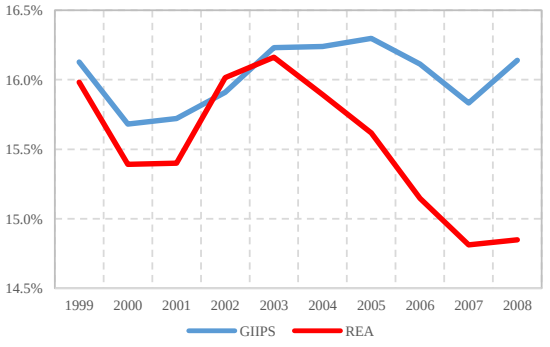
d: Value added nontradable sector as percentage of GDP (50% of output)



e: Value added nontradable sector without construction (33% of output)



f: Value added nontradable sector as percentage of GDP without construction (33% of output)



The GIIPS contain Greece, Ireland, Italy, Portugal and Spain. The REA contains the other EMU-12 countries excluding Luxembourgh: Austria, Belgium, Finland, France, Germany and the Netherlands. In Figure a, c and e 1999 = 100.

3 Model description

The model builds on the two-region two-sector framework introduced by Stockman and Tesar (1995) and Obstfeld and Rogoff (1995). The regions are labeled 'North' and 'South'. Following monetary integration, both regions become part of a single monetary union. Both regions exist of a large number of identical households, a large number of firms and a government which all have perfect foresight. The union has a single central bank which keeps the union price level constant. Households consume, supply labor, accumulate financial assets (one-period risk free bonds), hold money, and own the firms. Firms buy capital from capital producers and hire labor from households. In each region there are two types of firm, producing nontradable goods (N) and tradable goods (T) respectively. As in Vogel (2014) and Bonatti and Fracasso (2013), the tradable good is used either as consumption good or as investment in the tradable and nontradable capital stock. The nontradable good can only be consumed.

The monetary union as a whole is a closed economy, a simplifying assumption which we relax in section 5.2. Within the union labor is mobile across sectors, but not between regions. Exchange rates are fixed, i.e., pegged in the immediate run-up to EMU, and irrevocably fixed thereafter. In the run-up to EMU, regional interest rates are higher in South than in North by an exogenous premium, which can be thought of as reflecting e.g. exchange rate or inflation risk (for a similar approach, see Kollmann et al., 2015). Following the introduction of the euro and the establishment of a single central bank, this premium disappears and interest rates converge.

3.1 Households

Households that live in region $j \in \{n, s\}$, where n = North and s = South, maximize lifetime utility by choosing consumption, labor supply and money holdings:

$$U^j = \sum_{v=0}^{\infty} (\beta^j)^v \left[\log C_t^j - \frac{\theta^j (L_t^j)^{1+\sigma_l}}{1+\sigma_l} + \frac{\chi \left(m_t^j \right)^{1-\sigma_m}}{1-\sigma_m} \right], \tag{1}$$

$$\theta^j, \chi, \sigma_l, \sigma_m > 0 \quad \text{and} \quad 0 < \beta^j < 1,$$

where C_t^j denotes consumption in region j at time t, L_t^j denotes labor supply and $m_t^j = M_t^j / P_t^j$ denotes real money demand where P_t^j is the price index. The parameters $\beta^j = 1/(1+\rho^j)$, θ^j and χ denote, respectively, the discount rate, the weight of labor in the utility function and the weight of money in the utility function. The parameters σ_l and σ_m denote the inverse of the elasticity of work effort and the inverse of the elasticity of money demand.

The consumption good is a composite of a nontradable $C_t^{j,N}$ and a tradable good $C_t^{j,T}$ which are transformed into the final consumption good via a standard aggregator function: $C_t^j = (C_t^{j,N})^{\eta^j} (C_t^{j,T})^{1-\eta^j}$ where $0 < \eta^j < 1$ denotes the share of nontradables. Note that the tradable good is either produced in the home region j or in the foreign region denoted by j', i.e. consumption of the tradable good in region j is denoted as $C_t^{j,T} = C_t^{jj,T} + C_t^{jj',T}$. The nontradable good is only produced domestically. The consumer price index is a composite of

the price of the nontradable good $P_t^{j,N}$ and the price of the tradable good $P_t^{j,T}$, i.e., $P_t^j = \frac{(P_t^{j,N})^{\eta^j}(P_t^{j,T})^{1-\eta^j}}{(\eta^j)^{\eta^j}(1-\eta^j)^{1-\eta^j}}$.[5] For the tradable good the law of one price holds, as there are no trade restrictions any price difference is arbitraged away: $P_t^{n,T} = P_t^{s,T}$.

Households can buy single period bonds from firms in both North and South. We assume that, prior to EMU, there is an exogenous wedge between Southern and Northern risk-free interest rates:

$$r_{f,t}^n + \omega = r_{f,t}^s, \tag{2}$$

where $r_t^{f,j}$ is the endogenously determined risk free interest rate on bonds issued by region j and ω is an exogenous premium that disappears after monetary integration. The uncovered interest rate parity conditions ensures that after integration the nominal interest rate is the same in both regions: $r_t^{f,n} = r_t^{f,s} \equiv r_t^{f,e}$, where $r_t^{f,e}$ is the union interest rate.[6]

It is a characteristic of international business cycle models with incomplete financial markets that there is no unique deterministic steady state (see e.g. Schmitt-Grohé and Uribe (2003) and Boileau and Normandin (2008)). In particular, whereas the interest rate pins down both country's net lending, their external asset holdings are indeterminate. To pin down the equilibria, and prevent any one region from endlessly accumulating debt, we introduce a debt-elastic interest rate premium x_t^j. The interest rate premium increases in the regions' external debt level:

$$x_t^j = \xi e^{-N_t^j} - 1, \tag{3}$$

where ξ denotes how strongly the interest rate premium responds to debt accumulation and $N_t^j \equiv \frac{NFA_t^j}{P_t^{j,T}Y_t^{j,T} + P_t^{j,N}Y_t^{j,N}}$ denotes the net foreign asset position as percentage of GDP, NFA_t^j denotes the net financial assets of region j and $P_t^{j,T}Y_t^{j,T}$ and $P_t^{j,N}Y_t^{j,N}$ denote nominal GDP in the tradable and nontradable sector respectively. As such, a region's borrowing rate is given by $r_t^j = r_t^{f,j} + x_t^j$. This implies that the rate paid by the borrower is higher than the one received by the lender.[7]

[5] Minimizing the expenditure necessary to obtain one unit of the composite good C_t^j, i.e., maximizing $C_t^j = (C_t^{j,N})^{\eta^j}(C_t^{j,T})^{1-\eta^j}$ subject to the constraint $P_t^j C_t^j = \sum_{j'}^{j}\{P_t^{j',T}C_t^{jj',T}\} + C_t^{j,N}P_t^{j,N}$, gives the consumer price index.

[6] As the union-wide price level is kept constant by the monetary authority, at the union level nominal equals real. This is not necessarily the case at the level of the individual regions however, as movements in relative prices can drive a wedge between nominal and real rates.

[7] The difference can be thought of, and microfounded as, the cost of financial intermediation (Boileau and Normandin, 2008). Alternatively, it can be interpreted as a premium on default risk that is absorbed by the intermediary bearing the risk. During the first decade of EMU risk premia did not increase smoothly: they were mostly absent during the first decade of the EMU while they suddenly spiked when the solvency of the Southern states became questionable. In Section 5.3 we discuss the consequences of a more sudden increase in the interest rate premium.

The household budget constraints are represented by:[8]

$$\sum^{j'} B_t^{j'j} + P_t^{j,T} C_t^{j,T} + P_t^{j,N} C_t^{j,N} + M_t^j = \sum^{j'} (1 + r_{t-1}^j) B_{t-1}^{j'j} + \pi_t^{j,N} + \pi_t^{j,T} + L_t^j W_t^j + M_{t-1}^j, \tag{4}$$

where $L_t^j W_t^j$ denotes nominal labor income, $B_t^{j'j}$ denotes net bonds issued in country j and held by households in country in j', $\pi_t^{j,N}$ and $\pi_t^{j,T}$ are firm profits (hence households are the true owners of the firms). Households maximize their utility by choosing consumption and labor supply and bond holdings, subject to the budget constrained and a no-Ponzi condition. Labor is perfectly mobile within regions, bus does not move across the two regions. As a consequence, the wage rate is equal across sectors but may differ between regions.

3.2 Firms

In both regions the economy is occupied by two types of intermediate firms which produce wholesale tradables (T) and wholesale nontradables (N), respectively. For brevity we define $Z \in (T, N)$. Both sectors hire labor from the household sector, buy capital from the capital producers, and sell their wholesale goods to retailers. Retailers use the wholesale goods to produce the final goods. The retailers are introduced only to realize monopolistic competition in a tractable manner.

The aggregate production technologies of the nontradable and tradable intermediate firms are specified by a Cobb-Douglas form:

$$y_t^{j,Z} = A_t^{j,Z} (K_{t-1}^{j,Z})^{1-\alpha^Z} (L_t^{j,Z})^{\alpha^Z}, \tag{5}$$

where $A_t^{j,Z}$ denotes the productivity level in sector Z, $K_t^{j,Z}$ denotes the physical capital stock, total labor demand is given by $L_t^j = L_t^{j,N} + L_t^{j,T}$ and α^Z denotes the share of labor in production. Both types of firms accumulate capital according to the following accumulation identities:

$$K_{t+1}^{j,Z} = (1 - \delta) K_t^{j,Z} + I_t^{j,Z}, \tag{6}$$

where $I_t^{j,Z}$ denotes investment in the physical capital stock and δ is the depreciation rate. The nontradable and tradable firms hire labor and buy physical capital from capital producers to minimize costs subject to their production constraint, see Annex B.3

Capital producers sell their capital to the intermediate firms in a perfectly competitive environment. For reasons of tractability we assume that capital producers acquire investment (mobile across borders and between sectors) to produce capital. They borrow from the domestic households to produce capital. Consequently, the return to capital equals the domestic borrowing rate r_t^j. The nontradable and tradable capital production function is subject to diminishing

[8] We assume that, within regions, actuarially fair priced state-contingent securities exist that insure each household against idiosyncratic variations in labor and dividend income. Consequently, at the regional level, individual household income will correspond to aggregate household income.

returns to scale and represented by: $I_t^{j,Z} - \frac{\phi P_t^{j,T}}{2}\left(\frac{I_t^{j,Z}}{K_t^{j,Z}} - \delta\right)^2 K_t^{j,Z}$ where capital adjustment costs are denoted in the price of tradables. Maximizing profits yields the price of capital (see Annex B.3).

We model monopolistic competition by introducing a retail sector that aggregates the intermediate goods produced by the nontradable and tradable firms respectively, into two final products that are consumed by consumers or turned in new investment in case of tradable goods. Retailers buy the products of the intermediate firms and use the following CES production functions to produce the final goods (Dixit and Stiglitz, 1977):

$$Y_t^{j,Z} = \left[\int_0^1 y_t^{j,Z}(i)^{1-1/\mu^{j,Z}} di\right]^{1/(1-1/\mu^{j,Z})}, \tag{7}$$

where $y_t^{j,Z}(i)$ denotes nontradable or tradable output produced by intermediate nontradable or tradable firm i, $Y_t^{j,Z}$ is the final goods and $\mu^{j,Z}$ denotes the degree of substitutability between the intermediate products and determines the amount of market power of the nontradable and tradable firms. In the limit ($\mu^{j,Z} \to \infty$), pricing is perfectly competitive. Hence, both the nontradable and tradable sector intermediate firms face downward sloping demand (7) for their products because we assume imperfect substitutability between intermediate products.

Retailers minimize the cost of buying output from intermediate firms $\int_0^1 P_t^{j,Z}(i) Y_t^{j,Z}(i) di$ subject to the CES production function, (7). The retail sector is perfectly competitive. Therefore both type of retail firms maximize their profit function by setting prices equal to their marginal costs $mc_t(i)$. The aggregate nontradable and tradable price can be expressed as the weighted sum of the intermediate good prices:

$$P_t^{j,Z} = \left[\int_0^1 p_t^{j,Z}(i)^{1-\mu^{j,Z}} di\right]^{1/1-\mu^{j,Z}}. \tag{8}$$

3.3 Monetary authority and government sector

The monetary authority sets its money supply to stabilize the union's price level P_t^e, which consists of the weighted sum of the aggregate price levels of the two regions:

$$P_t^e = hP_t^n + (1-h)P_t^s, \tag{9}$$

where h denotes the respective share of North and $(1-h)$ denotes the share of South in the Union. As prices are perfectly flexible, the monetary authority can always adjust money supply such that the price level in the union is constant over time (see Annex B.4).

The government engages in debt-financed government consumption. The government uses both tradable and nontradable goods to produce aggregate government consumption. The aggregator function is similar to the aggregator function for the private consumption good, with

equal weights:

$$G_t^j = (G_t^{j,N})^{\eta^j}(G_t^{j,T})^{1-\eta^j}, \quad 0 < \eta^j < 1. \tag{10}$$

The government minimizes the cost of a given amount of government consumption: $P_t^j G_t^j = \sum_{j'}^{j}\{P_t^{j',T} G_t^{jj',T}\} + G_t^{j,N} P_t^{j,N}$. It takes the prices of the tradable and nontradable goods as given. Accordingly, government consumption of both goods depends on the respective prices levels of both goods. While we set steady state government spending equal to zero, we do experiment with debt-financed government spending (or saving) shocks.

3.4 Market equilibrium conditions

The goods market equilibrium in the market for nontradables requires that production of nontradable goods in each region is equal to consumption of nontradable goods of consumers and the government in each region:

$$Y_t^{j,N} = C_t^{j,N} + G_t^{j,N}, \tag{11}$$

where $G_t^{j,N}$ denotes government spending in the nontradable sector. The market for tradables and investment is fully internationally integrated. Hence, equilibrium requires that production in the Union as a whole is equal to consumption and investment in the Union as a whole:

$$\sum_j Y_t^{j,T} = \sum_j \left[C_t^{j,T} + I_t^{j,T} + I_t^{j,N} + AC_t^j + IC_t^j + G_t^{j,T}\right]. \tag{12}$$

Here, $AC_t^j = \sum_Z \left[\frac{\phi P_t^{j,T}}{2}\left(\frac{I_t^{j,Z}}{K_t^{j,Z}} - \delta\right)^2 K_t^{j,Z}\right]$ denotes the combined capital adjustment costs in the tradable- and the nontradable sector (which, like the investment good itself, is expressed in terms of tradables) and IC_t^j denotes the cost of financial intermediation ($x_t^j NFA_t^j$). While the current account of the union as a whole thus needs to be balanced, individual regions are allowed to run deficits or surpluses. As borrowing and lending is only possible through one-period risk free bonds, a region's net financial asset position (NFA) is denoted by:

$$NFA_t^j = (1 + r_{t-1}^j)NFA_{t-1}^j + P_t^{j,T}(Y_t^{j,T} - C_t^{j,T} - I_t^{j,T} - I_t^{j,N} - AC_t^j - IC_t^j - G_t^{j,T}). \tag{13}$$

The current account balance is defined as the first difference of a country's NFA. Finally, equilibrium in the market for financial assets requires:

$$NFA_t^n + NFA_t^s = 0. \tag{14}$$

Table 1: Calibrated parameters

Parameters	Description	Value
β^n	Discount factor households	0.990
β^s	Discount factor households	0.980
σ_l	Inverse of the elasticity of work effort	2.00
σ_m	Inverse of the elasticity of money demand	2.00
θ^n	Weight of leisure	1.000
θ^s	Weight of leisure	1.000
χ	Weight of money	0.050
η^n	Share of nontradables in consumption	0.667
η^s	Share of nontradables in consumption	0.667
α^T	Share of labor in the production function	0.550
α^N	Share of labor in the production function	0.600
δ	Depreciation rate of physical capital	0.030
$\mu^{N,n}$	Market power nontradable sector	5.000
$\mu^{N,s}$	Market power nontradable sector	3.500
$\mu^{T,n}$	Market power tradable sector	10.000
$\mu^{T,s}$	Market power tradable sector	10.000
ξ^n	Credit premium reaction	0.007
ξ^s	Credit premium reaction	0.007
$\bar{A}^{N,n}$	Productivity	1.000
$\bar{A}^{T,n}$	Productivity	1.000
$\bar{A}^{N,s}$	Productivity	1.000
$\bar{A}^{T,s}$	Productivity	1.000
h	Relative share of North in union	0.500
ϕ	Capital adjustment costs	2.000

4 Calibration

We calibrate the model to best match the evolution of the Northern and Southern parts of the euro area following monetary integration, and to simulate the effect of various policy measures. Time is quarterly. The parameter values are presented in Table 1. Both regions are equal in size. For simplicity, productivity levels are equal across regions and sectors, an assumption we relax later on. We furthermore assume that the discount factor in the North is higher than in the South. This assumption ensures that *prior* to monetary integration, both the South and the North run close to balanced current accounts. Following monetary integration and the resulting convergence of interest rates, the South borrows from the North. We calibrate the size of the country specific debt-elastic risk premium such that the South's external debt stabilizes at 70% of GDP, in line with the average external debt of the GIIPS in 2007. There are two important differences between the tradable and nontradable sector and between the nontradable firms in Northern and Southern Europe which are introduced to mimic the stylized facts but have no effect on the general results. First, we assume that $\alpha^N > \alpha^T$, i.e., the nontradable sector is more labor intensive than the tradable sector. Second, we assume that $\mu^{n,N} > \mu^{s,N}$, i.e., the nontradable sector in the Southern part of Europe is less competitive than the nontradable

sector in the Northern part of Europe. Third, in our baseline calibration the tradable sector is equally competitive in both parts of the union (due to the existence of a single market) and more competitive than the nontradable sector (that is, $\mu^{j,T} > \mu^{j,T} \forall j$).

As we analyze a large and highly persistent (arguably permanent) shock that can lead to large and long-lasting deviations from the initial steady state, log-linearizing the model around the steady state can lead to misleading results. Instead, we carry out a numerical simulation of the full nonlinear model, using Dynare's deterministic setting (see Adjemian et al., 2011). This assumes that i) the shock to interest rates is unexpected and ii) agents are certain that no future shocks will occur ('perfect foresight'). The key advantage of this approach is that it provides us with the exact transition path of the endogenous variables following the shock to the Southern interest rate, whereas any log-linearized solution would become less accurate the further the variables move away from their initial steady state.

5 Model simulations

5.1 Two-region model

After monetary integration, the interest premium paid by South disappears and interest rates in North and South converge, see Figure 3a. Consequently, South experiences a demand boom: households reduce saving and increase consumption (Figure 3b), while firms increase investment. Capital starts to flow from North to South.

The capital inflow needs to be allocated between the tradable and nontradable sector. The allocation depends on two main channels. First, as wages increase (Figure 3c), the more labor intensive nontradable sector experiences a relative cost increase compared to the tradable sector. The relative price of the nontradable good thus increases. As a result, demand for nontradable products increases less than the demand for tradable products ('demand effect'). Southern consumption of tradables increases by more than the consumption of nontradables.

However, whereas tradable goods can be imported, nontradable goods need to be produced at home. Consequently, a second channel emerges which more than offsets the first one. In the absence of foreign competition, firms in the nontradable sector have relatively ample space to increase prices when their production costs increase without slackening demand ('supply effect'). Competition with the North implies that Southern firms active in the tradable sector have less room to increase their prices as production costs increase. The rising relative price of nontradables implies that, in real terms, capital and labor are cheaper inputs in the nontradable sector. The effect is a reallocation of capital and labor towards the nontradable sector (Figure 3f).

In the North, the opposite effect occurs: Southern demand for capital increases interest rates, which causes households to increase savings. Whereas Southern demand for tradables grows, domestic demand in the North falls. As a result, the nontradable sector shrinks and both wages and the relative price of nontradables fall. Capital and labor are reallocated to the growing

Figure 3: Consequences of monetary integration

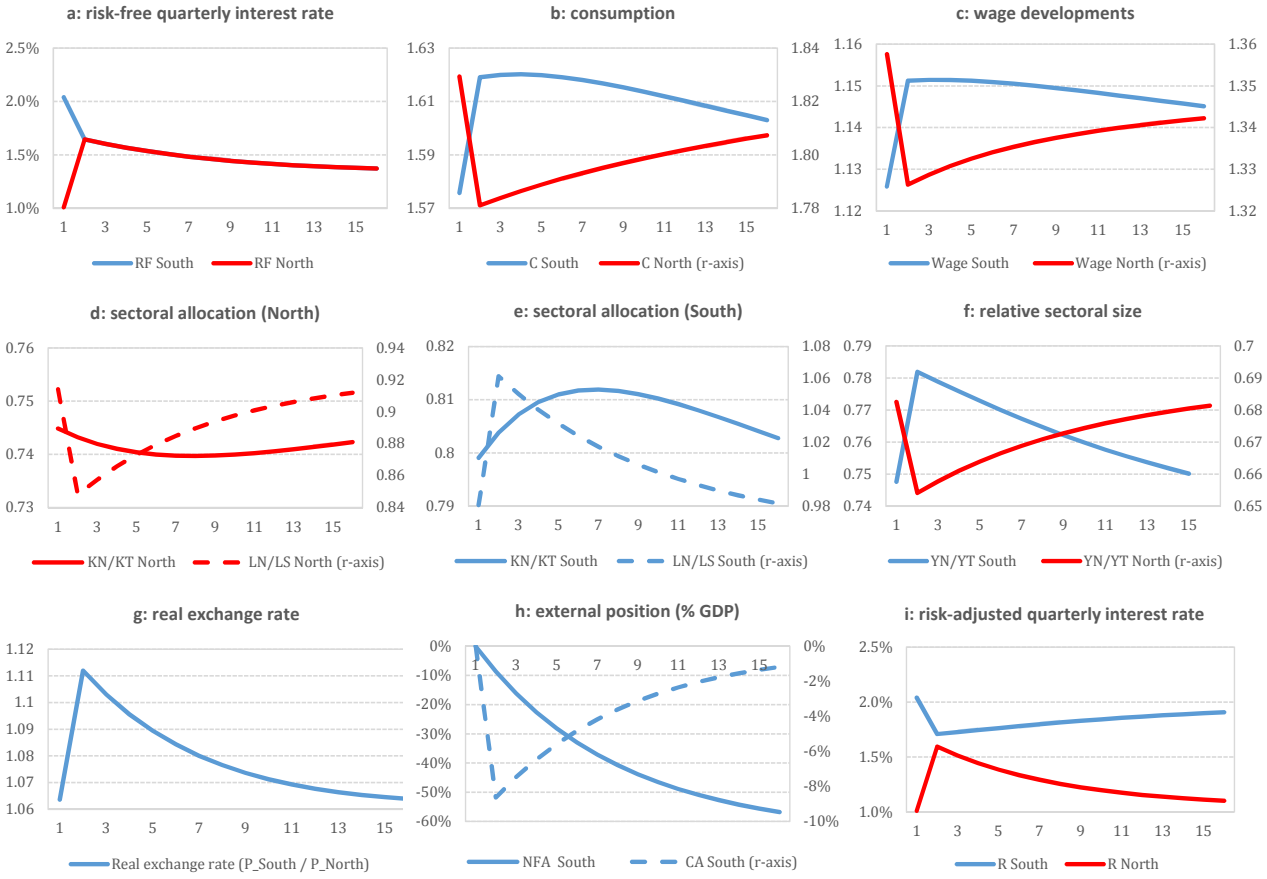


Figure shows the effects of the permanent elimination of the wedge between Southern and Northern risk-free interest rates (see equation (2)). The x-axis displays the number of quarters following the shock.

tradable sector.

The Southern boom in consumption and investment and the shift of productive resources to the nontradable sector cause the external position of South to deteriorate (Figure 3h). The increase in external debt causes an increase in the risk premium until the interest rate reaches a level at which the capital inflow stops and the net foreign asset position stabilizes. The rising interest rate also facilitates a shift of resources back to the tradable sector to produce the goods necessary to balance imports- and exports.

All results are obtained under the assumption of equal productivity levels across sectors and countries. This simplifies the interpretation of the results (e.g. ensuring that a sectoral reallocation of resources does not itself affect GDP), but is clearly not a realistic assumption. We therefore calibrate the productivity levels in the tradable and nontradable sector in both regions using the database constructed by Mano and Castillo (2015). Productivity is calculated as total value added per sector and country divided by total hours worked in each sector and country. Mano and Castillo (2015) classify a sector as tradable if more than 10% of the sector

is exported. We aggregate productivity at the region level by taking the weighted average based on the countries share in total EMU valued added. The resulting productivity levels, where we normalize tradable productivity in the North to 1 are: $\bar{A}^{N,n} = 0.76$, $\bar{A}^{T,n} = 1$, $\bar{A}^{N,s} = 0.79$, $\bar{A}^{T,s} = 0.92$.

Qualitatively, the results are unchanged: the reallocation to the nontradable sector following monetary integration still follows through when the nontradable sector is the less productive sector (results not included but available on request). As such, even if productivity in both sectors would remain constant, the relative growth of the nontradable sector hurts aggregate productivity. Accordingly, the model offers a structural explanation for the empirical findings documented by Borio et al. (2016) who show that credit booms like those experienced by Southern Europe after the introduction of the EMU are associated with a productivity slowdown driven by a reallocation of resources towards less productive sectors.

Results do also not depend qualitatively on the degree of competition in the Southern nontradable sector (see figure B.2). Even with a perfectly competitive nontradable sector, the fall in Southern interest rates induces a reallocation towards the nontradable sector. As such, eliminating 'rent seeking' would - in our setting at least - not have prevented the allocation of incoming capital flows towards the production of nontradables.

5.2 Including the RoW

So far, we assumed a closed economy for the monetary union as a whole. In this section, this simplifying assumption is relaxed by including a third country labeled 'Rest of the World' (RoW). In terms of size, it is equal to the combined Northern and Southern part of the monetary union. RoW has a flexible exchange rate with the monetary union, is connected to (initially, the Northern part of) the monetary union via an UIP and the Law of One Price and in terms of parameters mimics the Northern part of the monetary union. It is, therefore, best thought of as another advanced economy. See Annex 5.2 for the technical details.

As before, we simulate an interest rate shock in South. The addition of a third region somewhat amplifies the effects of this shock in South, while it attenuates the effects in North. Two channels are at work. Firstly, there is an exchange rate effect. The Southern boom increases the union-wide risk-free rate and induces an appreciation of the union's currency. To remain competitive, tradable prices must fall. In South, this amplifies the relative price increase of the nontradable good which contributes to an even faster reallocation of resources towards the nontradable sector. In North, this mitigates the fall in the relative price the nontradable good, which dampens the reallocation towards the tradable sector. Secondly, and somewhat trivially, the addition of a third region increases the size of the total economy. Southern imports no longer need to come exclusively from North. As a result, the impact of the Southern boom on interest rates in North is attenuated. Interest rates do rise, and North continues to realize a current account surplus, but compared to the two-region case this is only approximately half as large. In contrast, the attenuated response of risk-free interest rates implies South enjoys a boom and a current account deficit which are even larger than in the two-region case.

The Southern boom also induces the RoW to run a current account surplus. Whereas the surplus in the Northern part of the union was induced by a rising interest rate, the RoW surplus is induced by the appreciation of the union currency. RoW tradable goods get cheaper which means by the Law of One Price that the domestic currency price increases. Consequently, resources are reallocated to the tradable sector, the RoW enjoys a moderate boom and realizes a surplus on its current account.

Figure 4: Consequences of monetary integration: effects of including the RoW

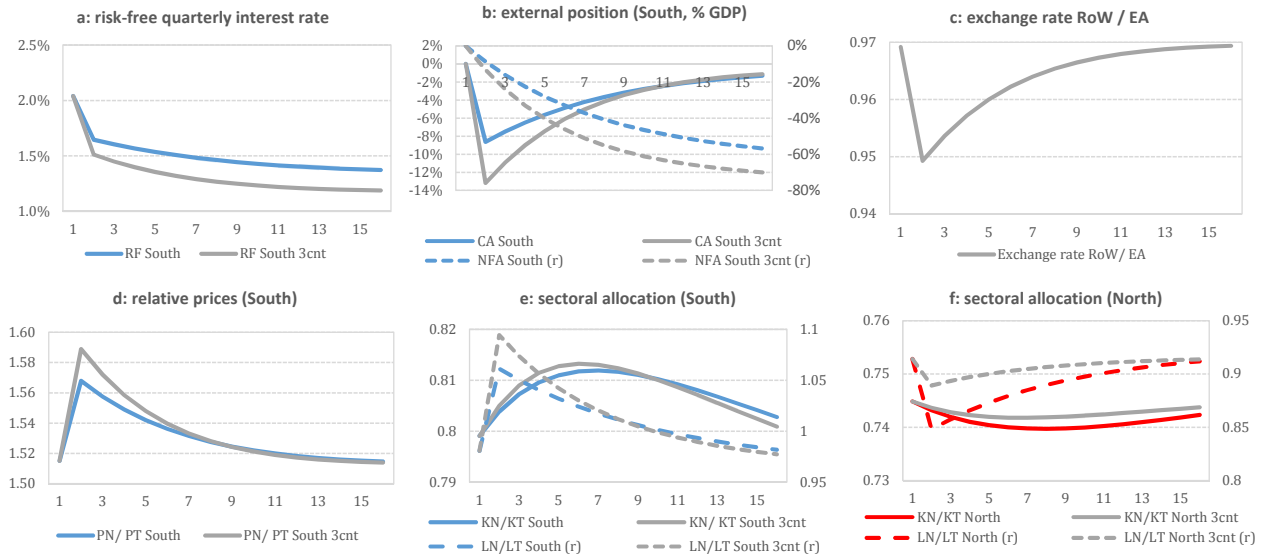


Figure shows the effects of the permanent elimination of the wedge between Southern and Northern risk-free interest rates (see equation (2)) in a closed (2-region)- and open (3-region) version of the model.

5.3 Crisis

Our model is primarily constructed, and calibrated, to show how monetary integration can lead to the emergence of a sizeable current account deficit and relative growth of the nontradable sector in Southern Europe. Due to the presence of a debt-elastic interest rate, the model is stable. Yet, even in this setting, it is fairly straightforward to see how a crisis could occur. As in e.g. Eggertsson and Krugman (2012), the crisis can be modeled as a 'Minsky moment' in which risk aversion suddenly increases. In our case, this is easiest to simulate through an unexpected, permanent increase in the elasticity of the risk premium to a region's debt level (Equation 3 in section 3). The effects thereof are mostly intuitive and the opposite of the ones presented in section 5.1: external borrowing and investment in the South collapse, consumption falls, and resources temporarily reallocate to the tradable sector. Eventually a new steady state, with a lower external debt level and a stable current account, is reached. Annex B.7 presents the results in more detail.

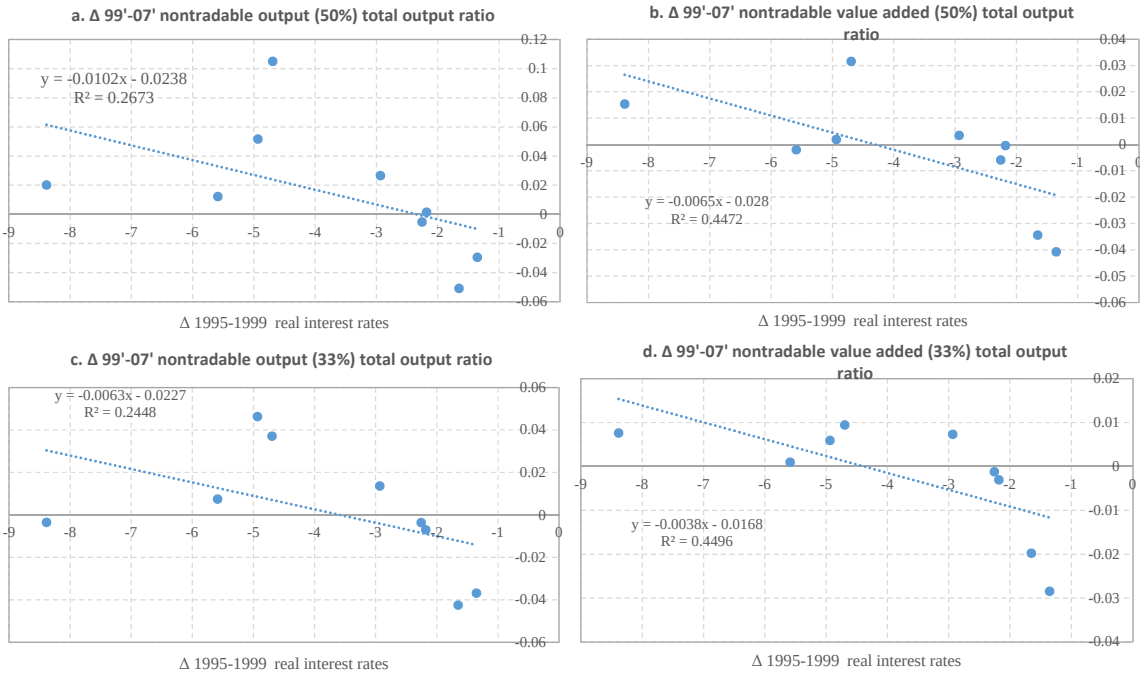
6 Empirical analysis

6.1 Methodology and data

The model's main predictions can be summarized as follows: i) the interest rate shock experienced by multiple Southern European countries in anticipation of EMU, led to a reallocation of resources towards the nontradable sector and the emergence of a current account deficit, while ii) in the Northern part of EMU an opposite process occurred in response to the developments in Southern Europe.

In Figure 5 we put the model's predictions to a simple empirical test: a bivariate regression. As dependent variable we use various measures of the relative growth of the nontradable sector over the period 1999-2007 and as explanatory variable the change in real interest rates over period 1995-1999. The results are, considering that we only have pre-EMU interest rate data for 9 countries, remarkably clear. The size of the interest rate shock appears a significant predictor of the subsequent growth of the nontradable sector.

Figure 5: Effects of falling interest upon EMU entrance on relative share of nontradables



Sample includes Austria, Belgium, Germany, Spain, France, Ireland, Italy, the Netherlands and Portugal.

In order to investigate this in more detail, we estimate the following reduced form panel-BVAR equation:

$$X_t = \alpha_0 + \alpha_1 D_t + \Phi(L) X_{t-1} + \varepsilon_t, \tag{15}$$

where $\Phi(L) \equiv \Phi_0 + \Phi_1 L^1 + ... + \Phi_p L^p$ is a lag polynomial and X_t is a vector containing the

observed variables:

$$X_t = \left[(y^N_{t,i} - \bar{y}^N_t), (y^T_{t,i} - \bar{y}^T_t), \left(\frac{B_{t,i}}{Y_{t,i}} - \frac{\bar{B}_t}{\bar{Y}_t} \right), (i^r_{t,i} - \bar{i}^r_t) \right]', \tag{16}$$

where $y^N_{t,i}$ denotes the growth rate of the nontradable sector at time t in country i from which we subtract the average growth rate of the nontradable sector in the euro area, $\bar{y}^N_t$, to control for any EA-wide trend, $y^T_{t,i}$ denotes the growth rate of the tradable sector of which we subtract the average growth rate of the tradable sector in the euro area, $\bar{y}^T_t$, $i^r_{t,i}$ is the ex-ante expected real interest rate of which we subtract the average real interest rate in the euro area $\bar{i}^r_t$.[9] Finally, $\frac{B_{t,i}}{Y_{t,i}}$ denotes a country's current account balance as percentage of GDP of which we subtract the euro area average current account balance $\frac{\bar{B}_t}{\bar{Y}_t}$.[10]

If applicable we include an exogenous dummy variable denoted by the vector of dummies $D_t \equiv \left[D^{fc}_t, D^{ec}_t \right]'$. The dummy D^{fc}_t controls for the global financial crisis taking the value 1 in 2009 and zero otherwise and the dummy D^{ec}_t controls for the euro area crisis taking the value 1 in 2011 and 2012 and zero otherwise. Finally, ε_t is a vector of stacked reduced form residuals.

To identify the shocks we assume orthogonality and use a Cholesky Decomposition. The ordering is as specified in (16), i.e, we let the real interest rate adjust contemporaneously to nontradable and tradable growth shocks, but growth in the nontradable and tradable sector is affected by a real interest rate shock only with a lag. The model is estimated using a (pooled) Bayesian estimation procedure. In order to let the data speak as much as possible, we impose a (agnostic) Minnesota prior: the unit root coefficient takes a prior value of 0.8. The hyperparameters are set at standard values, i.e., the overall tightness parameter is set equal to 0.1 and the lag decay parameter is set equal to 1. As (15) also includes two exogenous dummy variables we set the exogenous parameter tightness to 100. The data is observed at an annual frequency and therefore only one lag is included.[11]

Output growth for 10 euro area countries, Austria, Belgium, Germany, Finland, France, Italy, Ireland, Netherlands, Spain and Portugal is calculated using Eurostat data. The disaggregated output time-series are available on an annual basis in the Eurostat database and are used to calculate the growth rates of the nontradable and tradable sector relative to the weighted euro area growth rate. The disaggregated time-series are categorized in either the tradable or nontradable sector. Similar to the stylized facts presented in Figure 2c and d, we construct the nontradable sector by aggregating the 14 sectors that depend most heavily on domestic demand

[9] The use of time-fixed effects would also control for common trends at the euro area level, but in that case the control group would be a non-weighted average of developments in individual countries. This would place a disproportional weight on developments in small countries, and would not give an accurate picture of EA-wide developments. We experimented with time-fixed effects by including annual dummy variables to our specification. Results are qualitatively the same, see Figure B.4 in Annex B.8.

[10] All variables are expressed in growth rates or percentages and subsequently demeaned. These transformations ensure that our data series are stationary. Stationarity is also confirmed by the Levin et al. (2002) panel unit root test.

[11] The Akaike and Schwarz information criterion indicate a longer lag structure. However, the time series are too short to include more than one lag.

and which jointly produce 50% of total output.[12] Figure B.1 in the Apnnex shows which sectors are classified as a nontradable sector. We use annual nominal interest rates on 1-year government bonds as a proxy for the country-wide nominal interest rate and the consensus forecast inflation expectations one year ahead to transform the nominal interest rates into ex-ante real interest rates.[13] Finally, we use data from the World Economic Outlook database to collect data on current account balances.

The time-series cover the period 1996-2013 as no disaggregated data is available for all countries for the years 2014 and 2015. As in general no data is available for Luxembourg, we drop this country from our sample. For Greece we lack data on nominal interest rates on one year governments bonds before 1999. As our inflation expectations measure covers inflation expectations over a one-year period, the only consistent way to create ex-ante real interest rates is to use one-year interest rates. Tab B.2 in the Annex summarizes the descriptive statistics.[14]

6.2 Empirical results

We estimate the panel-BVAR over the sub-period 1996-2008 and over the entire sample period 1996-2013.[15] The first regression covers the build-up of euro area imbalances as explained by our model where the second regression also includes the bust as simulated in Section 5.3. As dynamics may have changed since the global financial crisis it is informative to estimate the panel-BVAR over both the sub-period and the entire period.

The results in Figure 6 show for the period $1996-2008$ that a country that is hit by a positive interest rate shock experiences a significant decline in the growth rate of the nontradable sector. Moreover, Figure 6 shows that the same does not hold for the tradable sector, i.e., countries that experience a positive interest rate shock do not experience faster or slower growth of the tradable sector. Hence, it appears that a negative interest rate shock, as experienced in Southern Europe and motivated by Figure 1, causes the nontradable sector in these countries to grow faster while the reverse occurs in the Northern countries. A country's current account is, however, not significantly affected by exogenous changes in the real interest rate.

Figure 7 shows the results for the period $1996 - 2013$. The response of nontradable- and tradable sector growth rates to an interest rate shock is now more markedly divergent. A positive interest rate shock still causes nontradable sector growth to slow, while the (positive) effect of the shock on tradable sector growth now approaches significance (in particular at longer horizons) at the 68% credibility interval. Moreover, a positive real interest rate shock now has a significant

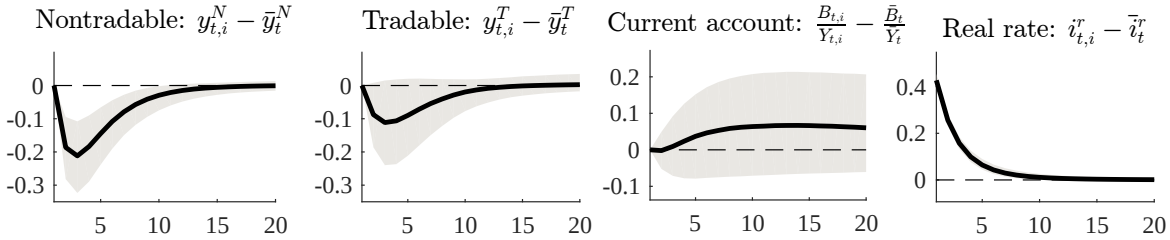
[12] The Eurostat classification is slightly different from the WIOD classification presented in 2. Specifically, the WIOD contains more detailed information about the openness of the sectors, but data is only available until 2011. We therefore match the WIOD classification with the Eurostat classification to categorize the Eurostat sectors in a tradable and nontradable sector.

[13] We also estimated the model with both nominal interest rates and inflation expectation. Results, which are not present here for conciseness, are qualitatively the same.

[14] For robustness we experiment with 10-year government bond yields as those are also available for Greece before 1999. The nominal rates are transformed in ex-ante expected real rates using the one year inflation expectations. To do so we assume that inflation expectations remain constant over the 10 year period. Results, which are not presented here, are largely consistent with the results presented below.

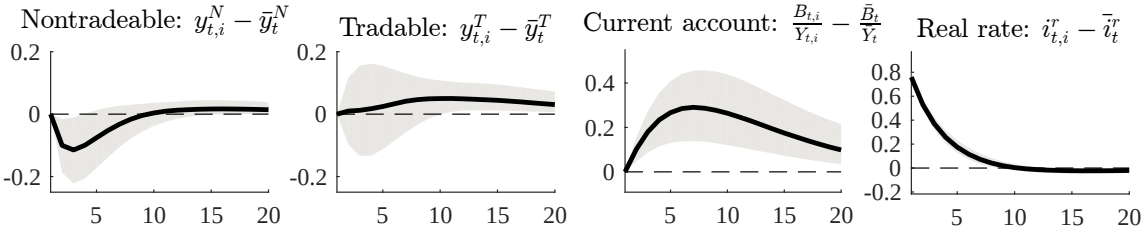
[15] The panel-BVAR is estimated by using the ECB BEAR-toolbox developed by Dieppe et al. (2016) which builds on the methodology surveyed by Canova and Ciccarelli (2013)

Figure 6: Real interest rate shock for sample period 1996-2008



Notes: the black lines represent the median response to a real interest rate shock estimated over the time period 1996-2008. Shaded areas denote 68% credibility intervals which are generated by drawing 50,000 draws from the posterior distribution of which 40,000 draws are discarded as burn-in iterations. Horizontal axes specify years. Vertical axes denote percent point deviations from average euro area growth, ratio or rate.

Figure 7: Real interest rate shock for sample period 1996-2013



Notes: the black lines represent the median response to a real interest rate shock estimated over the time period 1996-2013. Shaded areas denote 68% credibility intervals which are generated by drawing 50,000 draws from the posterior distribution of which 40,000 draws are discarded as burn-in iterations. Horizontal axes specify years. Vertical axes denote percent point deviations from average euro area growth, ratio or rate.

positive impact on the current account balance: in line with the hypothesis stemming from the model, a rising interest rate relative to the euro area average is associated with an improving current account balance.

7 Policy options

The results presented highlight major challenges in terms of correcting existing imbalances and preventing new ones. Macroprudential policy, limiting private leverage, could play an important role in preventing the developments stressed in this paper from reoccuring. Fiscal policy also offers a fairly straightforward tool to lean against excessive private borrowing. Fiscal consolidation, curtailing, domestic demand, directly improves the external position.[16] The fall in domestic demand also reduces the relative price of nontradables, inducing a shift of productive resources towards the tradable sector.

Currently, the first challenge for EMU is to reduce existing imbalances in a way that does not unduly harm GDP growth. In Section 5.3 we showed that a sudden increase in the interest

[16] In a monetary union, even away from the ZLB, Ricardian equivalence breaks down due to the fact that there is only a limited reaction of the union-wide interest rate to fiscal policy in an individual country/ region. As such, private borrowing does not fully offset government savings, and the external position improves.

rate premium induces a sharp rebalancing process as we saw in practice. In this section, various policy options that can accommodate a less disruptive rebalancing process are examined.

7.1 Increasing competition in the nontradable sector

Figure 8 shows the effects of a liberalization of the nontradable sector in South, i.e., a decrease in the mark-up on nontradable products. A liberalization of the nontradable sector causes nontradable prices to fall, increasing relative demand for nontradables. Real income also increases, contributing to increased demand for both tradable and nontradable products. As nontradable products need to be produced at home, this leads to an expansion of the nontradable sector. The domestic shortage of tradable products is imported from the North. Overall, output and the relative size of the nontradable sector increase while the current account position deteriorates.

Figure 8: Product market reform in South, transition path

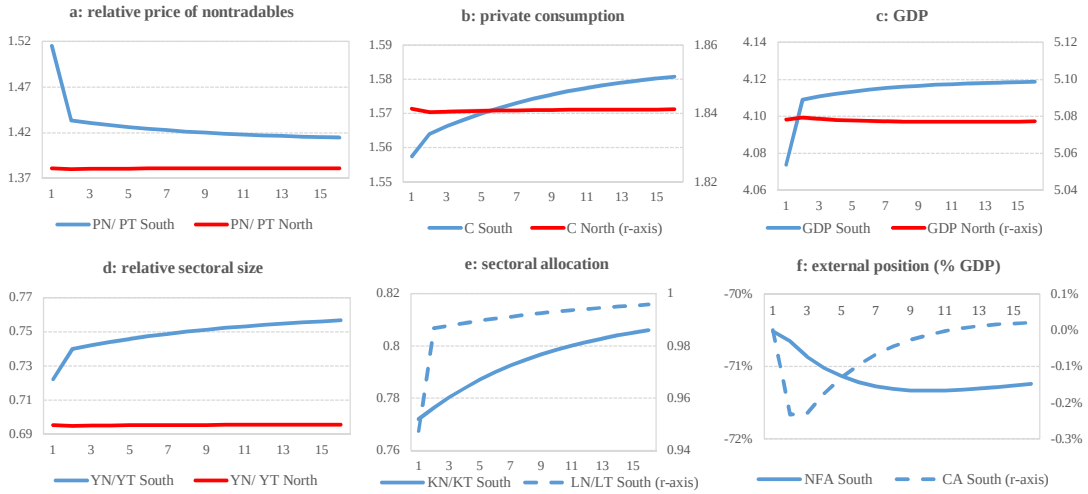


Figure shows the effects of a permanent 10 percentage points reduction of mark-ups in the Southern nontradable sector. Simulation conducted using the 2-region version of the model; results using the 3-region version are highly similar and available upon request.

Spillovers from a liberalization of the Northern nontradable sector are limited. North grows and from a Southern perspective both external demand and the interest rate increase. GDP and the sectoral allocation of resources in the South are largely unaffected. The Northern reforms do induce a fall in the Northern price level, which - given that prices at the union level are held constant by the single central bank - temporarily allows for some inflation in the South. This improves the ratio of net financial assets to GDP. Annex B.9 displays the results in more detail.

7.2 Deepening the internal market

The introduction of the euro was intended in part to deepen the internal market, thereby increasing competition in the market for tradables. Evidence on whether the euro achieved this is mixed. Deepening the internal market is however still very much seen as a European policy pri-

Figure 9: Deepening the EA internal market, transition path

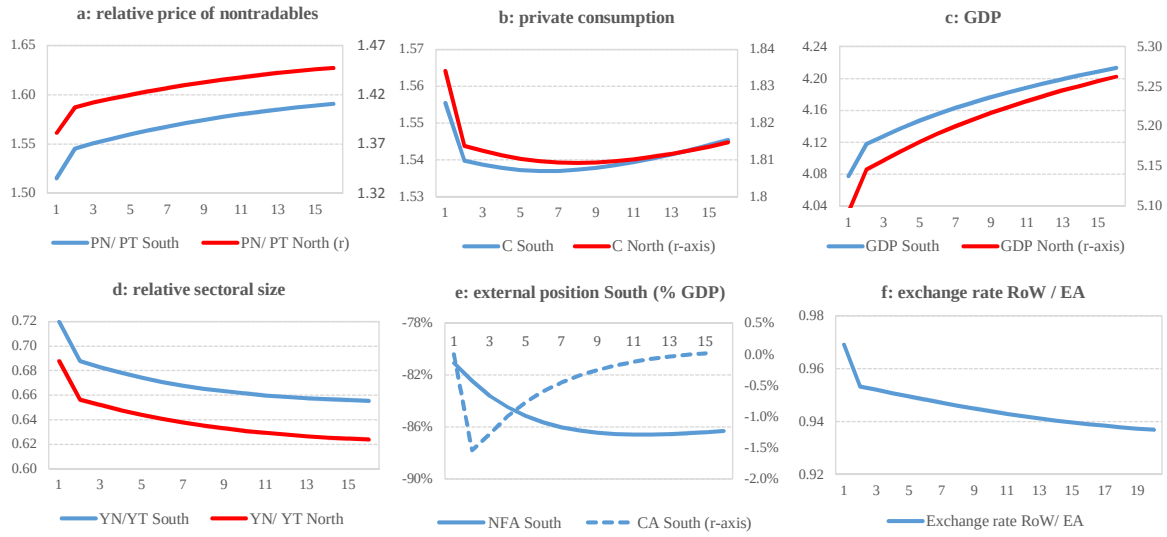


Figure shows the effects of a permanent reduction of mark-ups in the Northern and Southern tradable sector.

ority (see e.g. EC, 2015). We simulate the effects of a deepening of the internal market through a decrease in the mark-up in the tradable sector in both regions of the EA. As shown in figure 9, this induces a fall in the relative price of tradables and thereby speeds up the desired shift of resources towards the tradable sector. It boosts investment and GDP growth. As demand for tradable goods increases faster than supply, over the short to medium term the EA develops a trade deficit with the RoW. This is accommodated by an appreciation of the euro, which allows for a rise in the price of tradable goods in the RoW that dampens local demand. Over the long run, the tradable sector in the RoW shrinks marginally, whereas the tradable sector in both regions of the EA grows significantly.

8 Concluding remarks

In this paper, we documented empirically how growth of the nontradable sector in Southern Europe was a broad-based phenomenon that extended beyond the construction- and real estate sectors. We then showed in a two-region two-sector general equilibrium model that many of the key characteristics of the first decade of EMU can be explained by the major interest rate shock the Southern European countries experienced when joining EMU. The interest rate shock can be shown to explain both the divergence of current account positions and wage rates between Northern and Southern Europe, as well as the allocation of capital and labor towards the non-tradable sector in South. The allocation of incoming capital to the nontradable sector occurs irrespective of any differences in competitiveness or productivity across sectors or regions. We confirmed the relation between interest rate shocks and growth of the nontradable sector in a panel-BVAR for 10 euro area countries.

Our results highlight several challenges for policy makers. We documented how capital inflows in Southern Europe mainly benefited the nontradable sector. When foreign borrowing is not matched by an increased export capacity, a point made forcefully by Giavazzi and Spaventa (2010), solvability problems can emerge. In the model, a debt-elastic interest rate prevents these from occurring. In reality, the reaction of interest rates to the external debt level was arguably absent. Fiscal policy would have offered fairly straightforward tool to lean against excessive private borrowing. When imposed after the collapse of the boom, increased public savings can still help speed up the reallocation of productive resources towards the tradables, but only at the cost of an even deeper recession. In a quest for a more desirable solution, we investigated two options for product market reform. Improving the European internal market for tradables - further strengthening competition in this sector - appears to be the most promising option, facilitating a further rebalancing towards tradables while simultaneously boosting growth.

Our findings suggest various directions for further research. Throughout our article, we have considered whether a good is tradable to be exogenous. From a policy perspective, it is a highly relevant question to what extent improving the European internal market for services can contribute to increasing the share of traded 'goods', and what effects this would have. Additionally, our study focuses on the sectoral allocation of capital inflows in a nearly frictionless environment. Others have focused on the allocation of capital within sectors, highlighting the role of financial frictions. Combining both perspectives seems a fruitful avenue for further research. Finally, our study points to the need of explicitly monitoring a country's foreign borrowing, which since 2011 is done via the Macroeconomic Imbalances Procedure (MIP). To enforce the MIP, tools are needed to curtail excessive borrowing. Macroprudential policy offers promise in this respect, but still faces major challenges that need further investigation (Mendoza, 2016).

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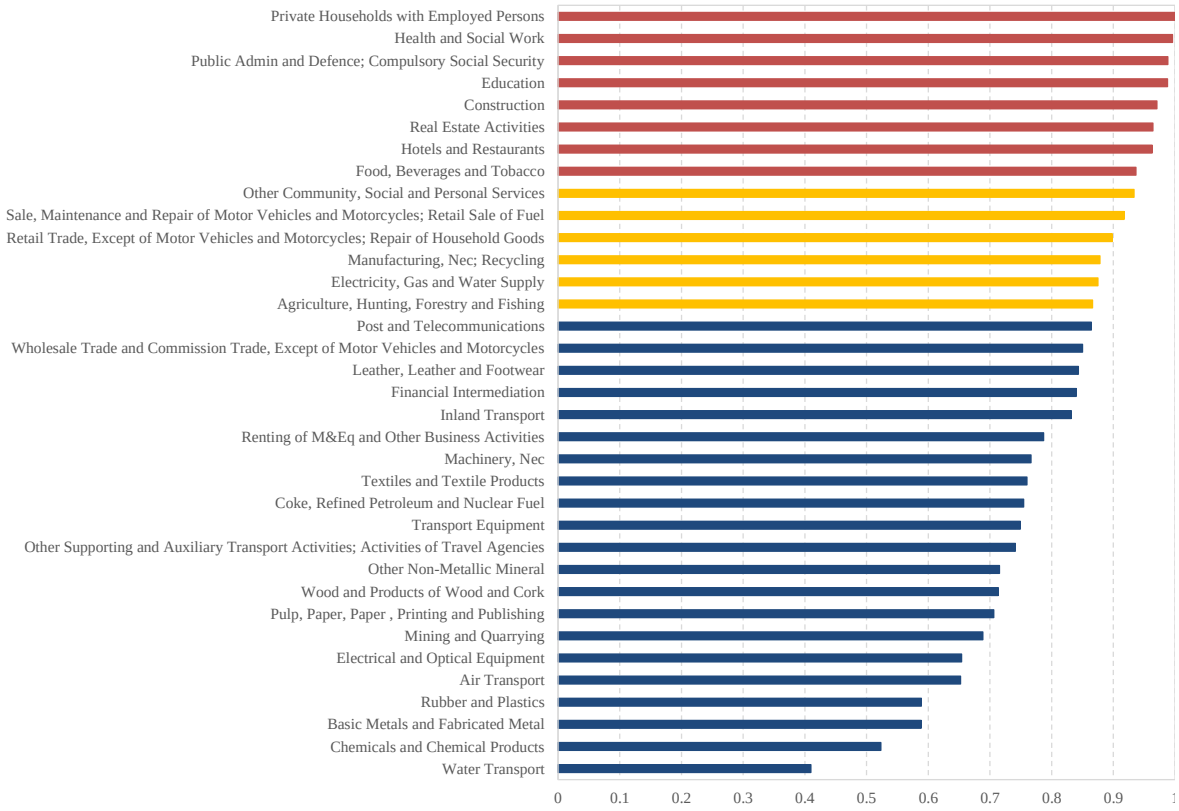
B Annex

B.1 Sectoral dependence on domestic demand

Figure B.1: Share of value added from domestic demand in the euro area



The red-bar sectors sum to a nontradable sector that produces 33% of total euro area output and the red- and yellow-bar sectors sum to a nontradable sector that produces 50% of total euro area output. Source: own calculations using WIOD, release 2013 (Timmer et al., 2015).

B.2 Households problem

Household maximization problem:

$$\max \sum_{v=0}^{\infty} (\beta^j)^v \left[\log \left(C_t^{j,N} \right)^{\eta^j} \left(C_t^{j,T} \right)^{1-\eta^j} - \frac{\theta^j (L_t^j)^{1+\sigma_l}}{1+\sigma_l} + \frac{\chi \left(m_t^j \right)^{1-\sigma_m}}{1-\sigma_m} \right] \quad \text{s.t.}$$

$$\sum_j^{j'} B_t^j + P_t^{j,T} C_t^{j,T} + P_t^{j,N} C_t^{j,N} + M_t^j = \sum_j^{j'} (1 + r_{t-1}^j) B_{t-1}^j + \pi_t^{j,N} + \pi_t^{j,T} + L_t^j W_t^j + M_{t-1}^j. \tag{B.1}$$

Households maximize their utility by choosing both consumption goods, labor supply, money holding and bond holdings, subject to the budget constraint and a no-Ponzi condition. The FOCs are:

$$\frac{1-\eta^j}{C_t^{j,T}} = P_t^{j,T} \lambda_t^h, \tag{B.2}$$

$$\frac{\eta^j}{C_t^{j,N}} = P_t^{j,N} \lambda_t^h, \tag{B.3}$$

$$\lambda_t^h = \lambda_{t+1}^h (1 + r_t^j) \beta^j, \tag{B.4}$$

$$\theta^j (L_t^j)^{\sigma_l} = W_t^j \lambda_t^h, \tag{B.5}$$

$$\chi \left(m_t^j \right)^{-\sigma_m} = \lambda_t^h - \lambda_{t+1}^h \beta^j, \tag{B.6}$$

where λ_t^h denotes the households' Lagrangian multiplier. Using the FOC for the tradable consumption good (B.2), $C_t^{j,T}$, to substitute the Lagrangian multiplier out gives:

$$P_t^{j,T} C_t^{j,T} = \frac{P_{t+1}^{j,T} C_{t+1}^{j,T}}{(1 + r_t^j) \beta^j}, \tag{B.7}$$

$$\frac{1-\eta^j}{C_t^{j,T} P_t^{j,T}} = \frac{\eta^j}{C_t^{j,N} P_t^{j,N}}, \tag{B.8}$$

$$C_t^{j,T} P_t^{j,T} = \frac{1-\eta^j}{\theta^j} \frac{W_t^j}{(L_t^j)^{\sigma_l}}, \tag{B.9}$$

$$\frac{M_t^j}{P_t^j} = \left[\chi \frac{C_t^{j,T} P_t^{j,T}}{1-\eta^j} \left(\frac{1 + r_t^j}{r_t^j} \right) \right]^{\frac{1}{\sigma_m}}. \tag{B.10}$$

B.3 Firms

Retailers are perfectly competitive and therefore we consider a representative retailer which buys input $y_t^{j,Z}(i)$ from intermediate firm i and produces output $Y_t^{j,Z}$ according the following

aggregator function:

$$Y_t^{j,Z} = \left[\int_0^1 y_t^{j,Z}(i)^{(\mu^{j,Z}-1)/\mu^{j,Z}} di\right]^{\mu^{j,Z}/(\mu^{j,Z}-1)}. \tag{B.11}$$

and has a budget constraint which is denoted by: $P_t^{j,Z} Y_t^{j,Z} = \int_0^1 p_t^{j,Z}(i) y_t^{j,Z}(i) di$. Retailers minimize their cost subject to their production function:

$$\mathcal{L}_t^j = \int_0^1 p_t^{j,Z}(i) y_t^{j,Z}(i) di - \lambda_t^r \left(Y_t^{j,Z} - \left[\int_0^1 y_t^{j,Z}(i)^{(\mu^{j,Z}-1)/\mu^{j,Z}} di\right]^{\mu^{j,Z}/(\mu^{j,Z}-1)} \right), \tag{B.12}$$

where λ_t^r is the retailers marginal cost of producing an extra unit of final output. The FOC w.r.t. to production input $y_t^{j,Z}(i)$ of firm i and production input $y_t^{j,Z}(i')$ of firm i' and dividing these FOCs gives the relative pricing equation:

$$y_t^{j,Z}(i) = y_t^{j,Z}(i') \left(\frac{p_t^{j,Z}(i)}{p_t^{j,Z}(i')} \right)^{-\mu^{j,Z}}. \tag{B.13}$$

If we combine the budget identity $P_t^{j,Z} Y_t^{j,Z} = \int_0^1 p_t^{j,Z}(i) y_t^{j,Z}(i) di$ and aggregator function (B.11) and substitute subsequently the relative pricing equation (B.13) to solve for $P_t^{j,Z}$, we obtain:

$$P_t^{j,Z} = \left[\int_0^1 p_t^{j,Z}(i)^{1-\mu^{j,Z}} di\right]^{1/1-\mu^{j,Z}}. \tag{B.14}$$

We can substitute (B.14), together with the relative pricing equation (B.13) for $y_t^{j,Z}(i)$, back in the budget identity to obtain retailer demand for intermediate product $y_t^{j,Z}(i)$:

$$y_t^{j,Z}(i) = \left[\frac{P_t^{j,Z}}{p_t^{j,Z}(i)} \right]^{\mu^{j,Z}} Y_t^{j,Z}. \tag{B.15}$$

Intermediary firms minimize their costs which consists of unit labor costs, the opportunity costs of holding a unit of capital and the costs of buying capital from the capital producers. The intermediate firm Lagrangian is expressed by:

$$\begin{aligned} \mathcal{L}_t^{j,Z}(i) =& W_t^j L_t^{j,Z}(i) + (1 + r_t^j) q_t^{j,Z} K_t^{j,Z}(i) - q_t^{j,Z}(1 - \delta^j) K_t^{j,N}(i) \\ & - \lambda_t^{j,Z}(i) \left(A_t^{j,Z} (K_t^{j,Z}(i))^{1-\alpha^j} (L_t^{j,Z}(i))^{\alpha^j} \right), \end{aligned} \tag{B.16}$$

where $\lambda_t^{j,Z}(i)$ is the Lagrangian multiplier of the firms which represents the intermediate firms' marginal costs. The FOC w.r.t. $L_t^{j,Z}(i)$ is represented by:

$$W_t^j = \lambda_t^{j,Z}(i) \frac{\alpha^j y_t^{j,Z}(i)}{L_t^{j,Z}(i)}, \tag{B.17}$$

where $y_t^{j,Z}(i) = A_t^{j,Z}(K_t^{j,Z}(i))^{1-\alpha^j}(L_t^{j,Z}(i))^{\alpha^j}$. The FOC w.r.t. $K_t^{j,Z}(i)$ is represented by:

$$1 + r_t^j = \frac{\lambda_t^{j,Z}(i)\frac{(1-\alpha^j)y_t^{j,Z}(i)}{K_t^{j,Z}(i)} + (1-\delta)q_{t-1}^{j,Z}}{q_t^{j,Z}}. \tag{B.18}$$

Using both FOCs in the production function gives the expression for marginal costs, $\lambda_t^{j,Z}$, which is the same for all intermediate firms:

$$\lambda_t^{j,Z} = \frac{1}{A_t^{j,Z}}\left(\frac{(1+r_t^j)q_t^{j,Z} + (1-\delta)q_{t-1}^{j,Z}}{(1-\alpha^j)}\right)^{(1-\alpha^j)}\left(\frac{W_t^j}{\alpha^j}\right)^{\alpha^j}. \tag{B.19}$$

Capital producers are perfectly competitive. Consequently, the individual capital producer's optimization problem corresponds to the aggregate problem. The aggregate capital stock evolves according to:

$$K_{t+1}^{j,Z} = (1-\delta^j)K_t^{j,Z} + I_t^{j,Z}. \tag{B.20}$$

Capital producers combine new investment $I_t^{j,Z}$ with undepreciated capital to produce new capital according to $\Phi\left(\frac{I_t^{j,Z}}{K_t^{j,Z}}\right)K_t^{j,Z} = I_t^{j,Z} - \frac{\phi P_t^{j,T}}{2}\left(\frac{I_t^{j,Z}}{K_t^{j,Z}} - \delta\right)^2 K_t^{j,Z}$. This functional form ensures that the price of capital is equal to unity in steady state. Capital producers choose investment $I_t^{j,Z}$ to maximize the profits from producing capital and then sell their capital for a price $q_t^{j,Z}$:

$$\max_{I_t^{j,Z}}\left\{q_t^{j,Z}\left[I_t^{j,Z} - \frac{\phi P_t^{j,T}}{2}\left(\frac{I_t^{j,Z}}{K_t^{j,Z}} - \delta\right)^2 K_t^{j,Z}\right] - P_t^{j,T}I_t^{j,Z}\right\}. \tag{B.21}$$

The FOC's gives the price of capital:

$$q_t^{j,Z} = P_t^{j,T}\left[1 + \phi\left(\frac{I_t^{j,Z}}{K_t^{j,Z}} - \delta\right)\right]. \tag{B.22}$$

As retailers face imperfect substitutability between intermediate inputs, intermediate firms have some market-power and can set their prices as a mark-up over their marginal costs $\lambda_t^{j,Z}$. Intermediary firms maximize their profits w.r.t. prices:

$$\pi_t^{j,Z}(i) = [p_t^{j,Z}(i) - \lambda_t^{j,Z}(i)]y_t^{j,Z}(i), \tag{B.23}$$

The FOC's w.r.t. $p_t^{j,Z}(i)$ after we have substituted demand for $y_t^{j,Z}(i)$ (B.15) and solving for $p_t^{j,Z}(i)$ gives:

$$p_t^{j,Z}(i) = \left(\frac{\mu^{j,Z}}{\mu^{j,Z}-1}\right)\lambda_t^{j,Z}. \tag{B.24}$$

Hence, intermediate firms set prices as a mark-up over their marginal costs. We can subsequently use (B.11) and (B.14) to aggregate over all firms and rewrite (B.17), (B.18) and (5) in terms of aggregate output $Y_t^{j,Z}$ and aggregate prices $P_t^{j,Z}$.

B.4 Monetary authority and government sector

Adding up real money demand in North and South gives real money demand in the Union:

$$\frac{M_t^e}{P_t^e} = \frac{M_t^n}{P_t^n} + \frac{M_t^s}{P_t^s} = \left[\frac{\chi}{1-\eta}\left(\frac{1+r_t^e}{r_t^e}\right)\right]^{1/\sigma_m} \left[(P_t^{n,T}C_t^{n,T})^{1/\sigma_m} + (P_t^{s,T}C_t^{s,T})^{1/\sigma_m}\right], \tag{B.25}$$

where we assume that $\eta^s = \eta^n = \eta$. Since the monetary authority has as its objective to stabilize the price level in the union, i.e. it can set the price P_t^e at an arbitrary level $\bar{P}_t^e$, the level of money supply set by the monetary authority is equal to:

$$M_t^e = \left[\frac{\chi}{1-\eta}\left(\frac{1+r_t^e}{r_t^e}\right)\right]^{1/\sigma_m} \left[(P_t^{n,T}C_t^{n,T})^{1/\sigma_m} + (P_t^{s,T}C_t^{s,T})^{1/\sigma_m}\right], \tag{B.26}$$

and as money supply equals money demand the resulting price level is constant at the arbitrary chosen level $\bar{P}_t^e = 1$.

The aggregator function is similar to the aggregator function for the private consumption good, with equal weights:

$$G_t^j = (G_t^{j,N})^{\eta^j}(G_t^{j,T})^{1-\eta^j}, \quad 0 < \eta^j < 1. \tag{B.27}$$

The government minimizes the cost of a given amount of government consumption: $P_t^j G_t^j = \sum_{j'}^{j}\{P_t^{j',T}G_t^{jj',T}\} + G_t^{j,N}P_t^{j,N}$. It takes the prices of the tradable and nontradable goods as given. Accordingly, government consumption of both goods depends on the respective prices levels of both goods:

$$\frac{G_t^{j,T}}{G_t^{j,N}} = \left(\frac{1-\eta^j}{\eta^j}\right)\frac{P_t^{j,N}}{P_t^{j,T}}. \tag{B.28}$$

B.5 Including the Rest of the World

The RoW economy is set up the same way as the Northern and Southern region, but has its own (floating) exchange rate. As before, the various regions are denoted by superscript j, with $j \in \{n, s, r\}$.

Prior to monetary integration, we assume the Rest of the World to be connected to the Northern part of the euro area via an UIP:

$$1 + r_{f,t}^n = (1 + r_{f,t}^r)\frac{E_{t+1}^{r,n}}{E_t^{r,n}}, \tag{B.29}$$

where $E_t^{r,n}$ is the nominal exchange rate between the rest of the world and the Northern part of the euro area (expressed as the price of one unit of RoW currency in units of region n currency).

As in the 2-region version of the model, Northern and Southern currencies are pegged, with the UIP between North and South given by:

$$r^n_{f,t} + \omega = r^s_{f,t}. \tag{B.30}$$

As such, in the above setup Southern Europe pays a risk premium vice-a-vis both the Northern part of Europe and the rest of the world that can be easiest thought of as an exchange rate risk premium. Following monetary integration, as the peg is exchanged for a more-difficult-to-reverse common currency, this premium disappears.

The Law of One Price is assumed to hold both within Europe, as between Europe and the rest of the world:

$$p^n_t = E^{r,n}_t p^r_t. \tag{B.31}$$

World equilibrium in the market for financial assets is now given by:

$$NFA^n_t + NFA^s_t + E^{r,n}_t NFA^r_t = 0, \tag{B.32}$$

where NFA^j_t represents the net financial assets held by region j denominated in domestic currency.

We set the weight of leisure to 0.2, so that the GDP and labor force in the rest of the world equals that of the combined Northern and Southern European region. In terms of other parameters, such as the degree of competition in the nontradable sector, the Rest of the World mimics the Northern part of Europe (see B.1). It is, thus, best thought as another advanced economy (e.g. the US).

Table B.1: Calibrated parameters

Parameters	Description	Value
β^r	Discount factor households	0.990
θ^r	Weight of leisure	0.200
η^r	Share of nontradables in consumption	0.667
μ^r	Market power nontradable sector	5.000
ξ^r	Credit premium reaction	0.007
$\bar{A}^{N,r}$	Productivity	1.000
$\bar{A}^{T,r}$	Productivity	1.000

B.6 Sensitivity to degree of competition in Southern NT sector

Figure B.2: Impact of monetary intergation on relative sectoral sizes in South, for different values of the NT markup in South

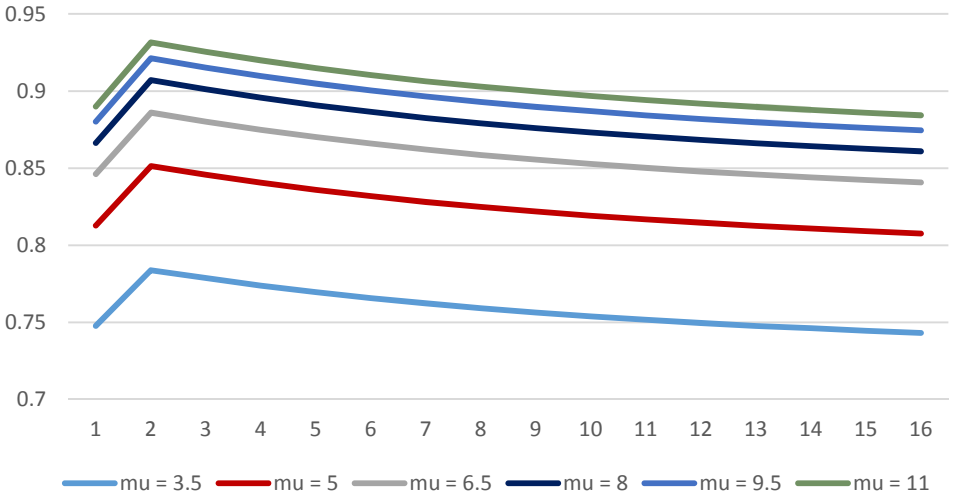


Figure illustrates the effects of monetary integration on the relative sectoral size in South, $\frac{Y_t^{s,N}}{Y_t^{s,T}}$, for different values of $\mu^{s,N}$, in the 2-region version of the model. See section 5.1.

B.7 Reaction to a sudden increase in the elasticity of interest rates to debt levels

Figure B.3: Reaction to a sudden increase in the elasticity of interest rates to debt levels

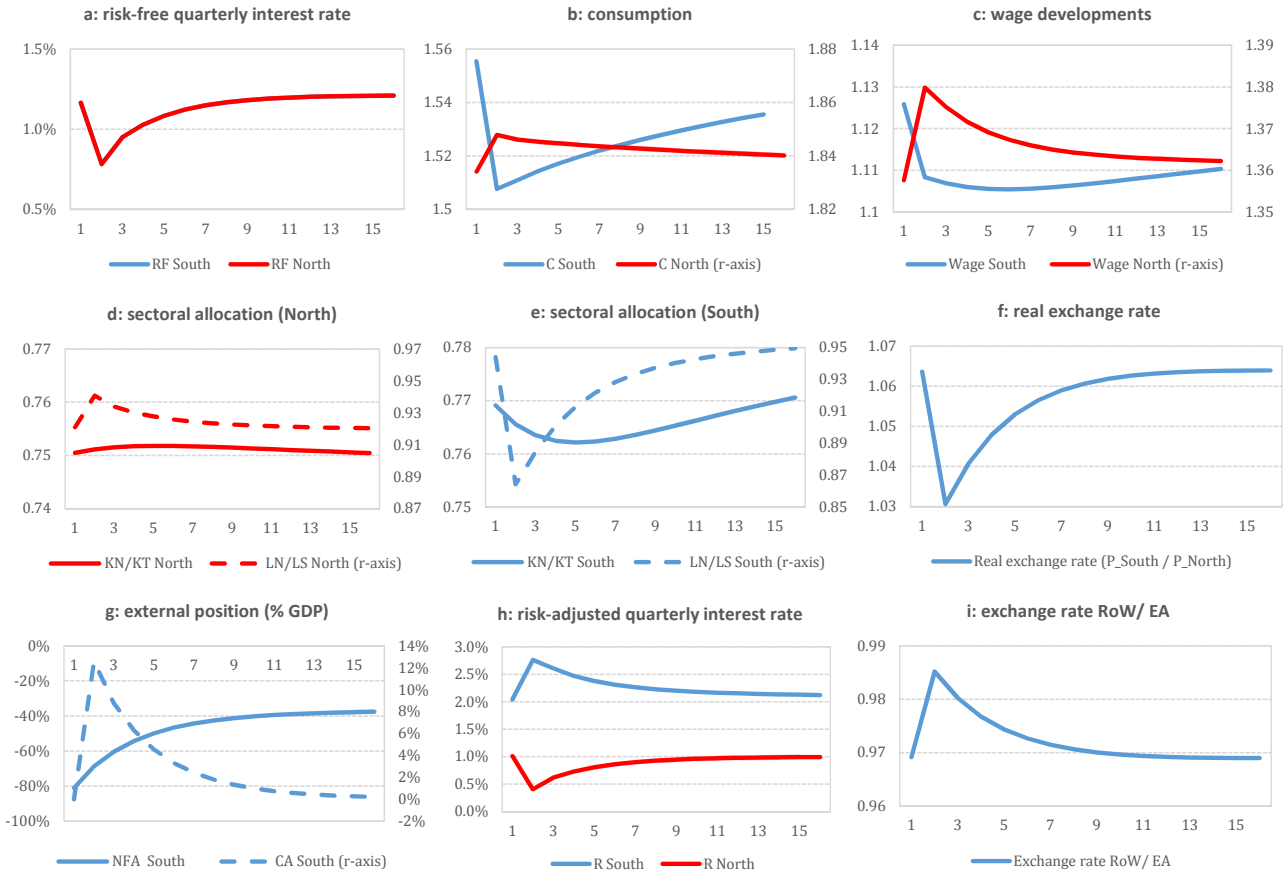


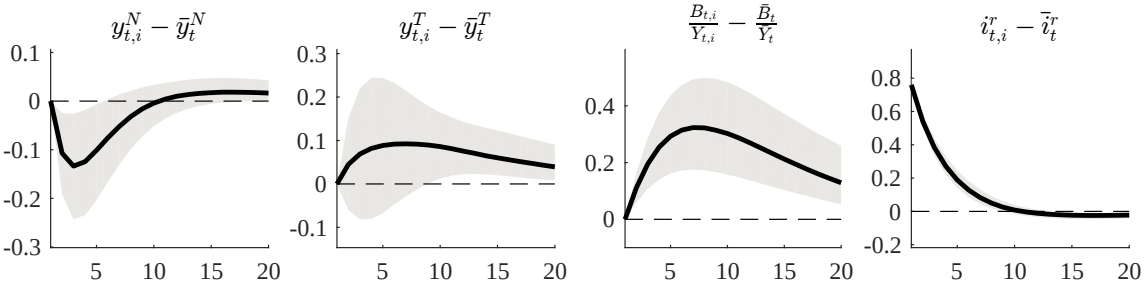
Figure illustrates the effects of a permanent increase in the debt-elasticity of interest rates. Simulations are conducted using the 3-region version of the model. Starting point of the simulations is the post-monetary integration steady state.

B.8 Empirics

Table B.2: Descriptive statistics

	$y^N_{t,i} - \bar{y}^N_t$	$y^T_{t,i} - \bar{y}^T_t$	$\frac{B_{t,i}}{Y_{t,i}} - \frac{\bar{B}_t}{\bar{Y}_t}$	$i^r_{t,i} - \bar{i}^r_t$	$y^N_{t,i}$	$y^T_{t,i}$	$\frac{B_{t,i}}{Y_{t,i}}$	$i^r_{t,i}$
Mean	0.48	0.47	−1.29	0.44	3.90	3.72	x	1.66
Median	0.37	0.25	−0.91	−0.08	3.89	4.77	x	1.19
Std. Dev.	2.87	3.83	5.00	5.11	3.45	5.99	x	5.14
Observations	198	198	198	198	198	198	198	198

Figure B.4: Real interest rate shock for sample period 1996-2013 (time fixed effects)



Notes: the black lines represent the median response to a real interest rate shock estimated over the time period 1996-2013. Shaded areas denote 68% credibility intervals which are generated by drawing 50,000 draws from the posterior distribution of which 40,000 draws are discarded as burn-in iterations. Horizontal axes specify years. Vertical axes denote percent point deviations from average euro area growth, ratio or rate.

B.9 Spillovers from NT sector liberalization in North

Figure B.5: Product market reform in North, transition path

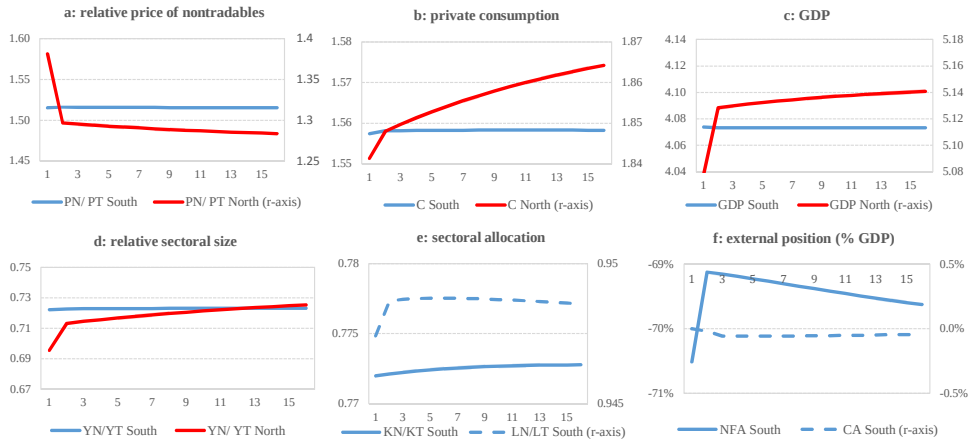


Figure shows the effects of a permanent reduction of mark-ups in the Northern NT sector. Simulations conducted using the 2-region version of the model. Simulations start from the post-monetary integration steady state.

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