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The cyclical and trend behaviour of Australian investment and savings

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Abstract

A spectral analysis of the Australian time series for the investment and savings ratios on monthly data over the period from September 1959 to December 2005 reveals that the major cyclical components of the savings and investment ratios cohere strongly. This suggests there is a medium to long term relationship between investment and savings. Further, the investment and saving ratios cohere strongly with the business cycle suggesting a procyclical pattern of investment and saving behaviour on Australian data. A subsequent long memory analysis reveals that the saving and investment ratios, the investment ratio and real GDP and the savings ratio and real GDP are fractionally cointegrated. The policy implications are explained.

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An Overview of Real Interest Rate Interdependence Among the G7 Nations

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An Overview of Real Interest Rate Interdependence Among the G7 Nations

Abstract:

We examine the interdependence of G7 90 day treasury bills on monthly data over the period 1970(1) to 2003(12). We find evidence for the presence of RIP among G7 treasury bill rates and on this evidence accept the hypothesis of a high degree of interdependence among G7 capital markets. We apply the time plot of a recursively estimated trace statistic to test for an increasing degree of integration and find little if any evidence of cointegration in the mid 1970s but interdependence increased markedly after the 1980 recession and again following the 1990 recession. From this time RIP appears to hold. A β parameter inconstancy is evident prior to mid 1979, however, the cointegration β parameters are constant over the period 1979(6) to 2003(12). The implications are explained and further research is indicated.

1. Why the G7 and Why Real Interest Parity?

One of the two major economic components of the controversial debate about globalism is the tendency towards the development of fully integrated global capital markets. The other is an often vexatious debate about trade liberalization but our purpose in this paper is to focus on the first component and describe the evolution of capital market integration among the G7 nations over the period January 1970 to December 2003. This is an historical time span over which global capital markets were subject to economic events which could have affected the degree of capital market integration (CMI). Two oil price shocks in 1974-75 and 1979-80; global recessions in 1981 and 1990; the Asian currency crisis in 1997 and the September 11 holocaust are all events which may have influenced the progress towards a global world capital market.

Much has been written and said about the impact of these individual shocks so it is appropriate to apply a different emphasis on CMI. Our evaluation of the pathway towards greater capital market integration is based on three characteristics. The first one focuses on the current state of play in relation to the degree of interdependence among G7 capital markets at the short end of the investment horizon. The second characteristic involves the changing extent of CMI among the G7 nations over the sample period while the third involves an examination of the stability between equivalent G7 short term real interest rates. The phrase ‘stability’ in the current context refers to the constancy of the parameters linking real rates of interest. In conducting this study, we are not completely silent about those shocks identified in the paragraph above, in fact we take pains to determine if periods of instability in the relationship between G7 real interest rates are associated with the occurrence of individual shocks although there is no formal analysis of this link. The impacts of these shocks warrant individual study whereas our focus is on the evolution of capital market integration. From what we have argued thus far, it is clear that two preliminary issues warrant some discussion: why is this study of CMI focussed on the G7 nations and why are the tests for CMI based on real interest parity?

The G7 nations are chosen as the basis for this analysis because the financial behaviour of these seven nations individually and collectively is of critical importance to the small and medium sized non member G7 nations which rely on the stability of the G7 for their own financial harmony. In this sense, the G7 is the engine room of the global financial system and the degree of its interdependence is significant for domestic economies outside the G7. If the G7 financial markets are closely integrated, then the prospects of a small nation running a monetary regime which increases its own national income and no one else's seems less likely to occur in this era of exchange rate flexibility given the dependence of the smaller nations on the G7 as a source of financial capital. Further, the more integrated are the G7s capital markets, the less likely it is that international transactors will have opportunities to diversify away systemic risk by trading at different real rates in individual G7 markets. Therefore it seems that an analysis of financial market integration focused on the G7 group is of great interest to policy makers and transactors outside the G7.

Real interest parity (RIP) is chosen as an empirical basis for studies of capital market integration because RIP provides a direct test of the proposition that capital markets are integrated. For example, those studies inspired by Feldstein and Horioka (1980) examining the relationship between the domestic savings and investment ratios provide a less direct basis for testing markets for the presence of CMI. The indirectness of the Feldstein-Horioka based arguments is evident in the interpretation of this well known condition. In particular, perfect CMI is deemed to hold if the domestic savings and investment ratios are unrelated.

Likewise, complete financial independence is implied if the domestic savings and investment ratios are equal implying that all of the investors needs for capital are satisfied from domestic savings. The RIP test is more direct, for if it holds, then a single global rate can be inferred.

Some recent tests for the presence of the RIP condition between the G7 countries or individual G7 countries with others outside the G7 generally reject its presence. Included among these are studies by Cumby and Mishkin (1986), Felmingham, Zhang and Healy (2000) and Fountas and Wu (1999). More recent studies of the G7 collectively include the studies conducted by Dreger and Schumaker (2003), Wu and Fountas (2000). Dreger and Schumaker, use monthly data over the sample period (1980:1 to 1998:12) applied to a cross section of G7 3 month term to maturity nominal interest rates. They base their tests for RIP on the differences between equivalent nominal rates in different countries. The US is treated as the foreign country in all of these bivariate studies. Dreger and Schumaker reject RIP between the US and each of the remaining G7 nations although there is some weak evidence of stationarity in the differences in equivalent rates between European members of the G7. Dreger and Schumaker base their analysis on weak form tests for stability and do not encompass the impact of shocks, generally and in particular those generated by the Asian crisis in 1997 or by September 11th 2001. The Dreger-Schumaker data set truncates prior to the occurrence of these two events. Wu and Fountas (2000) overcome the first of the limitations of the Dreger and Schumaker study by allowing for structural breaks. The Gregory and Hansen (1996) test is used to test for the bivariate cointegration of G7 short term real interest rates subject to a non predetermined structural break. The Wu and Fontas study is based on a time series covering the period 1974 to 1995 and produces strong evidence in favour of bilateral interest rate convergence between the US and several of the remaining G7 countries particularly at the short end of the capital market. However, Canadian and UK long run rates are not influenced by equivalent US rates so that these countries can expect monetary policy to act as a stabilisation tool in relation to these domestic economies.

Neither of these recent studies considers capital market events occurring beyond 1995 and 1998 respectively including the effects of the Asian crisis, so we need some later data to determine the full impact on financial market integration. Further both these studies focus on bilateral relationships. The present study updates the data set applied by taking into account both the effects of the Asian crisis and the impact of the September 11th holocaust. Both bivariate and multivariate analyses are conducted. The preference for both methodologies is explained presently.

The remainder of this paper is organised in the following manner: Section 2 details the methodological basis and its theoretical underpinnings, Section 3 defines the properties of the data set, results are discussed in Section 4 and the analysis concludes with an interpretation of the major results of the study in Section 5. Implications are also considered.

2. Real Interest Parity

The brief argument supporting the use of the RIP condition in the introduction warrants an extended comment. There is a theoretical aspect underpinning the preference for RIP based tests of capital market integration in addition to the policy issues referred to above and identified by Feldstein (1983). In a theoretical context RIP holds only if both uncovered and purchasing power parity both hold. The failure of either or both equilibria means that RIP cannot hold. The advantage of the RIP condition as a basis for assessing the degree of capital market integration is that it is closely linked to other international equilibria in the way described. In particular, if domestic real interest rates move together in the long run, then international capital flows will respond to equalise real returns across countries and individual monetary authorities cannot expect to maintain policies which influence real economic performance. Real interest parity provides a direct test of capital market integration as explained in the opening section of this paper.

2.1 Real Interest Parity

Following Mishkin (1984a), the real rate of interest for a country is given by the following:

$$r_t' = i_t - E_{t-1}\pi_t \qquad (1)$$

where i_t = the nominal rate of interest

π_t = the rate of inflation

r_t' = the real rate of interest

E = expectations operator conditional on information at time t-1

The real rate defined above, which is more precisely the *ex ante* real rate, is unobservable and, therefore, it is necessary to employ the *ex post* real rate which is defined formally:

$$r_t = i_t - \pi_t = r_t' - \left(\pi_t - E_{t-1}\pi_t\right) = r_t' - \varepsilon_t \qquad (2)$$

where r_t = the one period ex post real rate at time t

π_t = the actual rate of inflation

$\varepsilon_t = \pi_t - E_{t-1}\pi_t$ = the forecast error of inflation

A critical assumption underlying this model is rational expectations, which implies that the forecast error of inflation, ε_t, is unforecastable. Hence its expected value is zero as follows:

$$r_t' = E_{t-1}r_t \qquad (3)$$

The equality of real interest rates across countries implies that the following relationship holds:

$$r_t - r_t' = E_{t-1}(r_t - r_t^*) = 0 \qquad (4)$$

where, r and r^* are the interest rates of two different countries. Equation (4) suggests that the ex post real rate differential between countries is unforecastable given any information at time $t-1$.

Mishkin (1984b) has further shown that the equality of real interest rates is closely related to the uncovered interest parity and speculative efficiency conditions. An approximate form of the covered interest parity condition is given by the following:

$$f_t - s_t = i_t - i_t^* \qquad (5)$$

while the following ex ante version of purchasing power parity (PPP) is also applied:

$$E_{t-1}\left[(\pi_t - \pi_t^* \ - (s_t - s_{t-1})\right] = 0 \qquad (6)$$

and speculative efficiency requires the following:

$$f_t = E_{t-1}s_t \qquad (7)$$

Combining these three equations gives the equilibrium known as the UIP condition:

$$E_{t-1}\left[i_t - i_t^* - (s_t - s_{t-1})\right] = 0 \qquad (8)$$

Subtracting the PPP condition from the above equation yields a basis for the RIP test

$$E_{t-1}\left(r_t - r_t^*\right) = 0 = r_t' - r_t'^* \qquad (9)$$

This result (9) indicates the presence of a single real rate.

2.2 *The Johansen Test*

The Johansen (1988) VAR and Johansen and Juselius (1990) model is used to test for the presence of cointegration in both bivariate and multivariate cases. These cointegrative models are the basis of our tests for RIP among the G7. The analysis begins with an assessment of the strength of association of the time paths of the G7 individual real interest rates time series. This task is addressed by determining if there exists a long run equilibrium relationship involving the individual G7 series. This study is based upon the cointegration hypothesis as described by Hansen and Juselius (2002) in its error correction form as follows:

$$\Delta r_t = \mu + \sum_{i=1}^{p-1} \Gamma_q \; \Delta r_{t-p} + \gamma \; r_{t-1} + e_t \qquad (10)$$

Where r_t is a *(n*1)* column vector of p real interest rates, q the number of cointegrating vectors, μ is an *(n*1)* vector of constant terms, Γ is a coefficient matrix, e_t is a vector of Gaussian error terms. The cointegration hypothesis is formulated as follows:

$$H_1(q): \gamma = \alpha\beta' \qquad (11)$$

where α and β are $p \times q$ matrices of full rank. $H_1(q)$ requires the stationarity of Δr_t, although $\beta' r_t$ is stationary. The Johansen approach requires estimation of the above equation and the residuals are then used to compute two likelihood ratio tests for the determination of the number of cointegrated vectors: the trace test and the maximal eigenvalue test.

The maximum eigenvalue statistic is defined in the following:

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

where $\lambda\, r+1,\ldots\lambda n$ are the n-r smallest squared canonical correlations among the G7 rates of interest and T= the number of observations. The second test is based on the trace statistic under which the null hypothesis of r cointegrating vectors against the alternative of r or more cointegrating vectors. This statistic is given in expression (13).

$$\lambda_{\,trace} = -T\, \Sigma \ln (1 - \lambda i) \qquad (13)$$

The cointegrating vectors indicate the long term relationships present in the system. Perfect cointegration requires n-1 cointegrating vectors for n variables and a unit slope coefficient in the relationship between all pairs of real rates. In this study, perfect cointegration implies that six cointegrating vectors apply to the contegration among G7 real rates.

2.3 *An Increasing Degree of Interdependence?*

The authors second objective is to examine the time path of the cointegrating vectors for any evidence of an increasing degree of capital market interdependence over the sample period 1970(1) to 2003(12).

The approach adopted here in testing for an increasing degree of interdependence is based on the time path plot of rank statistics derived from recursive estimation of the cointegrating equation (10). This process is described by Hansen and Johansen (1999) and involves a base period estimate of the cointegration estimate using some of the sampled observations. Our base period is a monthly time series covering the period 1970(1) to 1973(12), thirty six observations in all. Then, holding the short run parameters of the cointegration constant at their full sample estimates but allowing the long run relationships to vary over time, recursive estimates are obtained by adding one additional set of observations in each recursion. An individual Trace statistic is obtained for the base period and for each recursive estimate so that the last trace statistic relates to the full sample period. An examination of the time path graph of the trace statistic estimated from the recursive cointegration will indicate the extent of any increase in the interdependence of the G7 short term interest rates structure. Rangvid (2001) shows that convergence is evidenced by an increase in the number of cointegrating vectors over time. The Trace statistics from the recursive estimation of (10) are shown on Figure 1. The vertical axis of the diagram are the chi-square values each normalized at the 10 percent critical value which is equal to one. An interpretation of Figure 1 is provided in the ensuing section of the text.

2.4 *Parameter Inconstancy*

The third and final procedure required for this study is to test for parameter constancy, in other words, to test for the constancy of the β' vector in (11) which is described by Hansen and Juselius (2002, p.58). The difference in terms of the assumptions underlying this test for parameter constancy and the recursive Trace test for changes in the number of cointegrating vectors is emphasised. In the case of the Trace test, the estimated value of β' is fixed in contrast to the test for β parameter constancy where β can change. This distinction between the trace test based on fixed β and the test of β parameter constancy highlights the role of the α and β' vectors in expression (11): α weights the contribution of each variable in the cointegrating equation and if the variable in question is weakly exogenous $(\hat{\alpha} = 0)$ then it will play no role in the error correction process. The estimate of α, $(\hat{\alpha})$, is the speed of adjustment towards equilibrium. The β parameters are the slopes of the cointegration regression equation (10) and their inconstancy is a primary source of instability in the cointegrating function. Figure (2) shows the results of these inconstancy tests and is discussed in detail in Section 4.

3. Properties of the Data Set

The data used are three month Treasury bill rates for all countries – the US, Japan, UK, Germany, France, Canada and Italy. All data are obtained from *Global Financial Data.* The data is monthly and covers the period 1970.1 to 2003.12. Real interest rates are calculated as $i - \pi$, a representation which is consistent with the assumptions applied to the derivation of the real interest rate in Section 2.1 in particular, rational expectations. Table 1 presents the mean, skewness and kurtosis values and the Bera-Jarque (BJ) statistics for normality for each series.

Table 1: Statistics about Real Interest Rates

	US	Japan	Germany	Britain	France	Canada	Italy
Mean	6.03	3.01	4.92	8.14	7.61	7.22	9.96
Skewness	0.97	-0.20	0.73	0.33	-0.13	0.75	0.02
Kurtosis-3	1.49	-1.26	0.14	-0.89	10.59	0.40	-0.89
BJ Statistic	101.71	29.7	36.5	20.87	1907.7	40.97	13.79

The Bera-Jarque statistic for normality is asymptotically distributed as a χ^2 with 2 degrees of freedom. The critical $\chi^2_{(.01)}$ value at the one percent level is 9.21.

The mean value of real interest rates for Japan is the lowest (3.01) while for Britain, France and Italy the means are larger suggesting that Japan is a low interest rate country. The real rates for Japan and France appear to be skewed to the left while for the US, Germany, Britain, Canada and Italy the data series are skewed to the right. The kurtosis statistic for all series except France is below 3 in value indicating non normality in each case. For France, the kurtosis statistic is 10.59 suggesting excess kurtosis beyond that of the normal distribution. The last line reports the Bera-Jarque (BJ) test for normality. This is calculated as follows:

$BJ = n\left[\frac{s^2}{6} + \frac{(k-3)^2}{24}\right]$ where s denotes skewness, k represents kurtosis and n is sample size.

Under the null hypothesis of normality, the BJ statistic is distributed as χ^2 with 2 degrees of freedom. All the BJ values are greater than the $\chi^2_{(.01)}$ level of 9.21 suggesting that the errors in all series are nonnormally distributed. The non- normality of the individual time series confirms our choice of the test statistics applied later in this study. Such tests must be robust to non-normality. The ones applied in Sections 3 and 4 of this paper satisfy the requirements for robustness. However, alternative tests which may have been relevant to this study, but are not robust in the way described cannot be applied. For example, a simple Chow test for structural breaks was not be utilised for this reason.

Table 2 presents results for unit root tests. The results suggest that all interest rate series are non stationary except the UK series which appears to be I(0) under the Phillip-Perron (1987) test and I(0) at the 5% level under the ADF and KPSS test. However, each data series is I(0) in first differences.

Table 2: Unit Root Tests

Variable	**ADF**	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
	Levels			First Differences		
Interest Rates:						
U.S.	-2.18	-1.78	0.793***	-19.37***	-8.09***	0.08
U.K.	-3.10**	-4.01***	0.711**	-23.58***	-22.29***	0.09
Canada	-1.86	-1.90	0.676**	-20.51***	-15.77***	0.08
Japan	-2.80*	-2.69*	1.82***	-26.82***	-23.47***	0.44*
France	-2.66*	-1.19	1.09***	-42.90***	-17.12***	0.12
Italy	-1.59	-1.71	0.865***	-22.10***	-9.93***	0.25
Germany	-2.30	-2.37	0.398*	-22.52***	-17.50***	0.07

Note: Significance levels for the ADF and Phillip-Perron test without trend are : 10%, -2.58: 5%, -2.90 and 1%, -3.51
Significance levels for the KPSS test are: 10%, 0.347: 5% 0.463: 1%, 0.739 (null hypothesis: the series is stationary)
*, **, *** significant at the 10%, 5% and 1% levels respectively.

4. The Evidence About RIP Increasing Cointegration and Parameter Inconstancy

The evidence pertaining to the three aspects of G7 capital market integration is now presented beginning with an analysis of the current state of play in relation to the extent of financial integration among the G7 countries.

4.1 *Real Interest Parity Holds?*

We address this issue in the process of analysing the results of both bivariate and multivariate cointegration studies. These are shown on Tables 3 and 4 respectively.

Table 3: Johansen Maximum Likelihood Cointegration Test for the Bivariate Models

Null	Alternative	mλ	Trace	95% critical value mλ	95% critical value Trace
		US-CANADA			
r=0	r=1	24.81	28.35	15.87	20.18
r<=1	r=2	3.54	3.54	9.16	9.16
		US- JAPAN			
r=0	r=1	37. 13	41.60	15.87	20.18
r<=1	r=2	4.47	4.47	9.16	9.16
		US-UK			
r=0	r=1	27.68	31.35	15.87	20.18
r<=1	r=2	3.67	3.67	9.16	9.16
		US-GERMANY			
r=0	r=1	19.42	24.37	15.87	20.18
r<=1	r=2	4.95	4.95	9.16	9.16
		US-FRANCE			
r=0	r=1	162.30	167.04	15.87	20.18
r<=1	r=2	4.73	4.73	9.16	9.16
		US-ITALY			
r=0	r=1	17.11	19.58	15.87	20.18
r<=1	r=2	2.46	2.46	9.16	9.16
		CANADA-JAPAN			
r=0	r=1	38.91	42.48	15.87	20.18
r<=1	r=2	3.57	3.56	9.16	9.16
		CANADA-UK			
r=0	r=1	43.92	46.76	15.87	20.18
r<=1	r=2	2.84	2.84	9.16	9.16
		CANADA-GERMANY			
r=0	r=1	22.48	22.60	15.87	20.18
r<=1	r=2	4.12	4.12	9.16	9.16
		CANADA-FRANCE			
r=0	r=1	181.44	185.46	15.87	20.18
r<=1	r=2	4.01	4.01	9.16	9.16
		CANADA-ITALY			
r=0	r=1	22.76	25.14	15.87	20.18
r<=1	r=2	2.38	2.38	9.16	9.16

Null	Alternative	mλ	Trace	95% critical value mλ	Trace
		JAPAN-UK			
r=0	r=1	35.69	45.16	15.87	20.18
r<=1	r=2	9.47	9.47	9.16	9.16
		JAPAN-GERMANY			
r=0	r=1	39.18	44.67	15.87	20.18
r<=1	r=2	5.48	5.48	9.16	9.16
		JAPAN- FRANCE			
r=0	r=1	174.55	197.14	15.87	20.18
r<=1	r=2	22.58	22.58	9.16	9.16
		JAPAN-ITALY			
r=0	r=1	46.59	49.24	15.87	20.18
r<=1	r=2	2.64	2.64	9.16	9.16
		UK-GERMANY			
r=0	r=1	23.87	29.18	15.87	20.18
r<=1	r=2	5.31	5.31	9.16	9.16
		UK-FRANCE			
r=0	r=1	159.94	168.92	15.87	20.18
r<=1	r=2	8.98	8.98	9.16	9.16
		UK-ITALY			
r=0	r=1	25.07	27.56	15.87	20.18
r<=1	r=2	2.48	2.48	9.16	9.16
		GERMANY-FRANCE			
r=0	r=1	187.26	192.59	15.87	20.18
r<=1	r=2	5.33	5.33	9.16	9.16
		GERMANY -ITALY			
r=0	r=1	15.87	18.76	15.87	20.18
r<=1	r=2	2.89	2.89	9.16	9.16
		FRANCE-ITALY			
r=0	r=1	228.68	231.33	15.87	20.18
r<=1	r=2	2.65	2.65	9.16	9.16

Table 4: Johansen Maximum Likelihood Cointegration Test for the Multivariate Models

Null	Alternative	mλ	Trace	95% critical value mλ	95% critical value Trace
		ALL			
r = 0	r = 1	324.36	499.02	46.47	132.45
r < = 1	r = 2	55.64	174.65	40.53	102.56
r < = 2	r = 3	46.56	119.00	34.40	75.98
r < = 3	r = 4	28.85	72.44	28.27	53.48
r < = 4	r = 5	23.09	43.59	22.04	34.87
r < = 5	r = 6	18.21	20.49	15.87	20.18
r < = 6	r = 7	2.28	2.28	9.16	9.16

These results from the full sample estimation of the cointegrating relationship (10) are suggestive and provide a case for the existence of real interest rate parity among the G7. This conclusion follows from the results displayed on Tables 3 and 4. In the bivariate case (Table 3) we find that the cointegration of real interest rate among pairs of G7 nations is almost universal: 20 of 21 bivariate analyses reveal cointegrated relationships at the 5 percent significance level according to the Trace and all 21 bivariate studies reveal the existence of a long run equilibrium involving relevant national pairings according to the maximum eigenvalue test. This RIP argument is supported by the multivariate study (Table 4) which indicates the presence of 6 cointegrating vectors among the G7 real rates of interest suggesting the presence of one common trend (the case of perfect cointegration) and therefore the existence of short run real interest parity among the G7 nations.

The implications flowing from this result are of great significance for the global economy. The existence of RIP indicates that perfect mobility applies to international financial markets and that interest rates, exchange rates, prices and nominal interest rates adjust to maintain RIP. A second implication concerns the opportunities open to international investors for systemic risk diversification. Perfect integration indicates few if any opportunities for risk diversification while for individual G7 governments, the prospects for the operation of independent long run monetary policies are not encouraged by the presence of market integration.

4.2 The Extent of G7 Real Rate Interdependence Increases Over Time

Now that we have discovered some evidence for the existence of short term RIP among the G7 nations then it is of interest to examine the evolution of this state from the beginning of our sample period in 1970(1). The results from recursive estimation come into play at this juncture, in particular, the time series graph of the Trace statistic derived from the recursive process and defined by expression (13). Its time path should display an upward slope for $j \leq r$ and is constant for $j > r$, so if there is a downswing in the time path of the trace statistic for any given cointegrating vector, then some instability is indicated. Figure 1 shows the time path of the recursive Trace statistics.

[Figure 1, about here]

The vertical axis of Figure 1 shows the χ^2 values for tests of the hypothesis that a particular cointegrating vector is significant. These critical test values are normalized at the 10 percent level of significance and so 10 percent always appears at the value 1 on the vertical axis of Figure 1. If a cointegrating vector is significant at this level the time path of the associated trace statistic will be above 1 on the vertical. So from Figure 1 we can determine how many cointegrating vectors are significant at any of the dates shown on the horizontal axis of the graph. Our intention here is to determine the extent to which the number of cointegrating vectors has increased (or reduced) through time. From Figure 1 little if any cointegration is evident. From 1976 to 1981 there is evidence of no cointegration at all; none of the cointegration vectors are significant. This situation changes in the 1980-82 recession when 3 cointegration vectors become significant. Another major disturbance is evident during the severely recessed global conditions prevailing in 1990 to 1992. This appears as a substantial shift in the one of the cointegrating vectors. In the wake of this recession we observe a further increase in cointegration among the G7 capital markets. From the second half of 1990 to 2000 six cointegrating vectors are significant, consistent with our previous findings of perfect cointegration and RIP.

The impact of some well known shocks can also be gleaned from this graphical analysis. There is substantial instability evident in these cointegrating relationships, particularly around the time of the first oil price shock as the time path of the two significant cointegration vectors falls sharply in the period 1975 to 1977. There is also some evidence (although it is inconclusive) of turbulence in 1997 to 1998 (the Asian crisis) and again in 2001 (9/11).

Returning to our second point of emphasis, the extent of integration strengthens following the two great recessions of this era, 1980 and 1990. How do we explain this standout feature of Figure 1, particularly, the 1990 recession? Our speculation is that the monetary policy reaction to recession in the form of rapid interest rate adjustments is to blame for instability on these occasions. These adjustments affected financial markets directly through price or interest rate cost effects. By way of contrast share market and exchange rate adjustments will act on financial markets less directly which may explain why the Asian crisis and 9/11 appear to be less impactive on Figure 1. Further research about the role of the nature and source of individual shocks is indicated here because the source of impacts on financial markets seem to matter for instability. Any event which leads to immediate interest rate effects seems likely to have greater impact in comparison with shocks which impact less directly on interest rate adjustments.

4.3 Parameter Constancy Applies from Mid 1979 and Beyond

The constancy of β slope coefficients in (10) is tested by applying the Hansen and Johansen (1999) procedure. This likelihood ratio test is constructed by comparing the likelihood function from each recursive sub sample with the restriction that the cointegration vectors estimated from the full sample fall within the space spanned by the estimated vectors of each individual recession. The test statistic is chi square distributed with $p-r$, r degrees of freedom. These recursive test results are graphed on Figure 2.

[Figure 2 about here]

The χ^2 critical values are plotted on the vertical axis and are normalized at the 10 percent level of significance which appears at the value 1. The null hypothesis for this test requires the constancy of β at the dates shown on the horizontal axis. The inconstancy of β is indicated if the graph on Figure 2 is above the value 1. The inconstancy of β is indicated on Figure 2 over the early part of the sample, during the period from 1974(1) to 1979(6) when the critical value of the test just exceeds one (1.0274). However, parameter constancy does apply to the cointegration vectors from 1979(6) to 2003(12). The time path of estimated parameters lie below 1 on Figure 1 for this period suggesting we accept the null of parameter constancy over the full period.

5. Conclusions

Our evaluation of the time path of short run real interest rate interdependence among the G7 refer to the years 1970 to the end of 2003. The evaluation was based on three hypotheses about interdependence: first, that the G7 had evolved as a highly interdependent group of global capital markets; second that this degree of interdependence had increased over the sample period and finally that G7 capital markets were subject to substantial instability in the form of parametric shifts and the impacts of shocks.

The evidence advanced in this analysis is summarised: we can accept the first and second hypotheses on evidence added in this study but we reject the third particularly in relation to parameter inconstancy. In relation to the first hypothesis both bivariate and multivariate cointegration studies suggest the presence of common trends among G7 real interest rates. In fact, the multivariate analysis indicates perfect contegration and the presence of a single common trend among the series for real rates on 90 day bills among the G7. This outcome is supported by 21 bivariate studies of G7 short term rates as cointegration is evident in each of these.

In the mid 1970s, we find the extent of cointegration actually weakening and it is not until the aftermath of the 1980-82 global recession that we find a strengthening of the interdependence of G7 capital markets. A noteworthy feature of this multi-variate cointegration analysis was the impact of the 1990 recession and the development of much closer links between real rates in its wake. There is a pattern evident here in relation to the two great recessions of the era 1970 to 2003. Deep recessions in 1980 and 1990 are followed by periods in which real interest rate linkages strengthen. In the present study, perfect cointegration appears to apply over the period 1993 to 2000 although there is some turbulence following the 9/11 tragedy. On the basis of this evidence we can accept the second hypothesis and we conclude that the G7 constitutes a closely linked group of capital markets apparently satisfying the special condition for the acceptance of RIP.

Finally, our tests for parameter inconstancy suggest a long period of parameter stability. The evidence suggests that parameter constancy applies from June 1979 to December 2003. However, the ten years preceding June 79 was a period of volatility as the parameters of the cointegrating vector were inconstant throughout the period dating January 1970 to May 1979.

Instability in this case coincides with the occurrence of two major oil price shocks, but surprisingly for some commentators, the Asian crisis in 1997 and the 9/11 tragedy did not lead to parameter inconstancy in global financial markets according to our evaluation.

The implications of these results are important. The existence of close links between the G7 member countries means that the prospects of individual G7 member countries preserving the integrity of a domestic monetary policy are diminished as the extent of market integration strengthens. For international financial transactors, the prospects for the minimization of systemic financial risks also lessen as individual G7 real rates move more closely together.

Further research is indicated and it will be focussed on the impact of shocks from differing sources. We have found that the greatest turbulence was caused by the two great recessions (1980 and 1990), while the Asian crisis and the 9/11 tragedy had an apparently lesser impact. This observation raises the following speculation: does the source and direction of individual shocks matter for the various manifestations of instability in the financial system? A formal answer is required.

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Figure 1: Trace Statistic Time Path 1970:1 – 2003:12

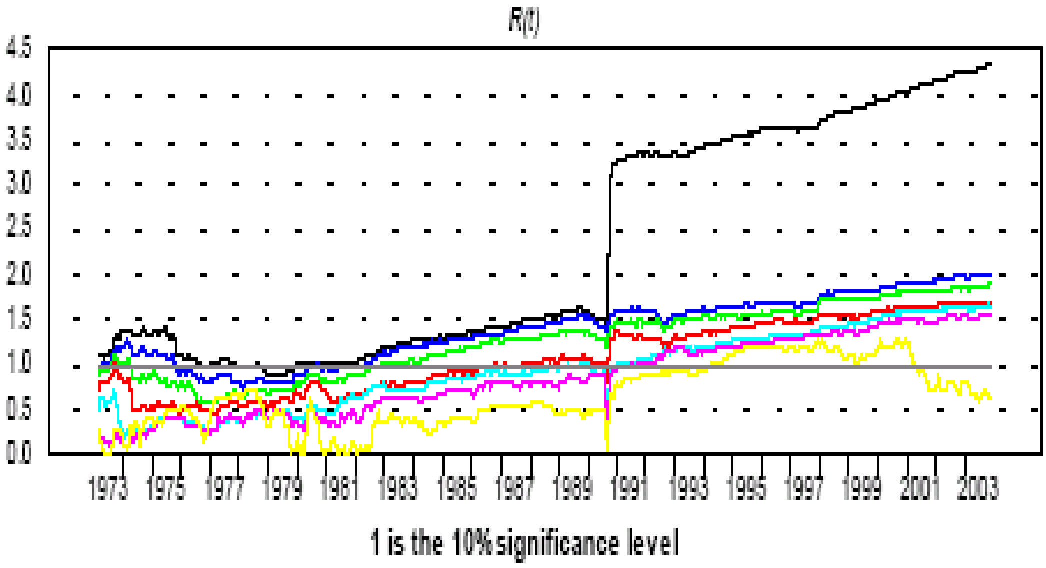

Figure 2: Test of known beta eq. to