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Abstract

The motivation of this paper is to examine whether any integration has taken place within the European Union retail banking sector during 1991-2008. An important contribution of our study is the application of methodologies which have not been hitherto employed in this area. First, we test for structural breaks in the deposit and lending rates and apply cointegration tests to both the original and demeaned time series. Second, we apply panel unit root tests that allow for structural breaks. In addition, we investigate both the 1990s and the more recent period, 2003-2008, thus providing a comparison between the new millenium and the 1990s. The stochastic structural break tests have revealed the presence of mostly 3 breaks during the 1991-2002 period and 2 breaks during the 2003-2008 period in both the deposit and lending rates, with the break dates closely clustered for most countries. The results on integration depend crucially on the methodology and data employed. Overall, the evidence points towards an integrated European retail banking sector, provided that we allow for structural breaks in the deposit and lending rates and employ panel tests that have more power than the time series tests.

Keywords: European retail banking; Integration; Structural break tests; Cointegration analysis; Panel unit root tests

JEL Classification: F36, G15, C51.C52, O52

1. Introduction

Prior to the launch of the Single European Market (SEM), the banking sector in many European Union (EU) countries was rather anti-competitive with entry restrictions against foreign banks and highly segmented with the functional separation of institutions. An important objective of the SEM was to shift the strategic mindset of the EU banks from a collusive and protective environment to a more liberalised and integrated market. However, the European financial landscape is still characterised by heterogeneity across countries. This is attributed to the differences in risk attitudes, cultural differences, differences in regulation, and the home-bias criteria, among other things. Given the importance of banking integration to the future success of the Single European Market and of the Eurpean Monetary Union, there is considerable interest, in assessing the degree of integration within the European Union banking market.

The banking literature reveals that the degree of integration in the financial markets can be assessed by using a number of alternative tests.These tests can range from simple quantitative flow analysis such as the volumes of cross-border flows or the share of foreign banks, to more complex econometric methodologies which investigate convergence among various financial asset prices, such as interest rate, bond yields, savings rates, etc. Most studies[1] test for integration in the wholesale money and bond markets. So far, fewer studies[2] have tried to estimate the degree of integration in retail banking, more specifically in the traditional lending and deposit activities such as consumer credit, mortgages, small and medium sized commercial loans and demand and savings deposits.

In this paper we take the view that integration is a process whereby segmented markets become unified and open and where participants enjoy unhindered access to services and products. Financial integration would therefore relate to a market where transactions are fluid, there is a high rate of capital flows and where there is a tendency for prices and returns on financial assets to converge. In the context of the banking market, it can be argued that any convergence process, if present, should be perceived as a long-run relationship. We use time series cointegration analysis and panel unit root tests to examine the relationship between the retail deposit/lending rates of 15 EU countries over the period 1991 to March 2008. A major contribution of our paper is the testing for structural breaks in the deposit and lending rates, which are

[1] Holmes and Pentecost (1995), Lemmen (1996), Alexakis et al (1997) and others.
[2] Centeno and Mello (1999), Kleimeier and Sander (2000, 2003), Schuler and Heinemann (2002a,b)

linked to various policy events in the EU, prior to applying time series cointegration methods and panel tests.

The rest of the paper is organised as follows. Section 2 reviews previous studies in this area. Section 3 outlines the econometric methods employed in the paper, while Section 4 describes the datasets used in the empirical investigation. Section 5 presents and analyses the empirical results. The final section concludes.

2. Existing literature

Studies that attempt to measure the degree of European banking integration range from flow-based analysis to price or quantity - based analysis and rely on different types of methodologies and have been conducted under different time periods. The earlier studies (Karfakis and Moschos (1990), Katsimbris and Miller (1993)) were done in the late 1980s and early 1990s, when capital controls were still in place in most European countries. Hence, not surprisingly, the results show little evidence of convergence. In subsequent studies, (Alexakis et al (1997), Hall et al (1992), Holmes and Pentecost (1995)), the tests capture trends of convergence, mostly towards the German rate. The recent studies more specific to the banking sector, (Kleimeier and Sander, 2000, 2003, 2006; Schuler and Heinemman, 2002a), extend their tests to the retail lending market. Kleimeier and Sander (2000) investigate the integration process in the retail lending market for 6 core European countries by using a cointegration approach and corresponding error correction model. Monthly time-series data for nominal lending rates and spreads[3] are tested for the periods 1985-1990 and 1993-1997, and cointegration analysis is performed for each country vis-à-vis a weighted European average. The overall results show that the structure of the European banking system is changing rapidly and that convergence is occurring. Kleimeier and Sander (2003) perform a similar analysis on nominal and real interest rates for mortgages, consumer and corporate lending for the euro-zone countries for the period 1995 to 2002. The data sample is divided into a pre-EMU and an EMU sub-group and the individual series are tested against a weighted European average. The results obtained show very little evidence of integration in the mortgage market and consumer credit whereas the corporate lending sector shows more evidence of integration. However,

[3] The lending rates refer to the national commercial bank prime lending rate. Spreads are calculated in 2 ways: 1) nominal spreads are calculated by subtracting money market rate from the lending rate, 2) relative spreads are obtained by dividing the lending rate by the money market rate.

as the authors point out, their EMU sample analysis is based on data for only 3 years and, as such, need to be interpreted with caution.

Kleimeier and Sander (2006) extend their analysis to include a difference-in-differences approach applied to the sigma and beta convergence measures which feature in Adam *et a*l (2002)[4]. The authors look at the integration of retail lending rates in 10 Euro-zone countries against a benchmark of 8 non-Euro-zone countries including Japan, U.S. and the UK, over the period 1995-December 2002. The analysis is performed on both interest rate levels and interest rate margins for mortgage and corporate loans rates. Kleimeier and Sander (2006) also perform rolling cointegration analysis on both bilateral combinations of the series and on the series for each individual country against a weighted regional average. Their evidence is similar to that obtained by Adam et al (2002) who report convergence in corporate lending and for mortgages. The authors also report convergence in the non-euro-zone countries and conclude that the convergence in the interest rates may be a result of global rather than purely regional integration.

Schuler and Heinemann (2002a) test for integration in the retail financial market, more specifically in four lending markets and in two deposits markets by testing for bivariate and multivariate cointegration between national interest rate spreads for 11 EU countries for the period 1993 to 2003. Instead of testing for cointegration between each national retail rate and the EU average rate as in Sander and Kleimeier (2000, 2003, 2006), the study tests for cointegration between every pair of national rates. Overall, signs of integration are detected in the market for short-term and medium and long-term loans and in the time deposits markets. The markets for mortgage and consumer loans and for savings deposits are found to be fragmented.

Other studies (Murinde et al, 2000, Adam et al, 2002) draw from the growth literature to model convergence tests. Baele et al (2004) also use a convergence measure, along side a news-based approach, to test for integration in retail lending rates to enterprises, consumer credit, mortgage rates and time deposit rates over the period 1990 to 2004 for up to 11 Western European countries. The results point to a segmented short-term lending market to enterprises while the consumer credit is still highly fragmented.

[4] *Adam et al (2002)* use a convergence methodology (beta and sigma convergence measures) to test for integration in the average spreads for 3-months inter-bank rates, 10-year bond yields, mortgage rates and corporate loan rates before and after 1999.

These results are similar to those obtained by Schuler and Heinemman (2002b) and Kleimeier and Sander (2003). Dermine (2005) mainly reviews the progress in European banking through a cross-border flow analysis. Affinito and Farabullini (2006) consider the interest rate differentials for lending and deposit rates in the euro-area for the period January 2003 to March 2005. The study uses two methods; the first approach tests for stationarity between the interest rate differentials for each pair of countries while the second approach tests for equality between the estimated country coefficients. The study concludes that the average interest rates tend to be more uniform across the euro area when the customers are larger and more sophisticated such as enterprises versus households and large versus small corporations. However, inferences from unit root tests based on 27 observations are quite unreliable.

Overall, the evidence from the existing literature points to a fragmented retail market for consumer credit while some convergence is noted in the corporate lending sector. As suggested by many, limited institutional convergence in European banking and national characteristics still play a major role.

3 Empirical methodology

The starting point in our empirical investigation is to test for unit roots in the deposit and lending rates using the ADF (augmented Dickey-Fuller) test. We then test for structural breaks in the individual time series for deposit and lending rates using the Bai and Perron (1998) stochastic multiple structural break model. Given the type of variables and the time period being investigated, it is very likely that the deposit and lending rates of the 15 EU countries are subject to single or multiple structural breaks. If the data series are subject to structural change, it can lead to wrong inferences being made when testing for unit roots and cointegration. This test should also provide information on whether the banking sector is converging. Hence, once the presence of structural breaks in the data series is ascertained, each time series is then demeaned so in order to remove the effect of the structural change. Subsequently, we test for cointegration between the country and European deposit/lending rates using the Johansen (1988) method. The latter is applied to both the original and demeaned time series. Generally, cointegration tests assume that the long-run relationship between the underlying variables do not change during the period under of study. The use of the demeaned data series should therefore give more robust and reliable inferences on the convergence process in the retail-banking sector.

Moreover, in spite of the numerous initiatives towards the creation of a Single Market in banking, the fact remains that there are country-specific variables which, if not taken into consideration, can lead to serious misspecifications. To allow for the country heterogeneity factors, we also uses panel data methods. As Baltagi (2001) pinpoints out, panel data give more informative data, less collinearity among the variables, more degrees of freedom and more efficiency. Also, as argued by Banerjee and Carrion-i-Silvestre (2006), the power of the tests for unit roots and cointegration might be increased due to the combination of the information coming from the cross-section ($i=1\ldots,N$) and time dimensions ($t=1,2\ldots T$). Consequently, the Im, Pesaran and Shin (2003), and Pesaran (2007) panel unit root tests are applied to the deposit/lending rates differentials between country and European rates. The reasoning being that if convergence is present, then the panel data sets should exhibit stationarity. For the reasons explained above, the panel unit root tests are applied to both the original and demeaned time data.

3.1 Unit root test of stationarity: the Augmented Dickey-Fuller test

One of the most popular tests of stationarity is the unit root test[5]. Consider the following process

$$Y_t = \rho Y_{t-1} + \mu_t \qquad \text{where } -1 \leq \rho \leq 1 \qquad (1)$$

If Y_{t-1} is subtracted from both sides, the equation can be written as

$$\Delta Y_t = \delta \, Y_{t-1} + \mu_t \qquad \text{where } \delta = (1-\rho) \qquad (2)$$

If the null hypothesis of δ =0 is tested and found to be true, then the series has a unit root and is therefore a nonstationary stochastic process. If however, δ is negative[6], then the series is stationary. The augmented Dickey-Fuller (ADF) consists of estimating the following regression:

[5] Several unit root tests exist but these vary depending on the size [p(type I error)] and power [p(type I error) – p(type II error)] of their tests. For the DF test, size distortions may occur because this test is sensitive to the way it is conducted, i.e. as a pure random walk or one with a drift or one with a drift and trend. In addition, most DF tests have low power.

[6] Given that δ = (1-ρ), for stationarity, ρ must be <1. Hence, δ must be negative.

$$\Delta Y_t = \beta + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-1} + \varepsilon_t \tag{3}$$

where ε_t is pure white noise and $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$. The ADF test builds on the Dickey-Fuller test which tests for the null hypothesis that δ =0. However, this test assumes that the error term μ_t is uncorrelated. The ADF test on the other hand consists of adding enough lagged values of the dependant variable ΔY_t until the error term is serially uncorrelated (Gujarati, 2003). Choosing the lag length, *k*, for the ADF test is an important element of the test because on the one hand, if the number of lags chosen is too small, then the remaining serial correlation in the errors will bias the test. On the other hand, if the number of lags chosen is too large, then this may lead to over-parameterization and loss of power (Zivot, 2005 , Caporale and Cerrato, 2005). Zivot (2005) further reports that Monte Carlo experiments indicate that it is better to have too many lags than not to have enough.

The two common methods of choosing a lag length are the Akaike Information Criterion and the Schwarz Information Criterion methods. However, Caporale and Cerrato (2005) indicate that these methods tend to select a lag value which is too small. The other method that is often suggested for the lag selection, *k*, is the recursive *t*-statistic procedure proposed by Campbell and Perron (1991). This approach, as argued Ng and Perron (1995), has better power properties than the alternative methods.

The steps for conducting the recursive *t*-statistic procedure are as follows:

- Set an upper bound for the lag length, $k_{\max}$,
- Estimate the ADF regression with the maximum lag length, $k_{\max}$,
- Check whether the absolute value of the t-statistic on $k_{\max}$ is significant at the 10% two-tail normal distribution i.e. 1.645. If so, set $k = k_{\max}$ and perform the unit root test. Otherwise, drop one lag and repeat this process until the t-statistic on the lobgest lag is significant.

In this research, the method proposed by Campbell and Perron (1991) is used to select the lag length and since the data set consists of monthly series, 12 is chosen as $k_{\max}$

3.2 Structural break test

Perron (1990) [cited in Garcia and Perron, 1996], argues and proves that if there is a shift in the mean of a series because of structural change, it will be difficult to reject the null hypothesis of a unit root even if the data series appear to be integrated of order 1. Hence to overcome the problem of wrongly detecting unit root, the structural break or breaks have to be identified (Garcia and Perron, 1996). In the context of this research, it must be noted that during the period under investigation, i.e. January 1991-March 2008, there has been significant milestones[7] in the history of the European single market. Therefore it is likely that the deposit and lending rates corresponding to this period may exhibit structural changes. Furthermore, any tests for structural breaks in the European banking interest rates series would reveal the extent to which the breaks periods coincide with the important events in the European financial integration process. The research also aims at identifying the factors that are responsible for the structural breaks and finding out if there are any similarities in the break dates for the 15 EU countries. In line with the aims of this research, the Bai and Perron (1998) stochastic multiple structural break model provides a powerful and flexible framework to test for the break dates and their time of occurrence. This method tests for the presence of multiple structural breaks occurring at unknown dates and provides an estimate of the breakpoints. This methodology also allows for general forms of serial correlation, heteroskedasticity in the errors and lagged dependent variables (Bai and Perron, 1998). Drawing from the discussion in Baele (2006) and as per the methodology proposed by Bai and Perron, the interest rate is regressed on a constant, which is tested for structure breaks. The following regression model with *m* breaks (m+1 regimes) is considered:

$$r_t = \beta_j + \varepsilon_t \qquad (4)$$

For j = 1,….., m+1, where r_t is the retail deposit or lending rate in period t and β_j is the mean interest rate level in the *jth* regime. The *m* breakpoints are represented by the partition (T_1,….,T_m) and to estimate the number and timing of the breaks, Bai and Perron have set up a least square algorithm which estimates the least squares estimates of β_j by minimising the sum of squared residuals:

[7] 1992 – Maastricht Treaty, 1994-EMU second stage, 1995 –Fourth enlargement round, 1998- ECB is established, 1999- EMU third stage (Baldwin & Wyplosz, 2004)

$$S_T(T_1,....,T_m) = \sum_{j=1}^{m+1} \sum_{t=T_{I-1}}^{T_i} (r_t - \beta_j)^2 \quad (5)$$

The estimated breakpoints are given by

$$(\hat{T}_1,....,T_m) = \arg\min_{T_1,...,T_m} S_T(T_1,....,T_m) \quad (6)$$

Where the estimated betas for a given *m*-partition is given by $\hat{\beta}(T_1,...,T_m)$. Hence the breakpoint estimators represent global minimisers of the objective function (2). To minimise equation (2), Bai and Perron (2003) have put forward an algorithm that is based on the principle of dynamic programming.

In selecting the number of mean breaks (*m*), Bai and Perron (1998) propose to use the F-statistic ($SupF_T$ (k)) for testing the null hypothesis of no structural break (*m*=0) against the alternative hypothesis that there are breaks (*m*=k). Bai and Perron (1998) points out that the test is limited by the nature of the regressors and by the presence or absence of serial correlation and heterogeneity in the residuals. Based on the $SupF_T$ (k), Bai and Perron (1998) derived two double maximum tests, both testing the null hypothesis of no breaks against an unknown number of breaks, given an upper bound *M*. The first double maximum statistic is given by:

$$UD\max = \max_{1 \le m \le M} SubF_T(m). \quad (7)$$

The second test, WDmax, assigns weights to the individual F tests so that the marginal p-values are equal across values of *m*. Bai and Perron (1998) provide asymptotic critical values of both tests for up to M=5, which should be sufficient for the purpose of this research. The UDmax and WDmax tests help determine whether there are breaks or not. On the next level, Bai and Perron (1998) have developed a $SubF_T$(m+1/m) to determine the optimal number of breaks. This tests the null hypothesis of *m* breaks against the alternative *m*+1 breaks. The critical values for each test statistic $SubF_T$(m+1/m) are provided by Bai and Perron (1998). With regards to the practical implementation of these tests, Bai and Perron (2004) propose to examine the UDmax and WDmax to check for the presence of breaks. If the double maximum statistics are significant, the $SubF_T$(m+1/m) should be used to determine the number of breaks by selecting the one that rejects the largest value of *m*.

3.2.1 Demeaning of individual data series

In order to obtain robust estimates of time series and panel data unit root tests as well for bivariate Johansen cointegration, each individual deposit and lending series for the period covering January 1991 to March 2008 is demeaned and thus rendered "break-free" as follows:

$$r_t* = r_t - \hat{\beta}_j , \tag{8}$$

Where r_t* is the demeaned retail deposit or lending rate in period t, t= T_{j-1} +1,…,T_j, j=1,…..,m + 1 and $\hat{\beta}_j$ (j=1,….m + 1) is the estimated mean level of volatility in the *jth* regime.

3.3 Johansen (1988) cointegration approach

The most popular method for testing for cointegration is the Johansen (1988) multivariate cointegration approach. In a bivariate model, the number of cointegrating vectors may be zero or one (r = 0,1). The VAR representation given by Johansen is as follows:

$$\Delta \vec{Y}_t = \delta + \Gamma \Delta \vec{Y}_{t-1} + ... + \Gamma_{k-1} \Delta \vec{Y}_{t-k+1} + \Pi \vec{Y}_{t-1} + \vec{\varepsilon}_t \tag{9}$$

Where

$\vec{Y}_t$ = $(Y_t, X_t)'$,

Γ = -(1-Π_1-Π_2-….Π_j), j=1,….,k-1 k= lag length

Π = -(1-Π_1-Π_2-…..-Π_k)

$\vec{\varepsilon}_t$ = $(\varepsilon_{1t}, \varepsilon_{2t})'$

Assuming that $\vec{Y}_t$ is a vector of I(1) variables with *r* linear combinations of $\vec{Y}_t$ being stationary, the matrix Π can be re-written as

$$\Pi = \gamma\beta' \tag{10}$$

where β denotes the matrix of cointegration vectors, while γ is the matrix of weights or the adjustment matrix.

Johansen's (1988) approach estimates equation (9) by maximum likelihood while imposing the restrictions in (10) for a given value of *r*. In order to test for the number of significant characteristic roots, Johansen (1988) developed a likelihood ratio statistic for the null hypothesis that there is at most *r* cointegrating vectors which is given by

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \tag{11}$$

where $\hat{\lambda}_{r+1}, \ldots, \hat{\lambda}_n$ are the (n-r) smallest eigenvalues of the determinant equation and *r* is the number of roots above which the remaining roots are significant. This test is known as the trace test and checks whether the smallest k-r_0 eigenvalues are significantly different from zero.

The other likelihood ratio test by Johansen (1988) is the maximum eigenvalue test which tests the null hypothesis of *r* cointegrating vectors against the alternative hypothesis of $(r+1)$ cointegrating vectors and is given by

$$\lambda_{\max} = -T \ln(1 - \hat{\lambda}_{r+1}) \tag{12}$$

The next step in applying the Johansen method is the selection of the maximum order of lag length for the VAR. Just like for the ADF test, the inclusion of too few lags may result in rejecting the null hypothesis too easily. Hence, the optimal lag length is selected based on the Akaike Information Criterion (AIC).

It should be pointed out that the Johansen approach is generally considered as a better estimation technique than the Engle and Granger method. However, it has been observed that this method does not perform very well in small samples and is sensitive to variables selection and to the number of lags included (Maddala and Kim, 1998).

3.4 Panel unit root tests

Over the past decade, several time series unit root tests have been extended to panel data. The most popular ones are the studies by Levin and Lin (1992, 2002), Hadri (1999), Im, Pesaran and Shin (2003) and Pesaran (2007). The panel unit root tests developed by Levin and Lin (1992) tests for the null hypothesis that each series in the panel contains a unit root, i.e. H_0: ρ =1 versus the alternative hypothesis that all individual series in the panel are stationary, i.e. H_1: ρ <1. This method assumes that 1) the coefficient of the lagged dependent variable is homogeneous across all the cross-section units of the panel and 2) the individual processes are cross-sectionally independent (Baltagi, 2001). Hadri (1999) proposes a residual-based Lagrange Multiplier (LM) test for the null hypothesis that the time series for each country are stationary around a deterministic trend against the alternative hypothesis of a unit root in panel data. In this research, the panel unit root tests developed by Im, Pesaran and Shin (2003) and Pesaran (2007) are used to test whether the difference between each country deposit or lending rate and the corresponding European deposit/lending rate is stationary. The presence of stationarity would support the hypothesis of convergence between the EU retail banking savings and lending rates.

3.4.1 The Im *et al* (2003) IPS panel unit root test

The Im, Pesaran and Shin (IPS) unit root test is chosen because it does away with the restrictive assumption in the Levin and Lin test that requires ρ to be homogeneous across *i*. The IPS test allows for a heterogeneous coefficient of $y_{i,t-1}$ and proceeds to compute an average of the ADF tests for each series within a dynamic panel. This is referred to as the *W-stat* test. The test allows for residual serial correlation and heterogeneity of the dynamics and error variances across groups.

The IPS framework assumes a stochastic process, y_{it}, which can be represented by ADF (without trend) as follows:

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \sum_{j=1}^{p_i} p_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \qquad (13)$$

The null hypothesis[8] is

[8] Note that in the case that the null hypothesis is rejected, the results do not provide any information on the identity of the particular panel members for which H_0 is rejected.

$H_0 : \beta_i = 0$ for all i

And the alternative hypothesis is

$H_1 : \beta_i \prec 0$,   i = 1,2,…..,N

The first step in the IPS unit root test is the t-bar statistic which is formed as an average of the individual t statistic for testing β_i=0 and is written as

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}(p_i) \tag{14}$$

Where t_{iT} are the individual ADF t-statistics for the unit root tests and p_i is the lag order in the ADF regression.

Th second step in the IPS test is the standardised *t*-bar statistics, the Z_{tbar} which assumes that as T $\rightarrow \infty$, the individual ADF statistics converge to η_i , the Dickey-Fuller distribution.

The test is given as

$$Z_{tbar} = \sqrt{N(T)}\frac{\bar{t}_{NT} - E(t_{iT})}{\sqrt{Var(t_{iT})}} \tag{15}$$

Where critical values for $E[t_{iT}(p_i,0)]$ and $Var[t_{iT}(p_i,0)]$ are obtained by Monte Carlo simulations.

The IPS test was subjected to various Monte Carlo simulations and the main findings reported by the authors are that when there are no serial correlation, the *t*-bar test performs very well even when T=10. However, when the disturbances in the dynamic model are serially correlated, the *t*-bar test procedures requires that both T and N are sufficiently large. In this research, T=144 and 63 and N=15. In addition, Im et al (2003) argue that in the presence of serially correlated errors, it is critical not to underestimate the order of the underlying ADF regressions. In the simulations conducted, the authors found that if a large enough lag order was selected for the underlying ADF regressions, the performance of the *t*-bar test was reasonably satisfactory (Im *et al*, 2003).

3.4.2 Pesaran's (2007) CIPS unit root test

One of the assumptions of most of the panel unit root tests, including that of Im et al (2003) is to assume that the individual time series in the panel are cross-sectionally independently distributed. To circumvent this restrictive assumption, it has been common practice to apply cross-section demeaning before running the panel unit root tests. However, as reported by Pesaran (2007), this approach is not effective when pair-wise cross-section covariances of the error terms differ across the individual series. In order to address this problem, Pesaran (2007) proposes a panel unit root test which allows for cross-sectional dependence by augmenting the ADF regressions with the cross section averages of lagged levels and first-differences of the individual series. Once the averages of the individual cross-sectionally augmented ADF statistics (termed as CADF) are computed, standard panel unit root tests, such as a modified IPS (2003) [termed as CIPS], can then be applied.

The CADF regression is described as:

$$\Delta z_{it} = a_i + b_i z_{i,t-1} + c_i \bar{z}_t + d_i \Delta \bar{z}_t + e_{it} \tag{16}$$

Where $\bar{z}_t = N^{-1} \sum_{i=1}^{N} z_{it}$ is the cross-section mean of z_{it}

The test for the null hypothesis $H_0 : \beta_i = 0$, for all *i*, against $H_1 : \beta_1 < 0; \beta_{N0} < 0, N_0 \leq N$, is given by the average of the individual CADF statistics, i.e. the CIPS test:

$$CIPS\,(N,T) = N^{-1} \sum_{i=1}^{N} t_i (N,T) \tag{17}$$

Where $t_i(N,T)$ is the cross-sectionally augmented Dickey-Fuller statistic for the i^{th} cross section unit given by the *t*-ratio of the coefficient of $z_{i,\ t-1}$ in the CADF regression The distribution of the CIPS test is non-standard and the critical values for 1%, 5% and 10% have been tabulated by Pesaran (2007) for different combinations of N and T.

3.4.3 Diagnostic test for cross-section dependence in the panel datasets

Before applying the CIPS test, it is useful to test whether cross-section dependence in the panel sets is actually present. The diagnostic test developed by Pesaran (2004) is chosen as this test is applicable to a variety of panel data models, including unit root heterogeneous panels. Pesaran's (2004) cross-section dependence (CD) test is based on the average of all pair-wise correlation coefficient of the Ordinary Least Squares residuals from the individual regressions in the panel. The CD test can be used to test for cross-section where 1) there is a fixed order *p*, or 2) no ordering of the cross section units is assumed. Pesaran (2004) also proves that the CD test is robust to single or multiple breaks in the slope coefficients and/or in the error variances of the individual regressions. The null hypothesis considers zero cross-dependence in the panel while the alternative considers the opposite. The CD test has a standard normal limiting distribution and is computed as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} Corr\,(\hat{\varepsilon}_i, \hat{\varepsilon}_j)\right) \Rightarrow N(0,1) \qquad (18)$$

$\hat{\varepsilon}_i$, i=1,….N, is a (Tx1) vector of estimated residuals.

4 Data sets and variable definitions

Four data sets have been compiled for the purpose of this research. The first one contains monthly short-term retail deposit rates for 14 EU countries for the period January 1991 to December 2002. The majority of the deposit data has been sourced from the ECB's (European Central Bank) database entitled "National Retail Interest Rates" and some missing data has been supplemented by data from the IMF, the Central banks and Datastream. The ECB discontinued this database in 2002 and replaced it by a more harmonised database entitled "MFI Interest rates" which starts in 2003 and runs to-date. Accordingly, a second data set has been compiled for the same type of deposit rates (short-term maturities) for the period starting January 2003 to March 2008 and includes 15 EU countries. The bulk of the data series in the second data set has been sourced from the ECB's database and the remaining data supplemented by data obtained from central banks. The third and fourth data sets contain monthly short-term lending rates to enterprises for the same countries and for the same periods, i.e. 1991-2002 and 2003-2008. The majority of the lending data has been sourced from the ECB's "National Retail Interest Rates" and "MFI Interest rates" databases and some missing data has been supplemented by data from the IMF, the Central banks and Datastream. Additional information on the data series is provided in Appendix A.

In order to test for cointegration, two sets of European average deposit and lending rates were constructed using as weights the share of each country's GDP in the total EU 14 or 15 GDP (all measured in Euros)[9]. For the 1991-2002 data series, the 1998 GDP figures were used to construct the weights, whereas for the 2003-2008 data series, the 2005 GDP figures were used. These weights are shown in Appendix B.

5 Empirical results

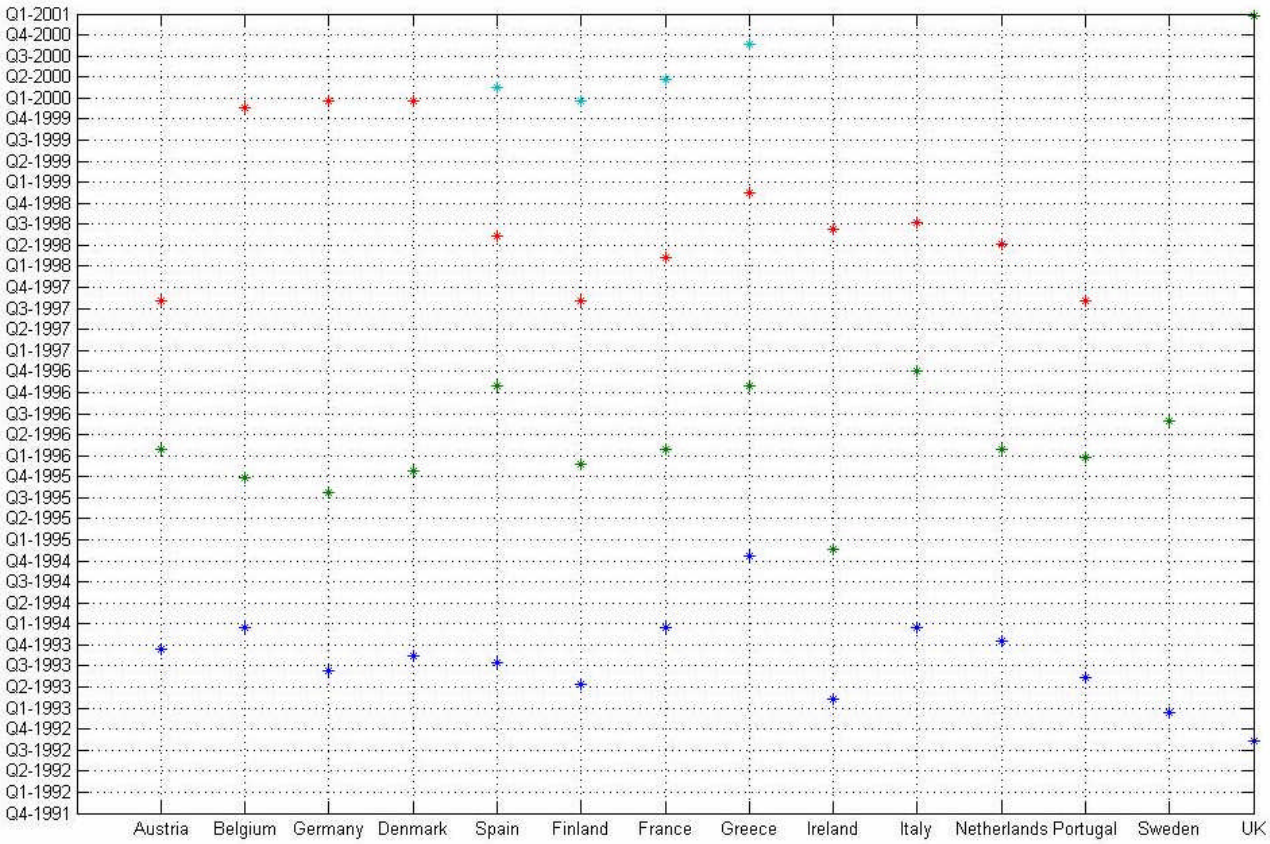
The tables for the ADF statistics are reported in Appendix C. The ADF unit root tests show that all the deposit and lending banking rates for the EU countries have a unit root in both sample periods. Therefore, these variables can be entered in a cointegration relationship. The next step in the analysis involves testing for structural breaks in all the four data sets.

5.1 Structural break tests in the European deposit and lending rates

The Bai and Perron (1998) structural break tests have been conducted using Perron's[10] GAUSS program and have been conducted in OxEdit[11]. The Bai and Perron (1998) *UD*max and *WD*max and the $SupF_T(m+1|m)$ statistics are reported in Appendix D, Tables 1 to 4. For all the deposit and lending rate series for the periods 1991-2008, the *UD*max and *WD*max indicate the presence of mean breaks. The $SupF_T(m+1|m)$ statistics suggest a selection of 2 to 4 breaks for the deposit and lending rates for the period 1991-2002 and the selection of predominantly 2 breaks for the period 2002-2008[12]. The break-dates for the EU countries are charted below.

[9] For an application of this methodology to the construction of European weighted average interest rates see, among others, Kleimeier and Sander (2003, 2006). This methodology is based on the OECD 'weighting scheme for aggregate measures'.
[10] The GAUSS program is available from Pierre Perron's home page at http://econ.bu.edu/perron/.
[11] Available from from J.A. Doornik, 1994-2006
[12] The actual break-dates are listed in Appendix E, Tables 1-4.

Chart 1: Structural break-dates for the deposit rates of the EU countries between 1991 and 2002

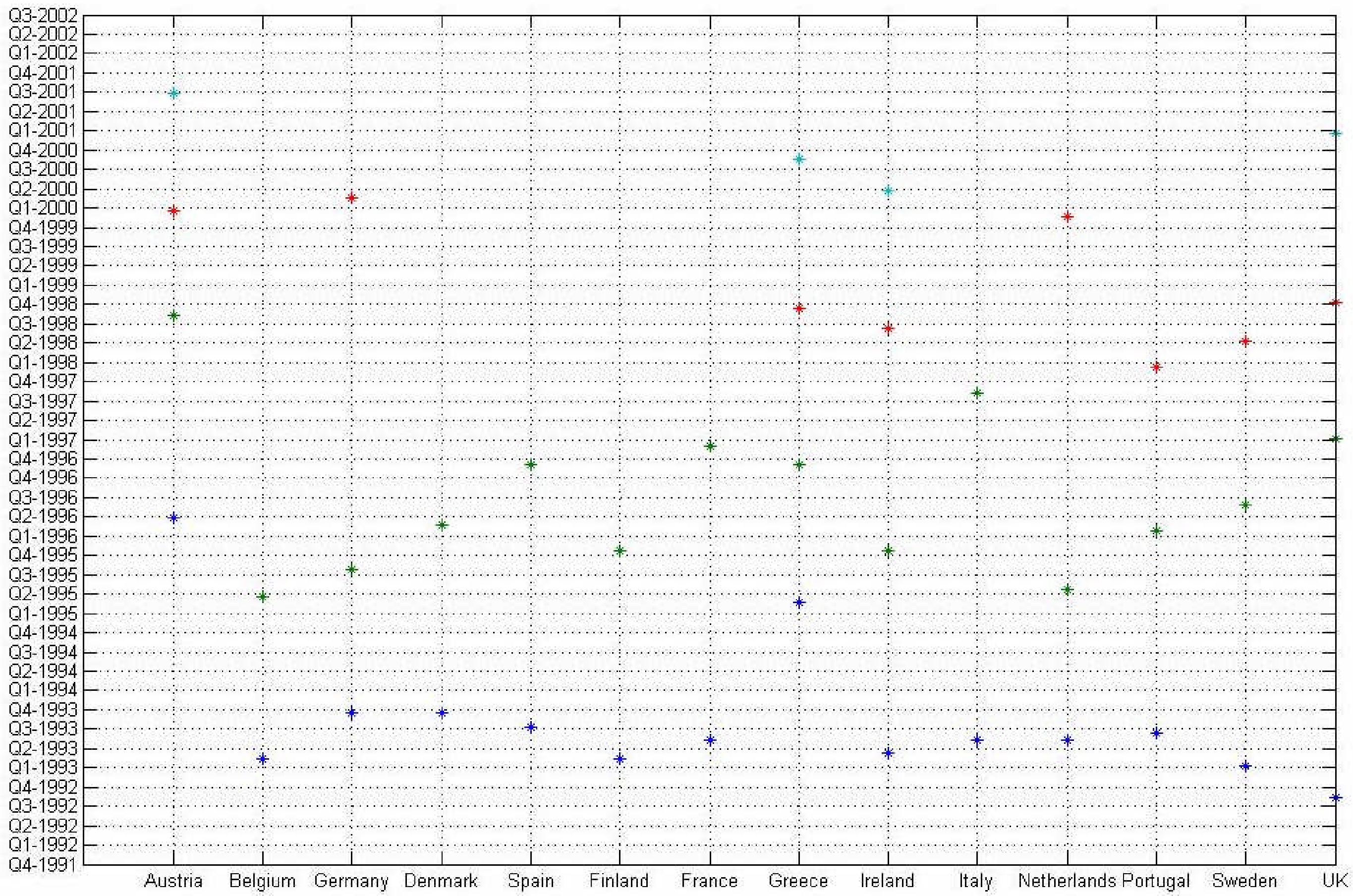


The structural break test results have produced some interesting findings with regards to the deposit rates for the period 1991- 2002. The testss for half of the EU countries yielded 3 breaks while the rest of the countries had either 4 or 2 breaks. From the above chart, it can observed that the break dates are clustered around similar times. For instance, the first break for nine[13] out of the fourteen countries occur mostly in the second and third quarters of 1993. Belgium, France and Italy have their first break in January 94 while for Greece, it occurs in November of the same year. The second break date for eleven[14] EU countries is clustered around quarters 4 of 1995 and quarters 1 and 4 of 1996. The third structural break in the data occurs in quarter 4 of 1997 for Austria, Portugal and Finland and is clustered around the second and third quarters of 1998 for France, Netherlands, Spain, Ireland and Italy. For the remaining countries exhibiting a third break, namely, Belgium, Germany, Denmark, it occurs in the first quarter of 2000. France, Spain and Portugal and Greece have a fourth break in the same year. To sum up, the deposit rates for most of the EU countries yielded a

[13]Austria, Sweden, Ireland, Finland, Portugal, Germany, Spain, Denmark and Netherlands
[14] Austria, Germany, Denmark, Finland, and Belgium in 1995 and France, Portugal, Netherlands, Sweden, Spain and Greece in 1996.

first break in 1993/94, a second break in 1995/96 and a third and/or fourth break in 1997/98 and/or 2000.

Chart 2: Structural break-dates for the lending rates of the EU countries between 1991 and 2002

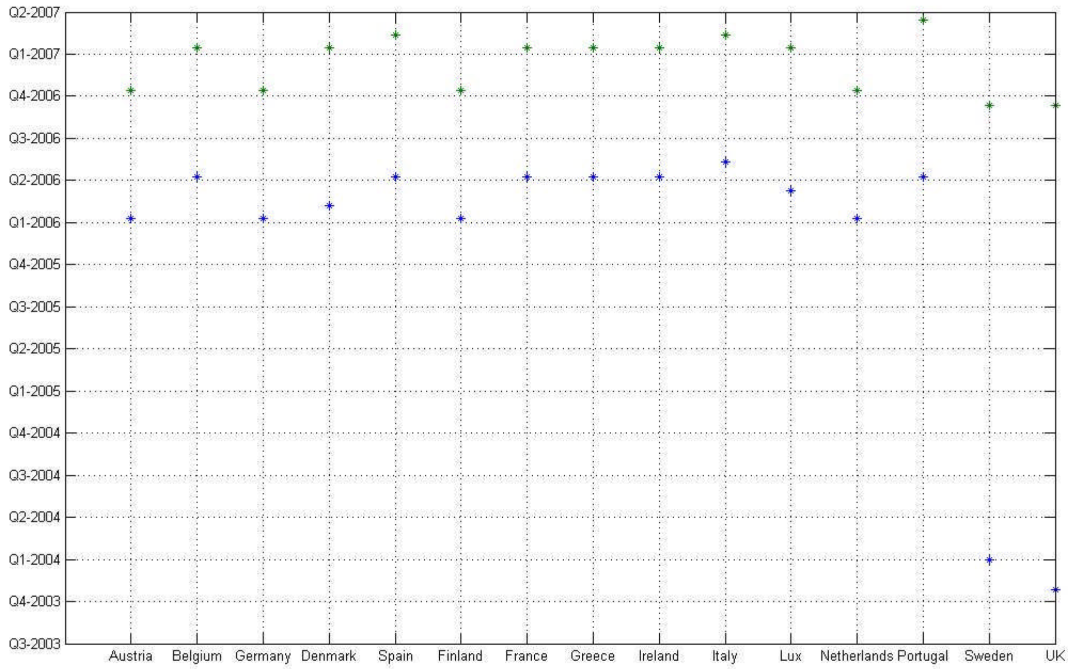


With regards to the lending rates for the 15 EU rates during the period 1991 to 2002, eight of the EU countries have exhibited 3 or 4 breaks while the remaining six countries have 2 breaks. Once more, the results for the break dates are clustered around similar times. The first break occurs in 1993 for eleven countries. For the remaining three, it occurs in 1992 (UK), in 1995 (Greece) and 1996 (Austria[15]). The second break for most of the eleven above countries except for Austria, France and Italy but now including Greece occurs in 1995/1996. France, Italy and the UK have their second structural break in 1997. The third structural break occurs in 1998 for four[16] of the countries, while for the UK it happens in early 1999. For Netherlands and Germany, the third break occurs in 2000, while in the same year Ireland and Greece had their 4th break. The UK data exhibits a fourth break in early 2001 while Austria

[15] Data for Austria starts in April 1995.

has its fourth break in September 2001. It can be observed that the occurrence of the structural breaks for the lending rates show very similar patterns to the break dates for the deposit rates.

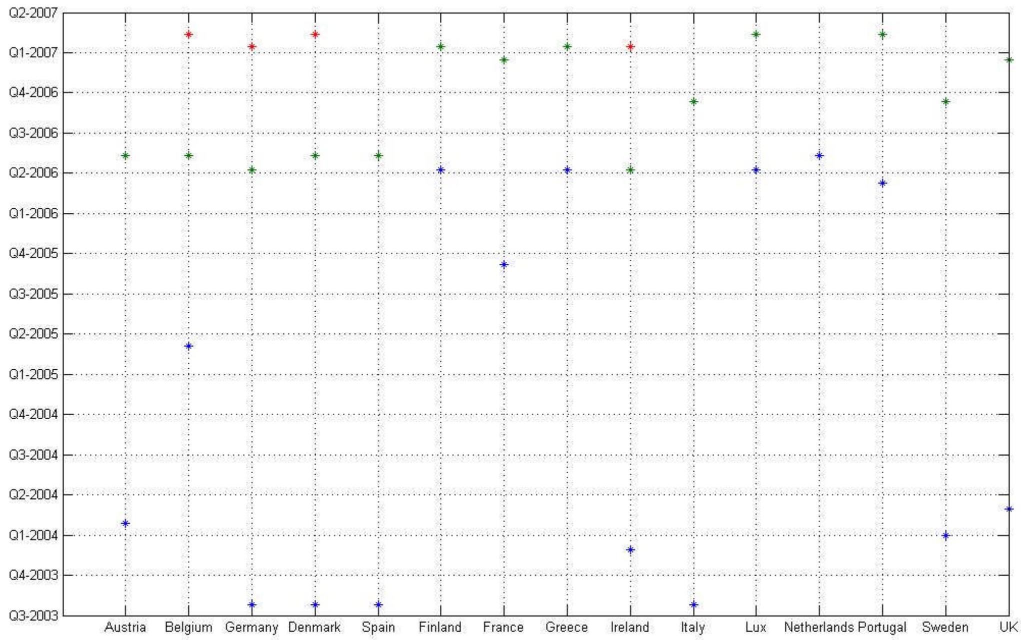
Chart 3: Structural break-dates for the deposit rates of the EU countries between 2003 and March 2008



For the period 2003 to 2008, the deposit rates data for all the 15 EU countries yielded 2 structural breaks, which are very closely clustered around certain dates. Thirteen of the countries have a first break between February to June 2006. For the other two countries, Sweden has a first break in February 2004 while the UK data shows a break in December 2003. Six of the countries[17], have their second structural break in October/November 2006 while the remaining nine countries have their second break between February- April 2007. It is very interesting to note that most of the data showed a specific break in February/May 2006 and February/March 2007.

[16] Portugal, Sweden, Ireland and Greece
[17] Austria, Germany, Finland, Netherlands, Sweden and the UK.

Chart 4: Structural break-dates for the lending rates of the EU countries between 2003 and March 2008



The 2003-2008 data series exhibited 3 structural break dates for six of the EU countries and 2 breaks for the remaining nine countries. The first break for the 15 countries are scattered across the time-line yet clustered around specific dates. For instance, four countries, namely, Spain, Denmark, Germany and Italy, have their first break in September 2003; Ireland, Sweden, Austria and UK have theirs in the first half of 2004; Belgium and France have a break in 2005 while the remaining five, i.e. Portugal, Finland, Greece, Luxembourg and Netherlands, have a first break between April and June 2006. The second structural break for all the 15 countries either occurs in 2006 or in 2007. Eight countries[18] have their second breaks in either May or June or October 2006 and the remaining seven countries[19] have their second break between January-May 2007. During the same period, Ireland, Germany, Belgium, Denmark, Austria and Spain have their third structural break. Again, what is noteworthy is that the breaks for most of the countries are clustered around May-October 2006 and January-May 2007.

One logical explanation for the break dates in the European deposit and lending rates is that they are the result of key events in the history of the EU. Table 5 in Appendix

[18] Germany, Ireland, Denmark, Austria, Belgium, Spain, Italy and Sweden
[19] France, UK, Finland, Greece, Portugal, Luxembourg and Netherlands

E attempts to match up the break dates with the events that may have led to their occurrence.

5.2 Cointegration test results

We have used the Johansen VAR cointegration model with intercept but no trend. The lag order for each VAR model, which includes each country's deposit/lending rate and the corresponding European deposit/lending rate, is selected according to the Akaike Criterion. The cointegration analysis has been performed on both the original and demeaned data. The trace and maximum eigenvalue test statistics are obtained at the 1% and 5% significance level and are reported in Appendix F.

5.2.1 Cointegration results for the deposit rates [1991-2002]

The results obtained display some interesting findings. The presence of cointegration was detected in the original deposit data for 7[20] out of the 14 countries. But when we used the demeaned deposit data, significant cointegration was found for 8[21] countries while for the remaining 6 countries, no cointegration was observed. The deposit series for four countries, namely Denmark, Spain, Finland and Netherlands showed no cointegration in both level and demeaned data while the series for Austria, France and Italy showed the presence of cointegration when demeaned data were analysed as opposed to level data.

5.2.2 Cointegration results for the deposit rates [2003-2008]

Our findings show that cointegration between the European average deposit rate and the deposit rates for 8[22] out of the 15 countries was evident irrespective of whether we use the original or demeaned data. However, the composition of countries that have one cointegrating equation differ with respect to original and demeaned data. For instance, the tests for Austria, Denmark, Finland, Luxembourg and Portugal show cointegration only when using demeaned data but not original data, whereas tests for Spain, France, Italy, Sweden and the UK show cointegration in the original but not the demeaned data.

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[20] BE, DE, GR, IE, PT, SE, and UK.
[21] AT, BE, DE, FR, IE, IT, SE and UK
[22] BE,DE, ES,FR,IT,NL, SE, UK (level data) and AT,BE, DE, DK, FI, LUX, NL, PT (demeaned data)

5.2.3 Cointegration results for the lending rates [1991-2002]

The tests indicate the presence of cointegration in the lending data for 5[23] out of the 14 countries. However, when the Johansen cointegration test was run on the demeaned data, significant cointegration was found between the European average lending rate and the lending rates for 9[24] countries. The interesting finding here is that the tests for Belgium, Denmark, Finland, Ireland, Italy, and the UK only showed evidence of cointegration when their demeaned series were used.

5.2.4 Cointegration results for the lending rates [2002-2008]

The results show evidence of significant cointegration between the European average lending rate and the lending rates for 7[25] out the 15 countries when using the original data. But interestingly, the number of significant cointegrating relationships rises to 13[26] countries once demeaned data were used. This finding adds more weight to the argument that in the presence of structural change, the data series need to be demeaned before any significant analysis can be performed.

Overall, the Johansen cointegration tests does not reject the presence of long-run cointegration between most of the individual EU member countries' rates and the European average rate, especially with regards to the lending rates. It can be observed that the data for some countries, namely Denmark, Finland, Spain and France show no cointegration almost consistently across the 8 data sets. The fact the Denmark and Finland do not belong to the Euro-area can explain this fact. However, it is surprising that Spain and France show similar results. In addition, the cointegration analysis has revealed that results obtained differ on the basis of whether original or demeaned data are used.

5.3 Panel unit root results: IPS (2003) test

The IPS results obtained for the original and demeaned panel data, reported in Appendix G, Table 1, differ significantly. For the deposit rates (difference between country rates and the European rate), the null hypothesis of a unit root in the whole panel of EU countries is rejected both for the original and demeaned series in the first sample period (1991-2002), though the rejection is stronger for the demeaned data. But for the more recent sample period, 2003-2008, the null hypothesis is rejected

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[23] AT, ES, GR, PT, SE
[24] AT, BE, DK, FI, GR, IE, IT, SE, UK
[25] AT, DE, ES, GR, LUX, NL, UK
[26] AT, DE, DK,ES, FI, FR, GR, IE, IT, LUX, PT, SE, UK.

(even at the 1% significance level) only when we use the demeaned data. These results indicate that the difference between each country deposit rate and the European weighted average deposit rate is stationary in the whole panel of EU countries for both sample periods when demeaned data are used, but only in the first period when the original data are used.

The results for the lending rates (difference between country rates and the European rate) show an even more marked difference than for the deposit rates. When we use the original data, the null hypothesis of a unit root in the whole panel of EU countries cannot be rejected for both sample periods. But when we use the demeaned data, the null hypothesis is strongly rejected, even at the 1% significance level, both for the 1990s and the more recent period 2003-2008. This supports the argument that the presence of structural breaks can lead to wrong inferences being made with regards to unit roots. The presence of stationarity in the whole panel, when the demeaned series are used, indicates convergence in the short-term lending markets for the EU countries.

5.4 Cross dependence in the error terms test results [Pesaran's (2004) CD test]

Before applying the CIPS statistics, the deposit and lending rate panel data sets are tested for cross-section correlations by using the Pesaran (2004) diagnostic test. The results are tabulated in Appendix G, table 2. The CD test statistics show that there is indeed cross-dependence in both the deposit and lending panel datasets, irrespective of whether $p = 1, 2, 3$ or 4. This, therefore, justifies the need to apply the CIPS panel unit root test.

5.5 Panel unit root results: Pesaran's (2007) CIPS test

The results for the CIPS test for the panel of differences between each country deposit or lending rate and the corresponding European weighted average deposit/lending rate, both for the original and demeaned data, are shown in Appendix G, Table 3. The statistics are based on an autoregressive process including an intercept term only.

The statistics reject the null hypothesis of a unit root in the whole panels of EU deposit and lending rates during the 1990s, irrespective of whether we use the original or the demeaned data. It is interesting to note, however, that the pattern changes significantly when we move to the more recent sample period, 2003-2008. When using the original data, the null hypothesis of a unit root in the EU panels of deposit and lending rates cannot be rejected. But the null hypothesis is strongly rejected for both EU panels of deposit the lending rates, even at the 1% significance level, when using demeaned data. This reinforces the need to perform unit root analysis on demeaned data when the presence of structural breaks has been detected. The overall CIPS tests results, based on the demeaned data, suggest convergence in the EU deposit and lending markets for both sample periods.

6 Conclusions

The motivation of this paper is to examine whether any integration has taken place within the European Union retail banking sector during the period 1991-2008. Using monthly data, we investigate the integration process in both the retail deposit and lending markets. An important contribution of our study is the application of methodologies which have not been hitherto employed in the literature on European banking integration. First, we test for structural breaks in the deposit and lending rates using recently developed stochastic tests and apply cointegration methods to both the original and demeaned time series. Second, we apply panel unit root tests, which have more power than the time series tests, while also allowing for structural breaks. Thirdly, we investigate both the 1990s and the more recent period, 2003-2008, thus providing a comparison between the new millenium and the 1990s.

The stochastic structural break test analysis has revealed the presence of mostly 3 breaks that occur during the 1991-2002 period in both the deposit and lending rates. It has been possible to cluster several of the 14 EU countries based on the break-dates. The data for the 2003-2008 period show the occurrence of mainly 2 breaks. In this case, the break dates are even more closely clustered for most of the 15 EU countries. An attempt has also been made to find the possible reasons for the break dates and indeed, it has been found that key events such as the introduction of the euro or the adoption of new financial legislation could possibly have had an impact on the interest rates. In fact, practically all of the deposit and lending series have had structural breaks during the period February to October 2006 and January to March 2007. This coincides with the introduction of a Services Directive.

Two econometric results warrant special mention. First, the empirical results obtained from the original data are in line with the previous literature that shows a segmented

European retail banking sector. However, the evidence on retail banking integration in Europe is stronger when we use data that allow for structural breaks. This reinforces the argument that the presence of significant structural breaks can lead to wrong inferences from cointegration and unit root tests, unless the tests are perfomed on the demeaned data. So our conclusions will be based on the latter data.

Second, the results obtained from the time series and panel data differ significantly. The cointegration tests based on the time series data provide mixed evidence on retail banking integration in Europe. In the case of deposit rates, only 8 out of 15 countries show convergence in both sample periods, though the composition of countries differs between the two periods. These results imply that integration in the deposit market is still limited. The picture was roughly the same in the short-term lending market during the 1990s, with only 9 countries showing convergence. But integration in the lending market has gained enourmous momentum during the new millenium, with 13 out of 15 counties showing significant convergence.

On the other hand, the panel unit root tests provide strong evidence of integration in both the deposit and lending markets for both the 1990s and the more recent period, 2003-2008. These tests show that the differences between the country deposit rates or lending rates and the corresponding European deposit or lending rate are stationary for the whole panel of EU countries during both sample periods.

Overall, the evidence points towards an integrated European retail banking sector, provided that we allow for structural breaks in the deposit and lending rates and employ panel tests, which have more power than the time series tests and also allow for heterogeneity across countries.

References

Adam K., Jappelli T., Menichini A., Padula M., Pagano M. (2002) Analyse, compare and apply alternative indicators and monitoring methodologies to measure the evolution of capital market integration in the European Union, *Centre for Studies in Economics and Finance, University of Salerno,* January.

Affinito M. and Farabullini F. (2006) Does the law of one price hold in retail banking? An analysis of national interest rate differentials in the euro area, *Bank of Italy, Economic Research Department,* August

Alexakis P., Apergis N. and Xanthakis E. (1997) Integration of international capital markets: further evidence from EMS and non-EMS membership, *Journal of International Financial Markets Institutions and Money* Volume 7,Issue 3.

Baele L., Fernando A., Hordahl P., Krylova E., and Monnet C. (2004) Measuring financial integration in the Euro area, *ECB Occasional Paper Series,* /No. 14, April

Baele L. (2006) Real interest rates in an integrating Europe, *Tilburg University, CentER and Netspar*, February version.

Bai J., Perron P. (1998) Estimating and testing linear models with multiple structural changes, *Econometrica*; Vol. 66, No. 1, pp. 47-68

Bai J. and Perron P. (2003) Computation and analysis of multiple structural change models, *Journal of Applied Econometrics* 18, 1-22

Bai J. and Perron P. (2004) "Multiple structural change models: a simulation analysis" *Working Paper*, Boston University, October.

Baldwin R. and Wyplosz C. (2004) *The Economics of European Integration*, McGraw Hill

Banerjee A. Carrion-i-Silvestre J. (2006) Cointegration in panel data with breaks and cross-section dependence, *Working Paper Series No. 591,* ECB

Baltagi B. H. (2001) *Econometric analysis of panel data*, 2nd Edition, John Wiley & Sons Ltd.

Campbell, J., Perron, P., (1991) Pitfall and opportunities: what macroeconomists should know about unit roots, *NBER Macroeconomics Annual*, pp. 141− 201.

Caporale, G., and Cerrato M. (2005), "Panel Data Tests of PPP: A Critical Overview", forthcoming in *Applied Financial Economics*, Special Issue on PPP.

Carrion-i-Silvestre J. L. and Sansó A. (2006) Testing the null of cointegration with structural breaks, *Oxford Bulletin of Economics and Statistics,* Volume 68, Issue 5, pp 623-646, October.

Centeno and Mello (1999), "How Integrated are the Money Market and the Bank Loans Market Within the European Union?, *Journal of International Money and Finance, volume* 18.

Dermine J. (2005) European Banking Integration: Don't Put the Cart before the Horse, *Cross-Border Banking, Regulatory Challenges Conference*, 6-7 October, Federal Reserve Bank of Chicago.

Garcia R., Perron P. (1996) An analysis of the real interest rate under regime shifts, *Review of Economics and Statistics*, Vol. 78, pp. 111-125.

Gujarati D. (2003) *Basic econometrics,* London, McGraw Hill

Groen, J.J.J. and F. Kleibergen (2003) Likelihood-Based Cointegration Analysis in Panels of Vector Error Correction Models, Journal of Business and Economic Statistics 21, 295–318.

Hadri K. (1999). Testing For Stationarity In Heterogeneous Panel Data, *Research Papers 1999_04*, University of Liverpool, Department of Economics and Accounting.

Hall, S.G, Roberston D., Wickens M.R.,(1992) "Measuring convergence of the EC economies" In *The Manchester School*, Vol LX supplement.

Holmes M.J and Pentecost E.(1995) Changes in the extent of financial integration within the European Community between the 1970s and 1980s, *Applied Economics Letters* No. 6 Vol.2.

Im, K. S., Pesaran, M. H. and Shin, Y. (2003) Testing for unit roots in heterogeneous panels, *Journal of Econometrics*, 115, 53–74.

Johansen, S. (1988) Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control* 12, 231-254.

Johansen, S. (1991) Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica* 59, 1551-1580.

Karfakis C. J. and Moschos D. M. (1990) Interest rate linkages within the European monetary system: A time series analysis In *Journal of Money, Credit, and Banking,* Vol. 22, No.3, August.

Katsimbris G. M. and Miller S. M. (1993) Interest rate linkages within the European monetary system: Further analysis. *Journal of Money, Credit, and Banking,* Vol. 25, Issue 4, November, pp 771-779.

Kleimeier S. and Sander H. (2000) Regionalisation versus globalisation in European financial market integration: Evidence from co-integration analysis, *Journal of Banking and Finance,* 24, 1005-1043

Kleimeier S. and Sander H. (2003) European financial market integration: Evidence on the emergence of a single eurozone retail banking market. *Research in Banking and Finance,* 3, 13-91

Kleimeier S. and Sander H. (2006) Regional versus global integration of euro-zone retail banking markets: Understanding the recent evidence from price-based integration measures. *The Quarterly Review of Economics and Finance*, 46, 353-368

Lemmen Jan (1996) *Financial Integration in the European Union: Measurement and Determination*, Center for Economic Research, Tilburg University

Levin A., Lin F. and Chu C. (2002) Unit root tests in panel data: asymptotic and finite-sample properties, *Journal of Econometrics* 108, pp. 1–24

Levine, A. and Chien-F. Lin. (1992) Unit Root Test in Panel Data: Asymptotic and Finite Sample Properties", *Discussion Paper No: 92-93*, University of California at San Diego.

Maddala G.S., Kim In-Moo (1998) *Unit roots, cointegration, and structural change* Cambridge University Press

Murinde V., Agung J. and Mullineux A. (2000) Banking system convergence in Europe, *University of Birmingham*, September. [www.eco.rug.nl/ccso/download/murinde.pdf]

Ng and Perron (1995) Unit root tests in ARMA models with data-dependent methods for the selection of the truncation lag, *Journal of the American Statistical Association* Issue 90, pp 269-281

Pesaran, M.H., (2004) General Diagnostic Tests for Cross Section Dependence in Panels, *Cambridge Working Papers in Economics*, No. 435, University of Cambridge, and CESifo Working Paper Series No. 1229.

Pesaran, M. H., (2007) A simple panel unit root test in the presence of cross-section dependence, *Journal of Applied Econometrics*, 22(2), pp. 265-312.

Schuler and Heinemann (2002a) How integrated are European Retail financial markets? A cointegration analysis, *In ZEW*, Germany. [ftp://ftp.zew.de/pub/zew-docs/dp/dp0222.pdf]

Schuler and Heinemann (2002b) Integration benefits on EU retail credit markets-evidence from interest rate pass-through, *In ZEW,* Germany. [ftp://ftp.zew.de/pub/zew-docs/dp/dp0226.pdf]

Yamagata, T., (2006) Gauss codes for computation of the CADF panel unit root test statistics proposed in Pesaran (2007). Available from: *http:www.econ.cam.ac.uk/faculty/pesaran/pub2007/CADFgauss6.zip*

Zivot E. (2005) Choosing the lag length for the ADF test, *Lecture notes*, [online] University of Washington, Available from: *http://faculty.washington.edu/ezivot/econ584/notes/unitrootlecture2.pdf* [Accessed May 2006]

Appendix A

Table 1. Additional information on the deposit rates used for the 1991-2002 period

Country	Type of deposit rate	Source
Belgium	3 months time deposit	ECB database: N8
Germany	3 months time deposit	ECB database: N8-2
Portugal	Time deposits with 31-90 days maturity	ECB database: N8-1
UK	Average deposit rate for 4 main clearing banks (91-94) + ECB N8: 90 day time deposit (95-02) [91-94 merged data]	IMF database
Italy	Average rate on savings deposits	Datastream (same as ECB N10)
Ireland	Monthly deposits for households	ECB database: N9-1
Greece	Savings accounts with commercial banks	ECB database: N9
France	3 months savings rate	ECB database: N9
Finland	Time deposits (unknown maturity)	ECB database: N8
Sweden	Savings deposits	ECB database: N8 Note: Quarterly data has been converted to monthly data using the cubic spline interpolation method
Spain	Repurchase agreement up to 3 months + synthetic rates	ECB database: N10-1
Netherlands	3 months time deposit rates	IMF database
Denmark	Current account deposits unspecified maturity	Danmarks Nationalbank
Austria	Datastream (91-94) and ECB N8 Savings a/c up to 12 months (95-02)	Datastream and ECB database:N8

Appendix A

Table 2. Additional information on the lending rates used for the 1991-2002 period

Country	Type of lending rate	Source
Austria	Short-Term [starts 95M04]	ECB database: N4
Belgium	6 months maturity	ECB database: N4-1
Germany	ST –wholesale current a/c credit	ECB database: N4
Spain	Variable rate	ECB database:N4
Finland	Medium-LT lending to enterprises /no maturity breakdown	ECB database: N5
France	Short-term	ECB database: N4
Greece	Short-Term	ECB database: N4
Ireland	Overdraft and term loans up to 1 yr	ECB database: N4
Italy	Min rate on loans to firms up to 18 months	ECB database: N4-2
Netherlands	Bank base rate for new business	ECB database: N4
Portugal	Commercial bills to non-fin. Enterprises (91-180 mat)	ECB database: N4-1
Sweden	ST loans to enterprises	ECB database: N4 Note: Quarterly data converted to monthly data using the cubic spline method
Denmark	Average lending rate from Datastream (95-02) and Danmarks National Bank reports and accounts (91-95),	Datastream and Danmarks Nationalbank Note: Quarterly data converted to monthly data using the cubic spline method
UK	IMF min base lending rate (clearing banks) [91-98], BOE average lending rate to non-financial corporations [99-2002] [merged data 91-98]	IMF and Bank of England

Appendix A

Table 3. Additional information on the deposit and lending rates used for the 2003-2008 period

Country	Deposit rates	Lending rates	Source
Belgium, Austria, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, & Portugal	Annualised agreed rate (AAR) / Narrowly defined effective rate (NDER), Credit and other institutions (MFI except MMFs and central banks) reporting sector - Deposits with agreed maturity, Up to 1 year maturity, New business coverage, Euro, Non-Financial corporations (S.11) sector	Loans: Annualised agreed rate (AAR) / Narrowly defined effective rate (NDER), Credit and other institutions (MFI except MMFs and central banks) reporting sector - Loans, Up to 1 year maturity, Outstanding amount business coverage, Euro, Non-Financial corporations (S.11) sector	ECB statistical database
Denmark	- Time deposits up to including 1 year, Effective interest rate, non-financial corporations	Loans Up to and including 1 year Up to and incl. DKK 7.5 mio. excl. overdraft facilities, non-financial corporations	Danmarks Nationalbank
Sweden	Average deposit rates	Average lending rates	Riksbank database
UK	- Monthly average of UK resident banks' sterling weighted average interest rate, interest bearing sight deposits from private non-financial corporations (in percent) not seasonally adjusted [03-04] - Monthly average of UK resident banks' sterling weighted average interest rates - new time deposits with a fixed original maturity <=1yr from private non-financial corporations (in percent) not seasonally adjusted ([04-08]	Monthly average of UK resident banks' sterling weighted average interest rate, other loans to private non-financial corporations (in percent) not seasonally adjusted	BOE statistical database Note : Deposit rates data has been merged

Appendix B

Table 1. Weights used for the European average rate [1991-2002]

	%
European Union (14 countries)	100%
Belgium	2.9
Denmark	2.0
Germany	25.2
Ireland	1.0
Greece	1.4
Spain	6.9
France	17.0
Italy	14.0
Netherlands	4.5
Austria	2.5
Portugal	1.4
Finland	1.5
Sweden	2.9
United Kingdom	16.4

Note: The weights represent the % share of each country's GDP in the total EU 14 GDP(measured in Euros) for the year 1998.

Table 2. Weights used for the European average rate [2003-2008]

	%
European Union (15 countries)	100%
Belgium	2.9
Denmark	2
Germany	21.7
Ireland	1.6
Greece	1.9
Spain	8.8
France	16.6
Italy	13.8
Luxembourg	0.3
Netherlands	4.9
Austria	2.4
Portugal	1.4
Finland	1.5
Sweden	2.8
United Kingdom	17.4

Note: The weights represent the % share of each country's GDP in the total EU 15 GDP (measured in Euros) for the year 2005.
Source: *Eurostat* online

Appendix C

Table 1. Unit root test for deposit rates [1991-2002]

Country	**Lag length**	**Augmented Dickey Fuller t-statistic for level**	**Augmented Dickey Fuller t-statistic for 1st difference**
Austria ATD	0	-1.749461	-11.19694
Belgium BED	6	-1.395939	-3.569319
Germany DED	3	-1.522149	-3.309032
Denmark DKD	5	-1.480782	-3.522288
Spain ESD	2	-1.431545	-4.225807
Finland FID	1	-2.244688	-5.228166
France FRD	11	-0.924637	-4.109442
Greece GRD	9	0.030029	-3.179449
Ireland IED	11	-2.313274	-3.670955
Italy ITD	2	-0.489276	-3.985430
Netherlands NLD	0	-1.703649	-12.01161
Portugal PTD	7	-2.635630	-4.316302
Sweden SED	10	-1.824340	-4.275567
UK UKD	3	-2.546826	-4.269087
EU average DREU	10	-2.245075	-3.718645

Table 2. Unit root test for lending rates [1991-2002]

Country	**Lag length**	**Augmented Dickey Fuller t-statistic for level**	**Augmented Dickey Fuller t-statistic for 1st difference**
Austria ATL	1	-2.460163	-3.509903
Belgium BEL	7	-1.965490	-3.185679
Germany DEL	11	-2.337274	-3.134497
Denmark DKL	10	-1.491097	-3.933820
Spain ESL	9	-1.324669	-3.583254
Finland FIL	10	-2.326288	-3.489951
France FRL	9	-1.298937	-3.773854
Greece GRL	4	-0.311026	-5.495875
Ireland IEL	7	-1.652703	-4.256577
Italy ITL	8	-0.983244	-3.292100
Netherlands NLL	2	- 1.575982	-3.961533
Portugal PTL	2	-2.806563	-4.941878
Sweden SEL	12	-2.296745	-2.940374
UK UKL	2	-2.487600	-4.449804
EU average LREU	8	-1.732815	-3.397088

Note: (a) The 5% ADF critical value is -2.88; (b) The ADF tests were conducted in Eviews 6 and the ADF model with intercept is used.

Appendix C

Table 3. Unit root test for deposit rates [2003-2008]

Country	Augmented Dickey Fuller t-statistic for level	Augmented Dickey Fuller t-statistic for 1st difference
Austria ATD	1.075823	-5.532175
Belgium BED	0.971873	-4.348543
Germany DED	1.045546	-4.173627
Denmark DKD	1.167311	-3.839586
Spain ESD	1.393973	-4.914590
Finland FID	0.986843	-3.266392
France FRD	1.169997	-5.017530
Greece GRD	1.590822	-6.656129
Ireland IED	1.397141	-3.818919
Italy ITD	0.545334	-3.725281
Luxembourg LUXD	1.053635	-5.556421
Netherlands NLD	1.080703	-5.072077
Portugal PTD	0.845507	-5.797258
Sweden SED	-0.436387	-3.133751
UK UKD	-1.630745	-4.938489
EU average DREU	0.748451	-4.450450

Table 4. Unit root test for lending rates [2003-2008]

Country	Augmented Dickey Fuller t-statistic for level	Augmented Dickey Fuller t-statistic for 1st difference
Austria ATL	0.382837	-3.809778
Belgium BEL	-0.137220	-5.273785
Germany DEL	0.928971	-4.157705
Denmark DKL	-0.106297	-7.483471
Spain ESL	0.796933	-3.055337
Finland FIL	0.238747	-3.762948
France FRL	0.455499	-5.808692
Greece GRL	0.902650	-3.873322
Ireland IEL	0.598114	-3.394293
Italy ITL	0.314645	-4.151829
Luxembourg LUXL	1.182120	-4.739098
Netherlands NLL	0.572700	-5.084628
Portugal PTL	0.964784	-4.560355
Sweden SEL	-0.436387	-3.133751
UK UKL	-0.811476	-4.050974
EU average LREU	0.403205	-2.913877

Note: (a) Given the relatively small number of observations, the lag length selected for each series is one; (b) The 5% ADF critical values are -2.91; (c) The ADF tests were conducted in Eviews 6 and the ADF model with intercept is used.

Appendix D

Table 1. Bai and Perron statistics for tests of multiple structural breaks in the deposit rates [1991-2002]

Country	Udmax[27]	WD max (5%) [28]	F(1/0)[29]	F(2/1)[30]	F(3/2)[31]	F(4/3)[32]	F(5/4)[33]
Austria ATD	-	-	-	-	-	-	-
Belgium BED	206.21***	219.37**	206.21***	42.16***	22.53***	1.83	-
Germany DED	627.98***	746.27**	139.62***	47.16***	33.57***	3.40	-
Denmark DKD	757.14***	1050.47**	220.15***	115.71***	25.19***	0.69	-
Spain ESD	692.11***	1190.05**	74.11***	440.72***	33.28***	18.78***	-
Finland FID	283.41***	621.91**	90.88***	25.77***	40.84***	139.42***	-
France FRD	143835***	247315**	74.47***	122.38***	122.38***	122.38***	-
Greece GRD	2337.62***	5129.60**	177.48***	153.06***	766.41***	43.30***	13.68**
Ireland IED	310.33***	310.33**	310.33***	3.59	14.42**	12.60**	4.88
Italy ITD	1785.38***	2570.22**	169.93***	103.67***	27.69***	1.62	1.62
Netherlands NLD	607.58***	1333.26***	6.54	520.23***	17.29***	3.10	-
Portugal PTD	307.53***	674.83**	53.38***	77.67***	31.25***	2.25	-
Sweden SED	427.29***	718.09**	60.81***	109.36***	10.00*	37.21***	-
UK UKD	82.22***	180.43**	71.20***	45.52***	13.30**	4.71	5.93
Average deposit rates	11278***	16236**	152.43***	328.26***	258.47***	4.09	-

Table 2. Bai and Perron statistics for tests of multiple structural breaks in the lending rates [1991-2002]

Country	Udmax	WD max (5%)	F(1/0)	F(2/1)	F(3/2)	F(4/3)	F(5/4)
Austria ATL	4951.92***	5884.69**	70.31***	41.44***	22.71***	105.43***	105.43***
Belgium BEL	1627.11***	3570.48**	92.42***	46.87***	12.02**	4.56	-
Germany DEL	431.83***	431.83**	431.83***	249.01***	37.65***	8.11	-
Denmark DKL	4911.97***	9748.51**	556.18***	358.90***	4.67	11.88*	-
Spain ESL	531.59***	789.76**	48.05***	320.43***	8.44	6.99	-
Finland FIL	262.86***	331.91**	69.53***	103.01***	3.71	13.41**	-
France FRL	377.95***	449.14**	45.33***	172.59***	1.64	1.05	0.20
Greece GRL	1449.00***	3179.65**	204.68***	177.66***	118.54***	30.30***	15.87***
Ireland IEL	78.35***	111.53**	65.90***	29.35***	28.92***	35.39***	-
Italy ITL	1355.87***	2331.34**	207.24***	586.77***	11.39**	5.40	-
Netherlands NLL	742.21***	1628.69**	142.60***	15.82***	42.12***	0.89	-
Portugal PTL	1111.81***	2439.73**	108.61***	269.84***	639.82***	6.22	4.42
Sweden SEL	241.50***	348.98**	52.00***	57.67***	36.04***	5.62	-
UK UKL	682.58***	982.64**	64.42***	34.72***	23.50***	23.50***	2.03
Average lending rates	884.58***	1941.10**	97.24***	206.45***	90.47***	32.00***	-

[27] 10, 5 and 1 per cent critical values are 7.46, 8.88 and 12.37, respectively.
[28] Critical value is 9.91.
[29] 10, 5 and 1 per cent critical values are 7.04, 8.58 and 12.29, respectively.
[30] 10, 5 and 1 per cent critical values are 8.51, 10.13 and 13.89, respectively.
[31] 10, 5 and 1 per cent critical values are 9.41, 11.14 and 14.80, respectively.
[32] 10, 5 and 1 per cent critical values are 10.04, 11.83 and 15.28, respectively.
[33] 10, 5 and 1 per cent critical values are respectively 10.58, 12.25 and 15.76, respectively.
***significant at the 1% level; ** significant at the 5% level; *significant at the 10% level.
The Bai and Perron (1998) test statistics have been computed using Perron's GAUSS code (available on his home page: http://econ.bu.edu/perron/) and were run in OxEdit.

Appendix D

Table 3. Bai and Perron statistics for tests of multiple structural breaks in the deposit rates [2003-2008]

Country	UDmax[34]	WD max (5%) [35]	F(1/0)[36]	F(2/1)[37]	F(3/2)[38]
Austria ATD	260.38***	374.84**	61.47***	70.63***	2.96
Belgium BED	438.85***	631.77**	97.80***	21.88***	4.22
Germany DED	290.85***	418.71**	77.62***	27.27***	5.44
Denmark DKD	113.64***	155.84**	113.64***	63.33***	6.19
Spain ESD	261.87***	376.99**	101.68***	115.38***	6.27
Finland FID	176.95***	254.73**	86.28***	23.62***	11.97**
France FRD	218.04***	313.89**	68.65***	34.07***	4.52
Greece GRD	125.37***	180.48**	67.85***	24.33***	9.66*
Ireland IED	188.43***	271.26**	97.68***	33.13***	2.66
Italy ITD	103.31***	143.81**	83.85***	24.03***	4.44
Luxembourg LXD	195.70***	281.73**	61.26***	15.18***	6.07
Netherlands NLD	289.94***	417.39**	82.04***	35.24***	3.92
Portugal PTD	173.35***	249.55**	70.13***	23.39***	3.21
Sweden SED	189.55***	272.87**	23.40***	50.20***	2.44
UK UKD	394.21***	567.50**	111.66***	42.41***	2.31
Average deposit rates	373.70***	537.98**	73.68***	48.19***	8.60

Table 4. Bai and Perron statistics for tests of multiple structural breaks in the lending rates [2003-2008]

Country	UDmax	WD max (5%)	F(1/0)	F(2/1)	F(3/2)
Austria ATL	179.23***	258.02**	55.25***	18.02***	22.51***
Belgium BEL	284.07***	408.95**	53.66***	6.66	15.76***
Germany DEL	235.11***	338.46**	104.01***	9.38*	182.07***
Denmark DKL	133.51***	192.20**	33.43***	17.02***	19.45***
Spain ESL	160.68***	231.32**	97.18***	7.95	19.38***
Finland FIL	142.12***	204.60**	69.77***	24.29***	13.25**
France FRL	201.15***	289.57**	47.43***	22.73***	2.56
Greece GRL	218.79***	314.96**	71.20***	27.75***	3.08
Ireland IEL	129.61***	186.59**	57.62***	56.70***	31.00***
Italy ITL	77.04***	110.91**	51.02***	19.01***	11.71**
Luxembourg LXL	132.43***	190.65**	68.87***	37.93***	5.84
Netherlands NLL	233.16***	335.65**	64.77***	40.71***	1.47
Portugal PTL	99.41***	118.14**	83.25***	23.86***	3.01
Sweden SEL	189.55***	272.87**	23.40***	50.20***	2.44
UK UKL	310.92***	447.60**	48.39***	79.65***	7.55
Average lending rates	206.08***	296.68**	90.29***	27.76***	7.36

[34] 10, 5 and 1 per cent critical values are 7.46, 8.88 and 12.37, respectively.
[35] Critical value is 9.91.
[36] 10, 5 and 1 per cent critical values are 7.04, 8.58 and 12.29, respectively.
[37] 10, 5 and 1 per cent critical values are 8.51, 10.13 and 13.89, respectively.
[38] 10, 5 and 1 per cent critical values are 9.41, 11.14 and 14.80, respectively.
***significant at the 1% level; ** significant at the 5% level; *significant at the 10% level.

Appendix E

Table 1. Structural break dates for deposit rates during the period 1991- 2002

Country	No. of breaks	Occurrence of break
Austria ATD	3	Oct 93, Feb 96 and Nov 97
Belgium BED	3	Jan. 94, Oct 95 and Feb 00
Germany DED	3	Jul 93, Aug 95 and Mar 00
Denmark DKD	3	Sept 93, Nov 95 and Mar 00
Spain ESD	4	Aug 93, Nov 96, Aug 98 and May 00
Finland FID	4	May 93, Dec 95, Nov 97 and Mar 00
France FRD	4	Jan 94, Feb 96, May 98 and June 00
Greece GRD	4	Nov 94, Nov 96, Feb 99 and Nov 00
Ireland IED	3	Mar 93, Dec 94 and Sept 98
Italy ITD	3	Jan 94, Jan 97 and Oct 98
Netherlands NLD	3	Nov 93, Feb 96 and Jul 98
Portugal PTD	3	Jun 93, Jan 96 and Nov 97
Sweden SED	2	Jan 93 and Jun 96
UK UKD	2	Sept 92 and Mar 01
Average deposit rates	3	May 93, Feb 96 and Nov 98

Table 2. Structural break dates for lending rates during the period 1991-2002

Country	No. of breaks	Occurrence of break
Austria ATL	4	Apr 96, Nov 98, Mar 00 and Sept 01
Belgium BEL	2	Mar 93 and Apr 95
Germany DEL	3	Oct 93, Aug 95 and May 00
Denmark DKL	2	Oct 93 and Mar 96
Spain ESL	2	Aug 93 and Dec 96
Finland FIL	2	Mar 93 and Nov 95
France FRL	2	Jun 93 and Mar 97
Greece GRL	4	Mar 95, Dec 96, Dec 98 and Nov 00
Ireland IEL	4	Apr 93, Nov 95, Sept 98 and Jun 00
Italy ITL	2	Jun 93 and Nov 97
Netherlands NLL	3	Jun 93, May 95 and Feb 00
Portugal PTL	3	Jul 93, Feb 96 and Mar 98
Sweden SEL	3	Feb 93, Jun 96 and Jul 98
UK UKL	4	Sept 92, Apr 97, Jan 99 and Mar 01
Average lending rates	4	Jun 93, May 96, Sept 98 and Jun 00

Appendix E

Table 3. Structural break dates for deposit rates during the period 2003-2008

Country	No. of breaks[39]	Occurrence of break
Austria ATD	2	Feb and Nov 06
Belgium BED	2	May 06 and Feb 07
Germany DED	2	Feb and Nov 06
Denmark DKD	2	Mar 06 and Feb 07
Spain ESD	2	May 06 and Mar 07
Finland FID	2	Feb and Nov 06
France FRD	2	May 06 and Feb 07
Greece GRD	2	May 06 and Feb 07
Ireland IED	2	May 06 and Feb 07
Italy ITD	2	Jun 06 and Mar 07
Luxembourg LXD	2	Apr 06 and Feb 07
Netherlands NLD	2	Feb and Nov 06
Portugal PTD	2	May 06 and Apr 07
Sweden SED	2	Feb 04 and Oct 06
UK UKD	2	Dec 03 and Oct 06
Average deposit rates	2	Feb and Nov 06

Table 4. Structural break dates for lending rates during the period 2003-2008

Country	No. of breaks[40]	Occurrence of break
Austria ATL	3	Mar 04, Jun 06 and May 07
Belgium BEL	3	Apr 05, Jun 06 and Mar 07
Germany DEL	3	Sep 03, May 06 and Feb 07
Denmark DKL	3	Sep 03, Jun 06 and Mar 07
Spain ESL	3	Sep 03, Jun 06 and May 07
Finland FIL	2	May 06 and Feb 07
France FRL	2	Oct 05 and Jan 07
Greece GRL	2	May 06 and Feb 07
Ireland IEL	3	Jan 04, May 06 and Feb 07
Italy ITL	2	Sep 03 and Oct 06
Luxembourg LXL	2	May 06 and Mar 07
Netherlands NLL	2	Jun 06 and May 07
Portugal PTL	2	Apr 06 and Mar 07
Sweden SEL	2	Feb 04 and Oct 06
UK UKL	2	Apr 04 and Jan 07
Average lending rates	2	Aug 06 and May 07

[39] Given that the number of observations are 63, the maximum number of breaks allowed in the Bai and Perron test, m, has been set at 3.
[40] Given that the number of observations are 63, the maximum number of breaks allowed in the Bai and Perron test, m, has been set at 3.

Appendix E

Table 5. Analysis of the break dates

Structural break date	Event
Late 1993 early 1994	▪ Feb 1992: Signing of the Maastricht Treaty ▪ 1992-93: ERM crisis and removal of capital controls ▪ Jan 1993: The Single Market enters into force ▪ Nov 1993: Treaty of European Union enters into force ▪ Jan 1994: The European Economic Area is established.
1995 and 1996	▪ Austria, Finland and Sweden join the EU in 1995 ▪ Dec 1995: Confirmation of the introduction of the single currency for 1999 at the Madrid European Council
1997 and 1998	▪ June 1997: Signature of the Treaty of Amsterdam which approved proposals on the third stage of the Economic and Monetary Union (EMU) ▪ June 1997: Adoption by the European Commission of an Action Plan for the Single Market ▪ March 1998: The Commission adopts the Convergence Report and recommends the adoption of the euro by 11 member countries in 1999 ▪ June 1998: Establishment of the ECB
February-May 2000	▪ Launch of the Euro in 11 countries in Jan 1999 ▪ Lisbon Agenda launched in March 2000
May-October 2006	▪ In Feb 2006, The European Parliament adopts a report on legislation opening up the EU single market for services. The Services Directive, also known as the Bolkestein Directive, is a major issue for the European Union.
January-May 2007	▪ Adoption of the Services Directive in December 2006 by the European Parliament and Council ▪ Completion of the fifth enlargement of the EU.

Appendix F

Johansen cointegration tests between each EU country's short term deposit or lending rate and the corresponding European weighted average rate

Country	Hypothesis	Deposit rates				Lending rates			
		Original 1991-2002	**Demeaned 1991-2002**	**Original 2003-2008**	**Demeaned 2003-2008**	**Original 1991-2002**	**Demeaned 1991-2002**	**Original 2003-2008**	**Demeaned 2003-2008**
Austria	**Trace test**								
	H_0: r=0	10.78852	29.27654**	15.97262	20.52549*	26.59746**	32.20835**	33.82232**	29.35232**
	H_1: r≤1	4.158600	9.913770*	2.470124	5.878777	5.389106	9.178876*	6.531825	10.61661*
Lag order	**Max. Eigenvalue**								
L_D=4,6,4,1	H_0: r=0	6.629920	19.36277*	13.50249	14.64672	21.20835**	23.02948**	27.29050**	18.73571*
L_L=4,2,12,4	H_1: r≤1	4.158600	9.913770*	2.470124	5.878777	5.389106	9.178876*	6.531824	10.61661*
Belgium	**Trace test**								
	H_0: r=0	21.49887*	25.39584**	33.83139**	24.41907*	8.143758	35.22566**	10.76258	33.04024**
	H_1: r≤1	7.198748	4.969590	2.991456	4.281063	2.733824	12.42543*	1.984612	14.18454**
Lag order	**Max. Eigenvalue**								
L_D=11,6,6,4	H_0: r=0	14.30012	20.42625**	30.83993**	20.13801*	5.409933	22.80024**	8.777969	18.85570
L_L=4,4,4,2	H_1: r≤1	7.198748	4.969590	2.991456	4.281063	2.733824	12.42543*	1.984612	14.18454**
Germany	**Trace test**								
	H_0: r=0	26.30767**	37.25077**	22.56629*	23.65876*	18.06683	37.60548**	29.67273**	23.82493*
	H_1: r≤1	7.499418	12.18478*	3.649700	8.397615	4.426292	14.17051**	8.038553	6.930805
Lag order	**Max. Eigenvalue**								
L_D=12,3,5,1	H_0: r=0	18.80825*	25.06598**	18.91659*	15.26114	13.64054	23.43497**	21.63418**	16.89412*
L_L=12,5,11,4	H_1: r≤1	7.499418	12.18478*	3.649700	8.397615	4.426292	14.17051**	8.038553	6.930805
Denmark	**Trace test**								
	H_0: r=0	14.27419	34.38566**	15.30617	30.16481**	12.77005	27.92308**	15.89161	40.17674**
	H_1: r≤1	4.829038	12.98070**	1.717420	8.448146	1.761563	10.35659*	2.096125	12.70956*
Lag order	**Max. Eigenvalue**								
L_D=2,5,4,4	H_0: r=0	9.445153	21.40496**	13.58875	21.71666**	11.00849	17.56649*	13.79548	27.46718*
L_L=11,7,4,2	H_1: r≤1	4.829038	12.98070**	1.717420	8.448146	1.761563	10.35659*	2.096125	12.70956*
Spain	**Trace test**								
	H_0: r=0	15.76956	36.23220**	19.60938	11.74287	20.59955*	34.28117**	31.93384**	36.23866**
	H_1: r≤1	5.127383	13.56532**	2.172848	4.560921	6.282648	14.83747**	3.303262	1.797805
Lag order	**Max. Eigenvalue**								
L_D=4,4,4,5	H_0: r=0	10.64218	22.66688**	17.43653*	7.181946	14.31690	19.44370**	28.63058**	34.44085**
L_L=5,3,10,11	H_1: r≤1	5.127383	13.56532**	2.172848	4.560921	6.282648	14.83747**	3.303262	1.797805

Appendix F. Cont'd

Country	Hypothesis	Deposit rates				Lending rates			
		Original 1991-2002	**Demeaned 1991-2002**	**Original 2003-2008**	**Demeaned 2003-2008**	**Original 1991-2002**	**Demeaned 1991-2002**	**Original 2003-2008**	**Demeaned 2003-2008**
Finland	**Trace test**								
	$H_0: r=0$	13.03909	44.07384**	12.39019	24.07464*	16.56943	21.33090*	8.085985	28.89500**
	$H_1: r\leq 1$	5.636437	12.98882**	2.597494	7.906219	5.325277	8.321438	2.517613	11.57647*
Lag order	**Max. Eigenvalue**								
L_D=3,1,4,1	$H_0: r=0$	7.402652	31.08502**	9.792699	16.16842*	11.24416	13.00947	5.568372	17.31853*
L_L=11,7,5,4	$H_1: r\leq 1$	5.636437	12.98882**	2.597494	7.906219	5.325277	8.321438	2.517613	11.57647
France	**Trace test**								
	$H_0: r=0$	13.97983	28.54793**	35.79057**	17.40348	15.35598	38.57737**	17.83107	26.52358**
	$H_1: r\leq 1$	5.769314	9.706866*	9.046086	4.228864	4.801301	15.89702**	6.191617	11.57923*
Lag order	**Max. Eigenvalue**								
L_D=2,1,10,4	$H_0: r=0$	8.210515	18.84107*	26.74449**	13.17462	10.55468	22.68035**	11.63946	14.94436
L_L=4,1,12,1	$H_1: r\leq 1$	5.769314	9.706866*	9.046086	4.228864	4.801301	15.89702**	6.191617	11.57923*
Greece	**Trace test**								
	$H_0: r=0$	24.25431*	33.59535**	16.04207	16.82922	24.56444*	31.92014**	22.43709*	33.39699**
	$H_1: r\leq 1$	4.966645	16.32899**	1.858602	4.114638	4.771150	9.613452*	2.796041	9.295489*
Lag order	**Max. Eigenvalue**								
L_D=4,1,4,4	$H_0: r=0$	19.28766*	17.26636*	14.18347	12.71458	19.79329*	22.30669**	19.64105*	24.10150**
L_L=5,1,7,5	$H_1: r\leq 1$	4.966645	16.32899**	1.858602	4.114638	4.771150	9.613452*	2.796041	9.295489*
Ireland	**Trace test**								
	$H_0: r=0$	20.84811*	30.03186**	14.71199	13.29992	18.95365	30.79028**	11.65614	29.42987**
	$H_1: r\leq 1$	6.514610	10.46721*	2.826929	2.303872	5.300539	10.29885*	3.591966	11.12328*
Lag order	**Max. Eigenvalue**								
L_D=11,10,4,10	$H_0: r=0$	14.33350	19.56464*	11.88506	10.99604	13.65311	20.49143**	8.064173	18.30659*
L_L=7,10,5,3	$H_1: r\leq 1$	6.514610	10.46721*	2.826929	2.303872	5.300539	10.29885*	3.591966	11.12328*
Italy	**Trace test**								
	$H_0: r=0$	15.53186	27.69281**	28.65130**	12.89642	10.56912	30.90694**	13.28302	23.92903*
	$H_1: r\leq 1$	4.376815	10.84871	3.696656	3.070740	3.095544	9.685450*	5.854038	9.011246
Lag order	**Max. Eigenvalue**								
L_D=7,1,6,6	$H_0: r=0$	11.15505	16.84410*	24.95464**	9.825675	7.473577	21.22149**	7.428986	14.91778
L_L=7,1,3,3	$H_1: r\leq 1$	4.376815	10.84871*	3.696656	3.070740	3.095544	9.685450*	5.854038	9.011246

Appendix F. Cont'd

Country	Hypothesis	Deposit rates Original 1991-2002	Deposit rates Demeaned 1991-2002	Deposit rates Original 2003-2008	Deposit rates Demeaned 2003-2008	Lending rates Original 1991-2002	Lending rates Demeaned 1991-2002	Lending rates Original 2003-2008	Lending rates Demeaned 2003-2008
Luxembourg	**Trace test**								
	H_0: r=0	-	-	9.774788	27.69332**	-	-	34.26375**	43.88263**
	H_1: r≤1	-	-	0.133685	4.650848	-	-	11.27407*	12.27079*
Lag order L_D=11,4 L_L=2,2	**Max. Eigenvalue**								
	H_0: r=0	-	-	9.641103	23.04248**	-	-	22.98967**	31.61184**
	H_1: r≤1	-	-	0.133685	4.650848	-	-	11.27407*	12.27079*
Netherlands	**Trace test**								
	H_0: r=0	11.22631	32.32358**	42.95021**	21.11265*	12.49254	39.32096**	19.51248	38.42481**
	H_1: r≤1	3.452191	15.92770**	10.73316*	5.825349	2.756313	15.57239**	2.075750	14.50463**
Lag order L_D=2,7,12,1 L_L=8,1,3,2	**Max. Eigenvalue**								
	H_0: r=0	7.774121	16.39588*	32.21705**	15.28730	9.736226	23.74856**	17.43673*	23.92019*
	H_1: r≤1	3.452191	15.92770**	10.73316	5.825349	2.756313	15.57239**	2.075750	14.50463*
Portugal	**Trace test**								
	H_0: r=0	33.19804**	45.23144**	12.29435	32.74481**	29.68152**	39.93130**	10.70230	28.34069**
	H_1: r≤1	4.034995	18.91523**	3.550195	11.51409	10.61787*	14.50221**	2.207687	8.723565
Lag order L_D=4,3,1,1 L_L=4,2,2,5	**Max. Eigenvalue**								
	H_0: r=0	29.16304**	26.31621**	8.744158	21.23072**	19.06365*	25.42908**	8.494611	19.61713
	H_1: r≤1	4.034995	18.91523**	3.550195	11.51409	10.61787*	14.50221**	2.207687	8.723565
Sweden	**Trace test**								
	H_0: r=0	24.64030*	28.42213**	20.75250*	19.06413	23.64998*	25.93173**	15.83660	32.65792**
	H_1: r≤1	4.518535	9.749695*	7.948231	7.776033	6.301194	9.614085*	4.138950	10.61696*
Lag order L_D=11,5,2,1 L_L=12,6,2,1	**Max. Eigenvalue**								
	H_0: r=0	20.12177*	18.67244*	12.80427	11.28810	17.34879*	16.31764*	11.69765	22.04096**
	H_1: r≤1	4.518535	9.749695*	7.948231	7.776033	6.301194	9.614085*	4.138950	10.61696
UK	**Trace test**								
	H_0: r=0	20.48759*	25.68420**	35.40791**	19.50492	14.21493	27.19364**	29.33615**	30.84451**
	H_1: r≤1	6.462749	9.515404*	11.01576*	9.171420	4.395617	9.533125*	10.72873*	12.45297
Lag order L_D=4,9,10,1 L_L=9,10,11,2	**Max. Eigenvalue**								
	H_0: r=0	14.02484	16.16879*	24.39215**	10.33350	9.819311	17.66052*	18.60743*	18.39154*
	H_1: r≤1	6.462749	9.515404*	11.01576*	9.171420	4.395617	9.533125*	10.72873*	12.45297*

Notes:
* Indicates rejection at the 5% level
** Indicates rejection at the 1% level

1. For the trace rank test :

At H_0 (r=0), the 5% critical value is 20.26 and the 1% critical value is 25.08
At H_0 (r≤1), the 5% critical value is 9.16 and the 1% critical value is 12.76

2. For the maximum eigenvalue rank test,

At H_0 (r=0), the 5% critical value is 15.89 and the 1% critical value is 20.16
At H_0 (r≤1), the 5% critical value is 9.16 and the 1% critical value is 12.76

3. The statistics are based on a Johansen VAR model with an intercept in the cointegrating equation and have been conducted in Eviews 6.

4. The lag orders of the VARs have been obtained by using the Akaike Information Criterion and run in Eviews 6;

5. The lag order selected for each VAR model is listed under L_D for the four deposit rates data sets and under under L_L for the four lending rates data sets, and they follow the same order as listed in the table.

Appendix G

Table 1. Im *et al* (2003) panel unit root test (IPS)

Sample	**Deposit rates**	**Lending rates**
1991-2002: original	-2.15941**	0.36898
1991-2002: demeaned	-11.9420***	-11.4862***
2003-2008: original	-1.29069*	-0.78042
2003-2008: demeaned	-5.91345***	-12.0407***

Note:

1) The critical values (one-tailed normal distribution) at 1% and 5% are -2.3263 and -1.6449 respectively.
2) The lag for each individual series is selected based on the modified Akaike criterion.
3) The model used is one with individual intercept and no trend
3) The IPS unit root tests are conducted in Eviews 6.0
*** indicates significance at the 1% level, ** significant at 5%, * significant at 10%.

Table 2. CD tests on the deposit and lending rates

Panel data	**Cross section dependence (CD) test statistics**
Deposit rates	
▪ 1991-2002 panel set	-3.28***
▪ 1991-2002 demeaned panel set	32.31***
▪ 2003-2008 panel set	15.27***
▪ 2003-2008 demeaned panel set	28.52***
Lending rates	
▪ 1991-2002 panel set	-5.22***
▪ 1991-2002 demeaned panel set	10.41***
▪ 2003-2008 panel set	0.88
▪ 2003-2008 demeaned panel set	19.87***

Note:

1. The critical values for the CD tests [standard two-tailed normal distribution] for 10%, 5% and 1% significance levels are 1.645, 1.96 and 2.575 respectively
2. The CD test statistics were run for each lag order (p) ranging from 1 to 12 and given similar results, the CD statistics reported in the table corresponds to p=6
3. The CD statistics were computed in OxEdit using the GAUSS code provided by Yamagata (2006)
*** indicates significance at the 1% level, ** significant at 5%, * significant at 10%.

Appendix G

Table 3. Pesaran (2007) panel unit root test (CIPS)

Sample	**Deposit rates**	**Lending rates**
1991-2002: original	-2.292** (p=9)	-3.797*** (p=6)
1991-2002: demeaned	-3.629*** (p=6)	-3.308*** (p=5)
2003-2008: original	-1.786 (p=5)	-1.399 (p=6)
2003-2008: demeaned	-3.280*** (p=5)	-2.599*** (p=5)

Note:

1. The CIPS critical values are listed in table 3b in Pesaran (2007).
   For N=15 and T=144, the critical values for 1%, 5% and 10% significance levels are around -2.425, -2.25 and –2.15 for case II [with intercept only].
   For N=15 and T=63, the critical values for 1%, 5% and 10% significance levels are approximately –2.435, -2.25 and –2.145 for case II [with intercept only].
   *** denotes significance at 1%, ** at 5%, * at 10%.
2. The lag order selected for each panel data set is indicated within brackets.
3. The model used includes an intercept.
4. The CIPS statistics were computed in OxEdit using the code written by Yamagata (2006).