A SEQUENTIAL TEST FOR STRUCTURAL BREAKS IN THE CAUSAL LINKAGES BETWEEN THE G-7 SHORT-TERM INTEREST RATES

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Abstract

This paper investigates changes in the causal structure linking the G-7 short-term rates by using a sequential test for the constancy of the adjustment coefficients in the error correction equations. This technique is only suitable to detect permanent structural breaks in the causal linkages. The hypotheses of interest are the US world-wide leadership, the disengagement of UK monetary policy from those pursued in the Eurozone after the collapse of the ERM, and the German leadership hypothesis (GLH) within the European Union (EU). While we do not find any examples of reversals of causality, the evidence points to a break in the causal linkages between UK and German rates after the third/fourth quarter of 1992. The empirical results are also consistent with a US world-wide leadership and a weak German leadership within the Eurozone.

Keywords: *Interest Rate Linkages, Long-Run Causality, Structural Breaks, Sequential Test*

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1. Introduction

In economic theory convergence between short-term interest rates can be explained taking two different approaches. If interest rates are treated as analogous to other asset prices, then their movements are naturally interpreted as being determined by financial flows in profit-seeking capital markets. This will normally give rise to a set of arbitrage conditions such as uncovered interest rate parity (UIP). Alternatively, they can be viewed as policy instruments, with their time paths being determined by a policy objective such as an exchange rate or an inflation target. These two approaches are not necessarily inconsistent, since deviations from interest rate parity may cause the exchange rate to move towards its policy target. As long as its deviations from the target are stationary, so will be those from interest rate parity. Interest rate linkages have therefore often been analysed in the context of a specific policy framework such as the Exchange Rate Mechanism (ERM).

For instance, numerous studies have attempted to test the so-called "German Leadership Hypothesis" (GLH), according to which Germany acts as the dominant player within Europe, and monetary authorities in other ERM countries are unable to deviate from the interest rates path set by the Bundesbank (see Fratianni and von Hagen, 1990, and Kirchgassner and Wolters, 1993). Taking this view, co-movements in interest rates arise because of policy convergence. But under pure arbitrage conditions one also expects interest rates to move together in the long run. So the question naturally arises: how is the system affected by a policy regime, and how will it change if there is a regime shift?

In general, one can think of changes in structure as changes either in the long-run relationships themselves (the cointegrating vectors) or in causality links (the loading factors). To be more precise, consider a Vector Error Correction Model (VECM), where the long-run matrix has been decomposed into a vector of loading weights and one of cointegrating relationships. A change in the structure of the system could occur through changes either in the former or in the latter. In order to make the problem of identifying the sources of structural change more tractable, one can assume that only the vector of loading weights is subject to change, either because the weights vary over time, or because they change from a zero to a non-zero value. Alternatively one can assume that cointegrating vectors which were not significant before may now enter a particular equation in the system, or viceversa. In other words, "new" cointegrating vectors might emerge as a result of structural changes. This means that a different set of variables exhibit long-run linkages depending on what period is considered.

A simple diagnostic test for structural change is suggested by Hao and Inder (1996), who extend the CUSUM test to the case of non-stationary regressors considering the FM-OLS residuals and replacing the error variance with the long-run variance estimate. Hansen (1992) derives the asymptotic distribution of a LM test for parameter instability against several alternatives in the context of cointegrated regression models. Quintos and Phillips (1993) develop a test for the null of parameter constancy in cointegrated regressions against the alternative that the coefficients follow a random walk. Seo (1998) defines LM tests statistics for structural changes in both the cointegrating vector and the vector of adjustment parameters for the cases of both a known and an unknown breakpoint. Hansen and Johansen (1999) suggest graphical procedures to evaluate the constancy of the long-run parameters of cointegrated systems.

Previous empirical studies, such as Caporale et al (1996), reported convergence in European rates after 1986. Artis and Zhang (1998), using rolling window cointegration techniques[1], found that there is widespread cointegration between both US and German short rates and those on other ERM currencies up to 1995, after which the US influence on world-wide rates vanishes. In the context of the ERM, with its target zones, there might be regime shifts owing to the policies pursued by central banks. Specifically, the stochastic properties of interest rates (volatility, level and speed of adjustment) are likely to be different in periods when the currency has to be defended from speculative attacks, compared to periods when the exchange rate is credible. Because of the UIP relation, switches in the process governing exchange rates are translated into switches in the process followed by interest rates. Such regime shifts tend to be more frequent and not to

[1] Note that the results from this estimation method are highly sensitive to the selection of the window width and the magnitude of the break. (see Barassi , Caporale and Hall (2001))

be as long-lived as changes in monetary policy regimes in the US, say. Dahlquist and Gray (2000) show that a Markov-switching model characterises adequately the behaviour of a number of EMS short rates.

In general, it would be problematic to specify the source of structural change in a model allowing for both types of changes, as such a model would typically not be identified. In the case of interest rates, since almost any theory suggests long-run co-movement, it is reasonable to assume that the cointegrating vectors are constant but the direction of causality changes. For instance, UK and German interest rates may have been set primarily in line with US rates prior to entering the ERM, but once full membership is achieved the UK rates may be driven by the German monetary stance which is still set with a view to the US. In both cases the three interest rates will move in line and be cointegrated on a pairwise basis, but the direction of causality will be different between the two policy regimes.

Here we concentrate on this type of structural change, and using sequential methods, test for changes in the matrix of loading weights. This way of testing for structural change in long-run causality was first suggested by Beeby, Funke and Hall (1998). However, a difficulty with the tests reported in Beeby et al (1998) is that standard distributions cannot be relied upon to test for the significance of the t-statistic. To overcome such a problem, in an earlier paper we derived, using Monte Carlo methods, the distribution and the critical values for the null of no breaks against the alternative of a single persistent one for different sample sizes (see Barassi, Caporale and Hall, 2001).

The present paper is organised as follows. The next section (section 2) introduces the sequential test methodology. Section 3 discusses the empirical results and their economic implications. A summary concludes.

2. A sequential test for structural change

Consider the following cointegrating VAR in error correction form,

2.1
$$\Delta Z_{1t} = \Gamma_{11}\Delta Z_{t-1} + \ldots + \Gamma_{1k-1}\Delta Z_{t-k+1} + \alpha_1(\beta' Z_{t-k}) + e_{1t}$$
$$\Delta Z_{2t} = \Gamma_{21}\Delta Z_{t-1} + \ldots + \Gamma_{2k-1}\Delta Z_{t-k+1} + \alpha_2(\beta' Z_{t-k}) + e_{2t}$$

where $\beta' Z_{t-k}$ is the stationary linear combination of the non-stationary levels that is assumed to be stable over time, and $\alpha = [\alpha_1, \alpha_2]$ represents the speed at which the variables in Z adjust to disequilibrium, and consider the case when any of the elements α_i of he matrix α switches over time to some $\alpha°$. This can happen in two basic ways:

A $\alpha = \begin{bmatrix} \alpha_1 \\ 0 \end{bmatrix}$, $\alpha\circ = \begin{bmatrix} \alpha_1^\circ \\ \alpha_2^\circ \end{bmatrix}$., $\alpha_2^\circ \neq 0$,

B $\alpha = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix}$, $\alpha\circ = \begin{bmatrix} \alpha_1^\circ \\ 0 \end{bmatrix}$. $\alpha_2 \neq 0$,

In case A Z_2 is exogenous and is not caused in the long run by Z_1 before the regime shift, but receives feedback from Z_1 afterwards. In case B the two states are reversed in terms of time.

In our setup, once the coefficient switches to its new value it does not go back to the original state. In order to detect the possible occurrence of a single permanent break we propose to estimate such a model including a dummy variable that should be multiplied by the error correction term. This dummy variable is then switched on for sub-samples of the data. The strategy consists in observing for which sub-periods this switching dummy is statistically significant. The intervals where the t-value of this dummy variable is larger indicate the presence of a shift in the coefficients to which it is attached for the period covered. Formally, the estimated model will be:

2.2 $$\begin{aligned}\Delta Z_{1t} &= \Gamma_{11}\Delta Z_{t-1} + \ldots + \Gamma_{1k-1}\Delta Z_{t-k+1} + \alpha_1(\beta' Z_{t-k}) + \alpha_1^{\circ} D_i(\beta' Z_{t-k}) + e_{1t} \\ \Delta Z_{2t} &= \Gamma_{21}\Delta Z_{t-1} + \ldots + \Gamma_{2k-1}\Delta Z_{t-k+1} + \alpha_2(\beta' Z_{t-k}) + \alpha_2^{\circ} D_i(\beta' Z_{t-k}) + e_{2t}\end{aligned}$$

with $D_i = (0_0, \ldots\ldots 0_{i-1}, 1_i, \ldots\ldots\ldots 1_T)$, where T is the sample size.

The test statistics for the null of no-break against the alternative of a single persistent break is given by

2.3 $$\tau = \left| \arg\max \left\{ t_{\alpha_i} = 0(n) \right\} \right|, n = 2, T-2 .$$ [2]

In a previous paper (see Barassi *et al.* 2001) we found that the test-statistic follows a non-standard distribution and using Monte Carlo methods we derived the 90 and 95 per cent critical values for different sample sizes.

Here we apply this procedure to bivariate systems linking the G-7 short-term interest rates as irreducible cointegrated (IC)[3] relations in order to investigate the occurrence of permanent breaks in the causal structure of these linkages, or reversals in the direction of causality. Our expectations are, given the results obtained in a previous study (see Barassi, Caporale and Hall, 2000), to find that exogeneity of US interest rates with respect to European ones holds, implying the absence of breaks in the adjustment coefficients of the error correction equations for the first difference of US rate. We also expect to find evidence of a break in the adjustment coefficients for the UK rate in equations involving the other European rates after the collapse of the ERM. Other testable hypotheses are the presence of breaks in the influence that Germany may exercise on the European rates (as the Germany leadership Hypothesis would require), and the stability of the causal structure within the G-7 system as a whole. Notice that the restrictive conditions within which our testing procedure works may not allow us to draw strong conclusions by simply comparing the value of the test statistic to the critical

[2] We consider the absolute value of the test statistic because its sign differs depending on the type of break that occurs.

values[4]. We will therefore also present the plot of the test statistic to show the breakpoints.

3. Empirical Results

For the empirical analysis we used IMF quarterly data on the three-month Treasury bill rates covering the period between 1980:Q3 and 1998:Q3. Notice that for efficiency reasons we have estimated single equations in error correction form rather than bivariate vector error correction models. This is legitimate as in an earlier paper (see Barassi et al, 2000) we found that there is bivariate cointegration between all the rates with unit cointegrating vectors. Once the cointegrating vectors are determined then single equation estimation becomes FIML.

More specifically, in Barassi et al (2000) we analysed causal linkages between the G-7 short-term interest rates by applying a methodology due to Davidson (1998) based on the concept of irreducible cointegrating relations (IC). Evidence was found that cointegration is a property of the G-7 short rates, and that it is important to test for irreducibility as a diagnostic. We also extended Davidson's (1998) methodology introducing the ranking of the IC relations according to the criterion of minimum variance. This allowed us to distinguish between structural and solved IC vectors without any prior theoretical assumptions[5].

Briefly, we found that the system of the G-7 interest rates has a rank of six. The immediate implication of this is the existence of six structural irreducible cointegrating regressions which we inferred by ranking the IC relations according to the criterion of the minimum variance. The two most significant relations involve the US and Canada, and Italy and France. The other four relations involve Germany and Japan, and Japan with

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[3] The definition of irreducible cointegrating relation is due to Davidson (1998) and refers to cointegrating subsets of variables that do not have any cointegrating subsets.

[4] The sequential testing procedure has reasonable power in detecting one permanent break only. The presence of multiple breaks may produce results that may not be unequivocally interpreted, especially if the multiple breaks have opposite direction.

[5] A solved vector is defined as a linear combination of structural vectors from which one or more common variables are removed by choosing offsetting weights such that the included variables are not a superset of any of the constituent relations.

USA, France and UK. Here we have estimated the error correction equations for each country, and bearing in mind the structural nature of some IC vectors we have inferred the causal structure that links the G-7 interest rates and tested for its stability. Specifically, six models were estimated for each country; in each equation we allow for the possibility that a particular country adjusts to one of the other G-7, and therefore for the possibility that each country is being influenced by any of the other six. So if we found that for country A all six adjustment parameters are zero or statistically insignificant, this would indicate that this country was not influenced by any of the other countries over the period considered.

The first observation to make is that most of the first differences of the G-7 interest rates seem to follow simple autoregressive processes of order one (AR(1)), apart from the US rates that require including some dummy variables to offset an ARCH effect corresponding to the monetary base targeting pursued by the Fed during the early 1980s. The complete results for all the countries are presented on Tables 1-7, which report the coefficient estimates and both OLS and Newey-West corrected standard errors. Notice that for ease of interpretation the sign of the adjustment coefficients is always presented as negative (even in the cases in which this is positive due to the ordering of variables in the original bivariate VARs). At any rate, none of the series exhibit explosive behaviour.

The causal structure is obtained from the OLS estimation and is presented in Tables 1-7. The first important result is the exogeneity of US rates with respect to all the others (Table 7). This is particularly evident in the error correction equations including the adjustment coefficients towards the structural long-run equilibrium relations with Canadian and Japanese rates, suggesting a US worldwide leadership. Interestingly, Japan shares four out of the six IC relations with the US, France, Germany and the UK. It seems that Japanese rates (Table 5) represent the *trait d'union* between American and European rates, being exogenous with respect to all other rates apart from the US and UK ones.

Another important result is the weak leadership of Germany within the European Monetary Union (EMU). The exogeneity of German rates with respect to the Italian and

French ones (Table 3) is clear, as they do not share any structural relations with the European ones and receive feedback from Japan (in a structural IC relation) and all the remaining rates included the UK. As for the UK rates, they seem to receive feedback from US and Canadian rates but not from the EU countries. This may be due to the presence of a break in the causal relationships with the latter rates after the third/fourth quarter of 1992, and it is one of the hypotheses we are interested in testing. Essentially, the US and Canada appear to constitute the fundamental block, UK rates respond to non-European rather than to other European rates, Italy is probably following France, and France and Germany respond to world rates rather than to each other. Lastly, Japan acts as the link between US and European rates.

These results, however, are all predicated on the assumption that the causal structure is constant over the sample period. A casual consideration of the structural changes which have occurred in the monetary policy structure of the world over the last 20 years makes this an unlikely assumption. Consequently, we will now apply the techniques outlined above to investigate possible changes in the adjustment coefficients in the single-equation error-correction models corresponding to the irreducible cointegrating relations for all the G-7 short-term interest rates.

The results are displayed in tables 8-14, and can be summarised as follows. First, we do not find evidence of structural changes in causality in the equations for the US, Canada and Germany. The US and Canada appear to have constituted a fundamental block throughout, with the US economy being a constant point of reference for all the other countries. Second, the weak German leadership within the Eurozone is confirmed, as German rates do not appear to be influenced by those of the EMU countries, but are influenced by all the other rates, including the UK ones.

Table 9 shows that there is some evidence of breaks in the equations for the French rate. These concern the feedback received from Canadian, German and Japanese rates (see figures 1, 2 and 3 respectively). The breaks seem to occur immediately after the collapse of the ERM, between the fourth quarter of 1992 and the first two quarters of 1993. It seems that in that particular period the feedback the French rate receives becomes stronger than in the past. The same conclusions can be drawn for the Italian short-term rate, that is closely linked to the French one in one of the structural relations, and from which it receives a stronger feedback from the third quarter of 1984 (figure 4). It appears, in fact, that German and Japanese rates start exerting a strong influence on it at the same time as on the French rate (end of 1992-early 1993), as shown in figures 5 and 6 respectively.

As highlighted in table 12, Japanese rates start following more closely the US and Canadian ones soon after the high volatility period due to the monetary base targeting pursued by the Fed, more precisely in the fist quarter of 1983 (figures 7 and 8). This result, given the linkages between the US and Canadian rates with the Japanese ones in two of the structural IC relations, again indicates that these two countries constitute the fundamental block of the G-7 group, the US being a world-wide leader. Lastly, one should notice that the UK rate stops receiving feedback from the German one exactly after the collapse of the ERM in the last quarter of 1992, as shown in figure 9.

4. Conclusions

In this paper we have investigated changes in the causal structure linking the G-7 short-term rates by means of an OLS-based sequential test for the constancy of the adjustment coefficients in error correction equations. This technique is only suitable to detect single permanent structural breaks in the causal linkages. Besides the constancy of the G-7 causal structure as a whole, the hypotheses of interest were the US world-wide leadership, the possible disengagement of UK monetary policy from that pursued in the Eurozone after the collapse of the ERM, and the German leadership hypothesis (GLH) within the European Union (EU).

The main results are the following. First, we did not find any cases of reversal of causality. Second, there is no evidence of changes in the feedback that the US, Canadian and German rates receive. Clearly, the US and Canada have consistently constituted the fundamental block of the G-7 group, with the US economy being a constant point of reference. Third, the absence of breaks in the adjustment coefficients in the equations for the German rate confirms the (weak) leadership of Germany within the Eurozone. Moreover, we found some evidence of breaks in the equations for the French and Italian rates, which appear to start following the German rates more closely after the collapse of the ERM. Another result is the link between Japanese rates and US and Canadian ones soon after the Fed stopped targeting the monetary base. Lastly, the evidence points to a break in the causal linkages between the UK and the German rates after the third/fourth quarter of 1992, implying the disengagement of UK policies from developments in the EU.

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Table 1. Canada: OLS-based estimates for the ECMs		
Dependent Variable: DCanada(t)		Error correction term
Constant	DCanada(t-1)	Canada-France(t-1)
-0.105 (0.148) [0.151]	0.212 (0.127) [0.108]	-0.057 (0.077) [0.059]
Constant	DCanada(t-1)	Canada-Germany(t-1)
0.094 (0.232) [0.169]	0.220 (0.118) [0.097]	-0.046 (0.053) [0.046]
Constant	DCanada(t-1)	Canada-Italy(t-1)
-0.212 (0.257) [0.218]	0.247 (0.122) [0.104]	-0.051 (0.062) [0.049]
Constant	DCanada(t-1)	Canada-Japan(t-1)
0.662 (0.357) [0.286]	0.276 (0.114) [0.106]	-0.130 (0.059) [0.051]
Constant	DCanada(t-1)	Canada-UK(t-1)
-0.164 (0.142) [0.152]	0.277 (0.112) [0.970]	-0.172 (0.068) [0.062]
Constant	DCanada(t-1)	USA-Canada(t-1)
0.362 (0.212) [0.249]	0.174 (0.110) [0.097]	-0.230 (0.078) [0.098]
OLS Standard errors in parenthesis		
Newey-West standard errors in brackets		

Table 2. France: OLS-based estimates for the ECMs		
Dependent Variable: DFrance(t)		Error correction term
Constant	DFrance(t-1)	Canada-France(t-1)
-0.114 (0.097) [0.102]	0.132 (0.110) [0.119]	-0.165 (0.047) [0.078]
Constant	DFrance(t-1)	Germany-France(t-1)
0.282 (0.195) [0.166]	0.292 (0.108) [0.110]	-0.093 (0.049) [0.032]
Constant	DFrance(t-1)	France-Italy(t-1)
-0.906 (0.323) [0.481]	0.263 (0.112) [0.104]	-0.232 (0.089) [0.141]
Constant	DFrance(t-1)	France-Japan(t-1)
0.564 (0.311) [0.243]	0.236 (0.112) [0.110]	-0.119 (0.052) [0.042]
Constant	DFrance(t-1)	France-UK(t-1)
-0.150 (0.103) [0.111]	0.174 (0.112) [0.128]	-0.087 (0.037) [0.036]
Constant	DFrance(t-1)	USA-France(t-1)
0.260 (0.130) [0.174]	0.228 (0.103) [0.105]	-0.146 (0.041) [0.062]
OLS Standard errors in parenthesis		
Newey-West standard errors in brackets		

Table 3. Germany: OLS-based estimates for the ECMs		
Dependent Variable: DGermany(t)		Error correction term
constant	DGermany(t-1)	Canada-Germany(t-1)
-0.140 (0.101 [0.068])	0.393 (0.106) [0.088]	-0.049 (0.023) [0.025]
constant	DGermany(t-1)	Germany-France(t-1)
-0.001 (0.118) [0.071]	0.448 (0.103) [0.103]	-0.001 (0.029) [0.023]
constant	DGermany(t-1)	Germany-Italy(t-1)
-0.028 (0.178) [0.112]	0.406 (0.107) [0.102]	-0.001 (0.024) [0.021]
constant	DGermany(t-1)	Germany-Japan(t-1)
0.204 (0.095) [0.102]	0.449 (0.096) [0.095]	-0.100 (0.036) [0.037]
constant	DGermany(t-1)	Germany-UK(t-1)
-0.247 (0.116) [0.102]	0.340 (0.106) [0.090]	-0.052 (0.025) [0.022]
constant	DGermany(t-1)	USA-Germany(t-1)
-0.095 (0.069) [0.065]	0.378 (0.101) [0.094]	-0.063 (0.023) [0.025]
OLS standard errors in parenthesis		
Newey-West standard errors in brackets		

Table 4. Italy: OLS-based estimates for the ECMs		
Dependent Variable: DItaly(t)		Error correction term
Constant	DItaly(t-1)	Canada-Italy(t-1)
0.374 (0.153) [0.151]	0.277 (0.100) [0.076]	-0.127 (0.036) [0.040]
Constant	DItaly(t-1)	France-Italy(t-1)
0.723 (0.302) [0.289]	0.376 (0.103) [0.083]	-0.233 (0.081) [0.091]
Constant	DItaly(t-1)	Germany-Italy(t-1)
0.312 (0.264) [0.220]	0.344 (0.105) [0.084]	-0.059 (0.035) [0.028]
Constant	DItaly(t-1)	Italy-Japan(t-1)
0.749 (0.352) [0.346]	0.369 (0.101) [0.080]	-0.090 (0.037) [0.039]
Constant	DItaly(t-1)	Italy-UK(t-1)
0.063 (0.135) [0.113]	0.293 (0.108) [0.090]	-0.057 (0.030) [0.031]
Constant	DItaly(t-1)	USA-Italy(t-1)
0.478 (0.217) [0.277]	0.324 (0.103) [0.071]	-0.099 (0.035) [0.046]
OLS standard errors in parenthesis		
Newey-West standard errors in brackets		

Table 5. Japan: OLS-based estimates for the ECMs		
Dependent Variable: DJapan(t)		Error correction term
Constant	DJapan(t-1)	Canada-Japan(t-1)
-0.295 (0.145) [0.158]	0.381 (0.183) [0.110]	-0.049 (0.027) [0.031]
Constant	DJapan(t-1)	France-Japan(t-1)
-0.229 (0.167) [0.157]	0.360 (0.106) [0.091]	-0.031 (0.028) [0.028]
Constant	DJapan(t-1)	Germany-Japan(t-1)
-0.058 (0.088) [0.104]	0.423 (0.105) [0.105]	-0.018 (0.034) [0.036]
Constant	DJapan(t-1)	Italy-Japan(t-1)
-0.088 (0.213) [0.144]	0.406 (0.105) [0.110]	-0.006 (0.023) [0.013]
Constant	DJapan(t-1)	Japan-UK(t-1)
-0.567 (0.190) [0.186]	0.324 (0.102) [0.102]	-0.087 (0.029) [0.031]
Constant	DJapan(t-1)	USA-Japan(t-1)
-0.022 (0.081) [0.080]	0.321 (0.109) [0.122]	-0.043 (0.020) [0.021]
OLS standard errors in parenthesis		
Newey-West standard errors in brackets		

Table 6. UK: OLS-based estimates for the ECMs		
Dependent Variable: DUK(t)		Error correction term
Constant	DUK(t-1)	Canada-UK(t-1)
0.032 (0.110) [0.121]	0.239 (0.106) [0.114]	-0.117 (0.051) [0.051]
Constant	DUK(t-1)	UK-France(t-1)
-0.086 (0.116) [0.118]	0.177 (0.108) [0.113]	-0.032 (0.049) [0.047]
Constant	DUK(t-1)	Germany-UK(t-1)
0.071 (0.209) [0.204]	0.184 (0.119) [0.114]	-0.045 (0.045) [0.047]
Constant	DUK(t-1)	Italy-UK(t-1)
-0.118 (0.155) [0.147]	0.156 (0.120) [0.110]	-0.004 (0.036) [0.038]
Constant	DUK(t-1)	UK-Japan(t-1)
0.447 (0.414) [0.354]	0.262 (0.122) [0.118]	-0.080 (0.065) [0.064]
Constant	DUK(t-1)	USA-UK(t-1)
0.245 (0.160) [0.145]	0.169 (0.111) [0.117]	-0.132 (0.045) [0.041]
OLS Standard errors in parenthesis		
Newey-West standard errors in brackets		

Table 7. USA: OLS-based estimates for the ECMs		
Dependent Variable: DUSA(t)*		Error correction term
Constant	DUSA(t-1)	USA-Canada(t-1)
0.040 (0.098) [0.071]	0.167 (0.072) [0.086]	-0.048 (0.038) [0.028]
Constant	DUSA(t-1)	USA-France(t-1)
-0.019 (0.108) [0.078]	0.251 (0.091) [0.113]	-0.019 (0.036) [0.023]
Constant	DUSA(t-1)	USA-Germany(t-1)
-0.054 (0.092) [0.078]	0.273 (0.087) [0.098]	-0.002 (0.032) [0.031]
Constant	DUSA(t-1)	USA-Italy(t-1)
0.056 (0.201) [0.175]	0.248 (0.090) [0.101]	-0.020 (0.033) [0.026]
Constant	DUSA(t-1)	USA-Japan(t-1)
0.261 (0.195) [0.251]	0.227 (0.109) [0.099]	-0.090 (0.048) [0.058]
Constant	DUSA(t-1)	USA-UK(t-1)
-0.162 (0.153) [0.162]	0.203 (0.112) [0.084]	-0.043 (0.045) [0.050]
(*) dummies for 1980:3, 1981:1, 1982:1, 1982:4 are included to account for the period corresponding to the Monetary Base Targeting pursued by the FED during the early 1980s		
OLS Standard errors in parenthesis		
Newey-West standard errors in brackets		

Table 8. Results of sequential test for structural change in causality for Canada						
	France	Germany	Italy	Japan	UK	USA
Test-statistic	-1.18	-1.71	-0.85	-2.52	1.27	2.50
** denotes rejection of the null of no break at the 95% level * denotes rejection of the null of no break at the 90% level						

Table 9. Results of sequential test for structural change in causality for France						
	Canada	Germany	Italy	Japan	UK	USA
Test-statistic	-2.82*	-5.18**	-1.60	-3.52**	-1.72	-2.37
** denotes rejection of the null of no break at the 95% level * denotes rejection of the null of no break at the 90% level						

Table 10. Results of sequential test for structural change in causality for Germany						
	Canada	France	Italy	Japan	UK	USA
Test-statistic	-2.18	-1.77	1.62	1.95	-1.95	1.13
** denotes rejection of the null of no break at the 95% level * denotes rejection of the null of no break at the 90% level						

Table 11. Results of sequential test for structural change in causality for Italy						
	Canada	France	Germany	Japan	UK	USA
Test-statistic	-2.24	-2.68*	-3.72**	-2.92*	-2.01	-2.50
** denotes rejection of the null of no break at the 95% level * denotes rejection of the null of no break at the 90% level						

Table 12. Results of sequential test for structural change in causality for Japan						
	Canada	France	Germany	Italy	UK	USA
Test-statistic	-3.25**	-1.83	2.48	-1.90	-2.41	-2.72*
** denotes rejection of the null of no break at the 95% level * denotes rejection of the null of no break at the 90% level						

Table 13. Results of sequential test for structural change in causality for UK						
	Canada	France	Germany	Italy	Japan	USA
Test-statistic	1.86	2.39	2.72*	1.01	1.78	2.06
** denotes rejection of the null of no break at the 95% level * denotes rejection of the null of no break at the 90% level						

Table 14. Results of sequential test for structural change in causality for USA						
	Canada	France	Germany	Italy	Japan	UK
Test-statistic	-1.85	2.40	2.00	2.02	1.52	1.36
** denotes rejection of the null of no break at the 95% level * denotes rejection of the null of no break at the 90% level						

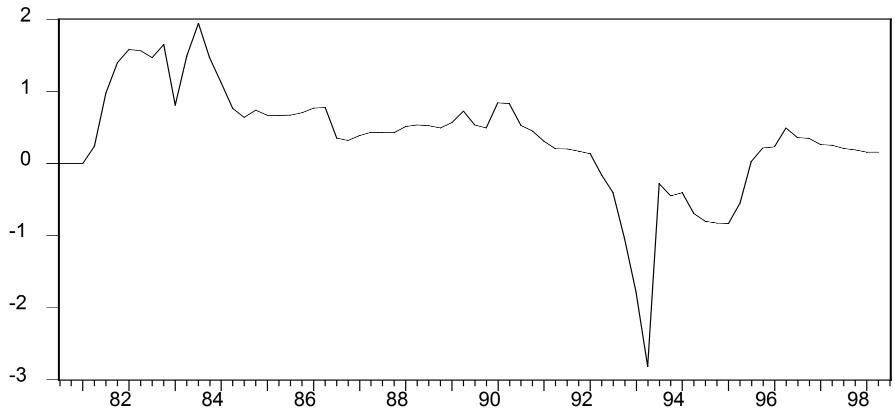

Figure 1. Test statistic for a break on the French adjustment coefficient
towards the long run relationship France-Canada

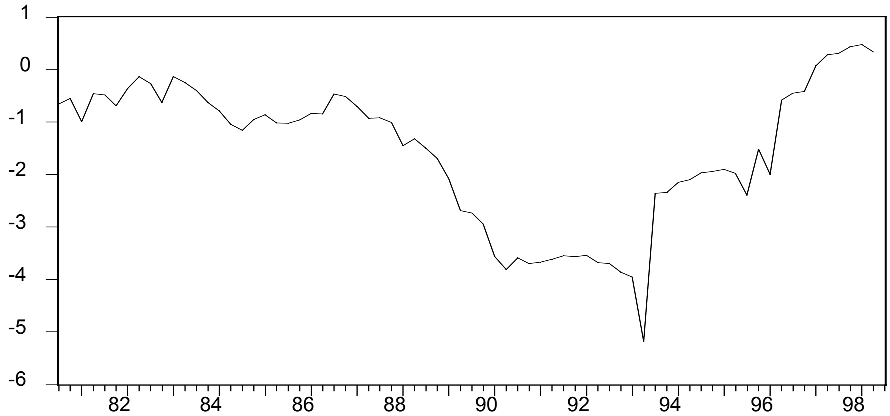

Figure 2. Test statistic for a break on the French adjustment coefficient
towards the long run relationship France-Germany

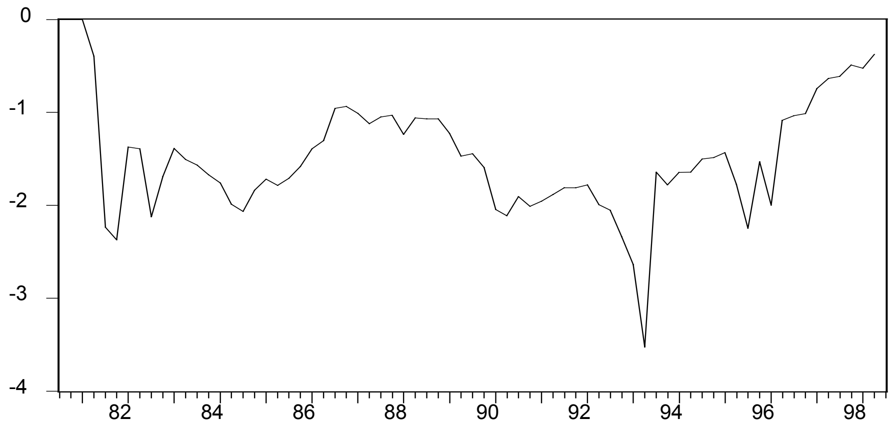

Figure 3. Test statistic for a break on the French adjustment coefficient
towards the long run relationship France-Japan

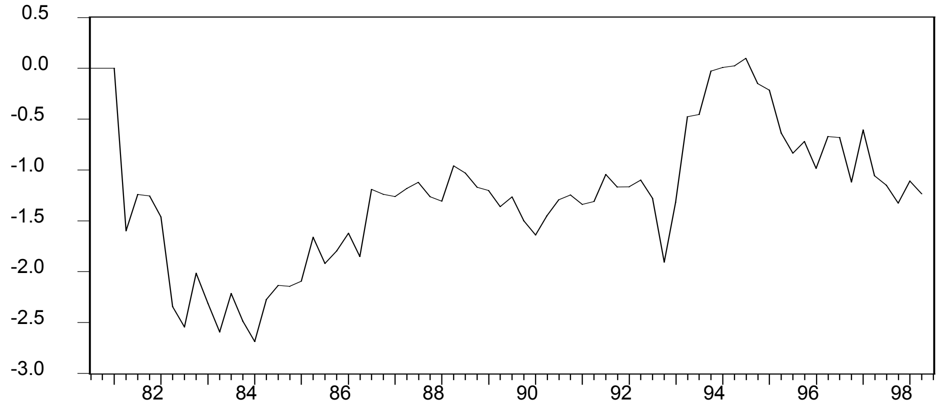

Figure 4. Test statistic for a break on the Italian adjustmen coefficient
towards the long run relationship Italy-France

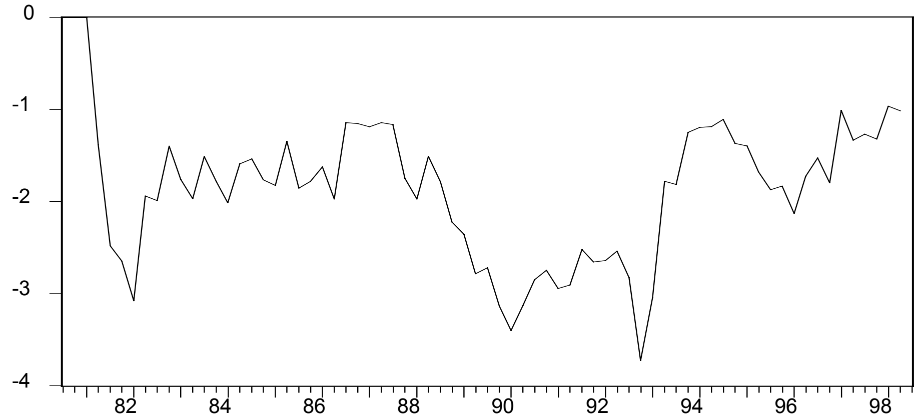

Figure 5. Test statistic for a break on the Italian adjustment coefficient
towards the long run relationship Italy-Germany

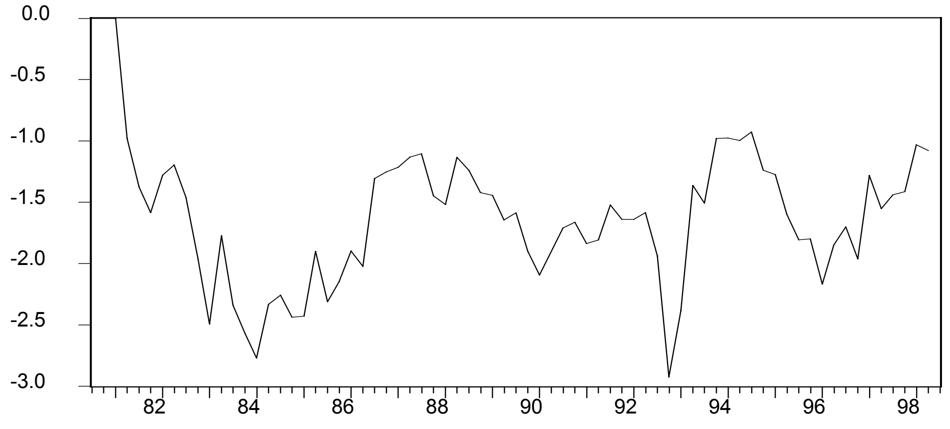

Figure 6. Test statistic for a break on the Italian adjustment coefficient
towards the long run relationship Italy-Japan

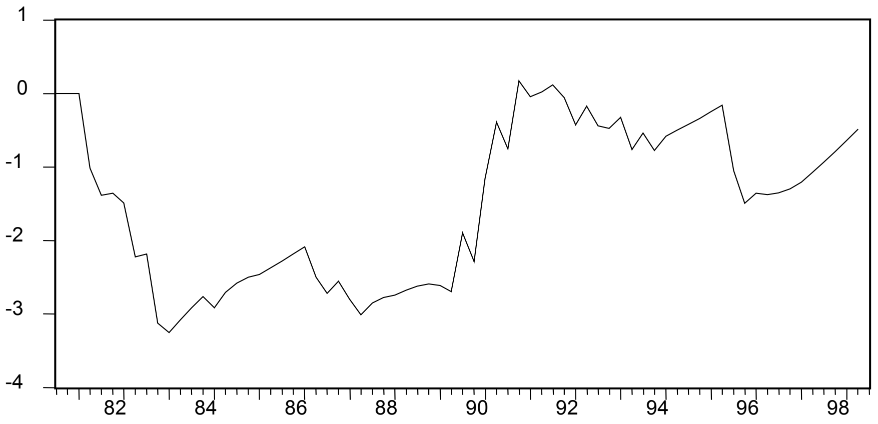

Figure 7. Test statistic for a break on the Japanese adjustment coefficient
towards the long run relationship Japan-Canada

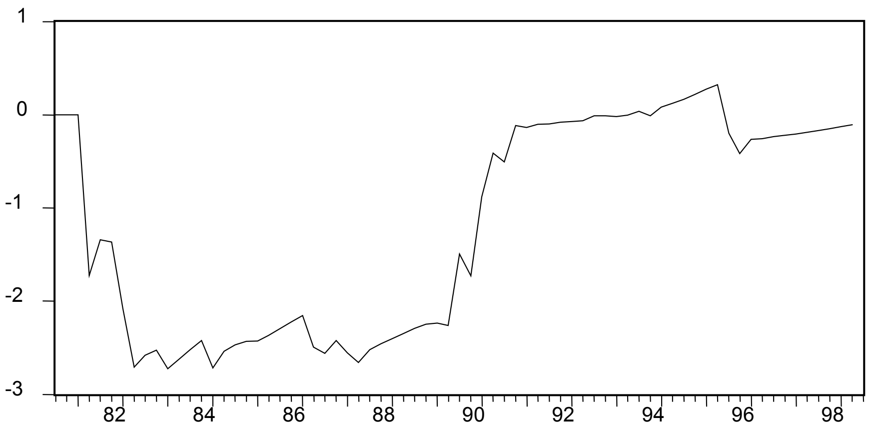

Figure 8. Test statistic for a break on the japanese adjustment coefficient
towards the long run relationship Japan-USA

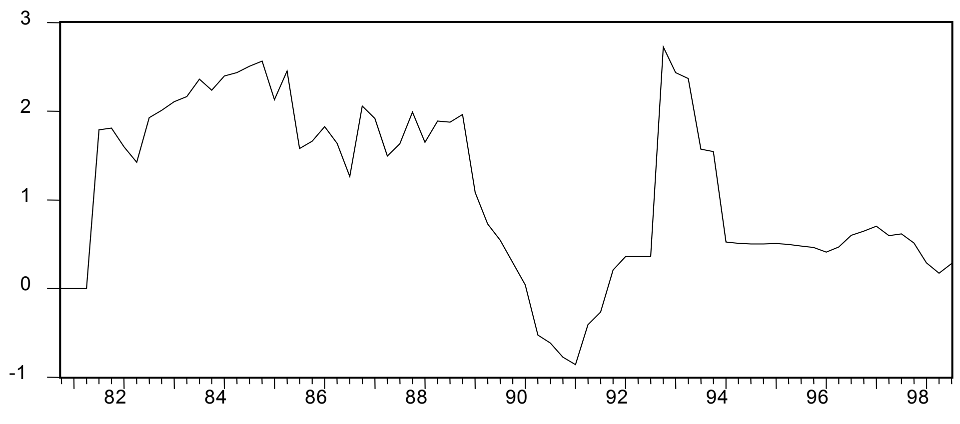

Figure 9. Test statistic for a break on the UK adjustment coefficient
towards the long run relationship UK-Germany