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Modelling the Trade Balance between the Northern and Southern Eurozone Using an Intertemporal Approach

ABSTRACT

We use an intertemporal model to examine the division of the Eurozone areas into countries with persistent trade account surpluses and those with persistent deficits. This is done by examining the trade account balances between a Northern group of countries that are in persistent trade account surplus and a Southern group of countries that have persistent deficits over the period 2001-2018. The theoretical model highlights the interaction of consumption, portfolio optimization between holdings of domestic and foreign bonds, fiscal balances, changes in the demand to hold money balances and changes in the pricing of risk in financial markets as reflected in changes in the interest rate differentials. We test the model using both the ARDL and Fully Modified OLS methodologies and find that it performs well empirically with relevant coefficients being both right signed and significant.

JEL Classifications F1, F31, F32

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1 Introduction

With the creation of the Euro, the current account imbalances between the southern and northern European countries increased and became more persistent. This finding is known in the literature as "European core-periphery dualism of current accounts" (De Santis and Cesaroni, 2016). The divergence in current account balances in individual eurozone countries has received increased attention in the literature, particularly since the European sovereign debt crisis that hit the region in 2010. Hope (2016) finds strong evidence that the introduction of the euro was responsible for the divergence in current account balances among member states in the run-up to the euro crisis. One string of the literature argues that this division was largely caused by higher productivity and lower inflation rates in the surplus countries compared to the deficit countries resulting in an appreciation of the real exchange rate and a worsening of the trade and current account deficits of the deficit countries. Another channel has focused on the interaction between the fiscal balance and the current account balance, and a third channel has emphasized the consequences of the financial integration in the area.

In this paper we examine how the trade account (and highly correlated) current account balances are the result of a complicated interaction of many forces. In addition, to the real exchange rate, these include intertemporal consumption choices, portfolio optimization choices and the associated capital flows between countries, the impact of interest rate changes and changes in the pricing of risk in the financial markets, real money balances and fiscal balances. We attempt to bring these various elements together on a theoretical basis using the intertemporal approach.

In the empirical application of our theoretical model, we distinguish two groups of countries. The first group consists of three northern countries that have had persistent trade account surpluses since the commencement of the monetary union, Germany, the Netherlands and Belgium. We aggregate their bilateral trade balances *vis-à-vis* the three deficit countries and treat them as a single economy that we call the Northern group. The second group is made up by the aggregation of three economies from the periphery of the eurozone, Greece, Spain and Italy. These economies have had persistent trade account deficits since the commencement of the monetary union. We aggregate these economies and their bilateral trade account deficits vis-à-vis the Northern group and countries and label them as the Southern group. In the empirical test of our model we firstly use an ARDL model, because, compared with other methods for testing co-

integration, the ARDL approach has the advantage of avoiding any classification between I(0) and I(1) variables. To ensure parameters of the co-integrating relationship are estimated consistently, Fully Modified OLS (FM-OLS) is used rather than OLS itself.

We contribute to the literature both in our theoretical model as well in our empirical approach. For the theoretical model, we extend the standard Intertemporal Current Account (ICA) model by including the fiscal balance and portfolio optimization. This allows us to analyse in a single model all three theoretical channels through which the European Monetary Union (EMU) contributed to the current account divergence among member states. Compared to other papers on the Eurozone current account dynamics, we contribute by introducing money in the utility function, which leads to the derivation of the real money balances. In the empirical part, we also contribute in our country selection and database. Instead of analysing bilateral relationships, we choose to work with two groups of countries, the Northern group vis-à-vis the Southern group. In this way, country-specific factors are less important and it enables us to focus on the structural differences between the core and periphery. To analyse the changes in sovereign bond holdings between domestic and foreign residents, we use the Bruegel dataset on sovereign bond holdings. This dataset gives us a unique insight into changes in the composition of sovereign bond portfolios during the European Monetary Union, as it allows us to distinguish between resident and non-resident investors. To the best of our knowledge, we are the first to use these data to analyse the issue of persistent trade account imbalances within the Eurozone countries[1].

The empirical part of our paper is closely related to Carrasco and Hernandez-del-Valle (2017). They test four hypotheses to determine the origins of the European imbalances, using Germany as the core country and Spain as the periphery, employing the Autoregressive Distributed Lag (ARDL) bounds testing approach. Compared to them, we do not include the fourth hypothesis (aging population and savings), as we consider that it is implicitly included in the first hypothesis (financial integration channel). More importantly, we depart from their work by analysing the three hypotheses in a comprehensive intertemporal theoretical model, instead of in separate settings. Additionally, we focus on two groups of countries instead of two individual countries, which make our results more general. Finally, we do not confirm their conclusion, as we find evidence of a long-run relationship between public finance and external imbalances.

[1] The Bruegel database of sovereign bond holdings developed in Merler and Pisani-Ferry (2012). We are not the first study to use the Bruegel data, Arnold and Soedheruizen (2018) use it in their analysis of the impact of the European Central Bank's refinancing operations.

Section 2 outlines a review of the literature. Section 3 sets the theoretical model and Section 4 outlines our dataset and explains how we aggregate the Northern and Southern economies. Section 5 presents our overall interpretation of what has happened between the Northern and Southern economies since 2001. Section 6 shows the results of our empirical test of the theoretical model using the ARDL approach and also the check for robustness using the fully modified ordinary least squares. Section 7 concludes.

2 Literature Review

The dynamics of the current account have been studied for decades. Within this literature, the Intertemporal approach of the Current Account (ICA), initially proposed by Sachs (1981), has become common since the early 1980s. The standard ICA model views the current account from the saving-investment perspective and features an infinitely lived representative agent who smoothens consumption over time by lending or borrowing abroad. Obstfeld and Rogoff (1994, 1996) and Singh (2007) survey the theory, which has been extended in many directions to include investment, time-varying interest rates, traded and nontraded goods, price rigidities, pricing to market behaviour, and monetary policy (Bussiere et al., 2018).

The countries in the European Monetary Union (EMU) are a particular case. Since the introduction of the euro in January 1999, current account imbalances have persisted and even grown. The literature has turned to ICA models to understand the mechanisms and dynamics of these imbalances. Bussiere et al. (2006) extend the standard ICA model to include two important standardized facts in the Euro zone: the persistence of current account positions and the relevance of the fiscal balance. Campa and Gavilan (2011) employ the ICA model to show that current account balances in the euro area are used to smooth consumption and are driven by expectations about future income and relative prices. Also, Ca'Zorzi and Rubaszek (2012) suggest that consumption smoothing, prompted by expectations of economic convergence and the removal of exchange rate risk, has been an important driving force for the build-up of current account divergence in the euro area.

The literature has identified three main channels through which the EMU contributed to current account divergence among member states. These channels are financial integration, competitiveness and fiscal deficit (Hope, 2016). Although the channels are not mutually exclusive, the majority of the empirical research tends to present evidence of the dominance of one channel.

The first is the **financial integration channel**. With the integration of the banking and capital markets in the EMU, and the dramatically reduced borrowing costs for the less-creditworthy member states in the periphery, capital flows from the core to the periphery increased, leading the former to accumulate current account surpluses and the latter to accumulate current account deficits (Hale and Obstfeld, 2016). According to the neo-classical theory of intertemporal utility maximization, diverging current accounts among countries is the natural consequence of a future convergence of economies with different levels of capital endowment. Countries with lower income *per-capita* and higher productivity growth attract foreign investment, in search of higher expected rates of return on capital. The productivity of the invested capital will eventually produce current account rebalancing (Blanchard and Giavazzi, 2002), unless the capital is channelled into sectors that do not improve the productive capacity of the economy (e.g. real estate) or if they delay the pace of necessary but politically costly structural reforms (Lane, 2012). The majority of empirical research has focused on and confirmed this channel. Schmitz and von Hagen (2011) interpret current account balances as the counterparts of international capital flows. They find that for eurozone members the net capital flows follow differences in *per-capita* incomes and that this tendency has increased following the adoption of the euro. Capital flows from relatively rich to relatively poor countries should be regarded as signs of properly functioning of the euro area, as it promotes economic convergence of the economies. Belke and Dreger (2013) show that countries with a lower *per-capita* income are likely to attract foreign capital due to their better growth perspectives. These countries tend to consume more and save less in anticipation of higher permanent income. This implies that domestic investment will exceed domestic savings, which in turn implies a current account deficit during the catching-up period. Hobza and Zeugner (2014) find that private sector financing from the 'core' countries play a key role in financing the euro area periphery's current account deficits before the European sovereign debt crisis. Once the crisis unfolded, this funding was replaced by the European Central Bank and other official flows. De Santis and Cesaroni (2016) study the impact of capital flows liberalization, which is an essential part of the financial integration in the EMU. They find that capital flows liberalization helps to explain the current account deterioration in the peripheral countries. Unger (2017) shows that in countries where the Eurozone common monetary policy has an expansionary effect, i.e. the periphery, the domestic non-financial private sector increases its liabilities. Also, aggregate demand increases, which leads to an increase in imports, and thus to a deterioration of the current account. Carrasco and Hernandez-del-Valle (2017) find that the financial integration channel is relevant for both the core country (Germany) and the periphery country (Spain). Germany's surpluses are attributed to capital exports to peripheral countries, while Spain's deficits are

associated with financial liberalization and the catching up process that incentivizes capital flows into the country, boosts private investment and worsens the current account balance. Fuller (2018) shows that the periphery has become increasingly dependent on the northern eurozone countries for the capital to sustain their demand-driven growth. At the same time, the northern eurozone countries have grown more reliant on peripheral external demand and capital exports.

The second is the **competitiveness channel**. The loss of price competitiveness, by changes in the relative prices, can be caused by changes in the costs (wages, productivity, production costs), changes in aggregate demand or a combination. The literature identifies particularly the divergence in real unit labour costs among member states as the main cause for the current account imbalances (Hope, 2016). In a monetary union, relative prices are measured by the real exchange rate. An appreciation of the real exchange rate implies that domestic products become relatively more expensive than foreign products, which makes domestic consumers change their consumption from domestic towards foreign goods, thus deteriorating the current account balance. Empirical literature is divided on this channel. Arghyrou and Chortareas (2008) present evidence that the real exchange rates influence the current account imbalances. On the other hand, Comunale and Hessel (2014) find that although changes in the real exchange rate have an influence, changes in differences in domestic demand are more important in explaining the trade balance. Belke and Dreger (2013) find that a lack in competitiveness is a complementary explanation to the financial integration channel. Carrasco and Hernandez-del-Valle (2017) come to the same conclusion, but only for the core country (Germany), and not for the periphery country (Spain). Germany's surpluses are attributed to non-price competitiveness advantages, in particular high added-value industries, with moderate wage increases.

The third is the **fiscal deficit channel**. This simultaneous fiscal and current account deficit is known as the "twin deficit hypothesis". Expansive fiscal policy can lead to an appreciation of the real exchange rate if it raises the demand for non-tradable goods relative to tradable goods, which then worsens the current account balance (Abbas *et al*., 2011). The effects become even stronger if the central bank raises the real interest rate to keep inflation at target. Salvatore (2006) proposes a theoretical framework in which the expected effects of a fiscal deficit are an increase in the real interest rate, followed by an appreciation of the domestic exchange rate, and lastly, a decrease in the current account balance (Gossé and Serranito, 2014). Kosteletou (2013) provides empirical evidence to support the twin deficit hypothesis. Additionally, not only the fiscal policy of the southern eurozone countries affect the current account balances, but also the fiscal policy

of the northern eurozone countries. Gossé and Serranito (2014) find that in the long run, the main drivers are the fiscal balances and the level of financial market development. On the other hand, Carrasco and Hernandez-del-Valle (2017) find no evidence of a long-run relationship between public finance and external imbalances.

Having completed our brief review of the literature, we now turn to our theoretical approach to analysing the issue of trade account imbalances between the North and South of the Eurozone. Our theoretical model recognises that trade account imbalances are the result of many complicated and interacting forces such as the real consumption and real income in the two regions, the desired portfolios of economic agents, the real exchange rate and changes in the rate of interest and degree of relative riskiness of investing in the surplus and deficit regions.

3 The Model

In this section, we develop an equilibrium model for the trade account determination for countries within a monetary union. Although the model can be widely applied to other monetary unions, our approach adjusts the standard Intertemporal model of the Current Account (ICA) to capture the various channels through which current account divergences emerged within the European Monetary Union. Our theoretical model shares elements of the workhorse specification as developed by Obstfeld and Rogoff (1995), however, it is tailored to reflect the specific characteristics of the Eurozone. More specifically, as opposed to the existence of a single financial asset within an integrated world capital market as assumed by Obstfeld and Rogoff (1995) and in the context of the financial integration channel, we explicitly model investment in domestic (Southern Eurozone) and foreign (Northern Eurozone) bonds, introducing the probability that the domestic government may honour its obligations. This has important implications, especially within the Eurozone framework, given the important role of changes in portfolio holdings and corresponding capital flows between the Northern and Southern economies following the adoption of the single currency. This allows us to explicitly introduce the risk premium variable in relative terms, which proves to be a significant determinant of the trade balance. In addition, by modeling the trade balance equation, we introduce the real exchange rate to capture the competitiveness channel through which the EMU contributed to the current account divergences among its member states. This is an important characteristic of our model building given the observed divergences in inflation rates between the Northern and Southern Eurozone economies. Furthermore, within the fiscal deficit channel, we expand Obstfeld and Rogoff (1995) and Bussiere et al. (2006) by assuming that government purchases are financed not only by taxes and seigniorage but also from

international capital flows. Divergences in the fiscal balances of the member states is an important feature of the eurozone since a centrally led monetary policy means that member states have used fiscal policy to steer their economies. Finally, for the portfolio optimization, we introduce money in the utility function, which leads to the derivation of the real money balances, which is shown to influence the trade account determination within the monetary union.

Assume for simplicity that the monetary Union consists of two groups, which have two different characteristics. The domestic economy or "Southern group" exhibits a persistent trade account deficit and is referred to as the domestic economy, whereas the second economy or "Northern group" exhibits a persistent current account surplus and is referred to as the foreign economy.

An infinitely lived representative agent from the domestic economy is assumed to respond optimally to the economic environment. Utility is assumed to be derived from consumption of domestic (Southern group) and foreign (Northern group) goods and from holdings of real money balances. The representative agent from the domestic economy (Southern group) is assumed to maximize the present value of lifetime utility given by:

$$E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{({C_t}^{\alpha_1} {C_t^*}^{\alpha_2})^{1-\sigma}}{1-\sigma} + \frac{X}{1-\varepsilon} \left(\frac{M_t}{P_t} \right)^{1-\varepsilon} \right] \qquad (1)$$

where C_t and C_t^* single, non-storable, real consumption of goods produced in the domestic (Southern) and foreign (Northern) economies respectively, $\frac{M_t}{P_t}$ are domestic real money balances (denominated in euros), $0 < \beta < 1$ is the individual's subjective time discount factor, σ, ε, X are assumed to be positive parameters, and $E_t(\cdot)$ the mathematical conditional expectation at t. For analytical tractability, following Kia's (2006) suggestion, we assume that α_1, α_2, are normalized to unity and that $0.5 < \sigma < 1$.

The present value of lifetime utility is assumed to be maximized subject to a sequence of budget constraints given by:

$$y_t + \frac{M_{t-1}}{P_t} + \frac{B_{t-1}^D (1+i_{t-1}^D) P(x_{t-1})}{P_t} + \frac{B_{t-1}^F (1+i_{t-1}^F)}{e_t P_t} = C_t + C_t^* q_t + \frac{M_t}{P_t} + \left[\frac{B_t^D}{P_t}\right] + \frac{B_t^F}{e_t P_t} \qquad (2)$$

where y_t is current real domestic income, $\frac{M_{t-1}}{P_t}$ are domestic real money balances expressed in current domestic (Southern) unit terms (with M_{t-1} nominal money balances respectively carried forward from last period), $P(x_t)$ a positive probability that the domestic government will honour

its obligations, with (x_t) a set of variables affecting this probability. The foreign bond (Northern bond) is considered to be risk-free, e_t is the nominal exchange rate and P_t the price index in the domestic (Southern) economy. B_{t-1}^D is the amount invested in domestic bonds issued in the domestic country at $t-1$ and i_{t-1}^D is the nominal rate of return on these bonds. Similarly, B_{t-1}^F is the amount invested by domestic investors in foreign bonds issued at $t-1$ and i_{t-1}^F is the rate of return on these bonds. q_t denotes the real exchange rate defined as $q_t = \frac{P_t^*}{e_t P_t}$ where P_t^* the price index in the foreign (Northern) economy with a fall meaning an appreciation of the domestic (Southern) economy's real exchange rate.

The agent is assumed to observe the total real wealth and then proceed with an optimal consumption and portfolio allocation plan. The right hand side in Equation 2 indicates that total real wealth is allocated at time t amongst real consumption $(C_t, C_t^* q_t)$, real money balances $(\frac{M_t}{P_t})$, and real bond holdings $(\frac{B_t^D}{P_t}, \frac{B_t^F}{e_t P_t})$.[2]

The representative agent is assumed to maximize Equation 1 subject to Equation 2. In order to arrive at an analytical solution for the intertemporal maximization the following necessary first order conditions are derived:

$$\beta^t U_{c,t} - \lambda_t = 0 \quad (3)$$

$$\beta^t U_{c^*,t} - \lambda_t q_t = 0 \quad (4)$$

$$\beta^t U_{\frac{M}{P},t} \frac{1}{P_t} - \lambda_t \frac{1}{P_t} + E_t\left[\lambda_{t+1} \frac{1}{P_{t+1}}\right] = 0 \quad (5)$$

$$-\lambda_t \frac{1}{P_t} + E_t\left[\lambda_{t+1} \frac{1}{P_{t+1}} (1 + i_t^D) P(x_t)\right] = 0 \quad (6)$$

$$-\lambda_t \frac{1}{e_t P_t} + E_t\left[\lambda_{t+1} \frac{1}{e_{t+1} P_{t+1}} (1 + i_t^F)\right] = 0 \quad (7)$$

where λ_t the costate variable, $U_{c,t}$, $U_{c^*,t}$ the marginal utilities from consumption and $U_{\frac{M}{P},t}$ the marginal utility from real money balances.

Dividing Equation 5 with Equation 6 and using Equation 3, Equation 8 is obtained:

$$U_{\frac{M}{P},t} + U_{c,t}(1 + i_t^D)^{-1} P(x_t)^{-1} = U_{c,t} \quad (8)$$

Equation 8 implies that the marginal benefit of holding additional real money balances at time t must equal the marginal utility from consuming domestic goods at time t. Equation 8 can

[2] All variables are expressed in real domestic (Southern) terms.

be rearranged to express the intratemporal marginal rate of substitution of domestic (Southern) consumption for domestic real money balances as a function of the domestic (Southern) bond return, and $P(x_t)$.

Combining Equations 3 and 4, equation 9 can be derived:

$$\frac{U_{c,t}}{U_{c^*,t}} = \frac{1}{q_t} \tag{9}$$

Equation 9 implies that the marginal rate of substitution of foreign (Northern) consumption goods for domestic (Southern) consumption goods is equal to their relative prices.

Following Equation 1 the marginal utilities of consumption and real money balances can be derived as follows:

$$U_{c,t} = \beta^t (C_t)^{-\sigma} (C_t^*)^{1-\sigma} \tag{10}$$

$$U_{c^*,t} = \beta^t (C_t)^{1-\sigma} (C_t^*)^{-\sigma} \tag{11}$$

Dividing equation 10 with equation 11 and using equation 9 we derive equation 12:

$$C_t^* = C_t (q_t)^{-1} \tag{12}$$

The marginal utility for real money balances is given as:

$$U_{\frac{M}{P},t} = \beta^t X \left(\frac{M_t}{P_t}\right)^{-\varepsilon} \tag{13}$$

Equations 8, 10, 12 and 13 imply that:

$$m_t = [(C_t)^{1-2\sigma} (q_t)^{\sigma-1}]^{-\frac{1}{\varepsilon}} (X)^{\frac{1}{\varepsilon}} \left[\frac{i_t^F}{1+i_t^F}\right]^{-\frac{1}{\varepsilon}} \tag{14}$$

Dividing equation 6 by equation 7 we derive equation 15:

$$\frac{(1+i_t^D)}{(1+i_t^F)} = \frac{1}{P(x_t)} \tag{15}$$

Given Equation 15 the Equation 14 can further be expressed as:

$$m_t = C_t^{\left[\frac{2\sigma-1}{\varepsilon}\right]} q_t^{-\left[\frac{\sigma-1}{\varepsilon}\right]} (X)^{\frac{1}{\varepsilon}} RP^{-\left[\frac{1}{\varepsilon}\right]} \tag{16}$$

where $RP = \frac{i_t^F}{(1+i_t^D)P(x_t)}$, a term reflecting the risk premium in relative terms.

Define the consolidated government-sector budget identity for the domestic and foreign economies as follows:[3]

Domestic: $\left[\frac{B_t^D}{P_t} - \frac{B_{t-1}^D}{P_t}\right] + \left[\frac{B_t^{D,*}}{P_t^*} - \frac{B_{t-1}^{D,*}}{P_t^*}\right] = \left[G_t + \frac{B_{t-1}^D i_{t-1}^D}{P_t} P(x_t) - T + \frac{B_{t-1}^{D,*} i_{t-1}^D}{P_t^*} P(x_t)\right] - [m_t - m_{t-1}]$ (17)

Foreign: $\left[\frac{B_t^{F,*}}{P_t^*} - \frac{B_{t-1}^{F,*}}{P_t^*}\right] + \left[\frac{B_t^F}{P_t} - \frac{B_{t-1}^F}{P_t}\right] = \left[G_t^F + \frac{B_{t-1}^{F,*} i_{t-1}^F}{P_t^*} - T^F + \frac{B_{t-1}^F i_{t-1}^F}{P_t}\right] - [m_t^F - m_{t-1}^F]$ (18)

Defining $FD = \left[\frac{B_t^F}{P_t} - \frac{B_{t-1}^F}{P_t}\right]$, $DF = \left[\frac{B_t^{D,*}}{P_t^*} - \frac{B_{t-1}^{D,*}}{P_t^*}\right]$ net factor payments $NFP = \frac{B_{t-1}^F i_{t-1}^F}{P_t} - \frac{B_{t-1}^{D,*} i_{t-1}^D}{P_t^*} P(x_t)$ and given the fact that *DF*–FD=NFP+TB the trade balance (TB) account can be written as follows:

$$TB = [G_t + \frac{B_{t-1}^D i_{t-1}^D}{P_t} P(x_t) - T] - [m_t - m_{t-1}] - [\frac{B_t^D}{P_t} - \frac{B_{t-1}^D}{P_t}] - G_t^F - \frac{B_{t-1}^{F,*} i_{t-1}^F}{P_t^*} + T^F + [\frac{B_t^{F,*}}{P_t^*} - \frac{B_{t-1}^{F,*}}{P_t^*}] + [m_t^F - m_{t-1}^F] \quad (19)$$

Equation 19 implies that:

$$TB = [FB_t - FB_t^F] + [\Delta RBH_t^{F,*} - \Delta RBH_t] - [m_t] + [m_{t-1}] + [m_t^F] - [m_{t-1}^F] \quad (20)$$

Where $\Delta RBH = \frac{B_t^D}{P_t} - \frac{B_{t-1}^D}{P_t}$ the change in domestic real bond holding held by domestic investors, $\Delta RBH_t^{F,*} = \frac{B_t^{F,*}}{P_t^*} - \frac{B_{t-1}^{F,*}}{P_t^*}$ the change in foreign real bond holdings held by foreign investors, $FB_t^F = G_t^F + \frac{B_{t-1}^{F,*} i_{t-1}^F}{P_t^*} - T^F$ and $FB = G_t + \frac{B_{t-1}^D i_{t-1}^D}{P_t} P(x_t) - T$ are the foreign and the domestic fiscal deficits respectively.

Log linearizing Equation 16 and taking the first difference we obtain:

$$-\log [m_t] + \log [m_{t-1}] = -\left[\frac{2\sigma-1}{\epsilon}\right][logC_t - logC_{t-1}] + \left[\frac{\sigma-1}{\epsilon}\right][logq_t - logq_{t-1}] + \left[\frac{1}{\epsilon}\right][logRP_t - logRP_{t-1}] \quad (21)$$

Substituting Equation 21 into Equation 20 we get the following specification for the trade account balance from the perspective of the domestic economy (Southern group).

[3] $\frac{B_t^{D,*}}{P_t^*}$ reflects holdings of domestic (Southern) bonds by foreign (Northern) investors and $\frac{B_t^{F,*}}{P_t^*}$ holdings of foreign (Northern) bonds by foreign (Northern) investors. Foreign (Northern) variables are denoted by F.

$$TB = \left[FB_t - FB_t^F\right] + \left[\Delta RBH_t^{F,*} - \Delta RBH_t\right] - \left[\frac{2\sigma-1}{\epsilon}\right]\left[\Delta \log C_t\right] + \left[\frac{\sigma-1}{\epsilon}\right]\left[\Delta \log\left(q_t\right)\right] + \left[\frac{1}{\epsilon}\right]\left[\Delta \log\ RP_t\right] + \left[m_t^F - m_{t-1}^F\right] \quad (22)$$

The expected signs of the components of the model are as follows:

$FB_t - FB_t^F$ Fiscal Balances	$\Delta RBH_t^{F,*} - \Delta RBH_t$ Real bond holdings	$\Delta \log C_t$ Domestic consumption	$\Delta \log(q_t)$ Real exchange rate	$\Delta \log\ RP_t$ Risk premium	$[m_t^F - m_{t-1}^F]$ Foreign real money balances
-	+	-	-	+	+

Linking our model to the literature, we see that the three main channels are included. The financial integration channel is captured by the bond holdings, the competitiveness channel by the real exchange rate and the fiscal deficit channel by the fiscal balance differential. However, in our intertemporal approach we also have a crucial role for domestic consumption and foreign holdings of real money balances.

4 Data

For our empirical analysis, we have collected quarterly data on six economies for the period 2001Q1 until the start of 2018. Where quarterly data was not available, for example, for fiscal deficits and national debts we have converted the annual data into quarterly data using the cubic spline methodology. For the purposes of this paper, we divide the selected Eurozone countries into the Northern group and the Southern group. The Northern group countries are Germany, Belgium and the Netherlands that have persistent trade account surpluses vis-à-vis the Southern group over the entire period while the Southern group of countries is represented by Italy, Spain and Greece that have persistent trade account deficits *vis-à-vis* the Northern group over the entire period. Each of the three southern countries has had bilateral trade deficits with all three of the selected Northern countries over the entire horizon that we study. The aggregate trade deficit of the Southern group is simply the sum of the three individual Southern countries bilateral trade deficits with the Northern group of countries which can also be expressed as a percentage of the Southern group's GDP.

The Northern real GDP is simply the sum of the three Northern economies real GDP and the Southern real GDP is the sum of the real GDP of the three Southern economies. The Northern Consumer Price Index (CPI) is the GDP weighted average of the three Northern economies and the Southern CPI is the GDP weighted average of the three Southern economies CPI. The

Northern nominal interest rate is the GDP-weighted average of the three Northern economies 10-year bond yields and the Southern nominal interest rate is the GDP-weighted average of the three Southern economies 10-year bond yields. The real consumption of the Northern group and Southern is calculated as the total real consumption of the three Northern and three Southern economies respectively. For deflation purposes we use the Northern and Southern GDP weighted consumer price indices. The fiscal deficit/surplus of the Northern group is the sum of the fiscal deficits/surpluses of the three Northern economies and can also be expressed as a percentage of Northern GDP. Similarly, the fiscal deficit of the Southern group is the sum of the fiscal deficits of the three Southern economies and can also be expressed as a percentage of Southern GDP.

The change in the Northern bond holding held by Northern residents less the change in the Southern bond holdings held by Southern residents is proxied from the Bruegel dataset of Sovereign bond holdings available from the Bruegel website. The Bruegel dataset gives the value of a country's sovereign bonds held by domestic residents and value of its sovereign bonds held by foreign residents for a large set of European countries. For each of our six economies we aggregate the total for each of the three economies in the Northern and Southern groups and then divide by their respective aggregates to calculate the share of Northern bonds held by Northern residents and the share of Northern bonds held by foreign residents. We repeat the same procedure for the Southern economies to calculate the proportion of Southern bonds held by Southern residents and foreign residents respectively. We then apply the proportion of Northern bonds held by Northern residents to the national debt of the three northern economies and the proportion of Southern bonds held by Southern residents to the national debt of the three southern economies. This enables us to calculate changes in bonds holdings of Northern residents minus changes in Southern bonds held by Southern residents and these differential changes are then scaled. For the money holdings of Northern residents, we used the sum of the M2 monetary aggregates in Euros for each economy and deflated these money holdings using the Northern CPI to obtain real Northern money balances.

To provide consistency, for the national debts and fiscal deficits we use the Maastricht Treaty definitions, which differ to some extent from the national definitions. The Northern group national debt is the sum of the three economies´ national debts, which is divided by the Northern GDP to obtain the Northern national debt to GDP ratio. Similarly, the Southern group national debt is the sum of the three economies´ national debts, which is divided by the Southern GDP to obtain the Southern national debt to GDP ratio.

5 Analysis and Interpretation of the Northern and Southern Groups Data

We commence our analysis and interpretation of the data on the relationship between the Northern and Southern groups prior to conducting our econometric testing of the model. Since the formation of the Euro two major crises that have afflicted the Eurozone area, the Global Financial Crisis (GFC) and the European sovereign debt crisis sometime referred to as the GIIPS crisis involving Greece, Ireland, Italy, Portugal and Spain which when combined have had a tremendous impact on the economies. We therefore split the analysis of data period in two subperiods, 2001-2009 and 2010-2018.

The pre-GIIPS crisis period, 2001-2009

As shown in Figure 1, the trade account of the South deteriorates quite rapidly after 2001. The Southern group had a quarterly trade deficit of 2.25% of GDP (€10 billion) in 2001Q1 *vis-à-vis* the Northern group and this increases to an unsustainable 7% (€50 billion) of GDP *vis-à-vis* the Northern group by 2008Q2. The deterioration in the trade account of the South *vis-à-vis* the North can be partly explained by the appreciation of the Southern group's real exchange rate against the North due to the Southern groups' relatively high inflation rate. Between 2001Q1and the beginning of 2013 there was an approximate 8% appreciation of the real exchange rate of the Southern group (see Figure 2). However, this cannot explain all of the deterioration of the current account deficit. Figures 3 and 4 demonstrate a noticeable increase in the Southern group's real income and real consumption relative to the North, which led to increases in Southern imports and an accompanying deterioration in the Southern group's trade deficit (see Figure 1).

The role of changes in portfolio holding and corresponding capital flows between the Northern and Southern groups during the period under study is also quite important. During the period 2001Q1 to 2009Q1 the proportion of Northern debt held by Northern residents declines quite significantly as depicted in Figure 5 from 58.6% to 41%, while the proportion of Northern debt owned by non-Northern residents rises from 41.4% to 59% suggesting capital flight from the South as Southern money is invested in Northern bonds. This picture is reinforced in Figure 6 when we look at Southern holdings of Southern debt which declines from 58.6% in 2001Q1 to 49% in 2009Q3, while non-Southern holdings of Southern debt increase from 41.4% to 51%. It is interesting to note that prior to the global financial crisis the fiscal deficits of the Southern group as a proportion of GDP were under control, as shown in Figure 7. The rationale for the capital flows from North to South was the belief that Southern debt was relatively safe due to the implicit

guarantee of the South being part of the eurozone and because the Southern economies were growing more rapidly than the Northern economies, as shown in Figure 3. This view is reinforced by our proxy of risk, the relative ability to repay by the South, which was improving up until the beginning of the European sovereign debt crisis as their GDPs were rising relative to their national debts while in the Northern group the debt to GDP ratio started to rise after 2007, as shown in Figures 9 and 10. The relative ability of the South to repay is depicted in Figure 10, from 2001Q1 to 2009Q2, the relative ability of the South to repay its debt improves from 0.686 to 0.832. However, once the Global Financial Crisis (GFC) is underway, the relative ability to pay falls only slightly to 0.812 by 2010Q3. Thereafter, there is a noticeable deterioration in the ability of the Southern group to repay coinciding with the European sovereign debt crisis. In their study, Belke *et al* (2018) show that there is a divergence in the business cycles between the core and periphery countries with the core countries having increased synchronization among themselves post 2007Q4 while the periphery countries experienced decreased synchronization with regards to the core countries and also among themselves.

The GIIPS crisis and post global financial crisis period, 2010-2018

The GFC and the European sovereign debt crisis had a large impact on all the economies in our study. The first thing to note is the deterioration in the economic growth rate of the Southern economies. The recession in the Southern economies leads to a fall in their rate of inflation relative to the North resulting in a gradual depreciation of the Southern real exchange rate. The fall in their GDPs and domestic consumption and to a lesser extent the depreciation of the Southern group's real exchange rate account for the significant improvement in the trade balance of the Southern economies. There is also a noticeable change in composition of bond holdings in the Southern region, where the Southern holdings of bonds held by foreign residents declines rather dramatically from 54.1% in 2010Q1 to 35.3% in 2013Q3 as foreign banks and foreign investors seek to rapidly reduce their exposure to the GIIPS during the crisis. The fiscal deficits in the South widen dramatically as taxes fall due to the severe recessions, resulting in fiscal deficits of over 8% of GDP by 2008Q2. The national debts of the South, which had fallen from 88.7% of GDP in 2001Q1 to a low of 76.1% in 2007Q3, start to rise dramatically to 118.2% by the beginning of 2013 and 121.3% by the beginning of 2018. This rise is far more dramatic than in the North where the national debt rises from 60.8% in 2001Q1 to 79.7% by the start of 2013 and then declines back to 64.3% by the start of 2018. This difference in the performance of the relative national debt to GDP ratio accounts for rapid deterioration of the Southern ability to repay. The other key metric

is the significant widening of the 10-year interest differential that reaches a historical low of just 15 basis points by 2007Q4 and then experiences an increase to 93 basis points by the beginning of 2010 followed by a dramatic rise to 609 basis points by the start of 2012 at the peak of the European sovereign debt crisis before falling back to 161 basis points by 2014Q3[4] as depicted in Figure 11.

In sum, there seems to be a story of before and after the GFC when looking to explain the trade balance between the Northern group and Southern group of economies. Before the GFC, the South is growing faster than the North with consumption rising faster than the North. The inflation rate in the South is higher than in the North, which contributes to increasing trade deficits in the South. However, once the GFC starts, the Northern group becomes less willing to finance the Southern group deficits. After the GFC, the continued economic slowdown in the Southern group contrasts with the recovery of the Northern group, the ability to pay of the Southern group worsens as its national debt to GDP surges which leads to sharp increases in the Southern interest rates relative to the North. This, in turn, contributes to an increase in the Sothern group's fiscal deficits and a decline in confidence in their economies.

[4] In their study, Caporale *et al* (2018) show that the spread between the 10-year bond yield in the GIIPS and the German 10-year bund yield is determined by the macroeconomic news flow over the period 1999-2014. They find that negative newspaper headlines increase the spread and that the reaction increased during the financial and GIIPS crises. They also find that news volatility also affects the volatility of the spread especially in the crises periods.

Figure 1 The Evolution of the Trade Balance of the South *vis-à-vis* the North

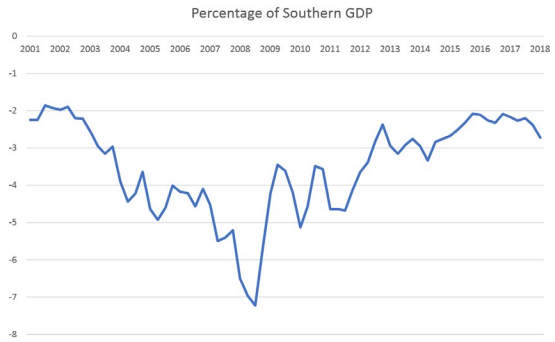


Figure 2 The Real Exchange Rate of the South

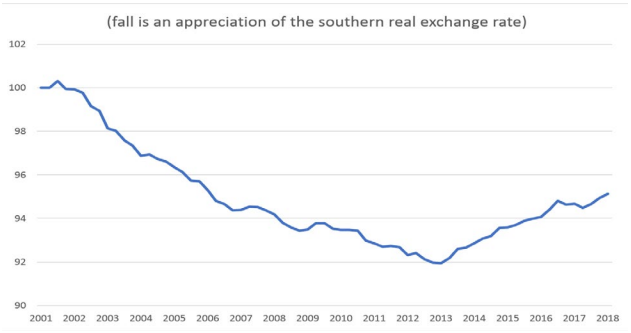


Figure 3 Northern and Southern Real GDP

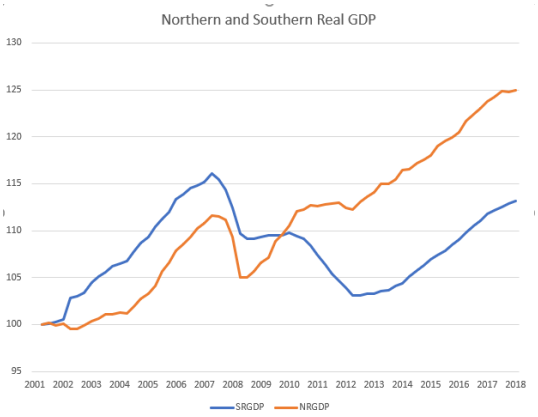


Figure 4 Northern and Southern Real Consumption

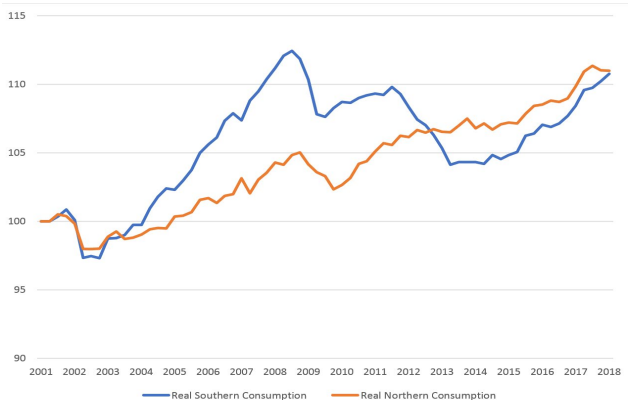


Figure 5 Proportion of Northern Debt held by Northern and Foreign Residents

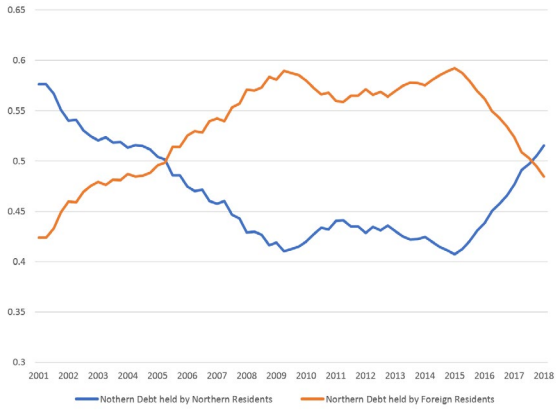


Figure 6 Proportion of Southern Debt held by Southern and Foreign Residents

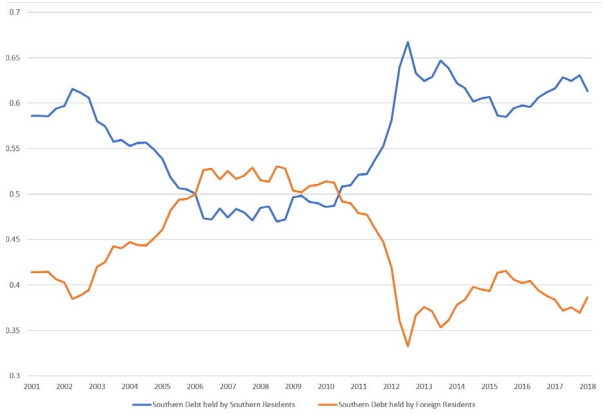


Figure 7 Northern and Southern Fiscal Deficits (% of GDP)

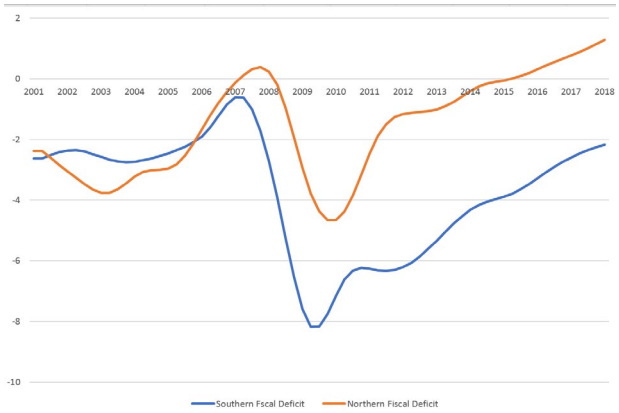


Figure 8 Northern and Southern National Debts (€ billions)

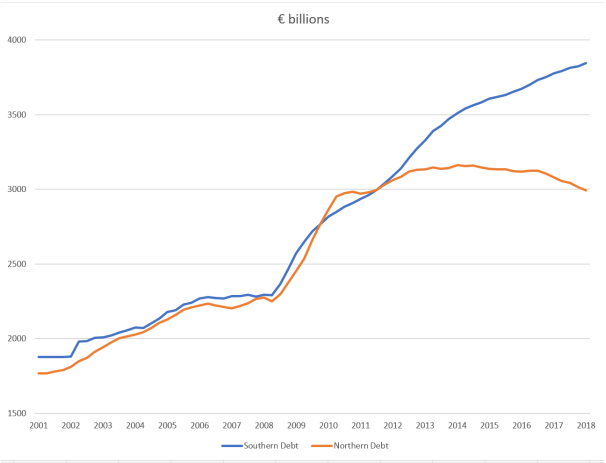


Figure 9 Northern and Southern National Debts (% of GDP)

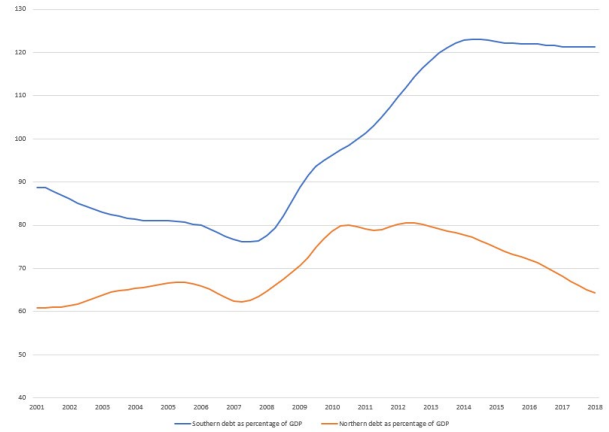


Figure 10 Southern Ability to Repay

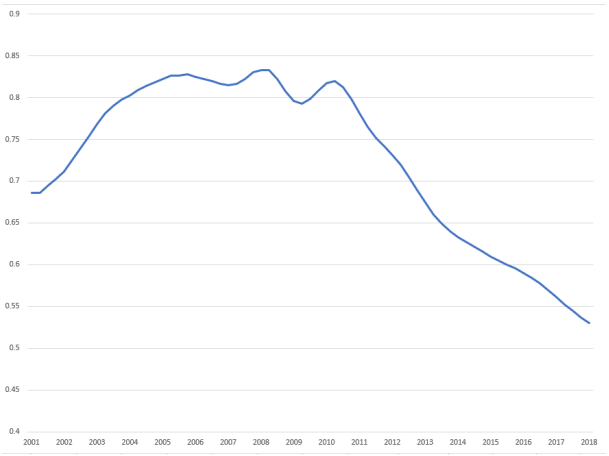
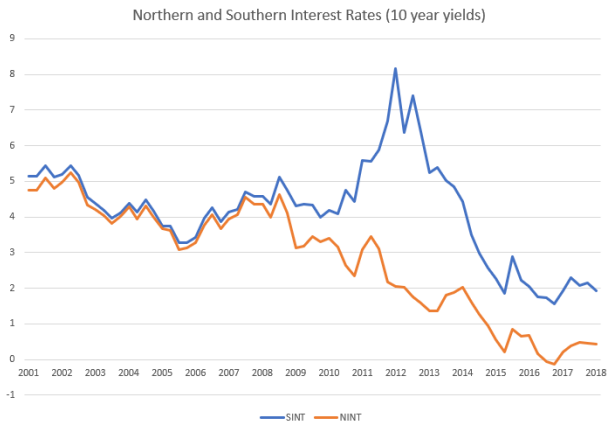


Figure11 Northern and Southern Interest Rates



6 Co-integration-analysis and results

For our empirical test, quarterly time series data are employed for the period 2001Q1 to 2018Q1 for the variables depicted by Equation 22. The Southern real trade balance is the dependent variable. The difference between the Southern real fiscal balance and the Northern real fiscal balance (as a percentage of GDP) is employed for the $FB_t - FB_t^F$ variable whereas the difference between the change of the Northern real debt held by Northern residents and the change in the Southern real debt held by Southern residents is employed for $\Delta RBH_t^{F,*} - \Delta RBH_t$. The change in the Southern real private consumption is used for $\Delta \log C_t$ variable. Given that the effect of the real exchange rate on trade balances remains ambiguous within an intertemporal optimization framework[5], we employ three different specifications for the $\Delta \log (q_t)$ variable. Initially, we construct the real exchange rate as the ratio of the Northern to Southern consumer price indices (CPIs). For robustness purposes and in order to capture any effects dominated by traded goods, we also construct the real exchange rate variable as the ratio of the Northern wholesale price indices to the Southern wholesale price indices. Finally, in order to capture the Balassa-Samuelson effect, we also employ the ratio of tradable to non-tradable goods between the South and the North. This definition of relative real exchange rates may have important implications for the trade balance determination associated with productivity and unit labour cost differentials between the South and the North. In all three cases, an increase in the real exchange rate reflects a depreciation of the Southern group. The M2 definition of the Northern real money balances is used for the $[m_t^F - m_{t-1}^F]$ variable with the money supply being deflated by the Northern consumer price index. Finally, the change in the relative risk premium variable is constructed based on the difference between GDP weighted average of the 10-year bond yields of the Northern and Southern groups respectively.

We employ the Autoregressive Distributed Lag (ARDL) bounds testing approach to co-integration as developed by Pesaran *et al* (2001) to test for a potential long-run relationship among the variables in Equation 22. The ARDL approach has many advantages compared with other methods for testing co-integration such as the Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (1990) approaches. In particular, the ARDL has the advantage of avoiding any classification between I(0) and I(1) variables, in contrast to many of the existing studies that employ a VECM approach. This is quite important since, according to the unit root tests the

[5] See Obstfeld (1982).

variables turn out to be I(0) and I(1)[6]. In addition, although a large data sample must be employed to follow the Johansen co-integration technique, the ARDL is a statistically significant approach to co-integration for relatively small data samples. Consequently, the ARDL co-integration equation employed for our empirical work is given by:

$$\Delta TB_t = -\sum_{h=1}^{p-1} \gamma_i \, \Delta TB_{t-h} + \sum_{j=1}^{k} \sum_{h=0}^{q_{j-1}} \Delta X_{j,t-h'} \beta_{j,h} - \hat{\theta} EC_{t-1} + \epsilon_t \qquad (23)$$

where X_j a vector consisting of all explanatory variables. EC_{t-1} is the error correction term, (p). the number of lags of the dependent variable and (q) the number of lags of the independent variables.

In order to provide robustness for the empirical results we also employ the Fully Modified Ordinary Least Square (FM-OLS) approach. The FM-OLS approach allows for the estimation of one co-integration vector even if multiple co-integrating vectors could be considered. Similar to the ARDL technique the estimator is not affected by the presence of stationary and non-stationary variables. In addition, as reported by Phillips and Hansen (1990) the FM-OLS provides an optimal estimation technique of co-integrating regressions (even in the small sample size case) since the method modifies least squares to account for serial correlation effects and for the endogeneity in the regressors that results from the existence of a co-integrating relationship[7].

Beginning with the ARDL estimation, we test initially for a possible long-run equilibrium relationship among the variables employed in Equation 22. The optimal lag length is chosen based on the Schwarz criterion (SC). Table 1 reports the F-Bounds Tests, along with the critical value bounds, for the three different versions of Equation 22, depending on the alternative real exchange rate specification. In Version 1 the real exchange rate is constructed based on the CPI ratio between the North and the South, in Version 2 the real exchange rate is constructed based on the ratio of the wholesale price indices between the North and the South and finally in Version 3 the real exchange rate is constructed based on the Balassa-Samuelson specification. Evidence suggests that for all three versions the F-statistic is greater than the upper level bound I(1) at all levels of

[6] We employ the ADF the PP and the KPSS tests for testing for unit roots/stationarity. According to these tests the trade balance and the fiscal balance variables turn out to be I(1) as compared to the other variables in equation 22 that turn out to be I(0).
[7] See Hargreaves (1994) for an overview of methods of estimating co-integrating relationships.

significance. Consequently, we can conclude that there is strong evidence of co-integration i.e. of a long run relationship among the variables[8].

Table 1. ARDL Bound Tests

(Null Hypothesis: No long-run relationship exists) F Statistic		
Version 1 (Real Exchange Rate CPI)	14.46 ***	k=6
Version 2 (Real Exchange Rate Wholesale Prices	6.26 ***	k=6
Version 3 (Real Exchange Rate Balassa-Samuelson effect)	4.93 ***	k=6
Critical Value Bounds	**I(0) Bound**	**I(1) Bound**
10%	1.99	2.94
5%	2.27	3.28
2.5%	2.55	3.61
1%	2.88	3.99

*** significant at 1%

Note: Version 1: The real Exchange rate is based on the CPI ratio; Version 2: The real Exchange rate is based on the Wholesale Price Indices ratio; Version 3: the real exchange rate is based on the Balassa-Samuelson effect.

Following the evidence of co-integration, we proceed to estimate the long run relationship among the variables for all three versions of the model. The estimated coefficients are reported in the top part of Table 2. The results suggest that for all variables and for all versions of the model, the coefficients are in accordance with the theoretical predictions i.e. right signed and highly significant. In addition, the overall magnitude of the coefficients does not seem to vary substantially among the different specifications.

More specifically, the coefficient for $FB_t - FB_t^F$ is negative and statistically significant, implying that a deterioration in the fiscal stance in the Southern group and/or a fiscal tightening in the Northern group deteriorates the Southern group's trade balance. The evidence is supportive of the twin-deficit hypothesis, as reflected by the fiscal deficit channel to the trade balance determination, providing new evidence that the Southern trade balance is affected by the fiscal stance in both the southern and the northern eurozone economies. Turning to the change in the real bond holdings, $\Delta RBH_t^{F,*} - \Delta RBH_t$, the coefficient is positive and statistically significant. This implies that an increase in the holdings of Northern debt by northern residents and/or a decrease

[8] We also tested for fractional integration of the variables, using the Geweke-Porter-Hudak (GPH) test for the existence of fractional integration and the modified GPH test, which tests unit series against fractional integration. From all these tests none of the variables in our model is fractionally integrated and therefore cannot be fractionally cointegrated. We refer to Appendix B for the results and more detailed explanations.

in the holdings of Southern debt by Southern investors will improve the Southern trade deficit. Within the financial integration channel of the trade imbalance determination the evidence highlights the contribution of financial linkages between the eurozone's core and periphery economies, suggesting that the net reduction in capital inflows for the Southern group may have beneficial effects on Southern trade balance. However, given the magnitude of the coefficients across all estimations our evidence suggests that the positive effect on the Southern trade balances, given Northern investors' preference towards northern bonds, may be rather limited.

Related to the change in the Southern group's consumption, the coefficient is negative and statistically significant, thus supporting the prediction of the model. This implies that an increase in the consumption of the goods produced in the Southern group's economies by Southern citizens deteriorates the Southern trade balance possibly due to an increase in the relative demand for Southern goods. If for example preferences change towards Southern goods i.e. the relative demand for Southern goods increases (given relative supply), the price level in the South will increase in order to equilibrate relative demand with relative supply, which can induce a deterioration in the trade balance of the South.

In relation to the real exchange rate, our evidence suggests that there is a long run trade balance deterioration due to a long run depreciation in the real exchange rate. The evidence further highlights the importance of the competitiveness channel in relation to the long-term nexus between the real exchange rate and trade balances for the south eurozone economies. As depicted in Table 2, the estimated coefficient for the real exchange rate is negative and highly significant, especially for the CPI and the Balassa-Samuelson definitions of the real exchange rate, supporting the theoretical prediction of the model. The evidence suggests that an increase in the CPI in the North or a fall in the CPI in the South i.e. a long-run real depreciation of the South will have a negative impact on the Southern long-run trade balance. This result is also confirmed through the Balassa-Samuelsson effect as depicted by the relative traded to non-traded price ratios of the South versus the North. Higher productivity in the Northern tradeable sector raises this ratio resulting in a deterioration of the trade balance of the South. The negative effect on the long-run trade balance could be attributed to the fact that the value effect may outperform the volume effect of the trade balance accompanied by inelastic import and export demands with respect to the real exchange rate. The result is also confirmed using the wholesale definition for the real exchange rate although the magnitude of the effect on the trade balance is not as strong as in the previous two cases. The

negative coefficients for the consumption and the real exchange rate imply a coefficient for the relative risk aversion is between half and one.[9]

In relation to the risk premium term $\Delta \log RP_t$ the coefficient is positive and statistically significant, thus supporting the prediction of the model. Evidence suggests that as the risk premium term increases the Southern trade balance improves. This may be because an increase in the risk premium implies that the Northern group will reduce its exposure to Southern debt and the South will increase its exposure to Northern debt and consequently the associated capital outflows from the South requires an offsetting improvement in the Southern trade account. Finally, the coefficient for the change in the Northern real money balances i.e. $m_t^F - m_{t-1}^F$, is positive (as predicted by the theoretical specification) and highly statistically significant. The empirical evidence suggests that an increase in the Northern real money balances will improve the Southern trade account through reduced capital inflows.[10]

Given the importance of model stability both for econometric inference and for policy analysis the corresponding CUSUM tests on the recursive residuals, for all different real exchange rate specifications, are presented in Figure 12, which shows that there is strong evidence in favour of the long-run structural stability for the model's coefficients. Additional tests related to the statistical viability of the results are reported in the bottom part of Table 2 indicating that there is no serial correlation of the residuals, no evidence of heteroscedasticity and that the residuals are normally distributed.

It is worth noting that the coefficient of the error correction term, for each of the three versions of the model, turns out to be negative and highly significant. The evidence suggests that the system adjusts towards the long-run equilibrium at a maximum speed of 23% per quarter. Given that causality in the long-run exists only when the coefficient of the error correction is statistically significant and different from zero, our evidence suggests that there is long-run

[9] We acknowledge the fact that there is a great debate in the literature related to the coefficient of relative risk aversion. In particular, the equity premium puzzle can be explained on the grounds of a high coefficient of relative risk aversion. However, our theoretical setup does not include equity markets. We leave this issue for future research.

[10] Reduced capital inflows may be induced due to reduced rate of interest in the south (as a result of lower expected inflation, given that the Fisher effect holds) which may induce investors in the North to invest less in the South and hold more Northern money balances. Given that prices in the South have to adjust in order to accommodate lower interest rates there might be a beneficial effect in the Southern trade balance.

causality from fiscal balances, real bond holdings, domestic consumption, the real exchange rate, the risk premium, and foreign money balances to the trade balance.

The FM-OLS results are presented in Table 3. The co-integration results confirm the previously reported outcome from the ARDL estimation as all coefficients come with the predicted sign and there is strong evidence for the significance of the coefficients. Although the magnitude of the coefficients is smaller compared to the ARDL coefficients, there are no substantial differences in the magnitude of the coefficients among the various model specifications in the FM-OLS estimation. Consequently, based on the overall empirical investigation, we report strong evidence in favour of our theoretical specification for modelling the trade balance between the Northern and Southern Eurozone[11].

Table 2. ARDL Co-integration results and misspecification tests

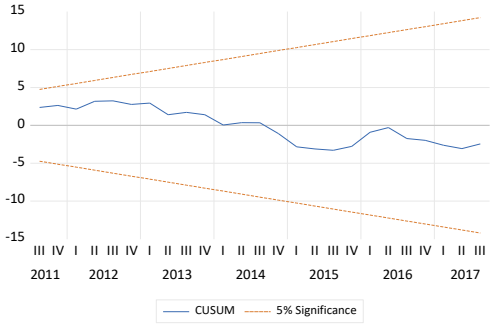
	Version 1 Real Exchange Rate (CPI)			**Version 2 Real Exchange Rate (Wholesale)**			**Version 3 Real Exchange Rate (Balassa-Samuelson effect)**		
Variable	**Coef-ficient**	**t-Stat**		**Coef-ficient**	**t-Stat**		**Coef-ficient**	**t-Stat**	
Fiscal Balances (β_1)	-1.29	-4.82	***	-1.47	-3.07	***	-0.62	-3.52	***
Real Bond Holdings (β_2)	0.006	4.08	***	0.010	2.71	***	0.002	2.18	**
Domestic consumption (β_3)	-2.35	-4.55	***	-3.85	-3.30	***	-0.48	-1.16	
Real exchange rate (β_4)	-6.65	-5.49	***	-2.21	-1.63		-5.60	-3.75	***
Risk premium (β_5)	4.75	5.51	***	3.44	4.12	***	3.81	3.94	***
Foreign real money (β_6)	1.97	12.94	***	0.87	2.00	**	1.89	13.04	***
$EC_{(-1)}$ ($\hat{\theta}$)	-0.23	-12.16	***	-0.12	-7.94	***	-0.21	-8.32	***
Breusch-Godfrey serial correlation LM test	$\text{prob}(\chi)^2 = 0.54$			$\text{prob}(\chi)^2 = 0.74$			$\text{prob}(\chi)^2 = 0.31$		
Breusch-Pagan-Godfrey Heteroscedasticity test	$\text{prob}(\chi)^2 = 0.12$			$\text{prob}(\chi)^2 = 0.11$			$\text{prob}(\chi)^2 = 0.17$		
Jarque-Bera Normality test	Prob = 0.49			Prob = 0.96			Prob = 1.93		

*** significant at 1%, ** significant at 5%

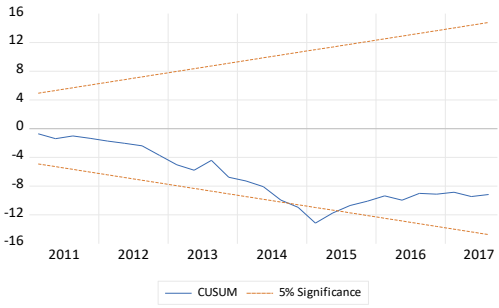
[11] Although uncertainty is implicitly included in the risk premium variable, for robustness purposes we also added Economic Policy Uncertainty (EPU) using data from www.economicpolicyuncertainty.com from the Southern group vis-à-vis the Norther group and also aggregate European Policy Uncertainty for the Eurozone area as an additional control variables in our analysis. For all specifications, we found the EPU coefficient is negative but not significant. Results are available upon request.

Figure 12. Stability tests

Version 1
(CPI definition of the real exchange Rate)
Cumulative Sum of Recursive Residuals



Version 2
(Wholesale definition of the real exchange Rate)
Cumulative Sum of Recursive Residuals



Version 3
(Balassa-Samuelson definition of the Real Exchange Rate
Cumulative Sum of Recursive Residuals

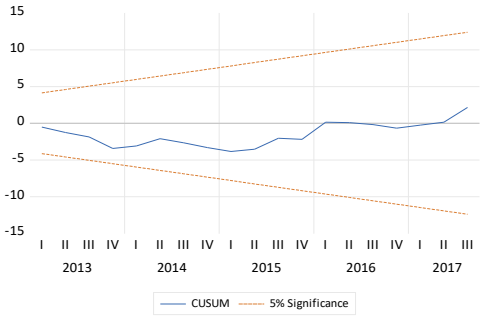


Table 3. FM-OLS Co-integration results

	Version 1 (CPI Definition of the Real Exchange Rate)			Version 2 (Wholesale Definition of the Real Exchange Rate)			Version 3 (Balassa-Samuelson Definition of the Real Exchange Rate)		
Variable	**Coef-ficient**	**t-Stat**		**Coef-ficient**	**t-Stat**		**Coef-ficient**	**t-Stat**	
Fiscal Balances (β_1)	-0.31	-2.14	**	-0.39	-5.98	***	-0.21	-1.83	*
Real Bond Holdings (β_2)	0.004	4.73	***	0.001	2.97	***	0.002	3.11	***
Domestic consumption (β_3)	-0.35	-1.65		-0.64	-4.14	***	-0.53	-2.40	**
Real exchange rate (β_4)	-2.66	-2.34	**	-0.86	-2.87	***	-0.97	-1.92	*
Risk premium (β_5)	2.05	2.69	***	1.05	2.51	**	1.68	2.30	**
Foreign real money (β_6)	0.90	3.12	***	0.28	1.58		0.57	2.08	**

*** significant at 1%, ** significant at 5%, * significant at 10%

Table 4. Co-integration tests

	Version 1 (CPI Definition of the Real Exchange Rate)	Version 2 (Wholesale Definition of the Real Exchange Rate)	Version 3 (Balassa-Samuelson Definition of the Real Exchange Rate)
Engle-Granger	***Prob=0.04 ******	***Prob=0.003 *******	***Prob=0.05 ******
Phillips-Ouliaris	***Prob=0.05 ******	***Prob=0.003 *******	***Prob=0.07 ****

*** significant at 1%, ** significant at 5%, * significant at 10%

7 Conclusions

We have employed a novel intertemporal approach to the current account to examine the issue of persistent trade account surplus and deficit countries in a monetary union. The model is tested by empirically using the ARDL approach to examine the persistent Southern eurozone countries bilateral current account deficit *vis-à-vis* the Northern eurozone countries over the period 2001Q1 to 2018Q1 and the results have been checked for robustness using the FM-OLS technique. Our results show that the bilateral trade account between the Southern and the Northern groups can be explained by the interaction of several forces; these include changes in real exchange rate, intertemporal consumption choices, portfolio optimization, changes in the demand to hold money balances, interest rate differentials and changes in the pricing of risk in the financial markets.

Our data and results suggest that prior to the European sovereign debt crisis the fundamentals in the South seem to justify the lowering of the risk premium on Southern assets as their economies grow rapidly, their fiscal deficits were largely under control and the South's ability to repay improved. These factors help to explain the increase in foreign holdings of Southern debt. However, in the run up to the GFC there is clear evidence that the trade balances of the Southern group were deteriorating and that the Northern group had been financing these increasing deficits. In retrospect, the GFC was the precursor to the European sovereign debt crisis. The key link seems to have been the rapid deterioration of the trade balance of the South and the subsequent fall in their real GDPs, which raised their fiscal deficits and national debt to GDP ratio, significantly worsening their ability to repay, which in turn raised interest rates on their debt.

One of our main results is the clear impact that fiscal deficits have on the trade balance, which highlights the importance of fiscal surveillance within the eurozone, in order to achieve a correction of the deficits and to make further progress towards a greater integration in the national budgetary preparations. The prolonged fiscal deficits in the Southern eurozone have raised reasonable concerns about their sustainability. Fiscal austerity measures have proved beneficial in reducing trade and current account deficits in the Southern eurozone economies. However, such measures also have important implications for economic growth and unemployment rates.

Our results are also highly supportive of using the intertemporal model to analyse the Eurozone crisis. It was a rise in Southern consumption relative to Northern consumption that initially widened the trade deficits between the Southern and Northern groups in the period

2001Q1 to 2008Q3 and the subsequent fall in Southern consumption relative to the North that improved the trade deficit position of the South after the GIIPS crisis. This suggests a need for policy makers to pay attention to potentially unsustainable consumption patterns within a monetary union.

In this paper, we have analyzed the trade account balance between two groups of countries. While this has given some very useful insights in future research there is the potential to complement this with a more detailed analysis at the country level, both in pairs and in a panel setting. In this paper we have only looked at changes in portfolios made up of sovereign bond holdings, another avenue for future research would be to extend the model to include a wider range of assets in residents' bonds such as holdings of domestic and foreign corporate debt and other forms of risky securities such as equities. There is also scope to see whether foreign direct investment flows have also been significant drivers of the trade balances within the Eurozone area. Another possible avenue for future research would be to apply the model in other monetary unions, such as the West African CFA franc and the Central African CFA franc. The model can also be useful for analyzing the dynamics in dollarized economies, such as Ecuador, Panama and El Salvador. Dollarization is a type of asymmetric monetary union where one country adopts another country's currency without obtaining any say in how that currency will be managed or even a share of the seigniorage revenues (Gruben *et al.,* 2012).

Appendix A: Description of variables

Table A.1: Explanation of the variables employed

Variable	Explanation
C_t	Real consumption of goods produced in the domestic economy (Southern) by the domestic (Southern) agents.
C_t^*	Real consumption of goods produced in the foreign economy (Northern) by domestic (Southern) agents.
$m_t = \frac{M_t}{P_t}$	Domestic (Southern) real money balances, with M_t domestic nominal money balances and P_t the domestic price index.
$m_t^* = \frac{M_t^*}{P_t^*}$	Foreign (Northern) real money balances, with M_t^* foreign nominal money balances and P_t^* the foreign price index.
y_t	Domestic (Southern) real income
e_t	Nominal exchange rate (normalized to unity)
q_t	Real exchange rate defined as $q_t = \frac{P_t^*}{e_t P_t}$
B_t^D	Amount invested in domestic (Southern) bonds by domestic residents.
B_t^F	Amount invested in foreign (Northern) bonds by domestic residents.
$P(x_t)$	A positive relative probability that the domestic (Southern) government will honour its obligations.
$B_t^{F,*}$	Amount invested in foreign (Northern) bonds by foreign (Northern) residents.
$B_t^{D,*}$	Amount invested in domestic (Southern) bonds by foreign (Northern) residents.
i_t^D	Nominal rate of return on domestic (Southern) bonds
i_t^F	Nominal rate of return on foreign (Northern) bonds
$U_{c,t}$	Marginal utility from consumption of domestic (Southern) goods by domestic agents.
$U_{\frac{M}{P},t}$	Marginal utility from domestic (Southern) real money balances.
$U_{\frac{M^*}{P^*},t}$	Marginal utility from foreign (Northern) real money balances.
G_t	Domestic (Southern) government expenditure.
G_t^F	Foreign (Northern) government expenditure.
T	Domestic (Southern) taxation.
T^F	Foreign (Northern) taxation.
FD	$\left[\frac{B_t^F}{P_t} - \frac{B_{t-1}^F}{P_t}\right]$ Change in the holdings of foreign (Northern) assets by domestic (Southern) residents in real terms.
DF	$\left[\frac{B_t^{D,*}}{P_t^F} - \frac{B_{t-1}^{D,*}}{P_t^F}\right]$ Change in the holdings of domestic (Southern) assets by foreign (Northern) residents in real terms.
FB_t^F	$G_t^F + \frac{B_{t-1}^{F,*} i_{t-1}^F}{P_t^F} - T^F$ Northern fiscal balance

FB_t	$G_t + \frac{B_{t-1}^D i_{t-1}^D}{P_t} P(x_t) - T$ Southern fiscal balance
ΔRBH	Change in domestic (Southern) real bond holdings held by domestic investors; $\frac{B_t^D}{P_t} - \frac{B_{t-1}^D}{P_t}$
$\Delta RBH_t^{F,*}$	Change in foreign (Northern) real bond holdings held by foreign investors; $\frac{B_t^{F,*}}{P_t^F} - \frac{B_{t-1}^{F,*}}{P_t^F}$
Explanation related to the variables in the regressions	
	$P(x_t)$ is the ratio of Foreign (Northern debt) (% of GDP) to domestic (Southern) debt (% of GDP) so when $P(x_t)$ increases (decreases) Southern credibility goes up (down).

Appendix B: Fractional cointegration

For the two series with unit roots, Real Southern Trade Balance (RSTB) and Fiscal Balance Difference (FBD), we estimate the modified Geweke-Porter-Hudak (GPH) (1983) log periodogram regression estimate of the long memory parameter, *d*, of fractional integration. Phillips (2007) argues that prior literature on semiparametric approach does not address the situation where *d=1*, a unit root. Phillips modifies the GPH estimator to accommodate the distribution of *d* under the null hypothesis that *d=1.* The modification allows one to test this null hypothesis against the alternative of *d not equal 1.* Tables B.1 and B.2 provide the estimates of *d* for different power values for Real Southern Trade Balance and Fiscal Balance Difference, respectively. Regardless of the value of power, the p-values are all greater than 2.5%, and in most cases much larger than this value, which provides very strong support for not rejecting the null hypothesis. RSTB is not fractionally integrated, but does have a unit root. It can also be seen from Table B.1 that the test of *Ho: d=0* is rejected at 5 of the 8 power levels indicating the series is not stationary. However, when the correct null hypothesis (*Ho: d=1*) is used, the p-values all are larger than 2.5% which consistently accepts *Ho*. The same conclusion also applies to the series Fiscal Balance Difference (FBD) (cf. Table B.2).

For the remaining series *(Change in Real Bond Holdings Difference, Change in log Real Consumption, Change in log Real Exchange Rate, Change in log Risk Premium* and *Northern Real Money Difference*), the standard GPH test of Geweke - Porter-Hudak (1983) test for fractional integration must be used, because these variables do not have a unit root. Test results demonstrate that none of these series is fractionally integrated.

Table B.3 reports the results from the GPH test for Change in Real Bond Holdings Difference. The results there indicate no statistical evidence for the existence of fractional integration. The results from application of this test to the other stationary series are the same, and available upon request.

After employing both tests, we conclude that none of the series is fractionally integrated, and therefore there is no need to test for the existence of fractional cointegration.

Table B.1: Modified LPR (log periodogram regression) estimate of fractional differencing parameter for Real Southern Trade Balance (RSTB)

Power Ords	Estimate of d	Std Err	t(H0: d=0)	P>t	z(H0: d=1)	P>z
0.4	0.78532	0.697024	1.1267	0.311	-0.7486	0.454
0.45	0.73579	0.520283	1.4142	0.207	-1.0092	0.313
0.5	0.97349	0.381534	2.5515	0.034	-0.1169	0.907
0.55	0.80498	0.296946	2.7109	0.022	-0.9617	0.336
0.6	0.67229	0.251493	2.6732	0.020	-1.7702	0.077
0.65	0.70491	0.196018	3.5962	0.003	-1.7822	0.075
0.7	0.84531	0.225835	3.7430	0.001	-1.0234	0.306
0.75	0.96009	0.194067	4.9472	0.000	-0.2984	0.765

Table B.2: Modified LPR estimate of fractional differencing parameter for Fiscal Balance Difference (FBD)

Power Ords	Estimate of d	Std Err	t(H0: d=0)	P>t	z(H0: d=1)	P>z
0.4	0.640104	0.448489	1.4272	0.213	-1.2549	0.210
0.45	0.676059	0.335059	2.0177	0.090	-1.2374	0.216
0.5	0.998352	0.385047	2.5928	0.032	-0.0073	0.994
0.55	1.163605	0.301631	3.8577	0.003	0.8068	0.420
0.6	1.193197	0.238857	4.9955	0.000	1.0436	0.297
0.65	1.190668	0.181336	6.5661	0.000	1.1515	0.250
0.7	1.157649	0.147317	7.8582	0.000	1.0430	0.297
0.75	1.093326	0.115103	9.4987	0.000	0.6979	0.485

Table B.3: LPR estimate of fractional differencing parameter for Change in Real Bond Holdings Difference

Power Ords	Estimate of d	Asy. Std Err	t(H0: d=0)	P>t	Asy. Std Err	z(H0: d=0)	P>z
0.4	0.009099	0.4654	0.0196	0.986	0.5071	0.0179	0.986
0.45	0.502662	0.5400	0.9309	0.405	0.4357	1.1537	0.249
0.5	0.233032	0.3862	0.6022	0.568	0.3482	0.6693	0.503
0.55	0.23839	0.3206	0.7435	0.478	0.2960	0.8054	0.421
0.6	0.124692	0.2664	0.4680	0.650	0.2610	0.4777	0.633
0.65	0.30149	0.3393	0.8886	0.390	0.2258	1.3354	0.182
0.7	0.363014	0.2851	1.2731	0.221	0.2021	1.7964	0.072
0.75	0.287796	0.2260	1.2736	0.217	0.1764	1.6318	0.103

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