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Real Interest Parity in the EU and the Consequences for Euro Area Membership: Panel Data Evidence, 1979-2005*

Martin O'Brien

Abstract: This paper examines whether macroeconomic convergence is an automatic outcome of forming a currency union by combining an analysis of real interest parity (RIP) in the EU with the argument for the endogeneity of the Optimum Currency Area (OCA) criteria. Using the DF-GLS and the CIPS* panel unit root test, RIP is tested for a sample of Euro area and non-Euro area EU member states with respect to Germany for key sub-periods covering 1979 M3 – 2005 M12. RIP is not found to hold for most of the sample between 1979 M3 and 1998 M12. There is evidence in favour of RIP for most of the Euro area sample during the 1999 M1 – 2005 M12 sub-period, exceptions being Ireland, Italy and Spain. RIP does not hold for any of the non-Euro area countries during the same period. This indicates some support for the endogeneity hypothesis, with the caveat that certain country-specific issues can seriously hinder the "automatic" integration process.

JEL Classification: F33; F36; F40

Keywords: *Real interest parity, OCA Criteria, European Monetary Union, Unit root tests*

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1. Introduction

Real interest parity (RIP) arises where real rates of return on similar assets are the same across countries. It has been widely examined in recent decades as a means of evaluating financial and capital market integration. Since RIP is conditional upon ex ante purchasing power parity (PPP) in the goods market it can also be considered as a general indicator of macroeconomic integration or convergence. This is of particular relevance to the dismantling of various capital controls from the 1970's onwards and, from the European perspective, the completion of the Single Market and the move towards European Monetary Union (EMU). The aim of this research is to specifically examine RIP in the European context. At issue is whether long-run RIP, or a convergence in real interest rates (RIR's), held for Euro area members with particular reference to key sub-periods between 1979-2005 and whether this has been significantly different for those EU members who are not in the Euro area, especially since the formation of the single currency.

Answers to this question would be of interest from a theoretical and a policy point of view. The rationale for forming a currency union has its foundation in Optimum Currency Area (OCA) theory, modern proponents of which assert the endogeneity of the OCA criteria (Frankel and Rose 1998). The OCA criteria of particular interest are the trade intensity between prospective currency union members and the synchronicity of their business cycles. Greater levels of macroeconomic integration would be synonymous with greater trade intensity and more synchronous business cycles, evidence of which should be seen in RIR convergence. De Grauwe and Mongelli (2005) have highlighted two further areas of "endogeneity", namely those of financial market integration and product and labour market flexibility, which may also be captured in analysing RIP. Endogeneity implies that countries, which ex ante do not meet the criteria to form a currency union, are more likely to meet these criteria after forming the union. This suggests that RIR's between Euro area members should be converging at a faster pace than those outside the currency union, especially since

the establishment of EMU in 1999. If this is found to be the case then policy-makers must consider the costs and benefits of joining or remaining part of the Euro area in a different light. If the endogeneity of the OCA criteria is not supported for current Euro area members, persistent divergences in RIR's could cause significant strain on the single currency and, given insights from the political economy sphere, could lead to current members leaving EMU.[1]

The sample includes eleven EU member states: Austria, Belgium, Denmark, France, Germany (the base), Ireland, Italy, the Netherlands, Spain, Sweden and the United Kingdom. Two panels will be constructed comprising of the Euro area and non-Euro area members. Long-run RIP would be consistent with a cointegrating relationship between German RIR's and those of the other sample countries. This analysis utilises the DF-GLS unit root test as per Elliot et al (1996) for the univariate country estimations and the CIPS* panel data unit root test developed by Pesaran (2007) for the panels. These unit root tests are first applied to the RIR's and subsequently the RIRD's with respect to Germany. Rejection of the null hypothesis of a unit root in the differentials in the presence of non-stationary RIR's would indicate a long-run cointegrating relationship between RIR's and support long-run RIP. RIP will be tested for the four key sub-periods highlighted by Fountas and Wu (1999) and the subsequent sub-period since the formation of EMU.

This paper explicitly combines RIP with the argument for the endogeneity of the OCA criteria. It does so by examining RIP since the formation of EMU and using these empirical results to draw meaningful inferences on the OCA criteria which would be of relevance to policy-makers. The remainder of the paper is structured as follows: Section 2 defines RIP and reviews the relevant literature on OCA and RIP in terms of methodology, theoretical underpinnings and empirical work while framing the current papers' contribution and rationale in these contexts; Section 3 outlines the practicalities of calculating RIR's and RIRD's and the testing methodology (DF-GLS and CIPS*) employed; Section 4 discusses the dataset used; Section 5 reports and

[1] The OCA criteria, and economic considerations generally, did not heavily influence the initial drive to establish EMU, which was primarily a political decision. However current non-Euro area countries, particularly the UK, cite economic arguments will (at least nominally) be the deciding factor as to whether they join or not.

discusses the empirical results of the DF-GLS and CIPS* panel data unit root tests and Section 6 concludes.

2. Real Interest Parity, the OCA Criteria and Currency Unions – Theoretical and Empirical Literature

2.1 Definition of Real Interest Parity

RIP arises where real rates of return on similar assets are the same across countries. For ex ante RIP to hold both uncovered interest parity (UIP) and ex ante purchasing power parity (PPP) must also hold. The UIP condition can be defined for domestic and foreign interest rates on similar instruments as

$$E[s_{t+1}] - s_t = i_t - i^*_t \quad (1)$$

where s is the log of the spot exchange rate, i is the nominal interest rate, E and * refer to an expected and foreign value respectively. Ex ante PPP maintains that

$$E[s_{t+1}] - s_t = E[\Delta p_{t+1}] - E[\Delta p^*_{t+1}] \quad (2)$$

where p is the log of the price level.

Applying the Fisher condition[2] to (1) and (2) yields

$$i_t - E[\Delta p_{t+1}] = i^*_t - E[\Delta p^*_{t+1}] \quad (3)$$

$$E[r_{t+1}] = E[r^*_{t+1}] \quad (4)$$

which denotes ex ante RIP, r being the RIR, divergences from which can be denoted as ε where

$$E[r_{t+1}] - E[r^*_{t+1}] = \varepsilon_{t+1} \quad (5)$$

Expected inflation rates are not observable in practice. To circumvent this problem the analysis assumes that expectations of inflation are formed rationally[3]

$$\Delta p_{t+1} = E[\Delta p_{t+1}] + \delta_{t+1} \quad (6.1)$$

$$\Delta p^*_{t+1} = E[\Delta p^*_{t+1}] + \delta^*_{t+1} \quad (6.2)$$

Where δ is the serially uncorrelated forecast error with a zero mean. From this we can write the ex post RIP condition as

$$r_{t+1} - r^*_{t+1} = y_{t+1} \quad (7)$$

[2] The Fisher condition says that $i_t = (1 + r_t)(1 + E[\Delta p_{t+1}])$

[3] Some authors have derived expected inflation rates from the interest rate term structure (e.g. Al Awad and Goodwin, 1998)

where y_{t+1}, the ex post RIRD, includes ε and $\delta - \delta^*$. Non-stationarity in the RIR's r_{t+1} and r^*_{t+1} accompanied with stationarity in the differentials i.e. y_{t+1}, implies strong RIP as there exists a long-run cointegrating relationship in this instance.

These time series characteristics of the RIR and RIRD's are evidence of RIP as a long-run phenomenon, significant differences from which can be seen for shorter horizons. More significant long-run RIR convergence for Euro area members relative to non-Euro area members since the formation of EMU would indicate that the short-run costs of entering the currency union are diminished over time as economies become more integrated. This forms the basis for this papers' analysis of RIP as evidence of the endogeneity of the OCA criteria in terms of economic integration/trade, financial integration and product and labour market flexibility.

2.2 The OCA Criteria and Currency Unions

The seminal paper by Mundell (1961) laid the foundation for OCA theory. Mundell hypothesised that the optimum domain for a given currency[4] may not be the same as the political jurisdiction of a nation state. There were therefore regions which may cross national borders where adoption of a single currency would make economic sense. Mundell defined these regions as exhibiting internal labour mobility. In a later paper, Mundell (1973) expanded the theory to incorporate capital mobility where regions with high levels of capital mobility present greater opportunities for portfolio diversification and risk sharing. McKinnon (1963) further defined an OCA as an area which has high levels of internal trade. Given that the region may include a number of independent states, this implies cross border trade and a significant degree of openness in the national economies. The free movement of goods, labour and capital by this reasoning should be reflected in greater trade intensity and more synchronous business cycles, i.e. the OCA criteria.

Frankel (1992) reviewed the evidence for international capital mobility in the light of the various liberalisations that had taken place since the 1970's. He noted that the increased level of capital mobility was not reflected in small or zero RIRD's as would

[4] And by default a single Central Bank for that domain.

be expected. To overcome this contradiction Frankel proposed a decomposition of the RIRD into a country or political premium and a currency premium. The former incorporates all barriers to cross border integration, capital controls, different tax regimes, transaction costs, default risk etc. The latter is the risk of depreciation in the currency investors' assets are denominated in. Using a sample of twenty-five countries he showed how the currency premium was much more volatile than the country/political premium, and indeed how the country/political premium appeared to have become obsolete. Following his logic any RIRD's are driven by the currency premium. In a currency union this premium would be non-existent, which would then lead to near zero RIRD's, i.e. RIP, indicative of greater macroeconomic integration. Also, different Government bonds become perfectly substitutable in a currency union (Fujii and Chinn, 2001), further reinforcing the redundancy of the country/political premium.

Frankel and Rose (1998) further emphasised the endogeneity of the OCA criteria in a macroeconomic sense. Using bilateral trade data, and measures of real activity from 1959 to 1993 for a sample of 20 OECD countries they showed that greater levels of integration have been followed by more synchronised business cycles, not necessarily preceded by them. The endogenous nature of this integration implies that basing a decision to enter a currency union on historical data might be naïve. If this is truly the case this greater pace of integration within a currency union should be reflected in the pace of convergence in RIR's between member states. Absence of a faster convergence rate would contradict the endogeneity hypothesis and the related hypothesis of the country/political premium being obsolete.

Rose and Engel (2002) using a number of estimation techniques found that members of currency unions tend to trade more with each other, have more stable real exchange rates and more synchronised business cycles. However they note that more integrated economies may tend to form a currency union and as such the direction of causality from currency union to integration (endogeneity) could not be confirmed by their analysis. They also found a significant border or home bias effect, as the degree of integration across countries in a currency union fell below the degree of integration across regions within a given country. Conversely, Thom and Walsh (2002) find no

significant change in trade intensity as a result of changing cross-border monetary arrangements of a free trade area. They find no significant fall in Anglo-Irish as a result of the break up of the Anglo-Irish currency union in 1979. Micco, Stein and Ordonez (2003) use a modified gravity model specification for a panel of countries, which supports the findings of a positive effect on trade as a result of a single currency. They show that membership in EMU causes bi-lateral trade between members to increase by 12 percent on average when compared to trade flows between countries that do not participate in EMU. These findings may indicate more flexibility in product markets as a result of the single currency.

To the extent that greater levels of integration can lead to countries specialising in certain industries (Krugman, 1991, Krugman and Venables, 1996 and Puga 2002) increased levels of bi-lateral trade would not automatically lead to greater business cycle synchronisation and minimising asymmetric shocks. Hughes Hallett and Piscitelli (2002) show that in such a case of industrial specialisation and the consequent trade between currency union members, business cycles can actually diverge in the presence of asymmetric shocks. Fidrmuc (2005) thus stresses the importance of intra-industry trade in the endogeneity dynamic. He shows that the absolute intensity of trade between countries is not significant in explaining the covariance of real economic activity among OECD countries from 1990-1999 when intra-industry trade is accounted for. Intra-industry trade itself can, however, induce convergence in business cycles. Thus, as per Krugman (1993), Fidrmuc shows the OCA endogeneity hypothesis holds to the extent that intra-industry trade is positively correlated with overall trade intensity.

In terms of the endogeneity of financial integration, Baele et al (2004) define integration as when agents across member states face a single set of rules when dealing with financial instruments/services, have equal access to these instruments/services and are treated equally when they are engaged in the market. This definition is closely tied to the law of one price, as is the definition of RIP above. Thus the use of RIP analysis to test the endogeneity of financial integration is valid. In their study of the government bond market in the Euro area, Adjaouté and Danthine (2003) show how nominal bond yields converged dramatically over the 1990's and

the dispersion of nominal bond yields since 1999 have tended toward zero, which could be taken as evidence of Euro area bond markets becoming more integrated. However when the dispersion between real bond yields are examined no evidence of convergence is found and there is no significant difference in the pattern of dispersion pre and post 1999. This can only be taken as evidence against an automatic mechanism of increased integration as a result of forming the single currency and highlights the role of price level differentials and country specific risk premia in this process.

The endogeneity of a more flexible labour market is particularly difficult to discern. Theory is relatively ambiguous on the subject. Some are concerned that monetary union provides a disincentive to labour market reform (Sibert and Sutherland, 2000), while others stress that in conjunction with union-wide product market deregulation labour market flexibility will follow as the power of trade unions are diluted (Blanchard and Giavazzi, 2003). This study uses the WPI as a deflator in calculating real interest rates, which should capture the different cost structures faced by firms in the individual countries, including labour costs. The results could therefore tentatively indicate whether the endogeneity hypothesis holds for the labour market.

Given the macroeconomic and financial aspects of the OCA criteria discussed above, RIP analysis would appear to be a convenient "catch-all" test for the endogeneity hypothesis.

2.3 Empirical Evidence of Real Interest Parity

Since the late 1970's numerous studies have investigated whether RIP actually holds or not. Early studies could not find in favour of RIP despite the various liberalisations experienced during the 1970's. The results however seem to be sensitive to the kind of analysis undertaken, as later work has found significant RIP relationships for some industrialised countries. These later studies take into account the time series characteristics of the RIR and apply more powerful unit root tests than the older studies. What follows is an analysis of both early and later studies which illustrates

the impact methodology has on analysing RIP and its relevance for the current research.

2.3.1 Early Studies of Real Interest Parity

Mishkin (1984) used quarterly data from 1967 Q2 – 1979 Q2 for Eurocurrency deposit market rates to calculate the RIR for the US, Canada, France, the UK, West Germany, the Netherlands and Switzerland using both the Consumer Price Index (CPI) and the Wholesale Price Index (WPI) as deflators. Eurocurrency deposit market rates were chosen for their similar default risk characteristics. RIRD's were calculated with respect to US rates. RIP was rejected using the CPI and WPI data at the 1% confidence level, as the RIRD's were significantly different from zero, thus providing evidence against RIP. The study however could not reject the possibility of RIR's converging toward each other in the long-run.

Jorion (1996) explicitly tested RIP for longer horizons and found evidence against it for the US, Germany and the UK for the period 1973 M8 – 1991 M9. Deflating monthly annualised Government bond yields of different horizons by the WPI, Jorion estimated the future annualised *m*-year RIR (for time horizon *t* to *t+m)* differentials with respect to the US. The results based on the WPI deflators for all investment horizons between three months and five years rejected RIP between the US and the UK. While the results for Germany were more encouraging at some investment horizons, Jorion concluded that RIR's had no tendency to be equalised over long investment horizons.

Mishkin's and Jorion's results were common up to the mid-1990's and it appeared as if the notion of RIP was obsolete.[5] Fujii and Chinn (2001) extended the time series under investigation to the beginning of the new millennium. Their data set included various long and short-term quarterly rates for the G7 countries and again they used the CPI and WPI indices as deflators for 1979 Q1 – 2000 Q1. Three, six and twelve month Eurocurrency yields were used as short-term rates and Government bond yields were their primary long-term rate. Using the Fisher relation and rational expectations

[5] Other examples include Mark (1985), Cumby and Mishkin (1986) and Taylor (1991)

they estimated the RIP condition by using the US rate to determine the other individual countries RIR. In this study therefore RIR's and not the differentials were the variables in question and they estimated the regression by GMM[6]. They found significant differences in the degree of capital mobility, i.e. evidence of RIP, measured at different maturity horizons. RIP was rejected using both the CPI and WPI price levels for short horizons of three, six and twelve months. Long-term horizons of five and ten years provided some evidence for RIP between the US and Canada and the US and the UK, contradicting the findings of Jorion (1996).

Many of the early papers made reference to the long-run aspect of RIP without applying techniques robust enough to establish whether the relationship held or not. Cointegration tests are commonly used to establish whether such relationships exist, advances in which have been made recently and applied to RIP analysis.

2.3.2 Real Interest Parity Analysis – Accounting for the Unit Root

Wu and Chen (1998) re-examined RIP given the tendency for RIR time series to contain a unit root by using three different panel unit root tests as put forward by Levin and Lin (1992), Im et al (1997)(2003) (IPS test) and Maddala and Wu (1996). These tests were applied to the RIRD's for Canada, Japan, France, Germany, Italy, the Netherlands, Switzerland, the UK and the US, with Germany and the US used as alternate base countries. Annualised ex post RIR's were calculated using monthly CPI data and 3-month Euro money market bid rates for the period 1979 M1 – 1996 M9.

Wu and Chen initially used the Augmented Dickey Fuller (ADF) cointegration test on the differentials. The null hypothesis of non-stationarity was not rejected six out of eight times for German relative rates and seven out of eight times for US relative rates. After correcting for serial correlation in the residuals by setting a lag length of eight periods in the ADF regressions they then applied the panel unit root tests. The Levin and Lin and IPS tests rejected the null hypothesis of non-stationarity at the 5% level for both German and US relative rates, whilst the Maddala and Wu test rejected

[6] GMM is Generalised Method Of Moments.

it at the 10% level. Wu and Chen report this as significant evidence for the convergence of real rates among their sample. It is also clear that findings in favour or against RIP are sensitive to the method used. The conventional ADF test found evidence of a unit root in the differentials while the more powerful panel unit root tests did not.

Similarly Fountas and Wu (1999) examined another time series characteristic of the RIR, namely the possibility for structural breaks, and its consequences for the analysis of RIP. Their sample included Belgium, Denmark, France, Germany, Ireland, Italy and the Netherlands, with Germany as the base. They used the same short-term rates as Wu and Chen and compliment the analysis with Government bond yields as long term rates. The CPI was used to calculate RIR's and all the data were quarterly from 1979 to 1993. Similar to Fujii and Chinn their analysis focused on RIR levels and not the differentials. They used the Gregory-Hanson method to test for cointegration between RIR's. This allowed explicitly for structural breaks in the time series, which can reasonably be expected in the European context given the different stages of the European Monetary System[7]. They showed that using the conventional Engle Granger cointegration test in the presence of such structural breaks could lead to an incorrect rejection of the null hypothesis of no cointegration, as this was the case for all their sample countries. However the Gregory-Hanson approach did not accept the null hypothesis of cointegration for long-term rates between Germany and most other ERM members except Belgium, Italy and the Netherlands, while German and French short-term rates were cointegrated.

Holmes (2002) took advantage of the key structural breaks from Fountas and Wu and used them to test for RIP between Germany, and a number of industrialised EU and non-EU countries. The study employed conventional ADF unit root tests and a panel data analysis of RIR's and RIRD's, specifically the IPS panel data unit root test used in Wu and Chen (1998) and put forward by Im et al (1997)(2003). He used three-month Treasury bill rates and CPI data to calculate ex post RIR's assuming rational expectations for the period 1979 M3 – 1998 M12. The ADF unit root tests and panel data tests showed that RIR's were predominantly non-stationary for the period 1986

[7] These are 1979m3-1986m4, 1986m5-1990m4, 1990m5-1993m7, 1993m8-1998m12. See section 5.1.

M5 – 1998 M12. The ADF test did not reject the null hypothesis of non-stationary RIRD's at the 5% significance level for any country from 1986 M5 – 1998 M12. He tested for the existence of long-run RIP between Germany and three panels aiming to capture the influence EU membership has on the convergence of RIR's. The results indicate that RIP with respect Germany held for those panels containing only EU members for the latter half of the 1980's and during the mid to late 1990's. RIP was not found to hold for the panel of non-EU members suggesting that membership of the EU, particularly since the creation of the Single Market and the adoption of the Maastricht Treaty, was significant in RIR convergence between EU member states.

The panel unit root tests applied in the papers above (Levin and Lin and Im et al) are conditional upon the assumption of cross sectional independence. In the context of a common and co-ordinated policy environment, such as the EU, where it is evident that some core economies are well integrated, such a stringent assumption may not be valid. O'Connell (1998) has shown that in the presence of contemporaneous correlation the power of the panel unit root tests assuming cross sectional independence diminish significantly. As such a new generation of panel unit root tests that do not rely on this assumption have been applied to RIP analysis. Chung and Crowder (2004) apply the Hansen (1995) covariate ADF and the Breuer, McNown and Wallace (2001) ADF-SUR panel unit root tests, and the DF-GLS univariate test put forward by Elliot et al (1996). Using monthly observations on 12 month Eurocurrency deposit rates deflated by the CPI, they were unable to find RIP holding for their sample of the US, UK, Japan, Germany and Canada from 1960-1996. They further analyse which of the underlying assumptions (PPP or UIP) causes the failure of the RIP relationship. They find the UIP is most likely to fail and argue this is consistent with a significant risk premium in foreign exchange markets.

2.4 Summary

RIP has been widely analysed as a means of gauging international financial and capital market integration and general macroeconomic convergence. Examining it in the light of currency unions is of particular interest to the argument for the endogeneity of the OCA criteria and how policy-makers weigh up the decision to enter or remain part of a currency union. Following the logic of Frankel (1992) and

Frankel and Rose (1998), RIR's must converge at a faster pace for currency union members than for non-currency union members. The current research explicitly tests whether this is the case for Euro area and non-Euro area EU member states. As noted above the analysis of RIP is sensitive to the method used. The time series characteristics of the RIR and RIRD must be accounted for. Therefore this paper utilises both the DF-GLS univariate test and the CIPS* panel unit root test put forward by Pesaran (2007). While the current research also takes advantage of the dates Fountas and Wu (1999) highlight as key structural breaks, it extends the procedure of Holmes (2002) and differs from it in a number of ways. Firstly there are more EU member states under examination. Secondly the RIR is calculated using WPI and Government bond yields (see Section 3). Thirdly, the CIPS* test is not dependant on the assumption of cross sectional independence as is the IPS. Fourthly, the member states are being differentiated into two panels, namely Euro area and non-Euro area panels. Associated with this is that the time period being considered is extended from 1979 to 2005. This extension incorporates the formation of EMU and specifically relates to the rationale of the paper, i.e. examining RIP in the light of the proposed endogeneity of the OCA criteria. Section 3 outlines the testing methodology used in the current paper given the insights from the literature.

3 Methodology

3.1 Construction of Real Interest Rates and their Differentials

As previously outlined, the aim of this paper is to determine whether RIP held for Euro area member states in key sub-periods from 1979 M3 to 2005 M12 and whether their experience is significantly different from other EU member states that are currently not part of the Euro area. Of particular interest is the sub-period 1999 M1 - 2005 M2. In order to answer this question RIR's and RIRD's with respect to Germany must be computed. To calculate the RIR (r_{t+12}), Government bond yields (i_t) are deflated using the Wholesale Price Indices (WPI).

$$E[r_{t+12}] = i_t - E[\Delta p_{t+12}] \tag{8}$$

where $E[r_{t+12}]$ is the expected or ex ante real return on the Government bond one year hence and $E[\Delta p_{t+12}]$ is the expected change in the price level (WPI) one year hence[8]. However expected inflation is not observable in practice. Various methods of constructing the RIR have been used to overcome this problem, such as deriving expected inflation from the interest rate term structure, employing an AR(4) data generating process and using an ex post construction. Similar to previous work, in this study the ex ante RIR is constructed using the ex post RIR[9]. In using the ex post RIR it is assumed that agents have rational expectations. Thus it is assumed that expected inflation can be proxied by actual inflation with a random inflation forecast error.

$$\Delta p_{t+12} = E[\Delta p_{t+12}] + \delta_{t+12} \tag{9}$$

where δ is the serially uncorrelated forecast error with a zero mean. Given this, the inflation rate used as a deflator in this study is calculated as

$$\Delta p_{t+12} = ln(WPI_{t+12}) - ln(WPI_t) \tag{10}$$

which uses the change in the log of the WPI as the inflation rate. Thus the ex post RIR's are derived as

$$r_{t+12} = i_t - [\, ln(WPI_{t+12}) - ln(WPI_t)] \tag{11}$$

Government bond yields will give an appreciation of the long run aspect of RIR's, as it appears from the literature that RIP holds better at long investment horizons (Fujii and Chinn, 2001). It is argued that such long-term instruments are more appropriate in analysing the extent of capital mobility for three reasons. Firstly, firms will tend to make their investment decisions based on long-term bond yields. Secondly, from an individual's point of view, long-term real rates are close approximations of returns expressed in terms of physical goods. Finally, given we are interested in the real rates of return converging towards parity across a number of different political entities on-shore rates are more useful than off-shore rates[10] (Fujii and Chinn, 2001). Government bond yields are invariably defined as the yields to maturity of bonds issued by the government of the state in question, or other bonds that would indicate longer-term rates.

[8] The time series under investigation are monthly in frequency, hence *t+12* is equivalent to one year.
[9] The *ex post* construction is the least likely to produce an *I*(1) series (Sun and Phillips, 2004).
[10] On-shore rates are those set by the domestic authorities while off-shore rates, e.g. Eurodollar rates, are determined by the international capital markets.

As outlined in Section 2, previous studies have used the CPI and/or the WPI as deflators. In this study the WPI is selected as it circumvents the issue of non-traded goods that CPI data encounters in analysing RIP (Mishkin, 1984). It is therefore useful in analysing the effects long-run real interest rate relationships have on trade among countries, firm's decisions to invest in other jurisdictions, and how this can lead to more integrated economies. Given this papers' rational for studying RIP in the context of the endogeneity of the OCA criteria, particularly the criteria of increased trade between currency union members, the WPI is also a more appropriate index to use.

RIRD's are calculated for the sample countries with respect to Germany:

$$r_{t+1} - r^{*}_{t+1} = y_{t+1} \tag{12}$$

where r_{t+1} is the domestic RIR, r^{*}_{t+1} is the German rate, and y_{t+1} is the differential. Germany is selected as the base country in this study given the evidence in support of German leadership in the general monetary conditions in the EU (De Grauwe, 1997; van Goempel and van Poeck, 1994).

RIP holds where y_{t+1} reverts around a mean of zero in the long run, i.e. where y_{t+1} does not contain a unit root in the presence of non-stationary RIR's. This implies a cointegrating relationship between r_{t+1} and r^{*}_{t+1}, the benchmark for RIP.

3.2 DF-GLS and CIPS* Unit Root Tests

As seen from the literature, evidence for RIP is sensitive to the methodology employed. Stationary RIRD's in the presence of non-stationary RIR's indicates a long run cointegrating relationship between RIR's and, as such, evidence of RIP.

As per Wu and Chen (1998), Holmes (2002) and Chung and Crowder (2004), univariate and panel unit root tests will be conducted on the individual country RIR time series and the corresponding RIRD's for each sub-period outlined by Fountas and Wu (1999) and the additional sub-period of 1999 M1 – 2005 M12. Conducting unit root tests on the RIRD's is only appropriate where both the domestic and German RIR's are found to be non-stationary. Given the low test power of the Augmented

Dickey Fuller unit root test, this paper applies the DF-GLS univariate test, which has been shown by Elliot *et al* (1996) to have desirable size and power properties above that of the ADF test. A local to unity GLS detrending of the data achieves this more powerful unit root test. Lag length selection is critical to the power of these tests. As such the MAIC criterion, as per Ng and Perron (2001) is used for each individual time series. This selection criteria has been shown by Ng and Perron to allow more powerful unit root tests than the Akaike or Bayesian information criteria.

The DF-GLS test equations for the RIR's (r_t) and the differentials (y_t) are, respectively:

$$\Delta \tilde{r}_t = \alpha + \pi \tilde{r}_{t-1} + \sum_{j=1}^{p^*} c_j \Delta \tilde{r}_{t-j} + \varepsilon_t \tag{13}$$

$$\Delta \tilde{y}_t = \alpha + \pi \tilde{y}_{t-1} + \sum_{j=1}^{p^*} c_j \Delta \tilde{y}_{t-j} + \varepsilon_t \tag{14}$$

where the null hypothesis of non-stationarity holds when $\pi \geq 0$. Critical values for the test ($T\mu$) are given by Elliot *et al* (1996). Autoregressive elements are included to account for serial correlation and a drift term is included as a deterministic component. As per Papell (2002) no time trend is included as this would be theoretically inconsistent with PPP and thus RIP.

Panel data unit root tests have been applied by Wu and Chen (1998) and Holmes (2002), among others, to overcome the deficiencies of the univariate tests in investigating RIP. A panel data approach is also useful given the rationale of this paper in comparing the parity conditions of two distinct groups of countries, Euro area and non-Euro area EU member states. The CIPS* test developed by Pesaran (2007) will be applied in this study of RIP on the RIR's and subsequently the RIRD's for the key sub-periods highlighted by Fountas and Wu (1999) and the subsequent sub-period since the beginning of EMU. The test is only appropriate on the RIRD's where both the domestic and German RIR's are found to be non-stationary as part of a panel.

To set up the CIPS* test, assume the RIRD's, y_{t+1} from eq. 7 above, are generated by the following process[11]

$$y_{it} = (1-\varphi)\lambda_i + \varphi_i y_{i,t-1} + u_{it} \quad (15)$$

i = 1, 2, . . ., N member states and t = 1, 2, . . . , T observations. Allowing for correlation across the panel it is assumed that

$$u_{it} = \rho_i u_{i,t-1} + \eta_{it}\,, \quad |\rho_i| < 1 \text{ for } i = 1, 2, \ldots, N \quad (16)$$

where the cross section dependence is allowed for by assuming a one-factor model for the residuals

$$\eta_{it,} = \gamma_i f_t + \varepsilon_{it} \quad (17)$$

and $\varepsilon_{it} \sim$ i.i.d.$(0,\sigma_i^2)$. It is convenient to write eq.'s 16 and 17 as

$$\Delta y_{it} = -\mu_i\beta_i(1-\rho_i) + \beta_i(1-\rho_i)y_{i,t-1} + \rho_i(1+\beta_i)\Delta y_{i,t-1} + \gamma_i f_t + \varepsilon_{it} \quad (18)$$

In this instance the null hypothesis is H_0: $\beta_i = 0$ for all i and the alternative H_A: $\beta_i < 0$, i = 1, 2, . . . , N_1; $\beta_i = 0$, i = N_1 + 1, N_1 + 2, . . . , N. This implies that if one country time series in a panel is non-stationary this may be sufficient to induce non-stationarity for the panel as a whole.

To allow for serially correlated errors within each time series in a panel, an AR(p) error specification such as below will yield the CIPS* test statistic by averaging the OLS t-ratios of b_i

$$\Delta y_{it} = \alpha_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + \sum_{j=1}^{p} d_{ij}\Delta\bar{y}_{t-j} + \sum_{j=1}^{p} \delta_{ij}\Delta y_{i,t-j} + e_{it} \quad (19)$$

Equation (19) is the basis of the CIPS* panel test for RIP using RIRD's. The test statistic is calculated by getting the average of the individual cross sectionally augmented ADF statistics from each member of the panel, with test statistics as per Pesaran (2007). The lag length (p) included to account for serial correlation is as per the MAIC for each individual country time series in the panel.

[11] The same can be assumed for the RIR's, r_{t+1}; substituting this for y_{t+1} into the derivation of the CIPS* test yields the method for the test applied on the real interest rates.

4 Data

4.1 Countries and Time Period

This section discusses the data used in this analysis. Data for the countries under investigation has been collected via the International Monetary Fund's International Financial Statistics (IMF IFS) database. The data sources are the national statistics offices in those states. The data is monthly in frequency.

A sample of eleven EU member states is included in the analysis; Germany (the base), Austria, Belgium, Denmark, France, Ireland, Italy, the Netherlands, Spain, Sweden and the United Kingdom.

The time period under investigation is 1979 M3 – 2005 M12. This time period incorporates the beginning of the Exchange Rate Mechanism through to the inception of the Euro. Fountas and Wu (1999) highlight the impact of structural breaks in leading to low unit root test power. Following Fountas and Wu the time period is separated into their four sub-periods from 1979 M3 - 1998 M12 and the subsequent sub-period up until 2005 M12 as follows; (1) March 1979 – April 1986 which covers the start of the Exchange Rate Mechanism (ERM) and significant changes in nominal exchange rates; (2) May 1986 – April 1990, which saw the elimination of any remaining capital controls between ERM members; (3) May 1990 – July 1993, which incorporates the introduction of the Single Market, the fall of the Berlin wall, and the ERM crisis in 1992; (4) August 1993 – December 1998, which saw hopeful Euro area members adhere to the Maastricht criteria; and (5) January 1999 – December 2005, the period since the start of EMU.

As outlined in the Methodology section, the panel data unit root test is applied for each sub-period after conducting the DF-GLS test for the individual time series. Two panels are constructed for the application of the CIPS* panel data unit root test, an Euro area and a non-Euro area panel. The Euro area panel, Panel A, consists of Germany, Austria, Belgium, France, Ireland, Italy, the Netherlands and Spain. The

non-Euro area panel, Panel B, consists of Denmark, Sweden and the UK. When conducting the test on the RIR's, Germany is included in both panels, whereas when conducting the test on RIRD's Germany is not included as the differentials are calculated with respect to the German RIR (eq.12). Individual country time series are dropped from their respective panels if the DF-GLS test rejects the null hypothesis of a unit root for the time series in a given sub-period.

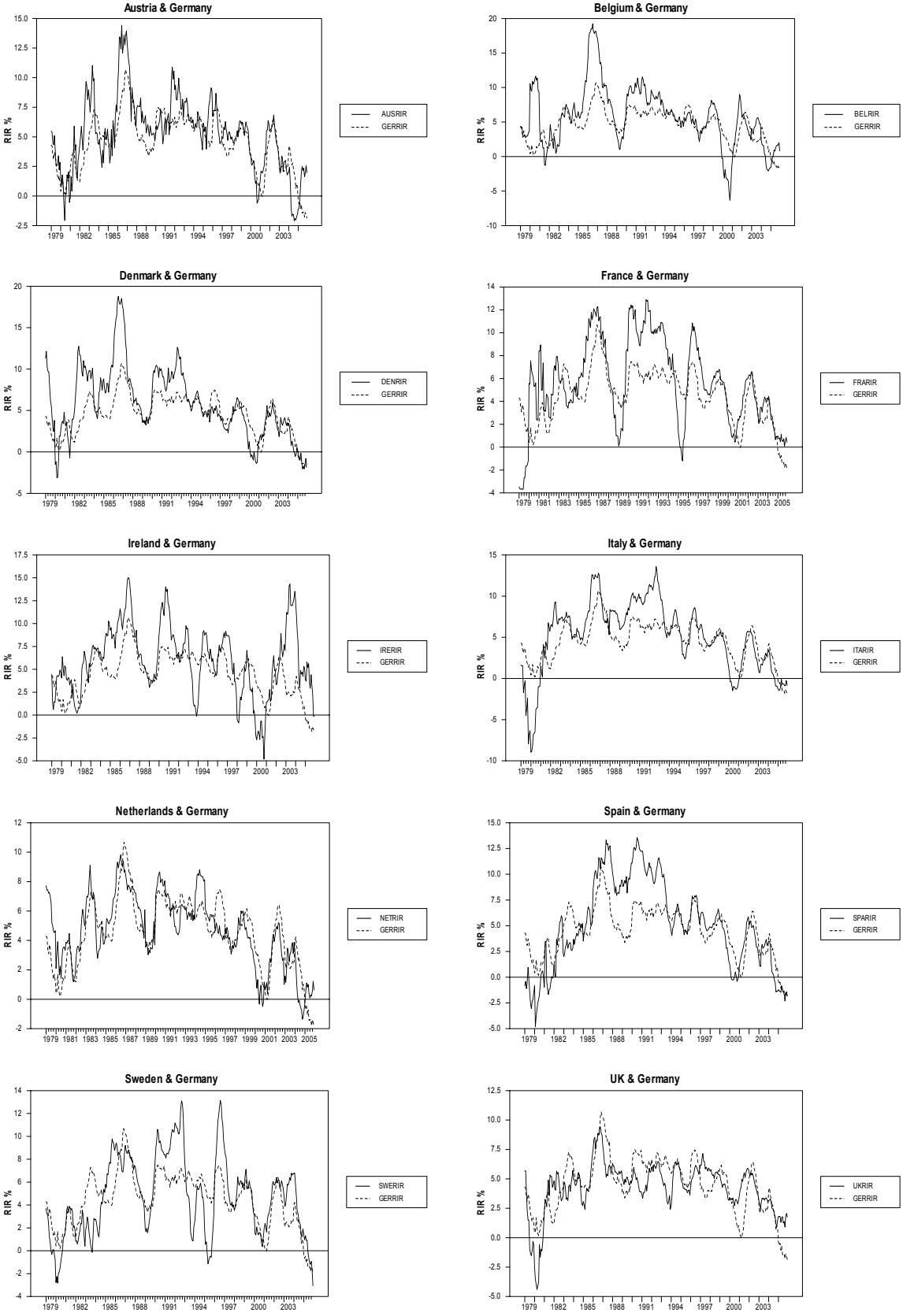
4.2 Dynamics of Real Interest Rates and Real Interest Rate Differentials

As noted in Section 3, Government bond yields are deflated using the WPI to derive RIR's. Government bond yields are collected from the IMF IFS line 61*. Likewise, the WPI is taken from the IMF IFS line 63[12]. The ex post inflation rates were derived as per eq.10.

Figure 4.1 shows the RIR's of the countries in question over the sample period. German rates are incorporated in the graph of each other country to see whether co-movement is evident or not. While some evidence of co-movement can be seen, especially for the mid 1980's, such analysis is insufficiently rigorous. The non-stationarity of the RIR's is also supported, as no mean reverting tendency is immediately apparent for any of the countries. Figure 4.2 plots the RIRD's for each country with respect to Germany. The magnitude of the differentials is worth noting. There is a definite tendency of dampening down in the differentials between 1993 and 1998. However a number of countries Denmark, Italy, Sweden, Spain have seen their differentials increase during the subsequent sub-period 1999 M1 – 2005 M12. The differential for Ireland has been relatively volatile during this period also. Little else can be ascertained from the plots as they are, but stationarity is not immediately apparent. The panel data unit root test will establish this more clearly. Both RIR and RIRD plots confirm that there is no apparent time trend in the series and as such a time trend is not included in the DF-GLS and CIPS* test regressions, consistent with Papell (2002). Section 5 reports the results of the tests outlined in Section 3.

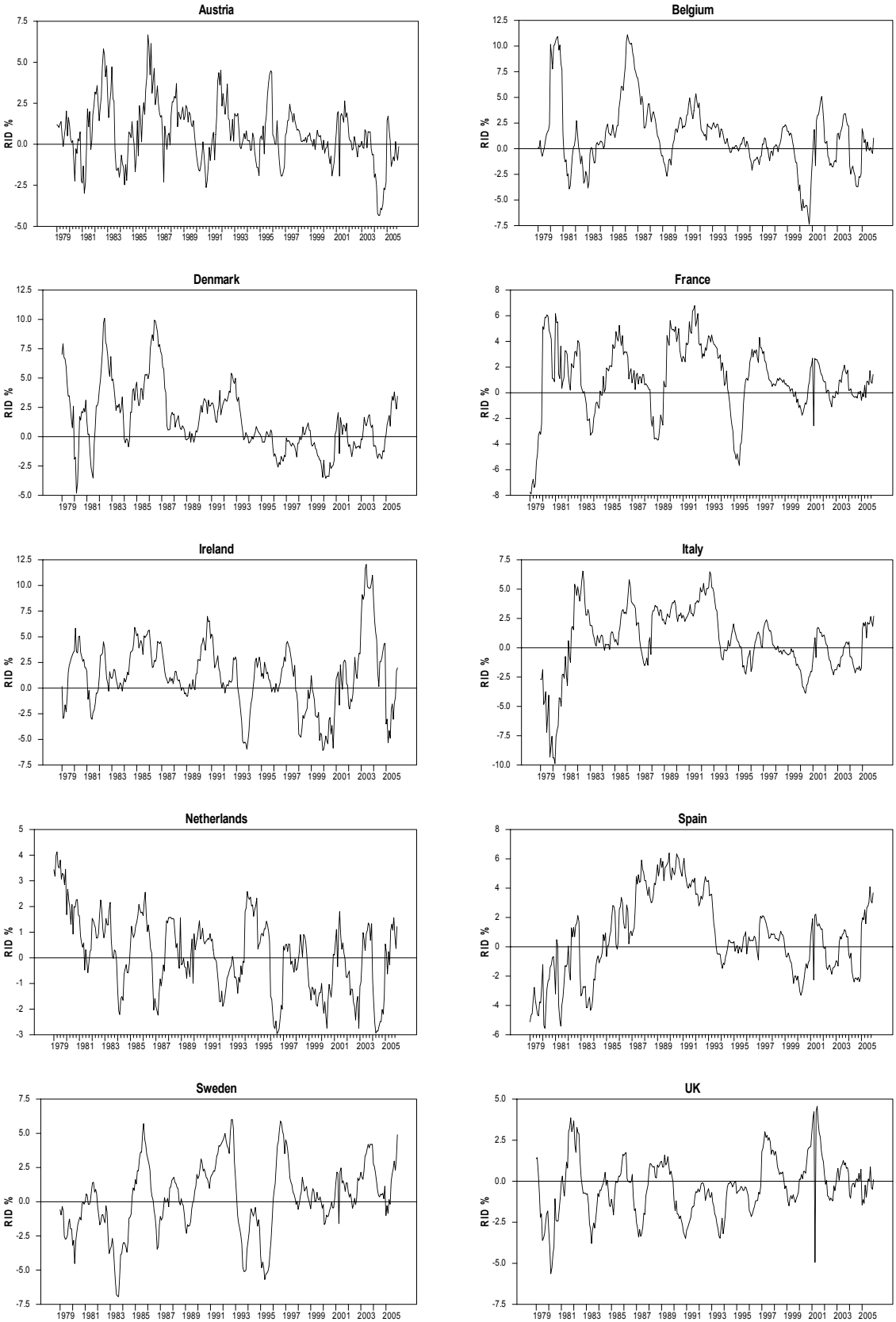
[12] The French index used line 63a prior to 1995

Figure 4.1: Real Interest Rates 1979 M3 – 2005 M12



Source: National Statistics Offices

Figure 4.2: Real Interest Rate Differentials w.r.t. Germany 1979 M3 – 2005 M12



Source: National Statistics Offices

5 Empirical Results

5.1 Real Interest Rates

Table 5.1 presents the DF-GLS results for the RIR's of the sample countries during the key sub-periods outlined in Section 4. The test regression is given by eq.13. Consistent with much of the recent literature, RIR's are found to contain a unit root more often than not. The French RIR is found to be stationary at the 5 per cent significance level from 1973 M3 – 1986 M4 and 1990 M5 – 1993 M7. Importantly the German RIR is non-stationary for all time periods. This is contrary to Holmes (2002) for 1979 M3 – 1986 M4 but it must be noted however that Holmes uses three-month Treasury bill rates as the interest rate under investigation whereas this paper uses Government bond yields. Four Euro area members real rates are stationary during the 1993 M8 – 1998 M12 period at the 95 per cent confidence level or greater. Subsequently these countries (Austria, Italy, Netherlands and Spain) are dropped from the CIPS* panel test for that time period, given the null hypothesis of the test outlined in section 3, as is the French rate 1973 m3 – 1986 M4, 1990 M5 – 1993 M7. All of the non-Euro area member states had non-stationary RIR's for all time periods. The 1999 M1 – 2005 M12 period is of particular interest in this paper. All of the countries in the sample for this time period have non-stationary RIR's.

Table 5.1: DF-GLS Unit Root Tests - Real Interest Rates

Country	**Period**				
	1979m3-1986m4	1986m5-1990m4	1990m5-1993m7	1993m8-1998m12	1999m1-2005m12
Germany	-1.262	-1.556	-1.509	-1.516	-0.911
Austria	-1.168	-0.400	-1.640*	-2.257**	-1.017
Belgium	-1.105	-1.120	-1.686*	-1.281	-1.280
France	-2.407**	-1.472	-2.099**	-1.650*	-0.310
Ireland	-0.642	-1.255	0.607	-1.865*	-1.682*
Italy	-1.456	-1.190	-0.768	-2.665***	-0.631
Netherlands	-1.905*	-0.705	-0.635	-2.394**	-0.967
Spain	0.791	-0.897	-0.705	-2.266**	-0.368
Denmark	-1.348	-0.708	-1.432	-1.376	-0.505
Sweden	-0.956	-0.931	-1.147	-0.851	-0.028
U.K.	-1.231	-0.784	-1.567	-1.151	-0.309
Critical Values					
1%	-2.601	-2.623	-2.638	-2.601	-2.61
5%	-1.95	-1.95	-1.95	-1.95	-1.95
10%	-1.61	-1.609	-1.606	-1.61	-1.61

*Notes: DF-GLS (Tμ) test statistics of the real interest rates for the key sub-periods, with critical values as per Elliot et al (1996). DF-GLS regression includes a constant. Lag length for each individual country series was selected using MAIC as per Ng and Perron (2001). ***, ** and * indicate rejection of the null hypothesis of non-stationarity at the 1%, 5% and 10% levels of significance repectively.*

While individual country time series may be non-stationary, when considered as part of a panel evidence against non-stationarity may be found due to higher test power. Table 5.2 reports the CIPS* panel data unit root test results for the Euro area (Panel A) and non-Euro area (Panel B) member states. Both Panel A and B include the German RIR as for the cointegration analysis on the differentials it is necessary that both the German and the domestic RIR contain a unit root and be integrated of the same order I(1). As noted above, individual country time series for particular periods have been dropped from their respective panels as their RIR has been found to be stationary using the DF-GLS test. Non-stationarity is the universal result for both panels and for all time periods, as the null hypothesis of a unit root cannot be rejected at the 95 per cent confidence level. This would imply that applying the same procedure as Fujii and Chin (2001) in this context could lead to a spurious regression as the base country and the other sample countries RIR's contain a unit root. Given this result cointegration analysis is appropriate by examining whether the RIRD's are stationary. Stationary RIRD's in the presence of non-stationary RIR's are consistent with RIP holding for the respective countries.

Table 5.2: Panel Data Unit Root Tests - Real Interest Rates

	Period				
	1979m3 - 1986m4	1986m5 - 1990m4	1990m5 - 1993m7	1993m8 - 1998m12	1999m1 - 2005m12
Panel A					
(N,T)	(7,98)	(8,48)	(7,39)	(4,65)	(8,84)
# Obs	658	356	258	240	646
CIPS*	-1.337	-2.13*	-0.116	-0.906	-1.436
Panel B					
(N,T)	(4,98)	(4,48)	(4,39)	(4,65)	(4,84)
# Obs	378	178	148	233	324
CIPS*	-0.181	-0.957	1.402	0.039	-1.064
Critical Values					
1%	-2.29	-2.36	-2.44	-2.32	-2.29
5%	-2.11	-2.16	-2.22	-2.13	-2.11
10%	-2.01	-2.05	-2.1	-2.03	-2.01

Notes: CIPS Panel Data unit root tests conducted on the real interest rates for the key sub-periods together with the corresponding critical values as per Peseran (2006) Table 2b. ***, ** and * indicate rejection of the null hypothesis of non-stationarity at the 1%, 5% and 10% levels of significance repectively. Test regression includes a constant. Lag length for each individual country series was selected using the MAIC. Panel A consists of Austria, Belgium, France, Germany, Ireland, Italy, Netherlands and Spain. Panel B consists of Denmark, Germany, Sweden and the UK. For some time periods countrys are excluded from their panel as their real interest rate was found to be stationary using DF-GLS.*

5.2 Real Interest Rate Differentials

Table 5.3 presents DF-GLS test results for the RIRD's. The test regression is given by eq.14. A stationary differential in the presence of non-stationary RIR's is evidence in favour of RIP. Prior to the last period evidence in favour of RIP between Germany and Denmark is found for 1979 M3 – 1986 M4, Germany, Italy and the Netherlands 1986 M5 – 1990 M4, and Germany and Belgium 1990 M5 – 1993 M7. Capital controls in place in Belgium and France would be consistent with the evidence against RIP for those countries in 1986 M5 – 1990 M4. However similar controls were in place in Italy, for which RIP held during that time period. The ERM crisis of the early 1990's, culminating in the widening of exchange rate bands and the exit of Italy and the UK from the mechanism would be consistent with the findings of non-stationarity in the 1990 M5 – 1993 M7 period.

One would expect that the 1993 M8 – 1998 M12 period would hold some significant differences in parity experience for the two panels. Panel A countries would have experienced coordinated monetary policy in the lead-up to EMU whilst Panel B countries would not. While RIRD's for only three Euro-area members (Belgium, France and Ireland) are examinable, there is no evidence of RIP holding for them with respect to Germany in this period. In fact Denmark and Sweden had a greater tendency toward RIP with Germany in this period with some weak evidence of stationary RIRD's at the 10 per cent significance level.

The most striking result from Table 5.3 is for the 1999 M1 – 2005 M12 period. There is significant evidence in favour of RIP between Germany, Austria, Belgium, France and the Netherlands as their RIRD's are stationary at the 95 per cent confidence level. This is in contrast with the non-Euro area countries, all of who's RIRD's are non-stationary. This can be taken as evidence in favour of the endogeneity hypothesis for the OCA criteria. The finding against RIP for the other Euro area members (Ireland, Italy and Spain) highlights an important caveat to this result. The panel unit root test should allow a more comprehensive interpretation of these results.

Table 5.3: DF-GLS Unit Root Tests - Real Interest Rate Differentials

Country	Period				
	1979m3 - 1986m4	1986m5 - 1990m4	1990m5 - 1993m7	1993m8 - 1998m12	1999m1 - 2005m12
Austria	-1.214	0.236	-1.189	-	-2.337**
Belgium	-1.451	-0.471	-1.977**	-1.561	-2.031**
France	-	-0.884	-	-1.32	-2.241**
Ireland	-1.723*	-0.968	0.292	-0.994	-1.914
Italy	-1.381	-2.176**	-1.195	-	-1.274
Netherlands	-1.934*	-2.405**	-0.804	-	-1.951**
Spain	0.096	-1.119	-0.742	-	-1.544
Denmark	-2.068**	-0.676	-1.167	-1.723*	-1.454
Sweden	-1.626*	-1.044	-0.966	-1.749*	-0.975
U.K.	-1.724*	-1.429	-1.042	-0.931	-1.804*
Critical Values					
1%	-2.601	-2.623	-2.638	-2.601	-2.61
5%	-1.95	-1.95	-1.95	-1.95	-1.95
10%	-1.61	-1.609	-1.606	-1.61	-1.61

*Notes: DF-GLS (Tμ) test statistics of the real interest rate differentials w.r.t. Germany for the key sub-periods, with critical values as per Elliot et al (1996). DF-GLS regression includes a constant. Lag length for each individual country series was selected using MAIC as per Ng and Perron (2001). ***, ** and * indicate rejection of the null hypothesis of non-stationarity at the 1%, 5% and 10% levels of significance repectively. Values excluded indicate the respective country real interest rate was found to be stationary for the time period.*

The CIPS* test statistics for the RIRD's are presented in Table 5.4. For all time periods there is no significant difference in the parity experiences of the two panels. This confirms the similar DF-GLS test results for those countries found to have non-stationary RIRD's reported above.

The result of non-stationarity for both panels in the 1993 M8 – 1998 M12 period indicates that coordinated policies by those countries in Panel A wishing to join the Euro area in the run-up to the Single Currency did not reflect itself in any greater degree of convergence as opposed to countries which remained outside the currency bloc. This finding is somewhat consistent with Fountas and Wu (1999), but contrasts with Holmes (2002) who finds evidence of RIP for some Euro area members.

The final time period is of particular interest for this paper. From Table 5.3, RIP is shown to have held for a core set of Euro area countries from 1999 M1 – 2005 M12. This was not the case for Ireland, Italy and Spain, the countries which populate Panel A during this period in Table 5.4. As part of the panel the null hypothesis of a unit root in their RIRD's is still not rejected, confirming the findings against RIP for those countries with Germany. Similarly, Panel B confirms the findings on the individual RIRD series for Denmark, Sweden and the UK, i.e. that RIP did not hold for those countries with Germany during 1999 M1 – 2005 M12 period. Given that RIP held for some core Euro-area countries and not for the non-Euro area countries over this last period is evidence in favour of the endogeneity hypothesis for the OCA criteria. However membership of the currency union in and of itself is not necessarily sufficient to induce macroeconomic convergence endogenously.

Table 5.4: Panel Data Unit Root Tests - Real Interest Rate Differentials

	Period				
	1979m3 - 1986m4	1986m5 - 1990m4	1990m5 - 1993m7	1993m8 - 1998m12	1999m1 - 2005m12
Panel A					
(N,T)	(6,98)	(5,48)	(5,39)	(3,65)	(3,84)
# Obs	568	219	183	188	246
CIPS*	-1.104	-1.308	0.681	-0.64	0.167
Panel B					
(N,T)	(2,98)	(3,48)	(3,39)	(3,65)	(3,84)
# Obs	192	137	111	184	244
CIPS*	-0.078	-0.443	0.329	-1.141	0.067
Critical Values					
1%	-2.29	-2.36	-2.44	-2.32	-2.29
5%	-2.11	-2.16	-2.22	-2.13	-2.11
10%	-2.01	-2.05	-2.1	-2.03	-2.01

Notes: CIPS Panel Data unit root tests conducted on the real interest rate differentials w.r.t. Germany for the key sub-periods together with the corresponding critical values as per Peseran (2006) Table 2b. ***, ** and * indicate rejection of the null hypothesis of non-stationarity at the 1%, 5% and 10% levels of significance repectively. Test regression includes a constant. Lag length for each individual country series was selected using the MAIC. Panel A consists of Austria, Belgium, France, Germany, Ireland, Italy, Netherlands and Spain. Panel B consists of Denmark, Germany, Sweden and the UK. For some time periods countries are excluded from their panel as their real interest rate or differential was found to be stationary using DF-GLS.*

5.3 Failure of RIP in EMU – Country Specific Issues

The findings for Ireland, Italy and Spain indicate that there are country specific issues that can seriously hinder the "automatic" integration process. Some of these country-specific issues can be highlighted by examining which assumptions underpinning RIP

(PPP or UIP) were broken for Ireland, Italy and Spain during the 1999 M1 – 2005 M12 period. Given the strong evidence in favour of increased trade as a result of forming the currency union (Rose and Engel, 2002; Micco, Stein and Ordonez, 2003) it would appear that long-run PPP is likely to hold in the European context. Also, the results of Chung and Crowder (2004) and Adjaoute and Danthine (2003) indicate that UIP is less likely to hold. However a failure of UIP in a currency union implies that the expected spot exchange rate, currently fixed between Euro area members, is anticipated to change in the future. Although nominal bond yields have converged over the period in question, real yield dispersion for some countries remain significant, which could be lending itself towards the findings for Ireland, Italy and Spain. Thus price differentials are an important factor.

Traistaru-Siedschlag (2006) has noted that temporary inflation divergence in the Euro area may be a necessary adjustment mechanism in the process of integration, while if more permanent country-specific issues drive the inflation differentials some Euro area member states may have RIR's hindering stable economic growth and impacting negatively on their competitiveness. Traistaru-Siedschlag also shows that labour market conditions, predominantly the dynamics of compensation per employee, are an important factor in the inflation divergence, particularly for Ireland. This papers' use of the WPI as a deflator aims to capture the different price constraints facing firms in the respective countries, including labour costs, and these divergences may explain the findings for Ireland, Italy and Spain. They also point to a rejection of the endogeneity hypothesis for labour market flexibility.

Honohan and Lane (2003) have shown that inflation divergence in the early years of EMU could be explained by the different exposures member states had to extra-EMU trade. If the positive effect of the single currency on intra-EMU trade intensity is muted, these divergences may be persistent.

If UIP is not holding for some Euro-area member states there is clearly a risk premium being attached to their sovereign debt, contrary to the logic of Frankel (1992). Sources of this risk premia could be attached to the labour market conditions above, or to the fiscal institutions operating in the member states. Hallerberg and Wolff (2006) find that fiscal policy remains a significant determinant of risk premia on Euro area

government bond yields and contributes strongly to differentials in bond yields. The endogeneity of financial integration is thus called into question.

An alternative reason for rejection of the endogeneity hypothesis could include heterogeneous monetary policy transmission mechanisms across the member states. This implies that a common monetary policy could in fact lead to divergence and not greater levels of convergence in the Euro area (Clausen and Hayo, 2006; Clements *et al* 2001). Further analysis of the individual member states transmission mechanisms, which of course include issues relating to labour market conditions, fiscal policies, industrial structure etc., is warranted. Also greater union-wide co-ordination in terms of labour market and fiscal policy may be necessary for country specific issues to be overcome.

6. Conclusion

This paper examined RIP in a European context. Of particular interest are the parity conditions experienced between Germany (the base) and a sample of Euro area and non-Euro area EU member states. An analysis of RIP for these two distinct groups has allowed some relevant inferences on the argument for the endogeneity of the OCA criteria to be drawn.

RIP was tested using both the DF-GLS test and the CIPS* panel data unit root test on the RIRD's with respect to Germany for five sub-periods covering 1979 M3 – 2005 M12. The final sub-period since the creation of the Euro, 1999 M1 – 2005 M12, is of particular interest in this paper. Stationary RIRD's in the presence of non-stationary RIR's is evidence in favour of a cointegrating long-run relationship between RIR's, i.e. RIP. *Ex post* RIR's were constructed by deflating Government bond yields by the WPI for each sample country. The sample countries were separated into Euro area and non-Euro area panels for the CIPS* test. The unit root tests on the RIRD's were only performed where both the domestic and German RIR was found to be non-stationary.

The results from both the DF-GLS and CIPS* tests indicate that RIP was a rare occurrence over the period 1979 M3 – 1998 M12. RIP is found to hold between Germany and Austria, Belgium, France and the Netherlands during the final period

1999 M1 – 2005 M12 using the DF-GLS test. The panel data unit root test indicates that other Euro area member states did not experience RIP with Germany during this sub-period. RIP did not hold for those EU member states not part of the Euro area during this period also. These results favour the endogeneity of the OCA criteria to some extent, with the caveat that country specific issues can hinder the integration process to such an extent that macroeconomic convergence is not solely determined by membership of EMU. Further research is necessary to examine fully the extent to which these country specific issues are temporary or persistent. This papers emphasis on longer term rates imply some persistence in these country-specific factors. Greater co-ordination of labour market and fiscal policy at a union-wide level may be warranted if some Euro area member states are to accrue the full benefits of EMU by having monetary conditions consistent with stable economic growth and competitiveness.

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