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Global imbalances and the Intertemporal External Budget Constraint: A multicointegration approach*

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Abstract

This paper analyzes the external solvency of a group of 23 OECD countries for the period 1970-2012 The empirical strategy adopted underlines the increasing importance of the financial channel for the external adjustment as proposed in Gourinchas and Rey (2007). We unify the traditional approaches to testing for external sustainability considering the stock-flow system created by the variables representing the external relationships of an open economy. External sustainability is tested using several types of cointegration and multicointegration tests. The results obtained point to weak sustainability in the flows analysis, whereas some degree of strong sustainability is found for up to six countries in the stock flow approach. Among these countries we find both non-European economies, such as Japan and New Zealand, and Euro-area members especially those with more restricted access to financing in the international markets.

Keywords: Current account, net foreign assets, multicointegration, structural breaks.

JEL codes: F32, F36, F37, C22.

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1 Introduction

Since the beginning of the 1990s, current account (CA) imbalances have been widening considerably in the world economy. Economic globalization has meant an increase in international trade and capital mobility facilitating the financing of larger and more persistent current account imbalances. However, the size of the imbalances has raised the key question of their sustainability and the nature of the adjustment process. Moreover, Obstfeld and Rogoff (2009) have recently related the problem of global external disequilibria to the current international financial crisis.

1 shows the current account balance as a percentage of GDP for the Euro area countries, the UK, the US and Japan.[1] The visual inspection shows the existence of a diverting trend between countries like the US – depicting increasing deficits – and Japan – showing persistent surpluses measured as a percentage of the Current Account (CA) position over their GDPs. Moreover, even in the case of the euro area, although the zone seems to be balanced as a whole – see Figure 1 – there are important differences among member countries. Figure 2 on the left graph shows that the peripheral Southern European countries have experienced significant deficits. According to Lane and Milesi-Ferretti (2007), the exposures across Europe are very heterogeneous (differences in trade patterns, financial exposures, and net external positions) so that the process of adjustment may constitute an asymmetric shock. This implies bilateral real exchange rate adjustments between creditor and debtor countries as members of the euro area. The same picture appears when we assess the nature and dimension of external imbalances by looking at the net foreign assets (NFA) position of the same group of countries. The negative values of the NFA position reflect the cumulated effect of persistent current account deficits, and therefore, the imbalance between foreign assets and liabilities. Figure 3 shows quite clearly another stylized fact: the preeminence and persistence of the net debtor positions among the developed countries. The only exceptions have been Japan, Norway (the only oil exporter country in the sample), and a group of core EMU members (Germany, France and Belgium).

While temporary current account deficits may simply reflect the reallocation of capital to countries where capital is more productive, persistent deficits may be regarded as a more serious issue. Deficits may lead to increased domestic interest rates to attract foreign capital. However, the accumulation of external debt due to persistent deficits may imply increasing interest payments that impose an excess burden on future generations.

Country-specific macroeconomic imbalances that before the crisis were underestimated by policy-makers and financial market participants alike have now come to light as destabilizing factors. Of special importance have been the growing external imbalances led by the convergence of interest rates that occurred in the eurozone from 1995 to 1997 on the verge of the launching of the euro. According to Sinn and Wollmershauser (2011), the low interest rates unleashed a credit-financed boom in the countries of Europe's periphery, which initially was very positive for these countries as it fuelled their growth; however it generated an increasing external imbalance and also increasingly large amounts of capital flowed into these countries to finance the current

[1] Caballero et al. (2008) divide the world into four groups: the United States (and "similar" economies such as Australia and the United Kingdom); the Euro Zone; Japan; and the rest of the world. This classification also emerges from our stylized facts analysis.

account deficit. The situation for the peripheral countries changed dramatically when the US financial crisis spilled over to Europe. This gave rise to a credit crunch in the area, which hit the peripheral countries particularly hard. Then, private capital was no longer willing to finance these countries' accumulating trade deficits. Therefore, countries that had experienced a boom on capital imports have remained since then stuck in a crisis of which they have yet to emerge. Globally, these include the US, the UK and the peripheral countries of the eurozone, and, to a lesser extent, also France and Italy. Only very recently academics and policy makers have expressed the need to reinforce a system of explicit surveillance for these macro imbalances where the external ones are especially relevant – see European Commission (2009) and Camarero et al. (2011).

The result of the process has been the need to implement financial assistance to Greece, Ireland and Portugal in the context of EU/IMF programmes as well as increasingly important (and dubious) operations of debt purchase by the ECB. The difficulties to implement a realistic European solution together with budgetary problems in the US have reinforced the European crisis extending the difficulties to other euro countries such as Spain, Italy, Belgium or, even, France.

Although many rich countries have benefited from the high degree of international financial globalization and have been able to finance their growing current account imbalances through foreign capital entries, the deterioration of the NFA position has been severe in many cases and calls for painful adjustments. These adjustments are particularly difficult inside a monetary union. Therefore, the recent financial and economic crisis of 2008-09 has raised serious concerns about the long-term sustainability of external imbalances in the euro area.

(Lane and Milesi-Ferretti, 2001, 2002) have examined the relationship between current account and changes in net foreign asset position at market value, and showed that the correlation between them is low or even negative. Lane and Milesi-Ferretti (2007) suggest that currency fluctuations influence the rates of return on inherited stocks of foreign assets and liabilities, in addition to operating through the traditional trade adjustment channel. The large gross cross-holdings of foreign assets and liabilities suggest that the valuation channel of exchange rate adjustment has grown in importance, relative to the traditional trade balance channel. More recently, Gourinchas and Rey (2007) have decomposed the external adjustment into a financial (valuation) channel and a trade (net export) channel and show that the deteriorations in net exports or net foreign asset position of a country have to be matched either by future net export growth (trade adjustment channel) or by future increases in the returns of net foreign asset portfolio (financial adjustment channel). The valuation channel is important in the short and medium-term while the net export channel is important in a long-time horizon.

As the current account represents the rate at which a country accumulates or decumulates foreign assets, one approach to judging whether an external balance of a given size is a problem is to see if it is consistent with the assumption that all external debts will ultimately be repaid. According to Trehan and Walsh (1991), current account I(0) stationarity is a sufficient condition for the intertemporal budget constraint to hold. This is the notion of intertemporal solvency. This concept, however, is a relatively weak criterion as requires only that large trade deficits today will be offset by equally (in present value terms) large trade surpluses in some future period. In the same vein, a more demanding criterion is sustainability. This concept adds on to the notion of solvency the idea that policies remain constant for the indefinite future. Thus, an external position is sustainable if, under the assumption that policies do not change, the country does not violate its intertemporal solvency constraint. Using this definition, a sustainable current account is one that changes in an orderly fashion through market forces without causing jarring movements in other economic variables, such as the exchange rate. According to Taylor (2002) the current account plays a role of a buffer against transitory shocks in supply (productivity) or demand (government spending, or interest rates, among others) in order to smooth the intertemporally-optimal consumption path.

From a theoretical perspective, the above flow approach has a major drawback, as it ignores valuation effects of stocks of foreign assets and liabilities and assume that the current level of NFA is sustainable. The empirical literature has rarely tackled the problem of the relationship between external debt and external deficit until very recently. The no-Ponzi game restriction, which is regarded as synonymous with the fulfillment of the Intertemporal External Budget Constraint (IEBC) that all countries face, requires that today's external debt is matched by an excess of future primary surpluses over deficits in present value terms. This condition imposes testable restrictions on the time series of key external position measures such as the stock of external debt, the current account deficit, and the long-run relationship between exports and imports.

In the last two decades, external sustainability has been tested through the use of non-stationary time series analysis. Two different approximations can be found in the literature. The first one consist of a univariate time series approach that has focused either on the stochastic properties of the current account deficit inclusive of interest payments or on the stock of external debt. Examples of empirical works based on the current account are Trehan and Walsh (1991), Wickens and Uctum (1993), Ahmed and Rogers (1995), Liu and Tanner (1996), Nason and Rogers (2006), and Engel and Rogers (2009), among others. Another stream of empirical research has analyzed the stationarity nature of the stock of external debt. Stocks have some advantages from an empirical viewpoint as they are less volatile and can provide long term relationships that are easier to estimate. The stock approach has recently been used by several authors thanks to the development of an external wealth database by Lane and Milesi-Ferretti (2007).[2] The second empirical strategy has been based on a multivariate approach focusing on the long-run properties of the flows of exports and imports. Some examples are Husted (1992), Fountas and Wu (1999), Irandoust and Sjoo (2000), Irandoust and Ericsson (2004), Arize (2002), Narayan and Narayan (2005), Herzer and Nowak-Lehmann (2006), and Hamori (2009), among others.

A common feature of the previously reported empirical literature is that it does not tackle properly the complex relationships between the external deficits (or the variables involved in this imbalance) and the evolution of the stock of external debt. Generally, the analysis of the dynamic responses of the current account to different shocks focus on the short run as in Glick and Rogoff (1995) and Milessi-Ferreti and Razin (1996) or they are estimated through simple

[2] Gourinchas and Rey (2007) use monthly data and an intertemporal budget constraint view to measure external imbalances in the United States. Similarly, IMF (2005) shows the different roles played by valuation effects in emerging and industrial countries.

cointegration techniques that are unable to capture the stock-flow mechanism shared by these variables. Although this mechanism could help to a gradual rebalancing, these benefits could turn into a problem if policies are not consistent with a credible medium-term policy framework aimed at external and internal balances, as expectations may not be well anchored. In this case, investors' preferences may quickly change and the fallout from disruptive financial market turbulence would likely be more elevated than it would had been otherwise. This is being the case in the present European sovereign debt crisis, which as some authors have outlined, is hiding a Balance of Payments crisis inside the euro area (Mayer (2011)). Moreover, a country running persistent current account deficits might be at the same time improving its NFA position if capital gains on its foreign assets exceed those on its foreign liabilities – see Lane and Milesi-Ferretti (2007). Additionally, if the country is located away from its equilibrium level of NFA, the current account deficit can be sustained precisely because the economy is adjusting to a higher level of long-term liabilities. Edwards (2001) shows that this adjustment process can lead to quite substantial current account deficits. Therefore, the ratio of net international debt to GDP is providing a medium term benchmark for assessing the sustainability of a country's current account deficit. Net international debt (stock) is the accumulation over time of current account deficits (flows). If an economy runs a current account deficit consistently, net international debt may become so great that foreign investors lose confidence in the economy's ability to service its debt or, worse yet, repay the principal. Once this happens, interest rates must rise or the borrowing country's currency must depreciate (the real exchange rate in a monetary union) to enable the country to continue financing its deficit. If this is the case, it means that the current account deficit has generated economic forces of its own to change its trajectory, and the current account deficit and the associated debt have become unsustainable. In other words, a country that is solvent may nevertheless not be able to finance a particular current account deficit if investors are not willing to provide the required funds, i.e., if the country is liquidity constrained, and therefore, its external position becomes unsustainable. Moreover, the discount factor on the external debt may also vary over time and states of the nature due, for instance, to valuations effects. Therefore, a situation of solvency may suddenly turn into another one of unsolvency, giving birth to a situation of external unsustainability. According to this, an adequate empirical approach must account for possible breaks in the equilibrium relationship.

To the best of our knowledge, the relationship between the current account and the net foreign asset position has only rarely been studied. Recently, Durdu et al. (2010) have analyzed the IEBC for a group of developed and developing countries using the Pooled Mean Group error correction estimation due to Pesaran et al. (1999) and with results pointing to the fulfillment of the external solvency constraint in most of the cases. In this paper, in order to capture the stock-flow equilibrium mechanism we extent previous literature by employing the multicointegration framework suggested in (Granger and Lee, 1989, 1990) and developed in Haldrup (1994) and Engsted et al. (1997). Multicointegration implies that in a bivariate I(1) system more than one cointegrating vector may exist, and therefore, the variables are bound together by two equilibrating forces. The first cointegrating relation reflects the flow equilibrium force, while the second relationship shows a deeper stock-flow relation. This empirical approach help us to extend the discussion of the IEBC and the external sustainability to a stochastic setting. (Bohn, 1995, 1998) has shown that sustainability depends critically on changes of state contingent claims prices that determine the discount rate on the external debt ("valuation effects"). Sustainability involves both satisfying the IEBC and a transversality condition. The transversality condition requires that the limit of the debt discounted at a rate that is a function of the probability distribution of future debt is zero. This correct discounting is especially important in economies where the rate of growth has been higher than real interest rates. Under this framework, traditional cointegration tests usually applied to test for external solvency are too simple.

The contributions of this research are threefold. First, based on Taylor (2002) and Gourinchas and Rey (2007) we encompass different theoretical approaches stressing the importance of both the current account side and of its counterpart through the net foreign asset position. We analyze both the Intertemporal External Budget Constraint (IEBC) and the link between CA and NFA, a key relationship for the long-run stability of the unified approach model of the current account. We unify these approaches considering the stock-flow system that external accounts variables configure. Second, from an empirical point of view, the novelty of our research is that we overcome former problems present in previous literature through the development of cointegration and multicointegration tests that account for the existence of multiple breaks. More specifically, we apply multicointegration techniques following the approach of Berenguer-Rico and Carrion-i-Silvestre (2011) to test the null hypothesis of non-cointegration in an I(2) framework, and extend it to allow for the presence of up to two structural breaks. The generalization for the two structural breaks is also conducted for the cointegration test statistic in Carrion-i-Silvestre and Sansó (2006). The third contribution is that we apply this analysis, for the first time, to a large group of developed 23 OECD countries focusing on the euro area for the period 1970-2012.

The remainder of the paper is organized as follows. Section 2 summarizes the arithmetic of external sustainability, as well as the main empirical approaches used for testing it. Section 3, presents the econometric model and the statistics applied to test for the presence of cointegration in an I(2) framework allowing for up to two structural breaks. Section 4 reports the results of testing for the OECD countries' debt sustainability using the approach that has been proposed in this paper. Finally, Section 5 concludes.

2 Theoretical framework: a unified approach to the arithmetic of intertemporal solvency

In this subsection we summarize the model developed by Gourinchas and Rey (2007). This model follows a dynamic or intertemporal approach and is based on two elements: an intertemporal external budget constraint (or IEBC) and a long-run stability condition. A country's ability to adjust its external wealth through borrowing and lending provides a buffer against economics shocks, but the long-run budget constraint shows that there are limits to how the buffer can be used. In their model, Gourinchas and Rey (2007) start from a country's intertemporal budget constraint and derive two implications. The first one is a link between the NFA position – also called "external wealth" – and the future dynamics of the current account. If total returns on NFA are expected to be constant, today's net foreign liabilities must be offset by future trade surpluses – the so called "trade channel". However, in the presence of stochastic asset returns, the expected capital gains and losses on gross external positions constitute a complementary adjustment tool called the "valuation channel".

The external constraint implies that today's imbalances must predict either future changes in the trade balance (flow adjustment), future movements in the returns of the NFA portfolio (changes in the stock of foreign assets), or both. In the short and medium term, most of the adjustment goes through asset returns, whereas at longer horizons it occurs via the trade balance.

The value of assets owned by domestic residents held abroad (A) minus the value of domestic liabilities to the rest of the world (L) is called the national NFA or external wealth of a nation. If its net foreign asset position is positive ($NFA > 0$), the country is a net creditor to the rest of the world. Conversely, if NFA is negative ($NFA < 0$) then the country is a net debtor, because its outstanding liabilities to the rest of the world exceed its claims on the rest of the world. All nations are subject to a budget constraint that requires that the value of gross domestic expenditure (GDE) or absorption, plus the change in the stock of foreign assets owned by domestic residents ($A_t - A_{t-1}$) equals the value of gross domestic product (GDP) plus the change in the stock of domestic debt owed to foreigners ($L_t - L_{t-1}$). Combining this relationship with the definition of the current account, it follows that the change in the net foreign asset position is the same as the balance on the current account. Let us start with a stylized version of the nominal balance of payments identity defined in domestic currency:

$$(GDP_t - GDE_t) + NFI_t + UT_t = (A_t - L_t) - (A_{t-1} - L_{t-1}). \tag{1}$$

Substituting in the definition of the net export balance ($NX_t = GDP_t - GDE_t$) and net foreign asset position ($NFA_t = A_t - L_t$), this simplifies to:

$$NX_t + NFI_t + UT_t = CA_t = NFA_t - NFA_{t-1}, \tag{2}$$

which says that the change in the net foreign asset position is the sum of net exports, net foreign income, and unilateral transfers or the balance on the current account. To keep the model basic a number of simplifying assumptions are needed. First, prices are assumed to be perfectly flexible, so that the analysis can be conducted in terms of real variables (all monetary aspects of the economy can be ignored). Second, the country is a small open economy, so it is price-taker and can lend or borrow overseas using debt financing. Third, there are no unilateral transfers. Under this assumption we know that apart from the trade balance, the only other nonzero item in the CA is the net foreign income.

Therefore, if the current account is in deficit ($CA < 0$), the change in the net foreign asset position is negative, indicating that the increase in foreign debt was greater than the increase in foreign assets over the year. A negative change in the net foreign asset position is referred to as a net capital inflow, since more capital flowed into the country through additions to the level of foreign debt than flowed out through purchases of foreign assets. Future current account and net foreign asset positions are related to the present current account and net foreign asset positions through future net foreign income flows.[3] The extent of these flows is influenced by the rates of return on foreign assets and foreign debt. Net foreign income[4] is essentially the difference between interest earned on foreign assets and interest paid on foreign liabilities:

$$NFI_t = i^A A_{t-1} - i^L L_{t-1}, \tag{3}$$

where r^A is the rate of interest residents earn on their foreign assets and i^L is the rate of interest that the country pays on its foreign liabilities. Theoretical analyses typically assume that there is no differential between the interest rate on foreign assets and debt, and that the interest rate on foreign debt exceeds the growth rate of nominal GDP, which suggests that the economy must shift to a net export surplus to maintain its current negative net foreign asset position.[5] Dividing by the level of GDP and imposing the foreign debt sustainability condition that the ratio of NFA to GDP be constant at a given level nfa^*, we find that the critical net exports to GDP ratio, nx^*, is:

$$nx_t^* = (g - i^L)nfa^*, \tag{4}$$

where g is the growth rate of nominal GDP.

According to Kouparitsas (2005) a country's current net foreign asset position is considered unsustainable if the associated nx^* is a relatively large fraction of GDP. Similarly, a current account deficit is considered unsustainable if it maintains or leads to an unsustainable net foreign asset position.

However, nx^* depends not only on nfa^*, which is weighted by the difference between the growth rate of nominal GDP and the interest rate on foreign debt, but also on the current ratio of domestic gross foreign assets to GDP, a^*, which is weighted by the difference between the interest rates on foreign debt and foreign assets, and the typical ratio of unilateral transfers to GDP, ut^*. In this paper we do not consider these two elements, and therefore, we use indistinctly nx and ca.

A by-product of this analysis is the current account to GDP ratio, ca^*, that would be required to maintain nfa^*. ca^* only depends on nfa^*, which is weighted by the growth rate of nominal GDP. Through a similar analysis, one can show that the critical current account to GDP ratio ca^* is:

$$ca^* = g \cdot nfa^*. \tag{5}$$

Moreover, many statistical databases do not take into account the unrealized capital gains from both changes in local currency prices and exchange rate adjustments. However, this

[3] See Lane and Milesi-Ferretti (2002) and Gourinchas and Rey (2007) for a more complete discussion of the longer term relationship between the U.S. net exports deficit and revaluations of the U.S. net foreign asset position.

[4] If we consider also the net flow of labor income income, we get the so-called "net remittances".

[5] In textbook examples there is no distinction between r^A and r^L, because they assume there is only one traded asset. In the real world, however, there are sometimes important differences, a clear example being the so-called "exorbitant privilege" of the US economy. This privilege comes from being able to borrow cheaply by issuing external liabilities in the form of reserve assets (Treasury Bills) while earning higher returns on US external assets (equity or FDI).

mechanism can be of increasing importance in a financially integrated world.[6]

In order to derive the different testing hypotheses, let us consider the accumulation identity for net foreign assets between t and $t-1$:

$$NFA_t = (1 + i_t)NFA_{t-1} + NX_t. \tag{6}$$

The equations displayed so far are characterizations of the period by period balance of payment. They adequate the current account deficit (surplus) to capital inflow (outflow) or net borrowing (lending) from (to) abroad. Iterating (6) forward and assuming that the expected value $E(r_t|\varphi_{t-1}) = r$, with φ_{t-1} being the information set available in $t-1$, we get

$$NFA_t = \sum_{j=0}^{\infty} \left(\frac{1}{1+r}\right)^j E(NX_{t+j} \mid \varphi_{t-1}) + \lim_{T\to\infty} \left(\frac{1}{1+r}\right)^T E(NFA_{t+T} \mid \varphi_{t-1}). \tag{7}$$

Equation (7) simply states that international agents are able to lend to an economy if they expect that the present value of the future stream of net exports surpluses equals the current stock of foreign debt. Hence, the sustainability hypothesis, or long-run external budget constraint implies that:

$$\lim_{t\to\infty} \left(\frac{1}{1+r}\right)^T E(NFA_{t+T} \mid \varphi_{t-1}) = 0. \tag{8}$$

This transversality condition means that the present value of the expected stock of debt when t tends to infinity must equal zero, that is, a no-Ponzi game condition. Following Trehan and Walsh (1991), given that the current account is $CA_t = NFA_t - NFA_{t-1}$, a sufficient condition for (8) to hold is that the current account is an I(0) stationary process. In the more realistic case of an economy with a positive rate of growth of output, we have that a first testing hypothesis is that the sustainability condition holds if the ratio $ca_t = \frac{CA_t}{Y_t}$ is I(0) stationary. This means that sustainability is possible with current account deficits as far as they do not grow faster than output in expected value.

An obvious test of sustainability is hence a unit root test on ca_t. This is what most of the literature has previously used as a test of sustainability. However, note that we are dealing here with expected values of future events. Changes in the agents' perceptions about risk, portfolio allocation decisions, future policy changes, transaction costs in international financial flows, among others features, can lead to changes in the dynamics of current account mean reversion and, hence, equilibrium values of the current account. In a deterministic economy the discount rate r is assumed to the level of the safe rate, usually the rate on sovereign debt instruments ($i = r$). However, the correct discount factor is not fixed but varies over time and states of nature.[7] Therefore, the appropriate transversality condition requires a zero limit on future external debt discounted at a rate that is subject to change and the fulfillment of the IEBC. In a deterministic setting with non-stationary data, these conditions have been empirically interpreted as requiring cointegration between imports and exports with a cointegrating vector

[6] See Lane and Milesi-Ferretti (2001) and Tille (2003) for detailed discussion of the size and history of valuation effects for the U.S. and other nations.

[7] This point has been raised by Bohn (1998) for a system of fiscal variables and adapted by (Fisher, 1990, 1995) for external imbalances.

(-1, ≤1). Although the saving-investment equilibrium approach does provide an analytical basis for the evaluation of external positions, its almost exclusive concern with flows limits its ability to assess the viability and adequacy of external indebtedness, a stock problem by nature. Moreover, the practical difficulty with the previous approach is that, in principle, any level of external debt is consistent with solvency provided that sufficient trade surpluses are generated in the indefinite future (Milessi-Ferreti and Razin (1996)). Thus, to make this approach operational, researchers typically assume that the economy targets a given debt-to-GDP ratio (nfa^*), and consider the particular case in which current policy would remain unchanged into the indefinite future – see Corsetti and Roubini (1991).

Consider a stochastic setting, in which the economy is characterized by an endogenous policy response to the balance of payments or a borrowing constraint that maintains external debt at some constant optimal ratio to income (nfa^*). Therefore, exports (imports) responds positively (negatively) to debt in excess of the optimal ratio. The arithmetic of solvency is primarily concerned with the question of whether net external liabilities grow less rapidly than their (marginal) rate of return, so that the present discounted value of net liabilities converges to some finite quantity. In practical terms, the arithmetic of solvency examines whether the net debt/GDP ratio grows more or less rapidly than the difference between the real interest rate and the economy's growth rate.

Finally, manipulating equation (6), the steady state ratio of net exports to net foreign assets is an I(0) stationary process with an unconditional mean NX/NFA that satisfies:

$$\frac{NX}{NFA} = \rho - 1 < 0, \tag{9}$$

where $\rho = \mathring{y}_t/\tilde{r} < 1$ implies that the real growth rate of wealth is lower than the rate of return of the net foreign asset portfolio ($\mathring{y} < \tilde{r}$), being $g = \mathring{y}$. Therefore, countries with steady state creditor positions ($NFA > 0$) should run trade deficits ($NX < 0$), whereas countries with steady state debtor positions ($NFA < 0$) should run trade surpluses ($NX > 0$). As long as $g > i$ the economy can continue to import more than it exports, that is, incur trade deficits, without the ratio of debt rising above the desired level (nfa^*). However, if for some realization of history the rate of growth is less than the real interest rate, the discount rate falls. If $g < i$ it triggers corrective efforts that entail promoting current account surpluses to reduce the future debt burden and stabilize nfa^*over time. Lane and Milesi-Ferretti (2002) point out that the correlation between the change in the net foreign asset position at market value and the current account is low or even negative. They also note that rates of return on the net foreign asset position and the trade balance tend to co-move negatively, suggesting that wealth transfers affect net exports. Moreover, Lane and Milesi-Ferretti (2007) show exchange rate effects on rates of return of foreign assets and liabilities.

Therefore, in a stochastic environment sustainable intertemporal external budgeting will be characterized by a long-run positive (negative) relationship between exports (imports) and external debt as outlined in (9) . This means that a long-run stock-flow relationship will be present between the current account flow variables and the stock of external debt.

In our paper we will also take into account the critique made recently by Bohn (2007) concerning the concept of sustainability[8] and its application in the context of unit roots and cointegration. He argues that these tests are not directly suitable for the assessment of sustainability and he derives three propositions that can be adapted to the case of the determination of external sustainability as follows:

1. If nfa_t is integrated of order m for any finite $m \geq 0$, then nfa_t satisfies the transversality condition, and nfa_t and nx_t satisfy the IEBC.

2. If exports and imports are integrated of order m_X and m_M, respectively (where $\Delta nfa_t = x_t - m_t$), then nfa_t is integrated of order m with $m \leq \max(m_X - m_M) + 1$, so the transversality condition and the IEBC hold.

3. If nfa_t and nx_t follow an error-correction specification of the form $nx_t + \rho\, nfa_{t-1} = z_t$ and z_t is integrated of order m for some $\rho < 0$ such that $|\rho| \in (0, 1 + r]$ where r is a constant interest rate, then nfa_t satisfies the transversality condition and the IECB holds.

To sum up, he shows that any finite order of integration of these series separately leads also to the fulfilment of the IEBC. Moreover, the cointegration relationship between exports and imports is not a necessary condition for the no-Ponzi game condition to hold but that a long-run relationship under as an error-correction specification between nfa_t and nx_t has to be fulfilled in order to avoid any explosive outcome among the variables that determine the external equilibrium in the long-run. In this paper, we propose an alternative approach to test for external sustainability based on multicointegration.

3 Econometric methodology

In this section we describe the testing strategy we use to address the theoretical issues described above. The empirical application is based on a database that consists of 23 OECD developed countries, both European and from the rest of the world. The sample covers the period 1970-2012, and the data has been obtained from the AMECO database provided by the European Commission.

As mentioned above, sustainable policies concerning the external sector must satisfy the IEBC and the transversality condition given in (8). In a deterministic setting with non-stationary data, these conditions have been empirically tested assessing whether there exist a cointegration relationship between imports (m_t) and exports (x_t) with a cointegrating vector $(-1, \leq 1)$ – see Leachman and Francis (2000). Pursuing this avenue requires, first, the determination of the order of integration of the (m_t) and (x_t) , and second, testing for the presence of a long-run relationship between these variables. Notwithstanding, visual inspection of these variables might let think that the presence of some non-recurrent shocks with large magnitude might have affected the evolution of these variables, something that needs to be taken into account when assessing the stochastic properties of time series if meaningful conclusions are to be obtained – see (Perron, 1989, 2006).

[8] Note that even if Bohn's assertions are originally referred to public finance, they can be easily applied to external imbalances.

The presence of a long-run relationship among imports and exports defines a first layer of sustainability, although it would be possible that stronger forces that define a stock-flow system might be acting to link these two variables and hence defining a deeper level of sustainability – i.e., a second layer of cointegration. In this paper, we propose to analyze if there is a relationship among the stocks of net foreign assets. Let us define $\sum_{j=1}^{t} M_j$ and $\sum_{j=1}^{t} X_j$ the cumulated imports and exports, respectively. We can specify a model such as:

$$\sum_{j=1}^{t} M_j = \beta_0' c_t + \beta_{2,0} \sum_{j=1}^{t} X_j + \beta_{1,0} X_t + u_t, \tag{10}$$

where c_t collects the deterministic regressors. Equation (10) includes the level of exports among the stochastic regressors in order to cover the feature that policymakers pay attention to both the stock of external debt (i.e., net foreign assets) and the current account position (exports) in their policies. This interpretation can be made if we note that setting $\beta_{2,0} = 1$ in (10) leads to:

$$\sum_{j=1}^{t} M_j - \sum_{j=1}^{t} X_j = \beta_0' c_t + \beta_{1,0} X_t + u_t \tag{11}$$

$$-NFA_t = \beta_0' c_t + \beta_{1,0} X_t + u_t, \tag{12}$$

where $NFA_t = \sum_{j=1}^{t} X_j - \sum_{j=1}^{t} M_j$ is the net foreign asset position. It can be seen that (11) defines a potential long-run relationship between the NFA_t and the current account once the constraint $\beta_{2,0} = 1$ is imposed – notice that this approach defines the multicointegration testing concept proposed in Granger and Lee (1989), where the cointegrating vector among the levels of the variables is assumed to be known. The specification given in (10) implies working within a stock-flow setup, which allows us to consider whether governments are taking corrective measures on flows – in our case, exports and imports – in such a way that they are also controlling, to some extent, the stock of external debt.

In this multicointegration setup and in order to test for external sustainability, we have to analyze the conditions in terms of the expressions above, and in particular, of the single equation model given by (10). This expression integrates the flow I(1) variable X_t and the I(2) stock variables $\sum_{j=1}^{t} M_j$ and $\sum_{j=1}^{t} X_j$. The parameters $\beta_{2,0}$ and $\beta_{1,0}$ define the first and the second cointegration layers, respectively. The first layer refers to the cointegration relationship between the flow variables, whereas the second relates flow and stock variables. The assessment of the degree of sustainability of external policy will depend on the values of these parameters. If $\beta_{2,0} > 1$ then surpluses have been, on average, predominant, whereas if $\beta_{2,0} < 1$, deficits have outpaced surpluses.

As noted above, most of the empirical studies have highlighted the existence of regimes in the sustainability process and some of them have introduced structural breaks in the analysis of the relationship between imports and exports. If such regime changes are present, as the literature concludes, the test statistic developed by Haldrup (1994) and Engsted et al. (1997) should not be applied since it does not account for regime shifts. One of the contributions of our paper is to implement a model and test statistic developed by Berenguer-Rico and Carrion-i-Silvestre (2011) to test for I(2) cointegration with regime shifts. To be specific, we define the model given by:[9]

$$Y_t = \mu + \xi t + \sum_{i=1}^{l} \theta_i DU_{i,t} + \sum_{i=1}^{l} \gamma_i DT_{i,t} + \beta_{1,0} X_{1,t} + \sum_{i=1}^{l} \beta_{1,i} DU_{i,t} X_{1,t} + \beta_{2,0} X_{2,t} + \sum_{i=1}^{l} \beta_{2,i} DU_{i,t} X_{2,t} + u_t, \tag{13}$$

where $Y_t = \sum_{j=1}^{t} M_j$, $X_{2,t} = \sum_{j=1}^{t} X_j$ and $X_{1,t} = X_t$, l denotes the number of structural breaks, $DU_{i,t} = 1$ and $DT_{i,t} = (t - T_i)$ for $t > T_i$, and 0 otherwise, where $T_i = [\lambda_i T]$ denotes the i-th break point, $i = 1, 2, \ldots, l$ – $\lambda_i \in \Lambda$ is the break fraction parameter, where Λ is a closed subset of $(0, 1)$, and $[\cdot]$ being the integer part.

Several cointegration possibilities exist in the system given by (13). If u_t is integrated of order two such that $\Delta^2 u_t = v_t$ is I(0), then there is no cointegration. If $\Delta u_t = v_t$ is I(0), then $(Y_t, X_{2,t})' \sim CI(2,1)$ with a changing cointegrating vector, whereas if the resulting error $z_t = Y_t - \left(\beta_{2,0} + \sum_{i=1}^{l} \beta_{2,i} DU_{i,t}\right) X_{2,t}$ cointegrates with $X_{1,t}$, we have a fully cointegrated system such that $u_t = v_t$ is I(0).

As pointed out in Haldrup (1994), in many situations it is likely that cointegration to at least I(1) level will occur, which leads us to test the null hypothesis of no cointegration at the first level, i.e., $u_t \sim I(1)$, against the alternative hypothesis of multicointegration with structural breaks, $u_t \sim I(0)$. In order to assess the integration order for $\hat{u}_t$, we estimate the augmented Dickey-Fuller (ADF) type regression,

$$\Delta \hat{u}_t = \delta \hat{u}_{t-1} + \sum_{j=1}^{p} \varphi_j \Delta \hat{u}_{t-j} + \eta_t, \tag{14}$$

and consider the t-ratio ADF statistic ($t_\delta(\lambda)$) for testing the null hypothesis that $\delta = 0$ computed from the OLS estimation of (14). So far, we have considered that the break points T_i, $i = 1, 2, \ldots, l$, are known a priori, although in most cases they are not. If so, we can follow previous proposals in the literature and compute the multicointegration ADF test for each possible vector of break points, $\lambda \in \Lambda^l$, which defines a sequence of statistics. Then, the infimum of the sequence of ADF statistics is taken, which defines the statistic:

$$t_\delta^* = \inf_{\lambda \in \Lambda^l} t_\delta(\lambda). \tag{15}$$

Berenguer-Rico and Carrion-i-Silvestre (2011) consider the case of $l = 1$ structural break providing critical values to test the null hypothesis of $u_t \sim I(1)$. In this paper we extend their analysis allowing for up to two structural breaks for the model specification given in (13).

4 Empirical results

4.1 Order of integration analysis

Given previous analyses in the literature and the expected effects of the different economic crises that might have affected the variables that we are dealing with, we start the analysis of the order of integration of the time series involved in our study investigating the presence

[9] See Model 8 in Berenguer-Rico and Carrion-i-Silvestre (2011).

of structural breaks. This is an important feature provided that unit root tests can lead to misleading conclusions if the presence of structural breaks is not accounted for when testing the order of integration. Therefore, the first stage of our analysis has focused on a pre-testing step that aims to assess whether the time series are affected by the presence of structural breaks regardless of their order of integration. This pre-testing stage of the analysis is a desirable feature, as it provides an indication of whether we should then apply unit root tests with or without structural breaks depending on the outcome of the pre-test. This testing problem has recently been addressed by Perron and Yabu (2009), who define a test statistic that is based on a quasi-GLS approach using an autoregression for the noise component, with a truncation to 1 when the sum of the autoregressive coefficients is in some neighborhood of 1, along with a bias correction. For given break dates, one constructs the F-test ($Exp - W_{FS}$) for the null hypothesis of no structural change in the deterministic components. The final statistic uses the Exp functional of Andrews and Ploberger (1994). Perron and Yabu (2009) specify three different models depending on whether the structural break only affects the level (Model I), the slope of the trend (Model II) or the level and the slope of the time trend (Model III). In our case, we focus on the specifications that allow for changes in the slope of the time series given the trending pattern that show the time series – see Figure 4.

The results reported in Table 1 show that we find marginal evidence against the null hypothesis of no structural break. Thus, the null hypothesis of no structural break is rejected for the exports variable for Canada, Greece, Netherlands, Norway and Switzerland by, at least, one of the three specifications that have been estimated. For the imports, the null hypothesis of no structural break is rejected for Canada, Iceland, Netherlands, Portugal and Spain. Taking into account these results, Tables 2 and 3 indicate that there is little evidence against the null hypothesis of unit root for both variables. For the exports, in general the M-tests do not reject the null hypothesis of unit root – the exception is for the modified Sargan-Bhargava (MSB) statistic for Canada, Greece, Norway and Switzerland.[10] For the imports and focusing on the M-type tests, the rejection of the unit root hypothesis is only found when using the MSB test for Canada.

Once we allow for multiple structural changes, the first striking feature is the presence of up to three changes in some cases and the variables are still non-stationary. Concerning the placement of the breaks, only in a few cases have the structural breaks occurred in the seventies or first years of the eighties: three times for both the exports (Canada, Greece and Norway) and imports (Canada, Iceland and Portugal). They are related to the response to the second oil crisis in some European countries. The second group of structural breaks are placed during the 1990s. Finally, two structural breaks are estimated in the 2000s for Switzerland – the first one is placed at 2000, which is mainly related with the creation of EMU, and at 2006, which mainly correspond to the recent world financial crisis and the recession that followed.

[10]We base our analysis on the M unit root tests as they show better performance in finite sample than the ADF test statistic.

4.2 Imports and exports relationship: First cointegration layer

In order to analyze the existence of a cointegration relationship between imports and exports we have estimated the model:

$$m_t = \mu + \beta_1 x_t + u_t,$$

where $m_t = M_t/GDP_t$, $x_t = X_t/GDP_t$, with M_t the nominal imports, X_t the nominal exports and GDP_t the nominal GDP, and computed the Engle and Granger (1987) cointegration test statistic using the estimated residuals of this equation. Results reported in Table 4 indicate that the null hypothesis of no cointegration is rejected at the 5% level of significance in six out of twenty-three cases when using the pseudo t-ratio ADF statistic, whereas it is rejected in eight out of twenty-three cases when using the normalized bias ADF statistic – the rejection of the null hypothesis is found in two additional cases for each test statistic if the level of significance is set at the 10% level. Therefore, in the most favorable case, we have found evidence against spurious regression in 43% of cases.[11] As a first robustness check, we have computed the Hansen (1992) $\sup F$ statistic to test the null hypothesis of parameter stability, a test statistic that is valid under the assumption that cointegration holds. As can be seen, the Hansen's $\sup F$ statistic does not reject the null hypothesis of parameter stability in any case.

Notwithstanding, the cointegration analysis might be biased by the presence of unattended structural breaks. In order to deal with structural breaks, we have proceeded to compute the Gregory and Hansen (1996) cointegration test statistic, which allows for the presence of one structural break under the alternative hypothesis of cointegration. Columns 7-12 of Table 4 present the result of the cointegration test statistics for the model that accounts for one structural break affecting only the level of the relationship (Model C using the notation in Gregory and Hansen (1996)):

$$m_t = \mu + \theta DU_t + \beta_1 x_t + u_t,$$

and also the results for the model that considers a structural break affecting both the level and the cointegrating vector (Model C/S using the notation in Gregory and Hansen (1996)):

$$m_t = \mu + \theta DU_t + \beta_{1,0} x_t + \beta_{1,1} DU_t x_t + u_t. \quad (16)$$

In this case, the use of the ADF statistic indicates that the evidence against the null of no cointegration increases when considering one structural break, leading to reject the null hypothesis of no cointegration in six additional cases – in one case using the Model C specification and in five cases using Model C/S specification.

As a confirmatory analysis, we have also computed the cointegration test statistics proposed by Carrion-i-Silvestre and Sansó (2006), which accommodate the presence of one structural break affecting the parameters of the model under both the null hypothesis of cointegration and the alternative hypothesis of spurious regression – i.e., this approach reverses the null and alternative hypotheses in Gregory and Hansen (1996). Carrion-i-Silvestre and Sansó (2006) test

[11] It should be mentioned that the performance of the pseudo t-ratio ADF test statistic is better in terms of empirical size and power when compared to the normalized ADF test statistic. Therefore, we could consider that more weight should be given to the former test statistic.

follows the suggestions made by Engle and Granger (1987), Phillips and Ouliaris (1990) and Engle and Yoo (1991), who argued that the natural specification to test should be the null hypothesis of cointegration rather than the null hypothesis of absence of cointegration provided that the null hypothesis will be only rejected when there is strong evidence against what the economic theory is proposing. Taking into account these concerns, we have estimated the model given by (16) considering the two equivalent specifications used for the Gregory and Hansen (1996) test statistics, i.e., the one given by Model An – which imposes $\beta_{1,1} = 0$ in (16) – and the one given by Model D – which does not impose any constraint in (16). In general, the application of the Carrion-i-Silvestre and Sansó (2006) test statistics points to the non-rejection of the null hypothesis of cointegration in all cases once the presence of one structural break has been considered in the model. However, there are some cases for which the null hypothesis of cointegration is rejected – see Columns 13-16 of Table 4. Using Model An specification, the null of cointegration is rejected for Finland, Greece and New Zealand, whereas for Model D it is rejected only for Finland. Taking both the results from Gregory and Hansen (1996) and Carrion-i-Silvestre and Sansó (2006) test statistics we conclude that there is strong evidence of no cointegration for Finland provided that both statistics indicate that the estimated residuals of the model are I(1), regardless of the model specification that is used. For Greece and New Zealand, we find evidence pointing to the presence of a changing long-run relationship between imports and exports when the slope of the model is allowed to change.

The DOLS estimates for each country are reported in Table 5. First, we present the results of the estimates for the model that does not include any structural break, which is the model specification that is suitable for seven cases according to the Engle-Granger test statistics – see the numbers in bold face. Second, we offer the estimation of the model that includes one structural break for the two relevant specifications that have been considered. In this case, the numbers in bold face indicate the model specification that is selected according to the BIC information criterion.

As can be seen, almost all the parameters are statistically significant at least at the 10% level of significance – the exceptions are Australia (the change in the slope), Italy (the intercept), Japan (the intercept), Norway (the change in slope), Switzerland (the constant, the level shift and the slope shift), UK (the level and slope shifts) and the US (the constant). In these cases, an hybrid specification could be estimated, although this does not affect the consistency of the other estimated parameters.

To sum up, the evidence found in this section leads to the presence of a long-run relationship between the ratios of imports over GDP and exports over GDP, although in some cases such a relationship has suffered from the effect of structural breaks. Moreover, except for the case of Finland all the countries analyzed seem to satisfy the IEBC and the transversality condition that ensure the sustainability of policies concerning the external sector. This result leads us to consider whether there exists a deeper level of relationship between the variables, a relationship that would involve the stock of debt and flows of the current account.

4.3 Stock-flow relationship: Second cointegration layer

In this section we have proceeded to test for the presence of a deeper cointegration relationship, i.e., a multicointegration relationship among imports and exports. In this case, we follow Engsted et al. (1997) and propose the following model:

$$\sum_{j=1}^{t} m_j = \mu + \xi t + \delta_1 x_t + \beta_1 \sum_{j=1}^{t} x_j + u_t, \tag{17}$$

which assumes that the stock variables (the cumulated imports and exports) can cointegrate with the level of exports and/or imports. This setup has been generalized in Berenguer-Rico and Carrion-i-Silvestre (2011) to allow for the presence of structural breaks, so that the model specification is given by:

$$y_t = \mu + \xi t + \sum_{i=1}^{l} \theta_i DU_{i,t} + \sum_{i=1}^{l} \gamma_i DT_{i,t} + \delta_0 x_{1,t} + \sum_{i=1}^{l} \delta_i DU_{i,t} x_{1,t} + \beta_0 x_{2,t} + \sum_{i=1}^{l} \beta_i DU_{i,t} x_{2,t} + u_t, \tag{18}$$

where $y_t = \sum_{j=1}^{t} m_j$, $x_{2,t} = \sum_{j=1}^{t} x_j$ and $x_{1,t} = x_t$, l denotes the number of structural breaks, $DU_{i,t} = 1$ and $DT_{i,t} = (t - T_i)$ for $t > T_i$, and 0 otherwise, where $T_i = [\lambda_i T]$ denotes the i-th break point, $i = 1, 2, \ldots, l$ – $\lambda_i \in \Lambda$ is the break fraction parameter, where Λ is a closed subset of $(0, 1)$, and $[\cdot]$ being the integer part.

The parameters β_1 and δ_1 in (17) define the first and the second cointegration layers, respectively – the same discussion applies for the model specification in (18) that considers structural breaks. The first layer refers to the cointegration relationship between the flow variables, whereas the second relates flow and stock variables. The assessment of the degree of sustainability of the external sector policy will depend on the values of these parameters. If $\beta_1 > 1$ then deficits have been, on average, predominant, whereas if $\beta_1 < 1$, surpluses have outpaced deficits. We can combine this information with the one provided by δ_1, which relates flow and stock variables. This parameter indicates how external sector policy reacts to the accumulation of debt or wealth. Concerning δ_1, sustainability will depend also on the value of β_1 – see Escario et al. (2012):

1. If $\beta_1 > 1$, we have a majority of deficits, so that sustainability will require $\delta_1 > 0$, that is, exports should increase to accommodate increasing levels of external debt.

2. In contrast, if $\beta_1 < 1$, surpluses have been predominant, so that exports should decrease to compensate the increasing levels of wealth (that is, $\delta_1 < 0$).

So far, the discussion that summarizes the different approximations in the literature on external sustainability leads us to distinguish two broad concepts of sustainability. First, we can test whether the external stand is sustainable looking at the value of the β_1 parameter in (17) – with the associated interpretation in terms of weak ($0 < \beta_1 < 1$) or strong ($\beta_1 = 1$) sustainability. We can think of this approximation as a way of testing for first layer (weak or strong) external sustainability. In this case, the flow variables standing for the external position of the economy are the ones in which we focus the analysis. Second, we can assess whether the external position is sustainable not only paying attention to the flow variables but also to the stock of external debt. In this case, the β_1 parameter in (17) and, equivalently, in (10) can take values smaller or larger than one provided that the inequality that affects the δ parameter goes on the opposite direction. This means that the practice of the governments that affect the flow fiscal variables is also influenced by the stock of debt. We can think of this second approximation as a way of testing for *second layer of external sustainability.*

Table 6 offers the results of the ADF test statistic to test for the null hypothesis of no multicointegration. For Austria and Portugal, for which a cointegration relationship without structural breaks has been found, evidence of a deeper level of cointegration is detected, revealing the existence of a stock-flow relationship between imports and exports. Such relationship is not present for the other four countries – Japan, New Zealand, the Netherlands and Spain – for which a cointegration relationship has been established. For the countries that required the inclusion of one structural break to obtain a cointegration relationship, we have not found evidence of multicointegration, a conclusion that remains robust to the consideration of two structural breaks. Further, there are two interesting remarks that should be highlighted. First, the stock-flow relationship found for Portugal remains unaltered as we consider up to two structural breaks in the analysis. Second, for the cases of Japan, New Zealand and Spain, the inclusion of two structural breaks is needed in order to find evidence of a multicointegration relationship.

In Table 7 we report the results of the DOLS estimation of the model (17) or (18), depending on whether the inclusion of structural breaks is required to obtain the multicointegration relationship. Note that the estimated coefficients corresponding to the cointegration relationships point to the existence of weak external sustainability as the majority of the coefficients are statistically significant and take a value between 0 and 1. However, this picture changes substantially when the stock-flow relationships among the variables involved in the external stand of the economy are accounted for. As we have already reported in section 2, according to Bohn (1998) there is a relationship between the stock of external debt of an economy and its primary external balance in the long run. Thus, if a country improves its primary trade balance when it accumulates an increasing stock of external debt over GDP, then its external debt is sustainable in the long run. However, the positive relationship between primary external balance and external debt does not need to hold to maintain the sustainability of the external debt position when the external debt over GDP ratio is low. Therefore, the combination of the sign and the statistical significance of both parameters, β_1 and δ, is critical for the purpose of our research. According to the results found for the multicointegration analysis, it appears that the coefficient for the flow variables corresponding to Austria ($\beta_1 = 0.7$), clearly signals to the existence of weak sustainability. However, if we account for the expected behavior of exports when a threshold level of external debt is reached, we find that exports are not diminishing accordingly (as δ takes a positive value, namely 0.43) and therefore the external imbalance is not corrected; thus the external position is not sustainable over time. The same happened with the Netherlands after the second oil crisis in 1979 ($\beta_1 = 1.23$ and $\delta = -0.56$)[12] or with Japan after the crisis occurred at the end of the nineties in Asia, the coefficient β_1 changing from 0.95

[12] Note that the coefficients for the first period are not significant.

in 1982 (=0.50+0.45) to 1.37 (=0.50+0.45+0.42) after 2000 while, δ took the value 0.97 and -1.13, respectively.

In the case of New Zealand, the analysis has to be restricted to the relationship among the flow variables, as δ is not statistically significant. Thus, the analysis focuses on the evolution of β_1 that ranges from -3.39 (before 1975) to 1.99 (before 1991) and to 0.59 (after 1991) showing, at most, a possible a weak sustainable position in the third period.

Spain shows weak sustainability ($\beta_1 = 0.81$) for the first period considered (1970-1987). After the Spanish entry into the European Union (EU), the country shows a regime change, with a $\beta_1 = 1.03$ and $\delta = -1.33$. We have run a Wald test to assess if β_1 is significantly different from 1. The value of the Wald test for the H_0 $(\beta_0 + \beta_1) = 1$ takes the value 0.16 and therefore, we cannot reject the null of strong sustainability (note that the χ^2 with two degrees of freedom is 5.99 at 5% of significance level). However, the situation changes dramatically in 2004 to a position of no external sustainability five years after the launching of the European Monetary Union. In this third period $\beta_1 = 5.17$ (=0.81+0.22+4.14) and $\delta = -3.14$.

As for Portugal, we have estimated three models allowing up to two breaks. In the model with one break, we cannot reject the null hypothesis H_0 $(\beta_0+\beta_1) = 1$ and, as δ is not significant, there is strong external sustainability in the second period (1980-2012). When we consider the two-break model we can find weak external sustainability for the first period (1970-1978) and strong sustainability in the third period (1985-2012) where β_1 is not significantly different from 1. The Wald test takes a value of 4.92 and the critical value with three degrees of freedom is 7.82.

The results found are consistent with the idea that countries more open to the international financial markets are less constrained to any intertemporal budget restriction. Therefore, we cannot find multicointegration for the majority of the EMU members before the crisis nor those OECD countries with hard currencies and open access to the international financial markets like the US or Canada. The existence of the second layer of cointegration for the case of Japan can be explained in the context of the Asian crisis that appeared at the end of the nineties.

5 Conclusions

In this research we aim at filling the gap in the literature on external sustainability in several respects. First, we improve previous empirical work on the intertemporal model trying to reconcile the main theoretical approaches relating financial and macroeconomic variables. We formulate hypotheses that can be tested in a multicointegration framework. Second, we estimate the long-run multicointegration relationships linking the net foreign asset position with the current account in order to ascertain whether the stock-flow approach is a valid hypothesis. Third, we develop previous tests of cointegration and multicointegration extending them to allow for multiple structural breaks. Finally, we provide evidence for a group of 23 OECD countries for a period spanning form 1970 until 2014.

The results point to the existence of weak sustainability for all the countries in our sample when we consider the traditional flow approach to the intertemporal external budget constraint. However, these first results are enriched by the multicointegration approach that help us to gain a deeper insigth into the complex relationships between the stock of net foreign assets and the primary external balance. According to our results only six countries exhibit a second layer of cointegration including the stock of net foreign assets. These countries are the Euro-area members Austria, the Netherlands, Portugal and Spain, as well as Japan and New Zealand.

Therefore, the process of globalization and the set up of the European Monetary Union seems to have made less binding the intertemporal budget constraint. All in all, our analysis allows us to distinguish several periods of time with different degrees of sustainability for the countries considered.

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A Appendix

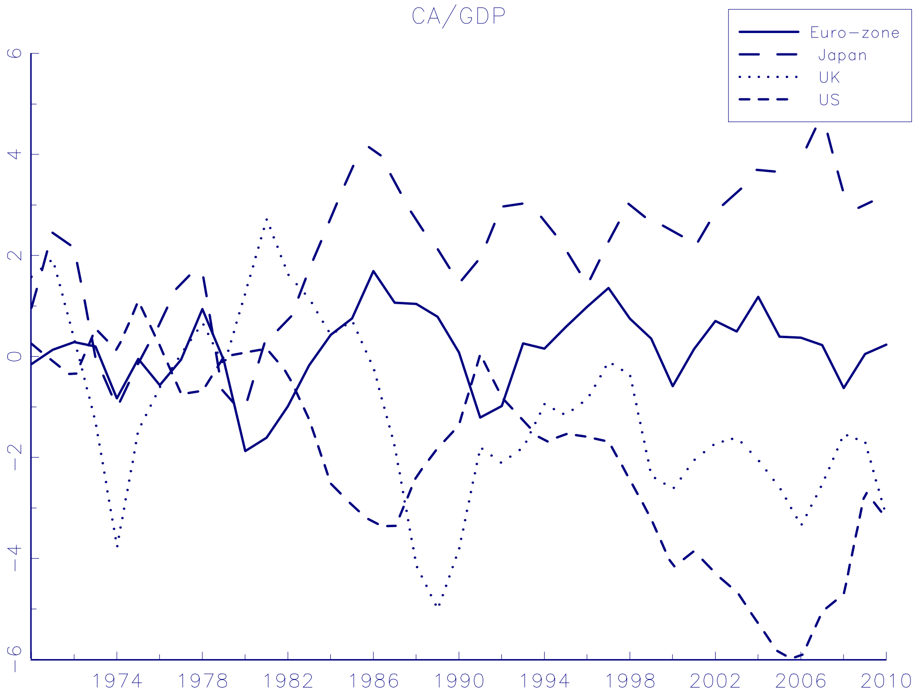

Figure 1: Current account over GDP ratio for the euro-zone

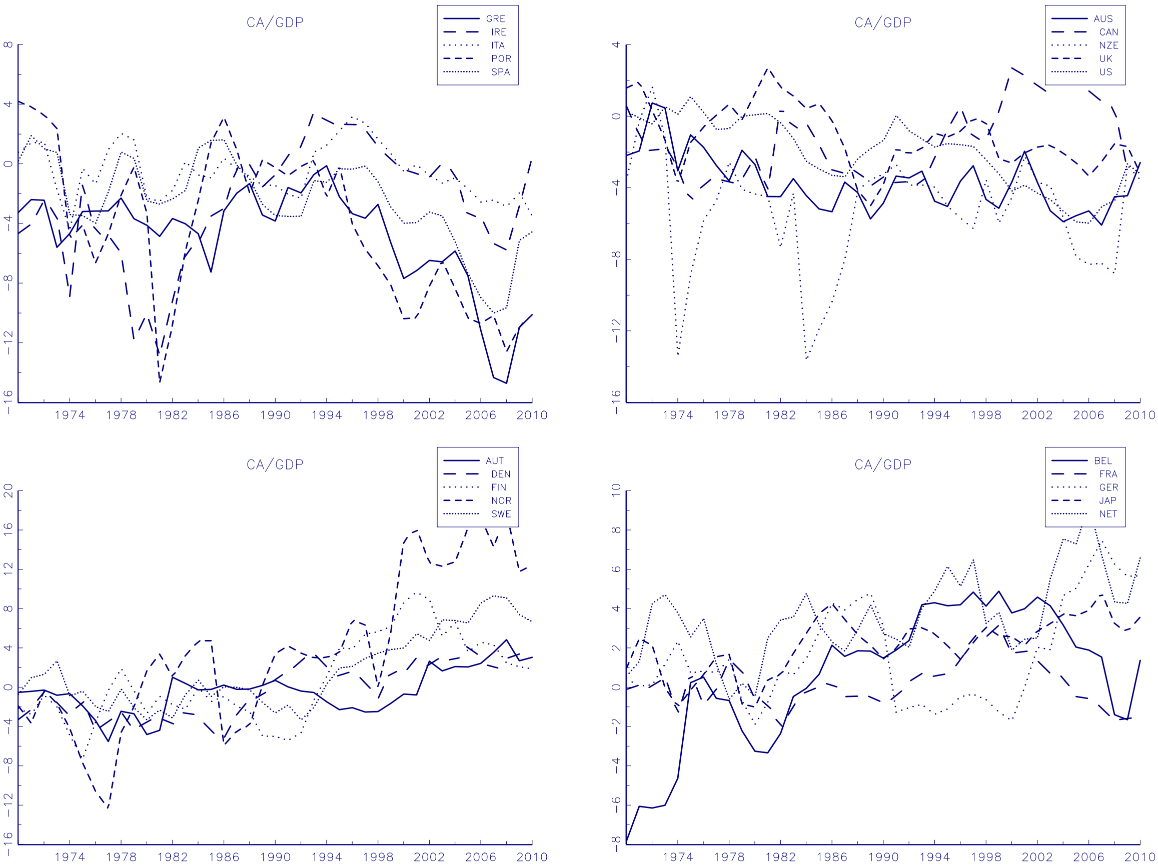

Figure 2: Current account over GDP ratio

Figure 3E: Net foreign assets over GDP ratio

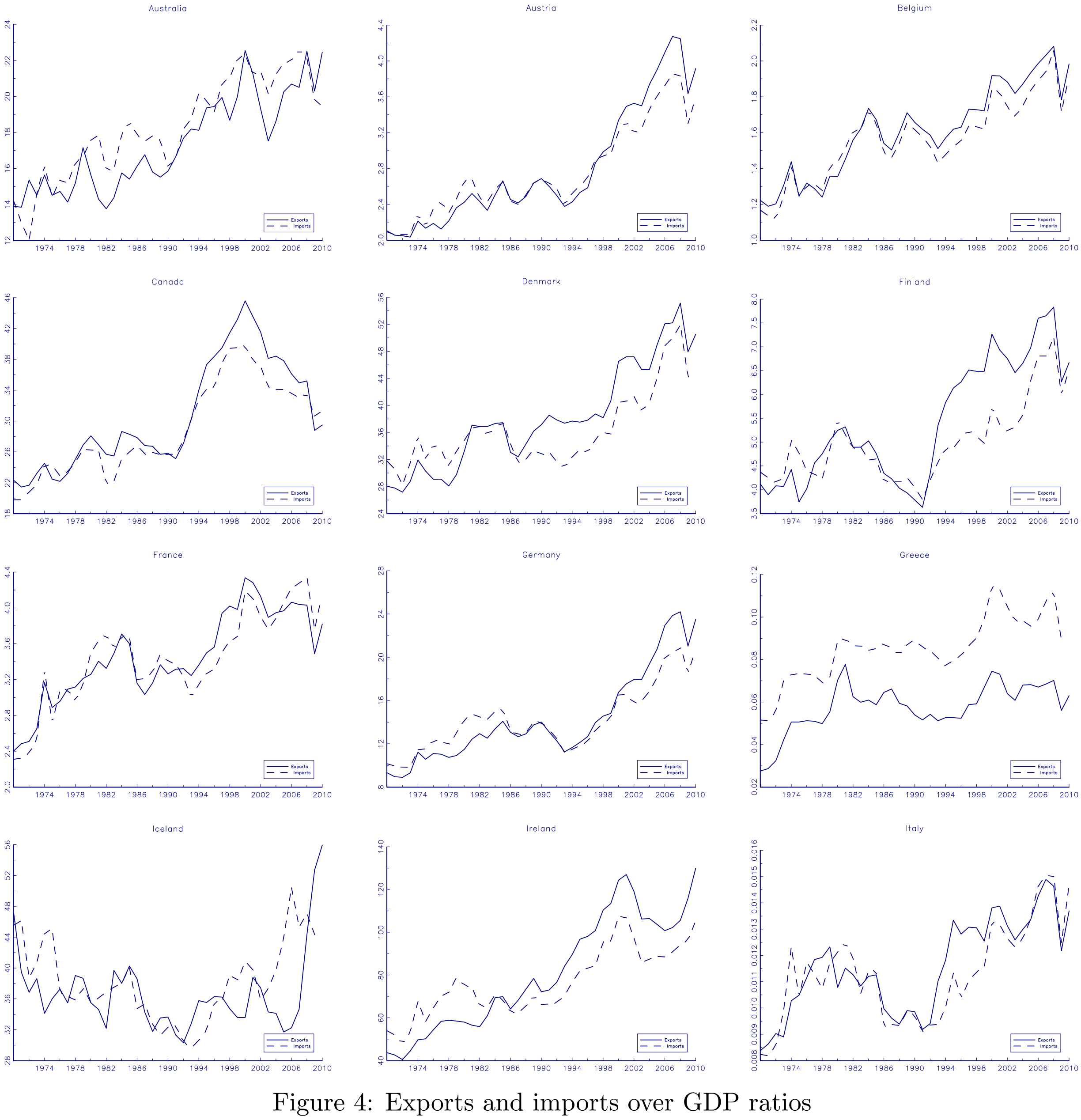

Figure 4: Exports and imports over GDP ratios

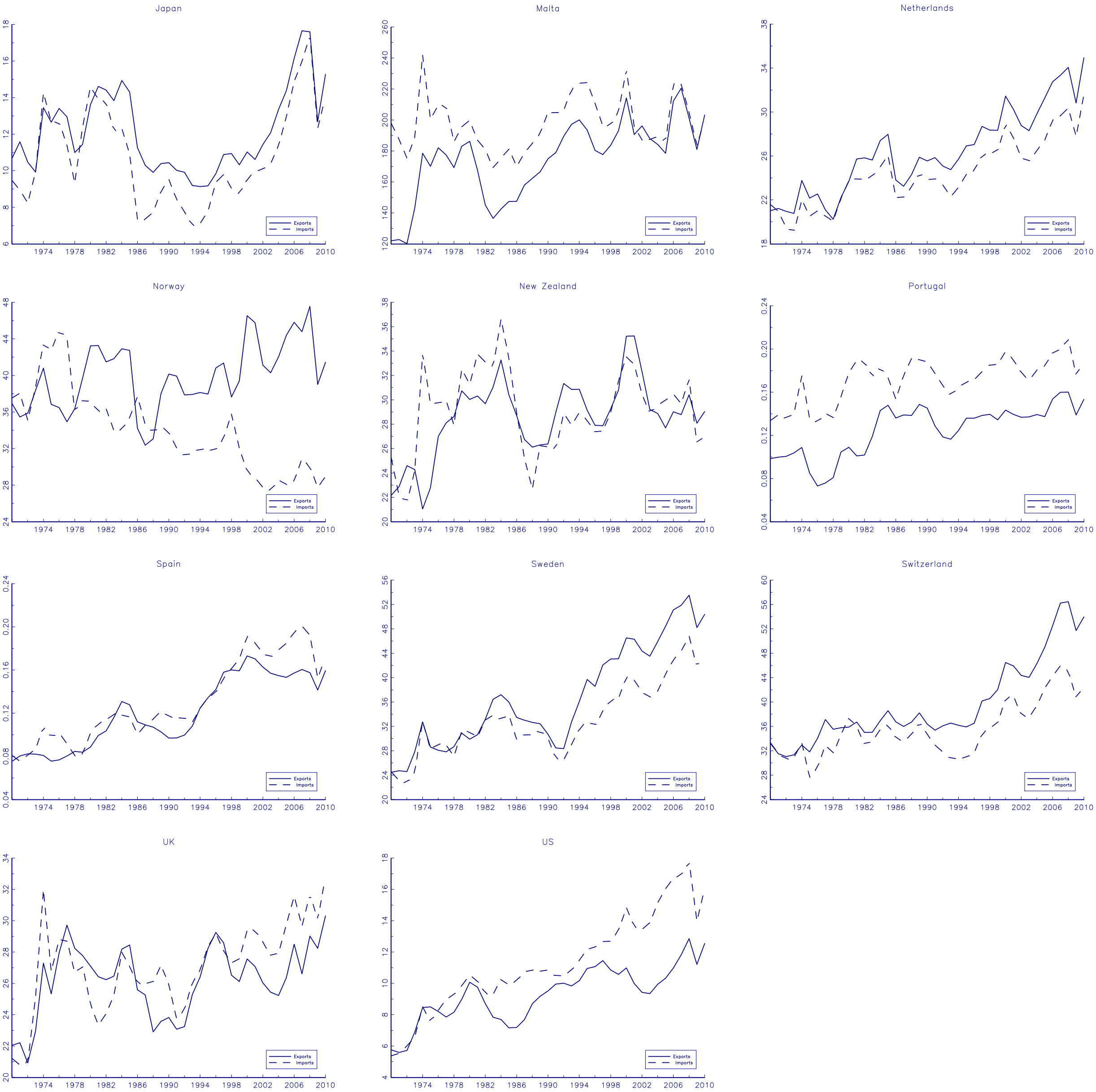

Figure 4 (cont.): Exports and imports over GDP ratios

Table 1: Perron-Yabu test statistics to test the null hypothesis of no structural breaks against the alternative hypothesis of one structural break

	Exports		Imports	
	II	III	II	III
AUS	-0.578	0.015	-0.454	0.195
AUT	-0.102	0.332	-0.465	0.057
BEL	-0.606	-0.073	-0.573	0.012
CAN	1.839**	4.936**	1.196*	2.864**
DEN	-0.535	0.615	-0.399	0.017
FIN	-0.430	0.391	-0.345	0.111
FRA	-0.326	1.006	-0.468	0.212
GER	0.522	0.964	0.010	0.864
GRE	0.629	5.434**	-0.341	1.395
ICE	0.555	1.540	0.749*	1.262
IRE	-0.596	0.229	-0.512	0.137
ITA	-0.501	0.521	-0.492	0.255
JAP	-0.421	0.209	-0.410	0.270
MAL	-0.516	-0.010	-0.619	-0.338
N	-0.520	1.858	-0.457	1.757
NZE	-0.389	0.967	-0.447	0.082
NOR	-0.600	2.193*	-0.636	-0.290
POR	-0.596	0.197	-0.119	19.734**
SPA	-0.566	0.695	-0.601	1.155
SWE	-0.417	0.217	-0.508	-0.040
SWI	5.086**	18.732**	-0.399	0.649
UK	-0.533	0.086	-0.624	-0.322
US	-0.478	0.101	-0.590	-0.383

Notes: The columns labelled as II and III present the results for the specifications defined by Models II and III, respectively, in Perron and Yabu (2009). The critical values at the 5 and 10% levels of significance are, respectively, 1.28 and 0.74 (Model II) and 2.79 and 2.15 (Model III). ** and * denote rejection of the null hypothesis of no structural break at the 5 and 10% levels of significance, respectively

Table 2: M unit root tests of Ng and Perron (2001) and Carrion-i-Silvestre et al. (2009). Exports over GDP

	Z_α	MZ_α	MSB	ADF	P_T	MP_T	MZ_t	$\hat{T}_1$	$\hat{T}_2$	$\hat{T}_3$
AUS	-20.376**	-15.133	0.180	-3.660**	6.003	6.212	-2.718			
AUT	-6.270	-5.517	0.298	-1.867	16.911	16.465	-1.643			
BEL	-20.906**	-15.443	0.180	-3.760**	5.625	5.908	-2.777			
CAN	15.387	15.274	-4.784**	-28.914	-18.261	0.165	-3.022	1982	1991	1999
DEN	-13.212	-10.938	0.214	-2.821	8.168	8.345	-2.336			
FIN	-7.483	-6.704	0.271	-2.026	13.293	13.603	-1.815			
FRA	-11.049	-9.108	0.224	-2.479	10.953	10.350	-2.043			
GER	-4.408	-4.039	0.320	-1.409	20.757	21.088	-1.291			
GRE	13.789	13.546	-3.798*	-21.371	-15.642	0.178	-2.780	1981	1996	
ICE	-5.002	-3.348	0.233	-1.163	21.792	18.880	-0.779			
IRE	-7.178	-6.448	0.272	-1.952	13.791	14.134	-1.753			
ITA	-10.047	-8.657	0.240	-2.411	10.426	10.536	-2.078			
JAP	-8.050	-7.234	0.257	-2.067	12.103	12.667	-1.858			
MAL	-12.323	-10.094	0.222	-2.737	9.495	9.048	-2.242			
NLD	-19.752**	-14.808	0.178	-3.507**	6.479	6.683	-2.629			
NZE	-8.903	-7.502	0.251	-2.238	13.038	12.251	-1.886			
NOR	9.355	9.616	-4.178**	-25.090**	-17.141	0.167	-2.854	1985		
POR	-10.728	-9.271	0.232	-2.490	9.416	9.833	-2.152			
SPA	-6.143	-5.658	0.293	-1.802	15.363	16.054	-1.660			
SWE	-8.810	-7.830	0.252	-2.223	11.117	11.645	-1.976			
SWI	10.284	10.171	-3.928**	-22.337	-16.100	0.176	-2.831	1996	2000	2006
UK	-10.230	-8.660	0.236	-2.413	10.997	10.654	-2.043			
US	-9.683	-8.305	0.244	-2.361	11.185	11.013	-2.025			

Notes: ** denotes rejection of the null hypothesis of unit root at the 5 % level of significance

Table 3: M unit root tests of Ng and Perron (2001) and Carrion-i-Silvestre et al. (2009). Imports over GDP

	Z_α	MZ_α	MSB	ADF	P_T	MP_T	MZ_t	$\hat{T}_1$	$\hat{T}_2$	$\hat{T}_3$
AUS	-16.217	-12.925	0.181	-2.939**	7.786	8.122	-2.342			
AUT	-7.389	-5.677	0.295	-1.628	15.556	16.029	-1.676			
BEL	-18.904**	-14.374	0.187	-3.526**	6.157	6.340	-2.681			
CAN	16.726	16.417	-4.304**	-25.638	-17.418	0.168	-2.924	1981	1991	1999
DEN	-8.547	-7.539	0.255	-2.181	11.866	12.124	-1.924			
FIN	-9.049	-7.919	0.245	-2.220	11.408	11.630	-1.943			
FRA	-14.192	-11.330	0.210	-2.979**	8.489	8.051	-2.378			
GER	-5.524	-5.140	0.292	-1.612	16.501	17.285	-1.500			
GRE	-10.459	-8.474	0.223	-2.329	12.364	11.296	-1.887			
ICE	13.277	12.885	-3.053	-15.193	-12.292	0.201	-2.470	1984		
IRE	-9.824	-8.617	0.238	-2.335	10.165	10.669	-2.048			
ITA	-10.624	-9.117	0.231	-2.453	9.938	10.111	-2.105			
JAP	-7.732	-6.981	0.262	-2.024	12.505	13.100	-1.828			
MAL	-20.972**	-15.455	0.180	-3.771**	5.651	5.900	-2.779			
NET	-19.719**	-14.485	0.177	-3.481**	7.328	7.054	-2.557			
NZE	-13.103	-10.764	0.212	-2.777	8.692	8.652	-2.282			
NOR	-16.225	-12.664	0.198	-3.216**	7.479	7.228	-2.510			
POR	11.536	11.383	-2.925	-14.205	-11.665	0.206	-2.402	1974		
SPA	-11.452	-9.770	0.222	-2.543	9.190	9.502	-2.170			
SWE	-12.749	-10.716	0.214	-2.729	8.199	8.606	-2.294			
SWI	-8.531	-6.808	0.268	-1.753	13.817	13.404	-1.822			
UK	-16.207	-12.653	0.196	-3.182**	7.628	7.370	-2.485			
US	-17.411**	-12.304	0.201	-2.787	7.561	7.435	-2.475			

Notes: ** denotes rejection of the null hypothesis of unit root at the 5 % level of significance

Table 4: Cointegration tests for the relationship between imports and exports

	Engle and Granger (1987)					Gregory and Hansen (1996)						Carrion-i-Silvestre and Sansó (2006)			
					Hansen	Model C			Model C/S			Model An		Model D	
	t-ratio	p-val	N. bias	p-val	$SupF$	ADF	k	$\hat{T}_1$	ADF	k	$\hat{T}_1$	SC^+_{An}	$\hat{T}_1$	SC^+_D	$\hat{T}_1$
AUS	-2.951	0.145	-17.108	0.060	3.590	-4.449*	1	1977	-4.479	1	1977	0.082	1989	0.071	1989
AUT	-4.055	0.014	-22.022	0.015	7.924										
BEL	-2.301	0.386	-9.078	0.377		-3.807	5	1991	-3.962	5	1991	0.091	1993	0.048	1993
CAN	-2.318	0.378	-11.034	0.255		-4.235	5	1990	-4.604	5	1990	0.079	1996	0.098	1985
DEN	-2.080	0.494	-7.672	0.484		-4.681**	3	1986	-5.124**	3	1986	0.118	1986	0.057	1987
FIN	-1.745	0.659	-7.491	0.499		-4.142	0	2004	-3.805	0	2004	0.169*	2001	0.205**	2001
FRA	-1.943	0.563	-8.449	0.423		-3.079	0	2004	-3.091	0	2004	0.096	1979	0.099	1982
GER	-2.100	0.484	-7.886	0.467		-3.842	5	1991	-4.511	4	1986	0.121	1985	0.072	1985
GRE	-2.385	0.347	-10.229	0.301		-4.268	1	1986	-5.402**	2	1987	0.151*	1996	0.108	1994
ICE	-2.518	0.289	-11.062	0.254		-3.051	0	2003	-3.926	0	2003	0.048	1995	0.048	1995
IRE	-2.417	0.333	-10.408	0.291		-3.988	0	1983	-5.187**	0	1983	0.066	1984	0.075	1982
ITA	-2.474	0.308	-12.084	0.204		-3.373	0	2003	-3.382	0	2000	0.123	1976	0.089	1982
JAP	-4.253	0.009	-35.773	0.000	7.442										
MAL	-3.909	0.020	-20.891	0.021	4.149										
NLD	-3.747	0.029	-18.906	0.037	2.108										
NZE	-2.306	0.383	-9.999	0.315		-5.160**	1	1984	-5.082**	1	1984	0.185**	1985	0.101	1985
NOR	-3.449	0.055	-19.057	0.036	4.195	-4.231	3	1985	-4.329	3	1985	0.035	1983	0.040	1984
POR	-3.814	0.025	-28.437	0.002	4.709										
SPA	-3.573	0.043	-25.396	0.005	5.826										
SWE	-3.250	0.083	-17.572	0.053	4.626	-5.190**	3	1990	-4.968**	3	1990	0.072	1983	0.117	1997
SWI	-2.689	0.226	-20.662	0.021	3.100	-4.088	1	1988	-4.397	3	1989	0.073	1991	0.059	1991
UK	-2.175	0.447	-8.603	0.411		-4.056	5	1991	-4.288	5	1991	0.047	1997	0.039	1997
US	-2.858	0.171	-17.164	0.059	2.901	-3.294	5	2003	-3.508	5	1989	0.090	1999	0.095	1999

Notes: The order of the autoregressive correction for the ADF test statistic is selected using the t-sig criterion in Ng and Perron (1995) allowing for a maximum of 5 lags. Columns 7-12 of the table presents the results for the Gregory and Hansen (1996) test statistic. For Model C (change in the level) the critical values at the 5 and 10% levels of significance from Table 1 in Gregory and Hansen (1996) are, respectively, -4.61 and -4.34 for the ADF. For Model C/S (change in the level and the slope) the critical values at the 5 and 10% levels of significance from Table 1 in Gregory and Hansen (1996) are, respectively, -4.95 and -4.68 for the ADF. Columns 13-16 present the cointegration test of Carrion-i-Silvestre and Sansó (2006) allowing for one structural break both under the null hypothesis of cointegration and the alternative hypothesis of no cointegration. In Model An the structural break only affects theh level of the relationship, whereas in Model D it also affects the cointegrating vector. ** and * denote rejection of the null hypothesis of no cointegration at the 5 and 10% levels of significance, respectively

Table 5: DOLS cointegration relationship estimates

	No structural break		One structural break						
			Model An			Model D			
	μ	β_0	μ	θ	β_0	μ	θ	β_0	β_1
AUS	0.01	1.01	-0.04	-0.02	1.36	**-0.07**	**0.02**	**1.58**	**-0.23**
	(0.93)	(14.42)	(-1.94)	(-2.94)	(10.21)	**(-1.76)**	**(0.48)**	**(5.79)**	**(-0.94)**
AUT	**0.01**	**0.74**	0.01	0.00	0.71	-0.01	0.02	1.45	-0.74
	(13.26)	**(41.21)**	(15.18)	(4.03)	(42.19)	(-1.23)	(2.30)	(4.18)	(-2.13)
BEL	0.00	0.74	0.00	-0.00	0.88	**0.00**	**-0.00**	**0.83**	**0.14**
	(7.33)	(25.18)	(2.80)	(-4.94)	(25.07)	**(4.23)**	**(-3.71)**	**(23.33)**	**(2.92)**
CAN	**0.04**	**0.82**	0.08	0.03	0.65	0.11	-0.03	0.51	0.20
	(3.69)	**(27.17)**	(4.59)	(3.00)	(9.78)	(3.12)	(-0.92)	(3.67)	(1.45)
DEN	0.11	0.66	0.05	-0.05	0.90	**0.14**	**-0.19**	**0.60**	**0.40**
	(5.19)	(12.27)	(3.10)	(-6.87)	(18.12)	**(4.56)**	**(-4.99)**	**(6.21)**	**(3.64)**
FRA	0.01	0.80	**0.01**	**0.00**	**0.67**	-0.01	0.02	1.34	-0.62
	(2.62)	(10.74)	**(3.45)**	**(2.13)**	**(7.25)**	(-1.99)	(3.61)	(9.09)	(-3.82)
GER	0.05	0.66	0.04	-0.01	0.74	**-0.01**	**0.04**	**1.17**	**-0.46**
	(10.04)	(20.67)	(10.56)	(-4.23)	(22.52)	**(-0.56)**	**(3.73)**	**(12.78)**	**(-4.86)**
GRE	0.00	1.21	0.00	0.00	0.60	**0.00**	**-0.00**	**0.62**	**0.70**
	(2.60)	(11.55)	(6.49)	(7.40)	(4.58)	**(7.17)**	**(-2.80)**	**(5.40)**	**(3.92)**
ICE	-0.18	1.53	-0.41	0.05	2.14	**-0.41**	**0.33**	**2.13**	**-0.79**
	(-1.57)	(4.91)	(-3.82)	(4.94)	(7.10)	**(-3.96)**	**(2.15)**	**(7.40)**	**(-1.85)**
IRE	0.32	0.54	**0.25**	**-0.13**	**0.74**	-0.09	0.27	1.40	-0.72
	(10.78)	(15.17)	**(10.38)**	**(-6.11)**	**(17.99)**	(-1.09)	(3.18)	(9.46)	(-4.79)
ITA	0.00	0.88	**0.00**	**-0.00**	**1.08**	0.00	-0.00	-0.07	1.23
	(1.04)	(9.76)	**(0.70)**	**(-3.93)**	**(11.37)**	(3.37)	(-3.87)	(-0.21)	(3.55)
JAP	**-0.01**	**0.97**	0.02	-0.02	0.78	0.03	-0.02	0.69	0.06
	(-1.12)	**(11.28)**	(3.15)	(-8.95)	(14.03)	(1.75)	(-1.34)	(4.70)	(0.47)
MAL	**1.13**	**0.47**	0.85	-0.13	0.66	0.85	-0.21	0.65	0.04
	(8.44)	**(6.27)**	(5.89)	(-3.41)	(7.69)	(5.62)	(-0.49)	(7.23)	(0.19)
NET	**0.04**	**0.77**	0.04	0.01	0.73	0.01	0.04	0.88	-0.15
	(6.85)	**(34.12)**	(7.77)	(3.68)	(31.37)	(0.22)	(1.01)	(4.64)	(-0.80)
NZE	0.10	0.65	0.11	-0.04	0.74	**0.22**	**-0.36**	**0.40**	**1.06**
	(2.31)	(4.20)	(2.44)	(-4.70)	(4.57)	**(5.19)**	**(-4.92)**	**(2.67)**	**(4.35)**
NOR	0.71	-0.93	0.70	-0.06	-0.79	**0.87**	**-0.21**	**-1.22**	**0.37**
	(8.50)	(-4.46)	(12.49)	(-7.88)	(-5.57)	**(9.40)**	**(-2.21)**	**(-5.22)**	**(1.54)**
POR	**0.00**	**0.69**	0.00	-0.00	1.18	0.00	0.00	1.66	-0.60
	(7.54)	**(7.78)**	(2.44)	(-3.19)	(5.55)	(0.12)	(0.88)	(5.09)	(-1.90)
SPA	**-0.00**	**1.15**	0.00	0.00	0.78	-0.00	0.00	3.08	-1.82
	(-0.53)	**(19.40)**	(2.77)	(3.90)	(6.92)	(-0.78)	(0.68)	(1.38)	(-0.82)
SWE	0.09	0.67	**0.08**	**-0.03**	**0.74**	0.20	-0.16	0.32	0.43
	(8.38)	(23.79)	**(8.94)**	**(-5.47)**	**(24.46)**	(8.46)	(-3.45)	(4.31)	(4.07)
SWI	0.12	0.59	0.08	-0.02	0.71	**0.04**	**0.02**	**0.83**	**-0.13**
	(7.54)	(14.64)	(5.09)	(-3.90)	(15.38)	**(0.80)**	**(0.44)**	**(5.74)**	**(-0.89)**
UK	0.06	0.81	0.18	0.03	0.30	**0.19**	**-0.05**	**0.26**	**0.28**
	(1.59)	(5.79)	(5.54)	(6.81)	(2.40)	**(5.63)**	**(-0.68)**	**(1.97)**	**(1.10)**
US	-0.04	1.74	**-0.00**	**0.03**	**1.17**	0.00	-0.07	1.15	0.92
	(-2.75)	(10.15)	**(-0.05)**	**(7.39)**	**(8.58)**	(0.16)	(-2.57)	(9.93)	(3.65)

Notes: t-ratio test statistics between parentheses. The number of leads and lags that is used in the DOLS estimation is selected using the BIC information criterion for all possible combinations of models that results from the definition of the following maximum number of lags and leads $k_{lags}^{max} = k_{leads}^{max} = 3$.

Table 6: Berenguer-Rico and Carrion-i-Silvestre ADF multicointegration test statistic with and without structural breaks

	No break		One break			Two breaks			
	ADF	k	ADF	k	$\hat{T}_1$	ADF	k	$\hat{T}_1$	$\hat{T}_2$
AUS	-3.268	1	-4.485	1	1980	-5.817	1	1979	1994
AUT	-5.177**	4	-5.135	5	2003	-6.571	1	1977	1989
BEL	-3.433	5	-5.166	2	1985	-6.495	5	1987	2004
CAN	-3.020	1	-6.005	5	1990	-6.997	5	1978	1989
DEN	-2.408	1	-5.422	3	1987	-6.781	3	1981	1988
FIN	-2.664	2	-4.334	5	1988	-7.845	3	1985	2003
FRA	-2.444	0	-4.791	0	1994	-7.443	2	1990	2001
GER	-2.833	1	-6.197	4	1986	-6.933	1	1982	1998
GRE	-2.955	5	-6.044	1	1986	-6.532	1	1976	1998
ICE	-3.189	1	-5.094	1	1998	-5.671	1	1983	2001
IRE	-2.313	1	-4.875	5	1993	-7.471	2	1982	1995
ITA	-1.438	0	-5.819	1	1992	-7.112	1	1981	1998
JAP	-2.859	1	-5.272	0	1985	-8.304*	1	1980	2000
MAL	-2.271	1	-4.207	1	1988	-7.833	1	1985	1998
NLD	-4.499	1	-7.535**	3	1986	-7.187	3	1977	1984
NZE	-2.467	1	-5.561	1	1990	-9.560**	3	1986	1997
NOR	-2.540	5	-6.285	1	1983	-7.294	3	1986	2000
POR	-5.585**	1	-7.613**	1	1986	-8.238*	1	1986	2004
SPA	-2.797	1	-5.098	1	2001	-9.439**	3	1988	2002
SWE	-2.389	5	-5.050	5	1992	-6.280	1	1982	1999
SWI	-2.644	1	-4.341	1	1987	-6.220	1	1984	1995
UK	-1.196	1	-5.308	1	1997	-6.513	1	1982	2000
US	-4.296	1	-4.345	1	1975	-5.924	1	1986	1997

Notes: The order of the autoregressive correction for the ADF test statistic is selected using the t-sig criterion in Ng and Perron (1995) allowing for a maximum of 5 lags. The critical values at the 5 and 10% levels of significance are, respectively, -5.17 and -4.79 for the no break case, -6.97 and -6.65 for the one structural break case, and -8.33 and -7.95 for the two structural breaks case (obtained by simulation). ** and * denote rejection of the null hypothesis of no cointegration at the 5 and 10% levels of significance, respectively

Table 7: DOLS estimation of the multicointegration relationship

	μ	ξ	θ_1	γ_1	θ_2	γ_2	δ_0	β_0	δ_1	β_1	δ_2	β_2	$\hat{T}_1$	$\hat{T}_2$
AUT	-0.02	0.01					0.43	0.70						
	(-4.19)	(22.78)					(2.48)	(45.45)						
JAP	-0.20	0.06	-0.70	-0.07	-1.25	-0.04	1.13	0.50	-0.16	0.45	-2.16	0.42	1982	2000
	(-16.58)	(7.34)	(-7.44)	(-8.90)	(-16.91)	(-14.71)	(14.29)	(7.96)	(-2.17)	(7.24)	(-11.68)	(18.79)		
NET	-0.03	0.31	-2.52	-0.27			-0.04	-0.44	-0.56	1.23			1979	
	(-0.51)	(5.49)	(-4.76)	(-4.80)			(-0.15)	(-1.73)	(-2.33)	(4.80)				
NZE	0.09	1.05	-7.49	-1.33	8.27	0.40	-0.71	-3.39	0.67	5.38	0.11	-1.40	1975	1991
	(0.38)	(3.53)	(-4.60)	(-4.43)	(6.98)	(6.58)	(-0.73)	(-2.65)	(0.65)	(4.18)	(0.28)	(-6.88)		
POR	-0.00	0.00					0.71	0.65						
	(-4.75)	(19.86)					(2.65)	(18.83)						
	-0.00	0.00	0.00	-0.00			-0.20	1.12	0.05	-0.07			1980	
	(-1.34)	(1.18)	(0.37)	(-0.24)			(-0.45)	(2.61)	(0.10)	(-0.16)				
	-0.00	0.00	0.01	0.00	-0.02	-0.00	-0.17	0.67	-0.29	-0.82	-0.12	1.33	1978	1985
	(-0.74)	(3.72)	(2.88)	(3.72)	(-5.62)	(-6.12)	(-0.42)	(2.64)	(-0.47)	(-2.57)	(-0.20)	(4.76)		
SPA	0.00	0.00	-0.00	-0.00	-0.16	-0.01	-0.00	0.81	-1.33	0.22	-1.81	4.14	1987	2004
	(0.46)	(2.86)	(-2.94)	(-1.80)	(-5.33)	(-5.23)	(-0.00)	(9.06)	(-4.65)	(4.36)	(-2.77)	(5.30)		

Notes: The number of leads and lags that is used in the DOLS estimation is selected using the BIC information criterion for all possible combinations of models that results from the definition of the following maximum number of lags and leads $k_{lags}^{max} = k_{leads}^{max} = [4 * (T/100)^{1/4}]$. The estimated break points are obtained through the minimization of the sum of squared residuals over all possible combinations of break dates.