# Twin Deficits, Real Interest Rates and International Capital Mobility

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**Abstract**

We argue that the interactions among the current account and budget balances and the real interest rate can provide more information about the effective degree of financial openness of an economy than simple saving-investment correlations. Cointegration tests reveal a variety of linkages between the variables across countries. A number of economies (Canada, Germany, Netherlands, and increasingly the UK) appear to be small and open, while Japan and the USA are effectively closed. The "twin deficits" and "current account targeting" hypotheses receive some support in the short run.

**Keywords:** International capital mobility, twin deficits, real interest rates.

**JEL Classification numbers:** F36, F41.

# 1. Introduction

Much of the literature attempting to assess the extent of international capital mobility has followed the saving-investment correlation approach initiated by Feldstein and Horioka (1980). Despite institutional developments (financial market liberalisation, lifting of capital controls) which have made capital more internationally mobile across the industrialised world in the last 20 years (see e.g. Grilli and Milesi-Ferretti, 1995; Mathieson and Rojas-Suarez, 1994), the Feldstein-Horioka findings of a high correlation suggest limited financial integration, giving rise to the "Feldstein-Horioka" puzzle.[1] The interpretation of such findings, however, has been widely questioned on the grounds that, in theoretical intertemporally-optimising models, saving and investment are likely to be correlated even in open economy models (Baxter and Crucini, 1993; Razin, 1995). It is also argued that the absence of any natural threshold magnitude of the correlation mars the interpretation of the results with inherent ambiguity (Taylor, 1997).

To overcome such criticism, Argimon and Roldan (1994) focuses on the causal relation between national and sectoral (public - private) saving and investment rates. The underlying rationale is very much in the spirit of the original Feldstein-Horioka argument but bypasses the ambiguities mentioned above: In closed economies, developments in saving determine investment, while in open economies the reverse causal ordering should hold. Argimon and Roldan (1994) find that in most countries in their sample, saving causes investment and the current account does not elicit any response by the government budget deficit; they interpret those results as signs of closed economies and of employment of policies other than fiscal (e.g., monetary policy and capital controls) in dealing with the external (im)balance.[2]

[1] Those findings have been corroborated by a large subsequent amount of literature. Obstfeld (1986, 1995) and Coakley, Kulasi and Smith (1998) provide good surveys.

[2] Testing for causality as a means of characterising economic openness has also been followed by Tsoukis and Alyousha (forthcoming) with mixed results.

An obvious problem with the causality approach is the lack of cointegration.[3] Although saving and investment should cointegrate in the very long run to ensure external solvency (Trehan and Walsh, 1991; Coakley, Kulasi and Smith, 1996), this may be difficult to uncover in available samples. In the medium term, missing variables like the budget deficit and the real interest rate may plausibly drive the current account. Those can therefore be used to shed additional light on the issue of financial openness. The role of the former has been highlighted in the literature on the "twin deficits" (see e.g. Abell, 1990; Kearney and Monadjemi, 1990; and Kasa, 1994, as well as the Argimon-Roldan approach) which suggests that the budget deficit may be a major influence on the external deficit. Against that, Ricardian equivalence implies the absence of any relationship between the two while the "current account targeting" hypothesis (Summers, 1988) would argue for reverse causality. The role of the interest rate is emphasised in Abell (1990) as a mediating mechanism between the two deficits. The real interest rate may also be particularly important as an indicator of the actual (as opposed to institutional) degree of openness. In a small open economy, the real interest rate is exogenous and therefore long-run causality is expected to run from it to the current account; whilst, in a large economy the loanable funds market clears and the real interest rate is determined by the deficit. A third important variable may be the real exchange rate; that is expected to be endogenous in the long run, however, at least because of full price flexibility.

In this paper, we investigate cointegration and the causal ordering between the current account, the budget surplus (both as ratios over GDP) and the real interest rate in a sample of industrialised economies for the post-war era. Our objective is to offer quantitative information on the extent of international capital mobility. Following the lead of Argimon and Roldan (1994), we employ causality tests that bypass the ambiguities associated with simple saving-investment correlations. The choice of variables is dictated by the foregoing discussion: The interactions between the current account (as the mirror image of the capital account, or excess supply of loanable funds) and the real interest rate offers additional information on openness. The structure of the paper is as follows:

[3] For instance, in Argimon and Roldan (1994), 4/9 countries show no saving-investment cointegration; a

Section 2 provides a theoretical basis for our empirical analysis and section 3 presents our empirical findings and interpretation. Finally, section 4 concludes.

## 2. Theoretical considerations

The relationship between the twin deficits, i.e., the fiscal deficit and the current account deficit, can be analyzed using the following national accounts identity:

$$CA = GNP\text{-}C\text{-}G\text{-}I \equiv S\text{-}I = (S^P\text{-}I^P) + (T\text{-}G) \qquad (1)$$

CA stands for the current account balance given by the difference between GNP and domestic absorption, the sum of consumers' expenditure C, total investment I and government expenditure G, or else the difference between total domestic saving S and investment. We follow the usual practice of utilising the CA as an indicator of capital mobility, since it is the "mirror image" of the capital account of the balance of payments (see e.g. Ghosh, 1995; Obstfeld and Rogoff, 1996). The S-I difference can then be broken down into the two sectoral balances, the private one (indicated by the superscripts P) and the government budget surplus (tax revenue T minus government spending G). With its elements expressed as ratios over GDP (Y), and pointing out the dependence of S and I on the real interest rate R, the last equality of (1) becomes:

$$CAY = SPY(R) - IPY(R) + SURY, \qquad (2)$$

$$CAY \equiv CA/Y,\ SPY \equiv S^P/Y,\ IPY \equiv I^P/Y,\ SURY \equiv (T\text{-}G)/Y.$$

With the saving and investment ratios representing behavioural relationships, (2) implies a long-run equilibrium relationship between the current account-to-income ratio, the fiscal surplus-to-income ratio and the real interest rate.

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similar finding is reported in Alyousha and Tsoukis (2000).

The Feldstein-Horioka approach is to investigate openness based on the simple correlation between SPY and IPY in (2), disregarding the effects of SURY or indeed R on either: In closed economies, where the availability of saving determines investment, the correlation should be close to unity. On the other hand, in open economies, investment is financed by the world pool of loanable funds, so that the correlation should tend to zero. Argimon and Roldan (1994) focus on causality tests between the same variables. While following the same method of cointegration/causality, our analysis above suggests that full investigation of causality among CAY, R and SURY may more richly characterise financial openness. Despite its simplicity, (2) allows us to formulate a number of hypotheses.

The "twin deficits" hypothesis recognises the role of the budget deficit in the context of (2) and implies a cause-and-effect relationship from SURY to CAY, given net private savings. The theoretical predictions regarding this hypothesis vary widely. In the Mundell-Fleming model under flexible exchange rates and perfect capital mobility, a fiscal expansion leads to a domestic-currency appreciation and a deterioration of the current account balance, hence the term "twin deficits". Imperfect asset substitutability is however a complicating factor and its recognition by the portfolio balance model leads to predictions of short-run and long-run effects of fiscal policy on the current account that may differ from those of Mundell-Fleming. Furthermore, wealth effects and wage and price inertia represent additional factors that will contribute to a deviation from the twin-deficit hypothesis (Marston, 1985). In contrast to vintage *ad hoc* models of the open economy, the optimizing models of the open economy explicitly take account of the nature of the fiscal expansion (i.e. temporary vs. permanent) in considering its effects on the current account and their consistency or not with the "twin-deficit" hypothesis; see e.g. Razin (1995); Obstfeld and Rogoff (1996).

A simple but powerful argument against "twin deficits" is, of course, provided by Ricardian equivalence which suggests that developments in SURY crowd out SPY one-

for-one, so that CAY=SPY+SURY-IPY is unaffected. [4] Reasoning in the Feldstein-Horioka vein on the other hand suggests that the shocks to SURY+SPY are matched by IPY in closed economies, so again the current account is unaffected. One may conclude that necessary conditions for "twin deficits" to emerge is the absence of Ricardian equivalence *and* financial openness. Any finding of twin deficits, therefore, must be interpreted as an indirect sign of financial openness.

Ultimately, the hypothesis needs to be resolved empirically. Evidence in its favour is offered by Abell (1990) and Kasa (1994), among others, while Friedman (2000) and Ahmed and Rogers (1995), for instance, are more sceptical. At the same time, as the work of Kearney and Monadjemi (1990) and Argimon and Roldan (1994) emphatically points out, there may be reverse causality between the two. This will, for instance, be the case if governments utilise their fiscal stance to target the current account via (2) (Summers, 1988). Though implying the opposite causal order to "twin deficits", current account targeting may also be interpreted as a sign of an open economy, since it also implies that the external balance is ultimately affected by the budget. Thus, the degree of causal link between the two balances, of whatever direction, is a measure of financial openness.

Our discussion of openness may be supplemented by the relation of the current account to the real interest rate, given an exogenous surplus. We can use the simple framework of Coakley *et al.* (1996) to illustrate its implications for causality. Accordingly, let the current account ratio of country j be a linear function of R:

$$CAY_{j,t} = \alpha_j + \beta R_{j,t} + \sum_i \phi^i \varepsilon_{j,t-i} \qquad (3)$$

where $\alpha_j<0$, $\beta$ and $0<\phi<1$ are parameters (the former subsuming the exogenous budget surplus). The geometric sum at the RHS captures all the primitive shocks (productivity

[4] Deficits induced from the tax side leave the consumption behaviour of the private sector unaltered and, by (2), should not show up in the current account. On the other hand, private agents realize that deficits generated by bigger spending show up as increased lifetime tax burden and reduced private resources, in which case they cut consumption commensurately. The result again is that the LHS of (2) is unaltered.

and spending) affecting the current account. (In the diagrammatic representation of the "scissors" of IPY(R) and SPY(R), the $\varepsilon_{t-i}$'s would be exogenous shifts of the schedules.) In a closed economy, $CAY_{j,t}=0$ for all j and t, implying:

$$R_{j,t} = \frac{-\alpha_j - \sum_i \phi^i \varepsilon_{j,t-i}}{\beta} \qquad (4a)$$

In this case, the exogenous process generating the current account also determines the real interest rate and causality runs from the former to the latter. In contrast, in open economies, there is a common real interest rate that clears the global market for (flow) loanable funds, implying:

$$R_{j,t} = R_t, \quad \forall j, \qquad R_t = \frac{-\sum_j \alpha_j - \sum_i \sum_j \phi^i \varepsilon_{j,t-i}}{\beta} \qquad (4b)$$

Hence, the real interest rate is determined by processes generated largely elsewhere, and therefore causes individual-country current accounts via (3).

Consequently, the real interest rate will be exogenous for small open economies, but will be caused by current account developments in large, nearly closed economies. The real interest rate can provide additional information when the budget surplus is present: For example, cointegration and causality from the budget deficit to the interest rate would imply that the domestic saving market clears and that the budget deficit crowds out private saving via the interest rate as befits a closed economy. [5] Causality from the real interest rate to the surplus may be interpreted as evidence of fiscal stabilisation policy at work with the real interest rate as the target variable.

[5] Note that Dwyer's (1985) "capital inflow" hypothesis, advanced to explain the US experience of the 1980s, suggests openness, in that a budget deficit is paired with capital inflow and an external imbalance; and, at the same time, it indicates a large economy which can affect the world real interest rate. Both

## 3. Empirical evidence

Based on the above analysis, we proceed to examine empirically the interrelationship between the external and budget balances and the real interest rate for 7 industrialised economies with post-war quarterly data.[6] Our dual aim is to characterise the interaction between the two balances and to find evidence on the degree of effective openness of the economies during the sample period. The sample of countries is representative in the sense that they range from small open economies to larger ones like the USA or Japan. The series used in the construction of our variables were obtained from the IMF *International Financial Statistics*.[7] After examination of the order of integration of the series (current account ratio CAY, budget surplus ratio SURY and real interest rate R), we examine both the long-run (cointegrating) relationships and associated causal ordering and the short-run interactions among the variables in question.

The empirical results are reported in Tables 1-5; instead of presenting them by Table, we comment on the full picture by country later on. Orders of integration are given in Table 1. In a number of cases, the current account ratio is an I(1) variable, possibly suggesting that external solvency is violated (see above). However, this result may alternatively be due to the finiteness of our sample. In all cases except Germany, two variables are I(1), allowing us to search for cointegration based on Johansen's (1988, 1991) test. Note however, that the relevant pairs vary from case to case. Table 2 gives the cointegration results, established for all cases except Australia. Table 3 lists the cointegrating vectors.

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elements can in principle be picked up in our framework, which can characterise experiences in a richer way than the "open-closed" continuum of the Feldstein-Horioka-type correlations.

[6] The countries are Australia (AU), Canada (CA), Germany (GE), Japan (JA), the Netherlands (NL), the United Kingdom (UK) and the United States (USA). The sample periods are indicated in Table 3. For Germany, the sample was restricted only to end of 1989 since there is evidence of a structural break in the saving ratio during 1990 following the reunification; the graph is available on request.

[7] The series were nominal interest rate 60, budget deficit 80, private consumption c (line 96f), government consumption g (91f), investment i (gross fixed capital formation 93e+change in stocks 93i), nominal and constant-price GDP (99b & 99b.c) and GNP (99a). Then DEFL≡99b/99b.c, CAY≡(GNP-c-g-i)/GDP, SURY≡80/GDP and R≡60(series)/400-(DEFL-DEFL(-4))/(4*DEFL(-4)). The US data are given slightly differently as government consumption+fixed capital formation (91ff) and private fixed capital formation (93ee). The data is seasonally adjusted at source.

Toda and Phillips (1994) discuss the equivalence between long run causality and weak exogeneity. This is examined by testing whether the loading coefficients in the Error Correction Model (ECM) for each equation is 0 (Urbain, 1992).[8] The results are reported in Table 4. Finally, short-run (Granger) causality is tested by looking at the block significance of the off-diagonal elements of the lag polynomials in the Vector ECM form of the VAR (Table 5).

A variety of cointegrating pairs and long/short run causal ordering emerges from these Tables, as was expected in view of the diversified nature of our sample. The results for Australia indicate no long-run cointegrating relationship. In addition, the Granger-causality tests show no short-run relationship among the three variables. Therefore, our model does not allow us to derive any conclusions regarding the openness of the economy. Moreover, it seems that there is no evidence supporting the twin-deficit hypothesis.

Canada shows cointegration of the budget surplus with the real interest rate: Their relationship is negative, being in principle consistent with either the budget deficit exerting a positive effect on the real interest rate through the demand for loanable funds, or the interest rate increasing interest payments and the deficit. The exogeneity test shows long-run causality going from the real interest rate to the surplus, supporting the latter hypothesis. This fact, together with the current account ratio exclusion from the vector (since it is I(0)), is (indirect) evidence mainly of a small open economy, since the domestic variables primarily are influenced by the real interest rate, rather than the opposite. In the short run, there is some evidence of reverse causality and current account targeting, insofar as the differenced current account emerges as significant in the ECM for the budget surplus.

Since no cointegration is evident in Germany, only short-run Granger causality could be examined. The single notable fact is that the budget surplus (mildly) and the real interest

[8] The full ECMs will not be shown for economy of space. The results are available on request and will be

rate (quite strongly) influence the current account. However, in the case of budget surplus or real interest rate equations, none of the other variables makes any significant contribution. There is thus consistent short-run evidence of an open economy, whose current account is determined by the exogenous world interest rate developments, and with a twin deficit which adds further weight to the evidence of openness, as suggested above.

The results for Japan imply a positive long-run association between the fiscal surplus and the real interest rate; the positive sign of the relation may be interpreted as fiscal stabilisation whereby the budget deficit is reduced (surplus increased) in order to bring the real interest rate down. The weak exogeneity tests show that there is bidirectional long-run causality between the two variables. A somewhat different type of causality applies in the short run, as shown by the Granger-causality tests of Table 5: It is evident that the real interest rate is caused mainly by the current account and it causes the fiscal surplus ratio. Hence, these results offer mixed evidence on the degree of financial openness of the Japanese economy. The signs of fiscal stabilisation and short-run current account influences on the real interest rate may be interpreted as signs of a large, rather insular financially economy. According to Granger-causality tests, there is no evidence supporting the twin-deficit hypothesis or the current account targeting hypothesis.

In the case of the Netherlands, it is the two balances that are related in the long term. As argued above, this relation is *prima facie* evidence of openness. While long-run causality goes from the budget surplus to the current account, the cointegrating vector implies a negative long-run relationship, which is consistent with current account targeting. The differenced SURY enters very strongly and positively the ECM for CAY, lending support to the twin deficit hypothesis in the short run. The real interest rate does not significantly enter either ECM, but the opposite is equally true: Neither CAY nor SURY influence R which then appears exogenous both on these grounds and on the fact that its nature (I(0)) is very different to the other two variables. Hence, Netherlands shows signs

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commented upon in the text.

of capital market openness; more cautiously, one may also suggest that the budget balance affects the external balance, so much so that the budget surplus is used as an instrument for current account targeting.

The UK experience is rather different: The sign of the cointegrating vector over CAY and R suggests that the influence runs from the latter to the former – one may think of the textbook "scissors" diagram of saving and investment against the real interest rate. The exogeneity test, however, suggests there is bi-directional long-run causality, with the somewhat stronger influence being that of the current account on the interest rate. A wealth of short-run interactions is also evident from Table 5, with both balances affecting each other and collectively the interest rate. Thus, over the whole sample, the UK gives mixed evidence as to financial market integration, showing less openness than may be justified by its size and lead in financial market liberalisation (see below). One may interpret this finding as showing that because London is a strong financial hub internationally, domestic saving market development unusually affected real interest rates in the UK.

However, further scrutiny of the UK case is desirable: The UK has been among the pioneers of lifting international capital controls and of financial market liberalisation, starting from the late 1970s. A Chow test of the same ECM for R run over 1972Q4-1984Q4 indicated structural instability; the same ECM for the remainder of the sample (1985Q1-1998Q1) when liberalisation was well under way, reduced the t-statistic of the EC term in the equation of R to 1.89, down from 3.21 and significant only at 10%. Hence, there are signs that towards the end of the sample period, the UK developed more into a small open economy in integrated international financial markets.

The cointegration tests for the US show a long-run association between the two ratios and the real interest rate. The signs in the cointegration vector are consistent with a number of hypotheses, namely twin-deficits, interest rates affecting the budget surplus, and a direct positive relation between real interest rates and the current account. However, the twin

deficits hypothesis is not supported by the insignificant negative coefficient in the current account equation of the ECM; it is not supported in the short run either, as shown by the insignificance of the lagged SURY terms in the CAY equation in Table 5. Based on the significance of the ECT in the interest rate equation and budget surplus equations, we conclude with the classification of the US as a closed economy and one where either of current account and real interest rate targeting is pursued by the fiscal balance. The last conclusion is also evident in the short run.

## 4. Conclusions

The aim of this paper is to quantitatively examine international capital mobility in a group of 7 industrialised countries in the post-war era. We argue that interactions among the triplet of variables, current account ratio, budget surplus ratio and the real interest rate, may offer richer information on the degree of international capital mobility than simply examining the relation between saving and investment, as has mainly happened so far. Our method of work is to examine causal relationships, as suggested by Argimon and Roldan (1994) as a way of avoiding the weaknesses of Feldstein-Horioka-type correlations. Thus, our contribution is to offer evidence on financial openness and evaluate it based on a unified discussion of hitherto rather disparate theoretical arguments.

These arguments are formalised via a number of well-known hypotheses which are also interesting in themselves. The "twin deficits" hypothesis would imply a causal ordering from the budget deficit to the external deficit, while the "current account targeting hypothesis" (Summers, 1988) argues that external adjustments may be sought via fiscal policy, in which case reverse causality prevails. We argued that each of the above gives indications of financial openness. The link between the two balances would be entirely denied by Ricardian equivalence and, perhaps more plausibly, in an effectively closed economy. Furthermore, the interactions between the two balances, primarily the external one, and the real interest rate may reveal the extent to which the country in question is effectively integrated in world financial markets. In a closed economy, the real interest rate

is domestically determined by the need to clear the (flow) market for loanable funds, while in an open one, it is given exogenously. This insight is essentially an extension of the original one by Feldstein and Horioka (1980). Accordingly, causality runs from the current account and secondarily the budget surplus to the real interest rate in a closed economy, while the opposite holds true in an open economy.

We examined these hypotheses by establishing cointegration among the I(1) variables and examining the causal ordering among them in the short and long runs. As expected by the nature of our industrialised country sample, a variety of experiences shows up in our results. A number of economies emerge as fairly open, notable Canada, Germany and the Netherlands, while the UK showed signs of progressively becoming more integrated in financial markets later on. Signs of being large and more financially closed economies were present for Japan and the USA; both are able to affect their real interest rates by domestic fiscal policies and have actually pursued such policies during the sample period; the US also shows signs of current account targeting. The "twin deficits" hypothesis is upheld only in the cases of Germany and the UK and only in the short run. Note, however, that the "opposite" hypothesis of current account targeting carries some weight in the case of Canada in the short run. Finally, regarding the relation between the two balances, the Netherlands presents a puzzle: There is some evidence consistent with current account targeting according to the sign of the cointegrating vector, a result not supported by the long-run exogeneity tests.

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## Table 1: ADF tests

| Country | Variable | Trend? | Lag | t-stat | result |
|---|---|---|---|---|---|
| Australia | CAY | N | 0 | -2.87 | I(1) |
| | SURY | N | 4 | -2.35 | I(1) |
| | R | N | 4 | -1.30 | I(1) |
| Canada | CAY | N | 0 | -3.17 | I(0) |
| | SURY | N | 4 | -2.30 | I(1) |
| | R | N | 4 | -2.12 | I(1) |
| Germany | CAY | N | 0 | -3.40 | I(0) |
| | SURY | N | 4 | -3.13 | I(0) |
| | R | N | 3 | -4.05 | I(0) |
| Japan | CAY | N | 1 | -3.51 | I(0) |
| | SURY | Y | 3 | -3.28 | I(1) |
| | R | Y | 4 | -2.84 | I(1) |
| Netherlands | CAY | Y | 4 | -3.02 | I(1) |
| | SURY | Y | 3 | -2.41 | I(1) |
| | R | N | 0 | -9.06 | I(0) |
| UK | CAY | N | 1 | -2.64 | I(1) |
| | SURY | N | 4 | -3.11 | I(0) |
| | R | N | 4 | -1.26 | I(1) |
| USA | CAY | N | 0 | -2.40 | I(1) |
| | SURY | N | 4 | -2.19 | I(1) |
| | R | N | 4 | -2.64 | I(1) |

Notes: Critical value with a deterministic trend: -3.46; without a trend: -2.88. The lag length was determined by the significance of the longest lag, testing down from a maximum of 4.

## Table 2: Cointegration results

| Country | VAR length | Max Eigen. stat | Trace stat | No. of vectors |
|---|---|---|---|---|
| Australia | 4 | 17.60 | 25.71 | 0 |
| Canada | 2 | 13.85* | 21.23** | 1 |
| Germany | 4 | - | - | 0 |
| Japan | 4 | 21.97** | 24.79** | 1 |
| Netherlands | 4 | 17.87* | 23.17* | 1 |
| UK | 6 | 15.77* | 18.46* | 1 |
| USA | 6 | 23.01** | 33.26** | 1 |

Notes: The VAR length was determined by the Adjusted LR test. ** indicates significance at the 5% level and * significance at the 10% level.

## Table 3: Cointegrating vectors

| | AU | CA | GE | JA | NL | UK | USA |
|---|---|---|---|---|---|---|---|
| CONST | | 0.01 | | | | 0.03 | |
| TREND | | | | | -0.001 | | |
| CAY | | | | | 1.00 | 1.00 | 1.00 |
| SURY | NA | 1.00 | NA | 1.00 | 0.003 | | -36.59 |
| R | | 0.28 | | -1.06 | | -0.63 | -18.11 |
| Sample | 1960Q3 | 1977Q3 | 1966Q1 | 1958Q4 | 1978Q1 | 1972Q4 | 1969Q3 |
| | 1997Q2 | 1995Q3 | 1989Q4 | 1997Q3 | 1998Q1 | 1998Q1 | 1998Q1 |

## Table 4: Weak exogeneity

| Country | CAY | SURY | R |
|---|---|---|---|
| AU | NA | NA | NA |
| CA | NA | -0.39** (3.65) | -0.20 (1.49) |
| GE | NA | NA | NA |
| JA | NA | -0.35** (2.90) | 0.18** (2.09) |
| NL | -0.60** (3.92) | -66.74 (1.27) | NA |
| UK | -0.10** (2.20) | NA | 0.07** (3.21) |
| USA | -0.001 (0.35) | 0.007** (3.02) | 0.005** (2.44) |

Notes: Shown are the coefficients and the absolute t-statistics (in parentheses) of the Error Correction Term in the relevant equation. ** indicates significance at the 5% level; * significance at the 10% level.

# Table 5: Granger causality tests

| | Variable | CAY | | SURY | | R | |
|---|---|---|---|---|---|---|---|
| | | LR | F(p, n-k) | LR | F(p, n-k) | LR | F(p, n-k) |
| AU | CAY I(1) | | | 0.50 | 0.15 | 2.51 | 0.77 |
| | SURY I(1) | 0.69 | 0.21 | | | 4.45 | 1.36 |
| | R I(1) | 1.84 | 0.56 | 1.44 | 0.44 | | |
| CA | CAY I(0) | | | 0.00 | 0.00 | 1.29 | 1.23 |
| | SURY I(1) | 5.54** | 5.49** | | | 2.01 | 1.93 |
| | R I(1) | 0.87 | 0.83 | 0.21 | 0.20 | | |
| GE | CAY I(0) | | | 9.12* | 2.04* | 14.31** | 3.31** |
| | SURY I(0) | 4.67 | 1.02 | | | 1.35 | 0.29 |
| | R I(0) | 5.14 | 1.13 | 2.10 | 0.45 | | |
| JA | CAY I(0) | | | 0.62 | 0.18 | 0.31 | 0.09 |
| | SURY I(1) | 1.88 | 0.55 | | | 8.56** | 2.61* |
| | R I(1) | 19.65** | 4.60** | 8.05* | 1.75 | | |
| NL | CAY I(1) | | | 13.06** | 4.20** | 0.99 | 0.88 |
| | SURY I(1) | 2.40 | 0.73 | | | 0.07 | 0.07 |
| | R I(0) | 3.45 | 1.02 | 3.46 | 1.03 | | |
| UK | CAY I(1) | | | 5.34** | 4.82** | 4.96 | 0.89 |
| | SURY I(0) | 13.65** | 2.45** | | | 7.69* | 1.34 |
| | R I(1) | 23.34** | 4.62** | 10.76** | 9.98** | | |
| USA | CAY I(1) | | | 8.34 | 1.47 | 1.79 | 0.31 |
| | SURY I(1) | 2.74 | 0.46 | | | 21.87** | 4.01** |
| | R I(1) | 0.95 | 0.16 | 8.13 | 1.44 | | |

Notes: This Table reports the results of variable exclusion tests. Rows indicate regressions. The variables in the 3rd column are the LHS variables; whilst the regressors are shown at the top of columns 4-9. The order of integration of variables is indicated in column 3. In the case of I(1) LHS variables, the results are based on the relevant ECM equations; in the case of I(0) LHS variables, the results are based on the VAR in differences of the order given for the levels-VAR in Table 2 minus 1 (except for Canada where one more lag was added). The statistics shown are the Likelihood Ratio (LR) and F-test statistics of exclusion of the relevant regressor from the equation. ** indicates significance at the 5% level; * significance at the 10% level.