DYNAMICS OF EQUITY MARKET INTEGRATION IN EUROPE: EVIDENCE OF CHANGES WITH EVENTS AND OVER TIME

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DYNAMICS OF EQUITY MARKET INTEGRATION IN EUROPE: EVIDENCE OF CHANGES WITH EVENTS AND OVER TIME

Abstract

This paper examines the integration of European equity markets over 1985-2002 using a relatively new set of three dynamic techniques that measure the extent of time-varying equity market integration from complementary perspectives. All three techniques are in agreement that there has been an increased degree of integration among European equity markets especially since the 1997-98 period. This evidence shows that despite several years of demonstrating political willingness by European leaders to integrate their economies, it was not until the establishment of the EMU and the ECB during 1997-98 that the markets deemed that European integration would in fact occur. We also show that despite this increased integration, the European equity markets are still dominated by the US market and are in fact convergent towards this market rather than a common internal measure.

I. INTRODUCTION

The political, economic, and monetary union of Europe is clearly a major historic process of much interest. Prior to the current attempts at European unification, there had been centuries of intrigue, discord, and warfare amongst the European powers including two world wars and a century of cold war between socialist and capitalist states. Thus, the union of European states has a great deal of history to overcome and this union has understandably been a slow and a deliberate process. Today unification is occurring against a backdrop of increasingly integrated global markets. Technology is making globalization more feasible and globalization is enhancing the returns to new technology. These mutually reinforcing trends of technology and globalization render national economies ever more open while raising global growth rates (Aggarwal (1999)). In this environment, European countries face significant pressures to integrate even if only to compete with the large North American and Asian economies. This paper investigates when and how fast European markets integrated.

Economic and Monetary Union among the countries of Western Europe has a long history beginning with the treaty of Rome and with increasing efforts made throughout the 1960's and 70's, but these efforts foundered on the economic uncertainty of the early 1980's. In 1979 came the *Exchange Rate Mechanism-ERM* of the *European Monetary System-EMS* (of which the UK was a member) and in 1987 the *Single European Act* was adopted. This provided a legal basis for the four freedoms of movement in the EEC – people, goods, services, and capital. Table 1 shows the dates of selected key events in the formation of the EMU, commencing in 1988 (for additional details see one of the many books on European integration, e.g., Gillingham (2003)). This paper is concerned with two issues: the extent to which European equity markets have reflected the legislative and political initiatives towards the EMU and also the extent and evolution of European equity market integration.

(Please insert Table 1 about here)

As well developed and large financial markets contribute significantly to economic growth (see Arestis, Demetriades and Lunitel (2001) and Beck, Levive and Loeysa (2000)), the development and integration of European financial markets is of particular importance. Further, the nature and extent of equity market integration is important for corporate managers as it influences the cost of capital, and for investors as it influences international asset allocation and diversification benefits (e.g., Sentana (2000)). While it is clear that there is now substantial monetary integration in Europe, the extent of economic and financial integration is less clear. As noted in Forbes and Chinn (2004), economic and industrial structures in countries differ and there will necessarily be differences in the degree of integration between equity markets. In this light, this paper examines the extent and evolution of European equity market integration. Further, it is widely contended (at least in the popular press) that the globalization of the world economy is increasing. However, among economists there still seems to be some controversy regarding the integration of economies and markets. Indeed, a recent International Monetary Fund conference on this topic concluded that "economists lack evidence of increasing synchronization of the world's economies" (Brooks, Forbes, Imbs and Mody (2003)). Similarly, in the more limited context of Western Europe, the actual extent of financial market integration is still unclear. This paper is an attempt to fill this gap in our understanding.

European countries vary greatly in terms of the structures of their financial systems – some are bank-centered like Germany while others are market centered like the UK and Ireland, while still others have a mixed system. Further, there can be many different measures of financial market integration (see for example surveys in Adam, Japepelli, Menichini, Padula and Pagano (2002) and Kearney and Lucey (2004)). However, this paper concerns itself primarily with equity market integration. In such a study, there is a choice of focusing on the integration of price levels or on the integration of asset risk profiles. Further complicating the issue is the fact that financial market integration is likely to vary over time and also the fact that financial data (especially price levels) are unlikely to be stationary.

Prior research on equity market integration has failed to satisfactorily account for many of these factors and much of it has focused on countries and areas other than Europe. For example, early attempts to assess international equity market integration, based on correlation and VAR (vector auto-regression) analysis, generally find rising equity market integration (see King and Wadhwani (1990) and Koch and

Koch (1991)). However, these papers are static in nature, and generally measure only average degrees of integration over contiguous time periods. Other studies using variations of the GARCH approach to account for time-varying volatility find evidence of price and volatility spillovers across major national equity markets (see Hamo, Masulis and Ng (1990); Koutmos and Booth (1994; Fratzscher (2001)). Noting the changing nature of market integration, some studies have examined various sub-periods to assess the dynamics of international integration (see Bekaert and Harvey (1995); Longin and Solnik (1995); Bodart and Reding (1999) and Ng (2000)).

A weakness of many of these studies is that a focus on comparative statics misses the important element of time variation in equity risk premia. The seminal works by Campbell (1987), Harvey (1989), Harvey (1991) and Bekaert and Harvey (1995) all show that the risk premium of equities is indeed time-varying. Thus, any attempt to model the integration of markets without taking account of this time variation may yield confusing and partial results. A number of approaches have been deployed to take account of time-varying equity risk premia in assessing equity market integration. Koch and Koch (1991) use a simultaneous equation model that they estimate over a number of contiguous sub-periods. They find significant and increased linkages among world equity markets. Similar in spirit is Longin and Solnik (1995) who use correlation and covariance matrix estimates, finding that over the 1960-1990 period there was a general increase in integration with covariance increasing markedly in times of macroeconomic instability. Hardouvelis, Malliaroupoulos and Priestley (1999) directly examine the speed of integration among the EU equity markets by the development of an explicit equilibrium asset-pricing model with a time-varying measure of integration. They find that the degree of integration is closely related to the probability of a country entering into EMU. Integration increases substantially over time and seems to be complete by mid-1998. Sentana (2002) by contrast, focuses on the question of whether the EMS has contributed to lower corporate cost of capital by estimating a time varying Arbitrage Pricing Theory (APT) model. He finds that not only was there only a small decrease in the cost of capital attributable to EMU, but that there was also no evidence that country risk was decreasing, indicating no great degree of integration. Rangvid (2001) uses a dynamic cointegration approach, focusing on quarterly share indices for France, Germany and the UK over the 1960:Q1 – 1999:Q1 period. He finds evidence of increasing convergence since 1982. Rangvid and Sorensen (2002) also use this recursive approach to confirm convergence in ERM exchange rates. Serletis and King (1997) uses a variant of two of the approaches we use and finds over the 1971-1992 period that European markets did demonstrate integration. Fratzscher (2001) uses a GARCH methodology to examine financial market integration in Europe and finds that the move towards EMU contributed towards increasing integration of financial markets in Europe. However, he finds that the degree of financial market integration in Europe has been very unstable and volatile over time. A more recent paper , Kim, Moshirian and Wu (2005), extracts time varying correlation coefficients from bivariate E-garch models of EMU member states, concluding that the EMU process has been associated with increased integration. In summary, given this literature and the non-stationary nature of stock prices, the use of dynamic cointegration techniques in examining international market integration can fill an important gap in the literature.

Using three complementary techniques to measure varying levels of integration over time, this paper documents important new findings regarding European equity market integration over the 1983-2002 time period. The three complementary techniques used to measure changes in integration over time include multilateral correlation analysis and the dynamic Haldane-Hall Kalman filter methodology. The latter analyses largely corroborate the results provided by the dynamic cointegrating technique – that there has been an increased degree of integration among European equity markets, especially during the important 1997-98 period that demonstrated greatly increased levels of integration. Interestingly, the evidence seems to indicate that despite several years of political demonstrations of the willingness of European leaders to complete the EU project, it was not until the establishment of the EMU and the ECB that the markets deemed that European integration would in fact occur. Thus, in examining time-varying cointegration in Europe, we believe, this study fills an important gap in the literature.

The remainder of this paper is organized as follows. Section II discusses the issues involved in the estimation of integration as a time varying process, Section III describes the application of the three new statistical methodologies and the data used, and Section IV shows the results. Section V concludes.

II. ESTIMATING INTEGRATION AND CHANGES OVER TIME

A number of methods can be used to estimate the nature and extent of financial market integration as a time varying process. We use estimates of traditional cointegration; the Haldane and Hall Kalman filter technique, and finally dynamic cointegration analysis as described in this section. The cointegration approach is by now standard and well known and we do not therefore dwell on its description and implementation. Two complementary methods are also used here. The first is the Haldane and Hall (1991) Kalman Filter based methodology, while the second involves a dynamic estimation of the eigenvalues which sheds light on multilateral correlations through time.[1]

Evolutionary Cointegration Analysis

The traditional Likelihood based cointegration approach generates two statistics of primary interest. The first is the λ_{trace} statistic, which (in this instance) is a test of the general question of whether there exist one or more cointegrating vectors. An alternative test statistic is the λ_{max} statistic, which allows testing of the precise number of cointegrating vectors. In a recursive analysis these test statistics can be plotted over time to examine the time varying nature of market integration.[2] This approach is in essence a visual application of the recursive cointegration approach of Hansen and Johansen (1992) that has also been applied in a somewhat different form by Rangvid (2001). There are two outputs that we take and analyze from this approach: first, the largest value of the λ_{trace} statistic which tests the general hypothesis of no cointegration versus cointegration, and second, the number of cointegrating vectors given by the λ_{max} statistic. A set of time-series that are in the process of converging should be expected, as in Hansen and Johansen (1992), Rangvid (2001) and Rangvid and Sorensen (2002) to show increasing numbers of cointegrating vectors. Intuitively, this makes sense. Consider a set of *p* series which have n cointegrating

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[1] Manning (2002) examines Asian stock market integration taking the Haldane and Hall (1991) approach of specifying time varying coefficients via a Kalman filter. Most papers using this time varying approach have examined currency or interest rate relationships (e.g., Zhou (2003)).

[2] Further details regarding the dynamic cointegration approach can be found in Barari and Sengupta (2002). Therein the process is described whereby the investigator can plot over time the values of selected test statistics from the traditional cointegration approach. However, Barari and Sengupta (2002) concentrates only on the λ_{trace} statistic.

vectors, $n<p$. This implies that there are n linear combinations of the p vectors that are stationary. If we later find that we have k vectors, $n<k<p$, there are additional combinations that can be used in the representation of the p data. This is tantamount to convergence of the stock markets as the markets are being increasingly driven by the same common stochastic trends i.e. increasing arbitrage activity between the markets. If we have a static number of cointegrating vectors then recursive estimation will simply lead to an upward trend in the λ_{trace} statistic. We estimate systems that include the EU countries and those that also include the USA. The first type of system shows the extent of Intra-EU integration, while the second shows the extent of EU market integration with the world markets.

The Haldane and Hall – Kalman Filter Procedure

The Haldane & Hall (hereafter HH) method estimates a simple equation of the following[3] specification via kalman filter estimation.

$$\ln\left(\mathbf{E}_{jt}/\mathbf{E}_{Bt}\right) = \alpha_t + \beta_t \ln\left(\mathbf{E}_{jt}/\mathbf{E}_{Xt}\right) + \varepsilon_{jt} \quad (4)$$

Here the market subscripted B is the preimposed internal base market and that subscripted X is the preimposed external market. Thus, for example, in testing for integration among SE Asian markets, Manning (2002) imposes the US market as the external market (to which the SE Asian markets are assumed to be converging) and Hong Kong as the dominant local market. Negative values of β_t indicate divergence, as does a tendency to move further from zero. We examine convergence to three potential markets – Frankfurt, London and New York.

The Kalman filter used in this paper works in the following way. The equation is estimated over an initial period, to initialize the coefficients and related information. Thereafter it is updated with the addition of each daily data point. Let $Y_t = \alpha_t + X_t\beta_t + \varepsilon_t$, $\text{var}(\varepsilon_t) = \eta_t$ be the measurement equation of interest. If we set β_t as the coefficient of interest at time t, then the transition equation is given by $\beta_t = \beta_{t-1} + \nu_t$, $\text{var}(\nu_t) = \text{M}_t$. Given the estimate of β_{t-1} from information up to that period ($\beta_{t-1|t-1}$)

with the associated covariance matrix Σ_{t-1}, the updated estimate is given by equations (5), (6) and (7).

$$S_t = \Sigma_{t-1} + \mathrm{M}_t \tag{5}$$

$$\Sigma_t = S_t - S_t X_t'(X_t S_t X_t' + \eta_t)^{-1} X_t S_t \tag{6}$$

$$\beta_{t|t} = \beta_{t-1|t-1} + S_t X_t'(X_t S_t X_t' + \eta_t)^{-1}(Y_t - \alpha_{t-1} X_t \beta_{t-1|t-1}) \tag{7}$$

Dynamic Eigenvalue Analysis

This dynamic approach to assessing equity market integration implies an investigation of the time series plot of the evolution of the systems' eigenvalues. Complementary to cointegration analysis which inquires after comovements in the levels of the equity market indices; an eigenvalue analysis inquires after comovements in their returns. Thus an eigenvalue analysis serves to complement the cointegration analyses by capturing interdependencies of a relatively short-term nature. The larger an eigenvalue estimate the higher the estimate of multilateral correlation in the system. An inspection of the evolution of this estimate thus provides an outline of the evolution of the level of multilateral linear interdependencies in the system.[4] Essentially, this approach extracts the most important uncorrelated sources of information in a multivariate system. Components thus extracted are constructed in such a manner that the explanatory power of the incremental component is maximized given the restriction of orthogonality. This collapses to an inquiry into the eigenvalues and vectors of the data matrix. In this context, eigenvalues may be understood as the unconditional variances of the projections of points on each of the components. Eigenvectors are the direction cosines showing how far the original variable space is to be rotated.

III. STATISTICAL METHODOLOGY AND DATA

In addition to estimating changes in multilateral correlations over time and deploying the Haldane

[4] While Forbes and Chinn (2003) describe how integration does not in principle imply increasing correlations, Bekaert and Harvey (2003) document that increasing correlations virtually always accompany market integration. In this light we conclude that increasing correlations are consistent with, although naturally not sufficient to infer, an ongoing process of integration.

and Hall (HH) approach, this paper also uses a recently introduced variation on the traditional cointegration approach, which in essence provides a visual representation of the extent and speed of the degree of integration. The Haldane & Hall convergence parameters are initialized over the January 1988 to September 1989 period and thereafter the Kalman Filter updating occurs each day. Each country's convergence with respect to the UK, Germany and the USA is estimated and the results presented.

In the case of the eigenvalue analysis, the evolution of the cumulative explanatory power of the first eigenvalue over an approximate 12-month moving window beginning on the 1st of January 1988 and ending on the 30th September 2002 for daily data for the full set of European equity market indices and the various systems of interest is estimated and plotted. The analysis is time varying in that the window moves -by dropping the 80 initial observations and including the 80 incremental observations - for each estimate of the first eigenvalue (80 observations correspond to approximately four months of data). To correct for the potential presence of time varying volatility in each estimation window we first filter the data using a GARCH (1,1) model. The series are standardized ~(0,1) prior to the eigenvalue analysis. In this sense the eigenvalue estimates are robust to heteroskedasticity. The results of this process are presented as a time series plot of the percentage variation explained by the first eigenvalue for each 12-month window

The recursive cointegration approach in essence runs a traditional cointegration analysis for an initial period, and thereafter updates as new data are added. It derives the statistic of interest over the chosen period t_0 to t_n. This period is then extended by j and the statistic is re-estimated from t_0 to t_{n+j}. We extend the sample period by a single day for each incremental new estimation. Eventually, the estimation procedure reaches the end of the data (equivalent to the static traditional cointegration estimation over all time periods). The relevant statistic is then plotted and the interpretation proceeds by examination of the plotted statistic. An upward trend indicates either increased integration and/or a move towards integration, a downward trend indicates decreased integration and/or a move away from integration.

Data

Daily data for the largest stock markets of EU countries, namely, France, Germany, Italy, the Netherlands, Spain, Sweden and the UK are analyzed. As is common in the literature, we also use data for the USA as a proxy for the world market index. The dataset covers the period of EMU integration and commences on 31 December 1987 and ends on 30 September 2002, providing 3847 data points in total.

One of the criticisms that can be levied at many of the prior studies cited above is that they rely on indices that have potentially different construction and inclusion patterns. To allow for uniformity in the indices as much as possible, FTSE All-World indices are used here. These are sourced from Thompson Datastream. A much more comprehensive description of the FTSE world indices can be found on their website, at http://www.ftse.com. Notably, the FTSE indices are designed to be consistent across countries and thus they allow for comparative studies.

To examine the process of convergence from the perspective of both the 'domestic' and 'international' investor we carry out all analyses in both € and $ terms, implicitly assuming therefore that the representative investor is fully hedged. The initial period for the traditional cointegration approach was set at 4 January 1988 to 7 March 1988 for the Intra-EU analyses and to 21 March 1988 for the World analyses. All data were I(1) in levels, and a lag length of 1 was selected (by both Likelihood ratio and multivariate AIC/BIC)[5] for this analyses.

IV. RESULTS

Evolutionary Cointegration Results

Shown in Figure 1 is a plot of the recursively estimated global λ_{trace} statistic and Figure 2 shows the number of cointegrating vectors. The trace statistic has been normalized to be equal to 1 at the 90% critical value. A number of points are evident from these graphs. For the majority of the time period under investigation, we can be confident that the EU market was integrated internally and with the world, the

[5] Details of these tests are available on request.

λ_{trace} statistic exceeding the 90% critical value. Second, in general there is an increase in the λ_{trace} statistic over the period and in the number of cointegrating vectors. This indicates a process of increased convergence was in operation. At no stage was there lack of cointegration between the EU and the USA.

Examination of the two plots in more detail yields some further insights. There are number of periods where the λ_{trace} statistic falls below the 90% level. These are June-September 1988, December 1989-August/September 1990 (the period of non-cointegration being slightly longer when measured in dollar terms), December 1990-March 1992 (as measured in $ terms, the λ_{trace} statistic hovering at or below 1 for much of this period), and February 1996-December 1996 (only when measured in € terms). One of the major events of the first period, which occurred at the end of the period of no-cointegration, was Margaret Thatcher's euroskeptical Bruges Speech. The second period commences with the collapse of communist regimes in Eastern Europe and ends with German reunification. The third period commences with the Rome Declaration and only ends in the run-up to the implementation of the first round of referenda on the Maastricht Treaty. The final period appears to correspond to the period between the Madrid Declaration II, which outlined the desire to move to EMU and the Dublin Declaration, which began the legal moves thereto.

(Please insert Figures 1 and 2 about here)

We can also see that the data indicate that integration proceeded rapidly after the December 1996 period, which is broadly in line with the results found by Hardouvelis, Malliaroupoulos et al. (1999). This period saw the Treaty of Amsterdam, the declaration of 11 nations as eligible for consideration for EMU membership, and the creation of the European Central Bank (ECB). Periods of rapid increase in the statistic include April-August 1997 when the mechanics of implementation of the Treaty of Amsterdam were being made public, January-April 1998 in the run-up to the notification of final membership, and the December 1999 period. The largest fall in the λ_{trace} statistic occurs between February and May 2000, a period during which, with the exception of the commission decision to allow in Greece as an EMU country, there was little EMU related activity. We also note from Table 3 that it appears, on average, that the same results are found when one measures in \$ or € terms, or when one uses the UK or the UK and USA as world proxies in the system.

Haldane and Hall (HH) Results

The Kalman Filter is initialized over the period 1 January 1988 to 20 September 1989 and the plots therefore show the dynamic estimates of the convergence parameters from 21 September 1989 to the 30 September 2002. Following Manning (2002), we calculate the average convergence factor of the various indices. Shown in Figures 3 and 4 are the (average) HH convergence factors to the Frankfurt, London and New York equity markets. The striking feature of these figures is that, dependent on whether one is looking in \$ or domestic € terms, the nature and extent of convergence is very different. While in both cases the convergence parameters are rapidly tending towards 0, the convergence benchmark, in domestic (€) terms the markets begin from a perceived level of integration, while for the \$ terms the starting point is one of lack of integration. It also seems clear that with a few minor exceptions this convergence was substantially completed by the mid 1990's. The evidence is that the markets had substantially converged by March 1994, after the establishment of the European Monetary Institute.

(Please insert Figures 3 & 4 about here)

Overall these results are congruent with the results from the recursive dynamic cointegration analyses. However, it is also worth noting that in no case do individual convergence factors for any country measure as being statistically equal to zero. Nor do the averages. We can conclude therefore from the HH factors that the European markets, while converging, have not yet converged completely. However, as is clear from Table 2, the convergence appears to be closer to New York than to London or Frankfurt, the average for the New York convergence being closer to zero than either the London or Frankfurt average convergences.

(Please insert Table 2 about here)

Dynamic Eigenvalue Results

Shown in Figure 5 and table 3 are the results of the robust eigenvalue analyses.[6] The plot shows the cumulative R^2 of the first eigenvalue estimated over a rolling 250-observation (approximately 12-month) window for the 4 systems of interest: *first* the European equity markets expressed in Euro, *second* the same system expressed in US dollar; and *third* and *fourth* both systems augmented by including the US equity market denominated in the corresponding currency. The results are qualitatively similar across the systems. Again, we see a gradual but uneven increase in the degree of integration i.e., common variance explained by the first eigenvalue. Overall the explanatory power rises from about 45 percent at the start of the sample period to a climax of about 65 percent in the final years of the sample period. The explanatory power exhibits two peaks. The first occurs in the 1991-93 period coinciding with the referenda on the Maastricht treaty, the Edinburgh declaration and the inception of the Single European Market. The first peak is curiously incongruent with the cointegration analyses demonstrating the presence of transient rather than long term interdependencies. Otherwise the robust eigenvalue analyses are largely consistent with the previous analyses. We again note from Table 3 that it appears, on average, that the same results are found when one measures in $ or € terms, or when one uses the UK alone or both the UK and USA as world proxies in the system.

(Please insert Figure 5 and table 3 about here)

It is important to note that all three types of analyses are in agreement regarding the second peak during the 1998-99 period coinciding with the notification of EMU membership, the establishment of the ECB and the launch of the Euro. It is somewhat interesting that immediately after this period all of the measures indicate a slight decrease in measured integration. Unlike Kim, Moshirian et al. (2005) we do not see significant effects on the integration process around the 1992 ERM crisis. Finally, the importance of the stock market bubble, which crashed in early 2000, as a factor in measured integration in Europe also seems quite clear from the results presented here.

[6] The eigenvalue estimates are robust to heteroskedasticity in the form of GARCH (1,1) effects.

V CONCLUSIONS

It is important to assess how the nature and extent of financial integration in Europe has evolved over time. For example, such an assessment permits the examination of how salient events appear to influence the level of equity market integration. In addition, financial markets are important for economic growth and their integration promotes economic, and perhaps, political integration. Further, financial market integration is also important for corporate managers and investors. However, it is neither easy nor straightforward to measure financial market integration. This paper builds on prior research by examining time-varying integration of European equity markets over the 1985-2002 period. It uses a relatively new set of three techniques that allow the measurement of time varying integration in equity price levels to assess financial integration in Europe. To our knowledge this is the first paper which has deployed these techniques simultaneously.

This study documents that on average the European equity markets have achieved increasing and considerable levels of integration. Even though our various measures differ somewhat as to the extent and speed of integration, the evidence presented here is broadly in agreement on the importance of the 1997-1998 period demonstrating greatly increased levels of integration. Interestingly, the evidence presented here shows that despite several years of political demonstrations of the willingness of European leaders to complete the EMU project, the importance of yielding power (the Treaty of Amsterdam) and yielding policy instruments (the establishment of the ECB) emerges as the only clear, important and credible signals of European integration for the equity markets. The evidence presented here also appears to indicate that the European equity markets taken together tend to converge to the US market.

Table 1: Key Political and Economic Events of the EMU Process

Date	Event
20-9-88	Margaret Thatcher, Prime Minister of the UK, delivers a heavily skeptical speech on the future development of the union (*Bruges Speech*)
12-4-89	*Delors Report* lays out the future roadmap for EMU
27-4-89	*Madrid Declaration* adopts the Delors Report and commits the EEC (sic) to EMU
9-11-89	*Fall of Berlin Wall*
9-12-89	*Strasbourg Declaration* declares that the EEC will move towards EMU. Start of Phase I of EMU
29-5-90	European Bank for Reconstruction and Development (*EBRD*) established
19-6-90	*Schengen I* agreement signed, providing for a common travel area in Europe
3-10-90	*German Re-unification*
15-12-90	*Rome Declaration* launches intergovernmental conference on EMU
10-12-91	*Treaty of Maastricht* agreed, transforming the EEC into the European Union
21-12-91	*Soviet Union collapses*
2-6-92	*Danish referendum rejects* Maastricht treaty
18-6-92	*Irish referendum accepts* Maastricht treaty
20-6-92	*French referendum accepts* Maastricht treaty
12-12-92	*Edinburgh Declaration* amends Maastricht treaty to assuage Danish and endorses moves to EMU
1-1-93	*Single European Market* (part of Maastricht treaty) in force. This represents the culmination of the original aims of the European Economic Community – the Common Market.
18-5-93	*Second Danish referendum* accepts Maastricht treaty
2-8-93	ERM bands widened from 2.25% to 15% each direction
29-10-93	*Brussels Declaration* on the start of Phase II of EMU
1-11-93	*European Union created* with ratification of all elements of Maastricht treaty
1-1-94	European Monetary Institute (*EMI*) – forerunner of European Central Bank is established, launching Phase II of EMU
12-6-94	*Austria votes to join EU*, including EMU
16-10-94	*Finland votes to join EU*, including EMU
13-11-94	*Sweden votes to join EU*, including EMU
28-11-94	*Norway votes to not join EU*
26-3-95	*Schengen II* extends common travel area
31-5-95	*Green Paper* on practicalities of monetary union (note transfer etc)
16-12-95	*Madrid Declaration II* adopts Jan 1 1999 for launch of Euro and start of Phase III of EMU
14-12-96	*Dublin Declaration* outlines the legal mechanisms for Phase III of EMU
2-10-97	*Treaty of Amsterdam* ratifies into law the Dublin Declaration
25-3-98	*Phase III membership notified*: 11 members that may adopt the Euro and move to Phase III named
3-5-98	*Determination Mechanism* for irrevocable conversion rates outlined
26-5-98	European Central Bank *(ECB) Board agreed*
1-6-98	*ECB established*
1-1-99	*Euro Launched*
22-9-00	*ECB intervention to support Euro*
28-9-00	*Danish Referendum rejects joining Euro*
2-1-01	*Greece becomes 12th Euro zone member*
1-1-02	*Euro replaces national currencies. Phase III ends. EMU Complete*

Table 2: Statistical Analysis of Haldane & Hall Convergence Factors

All statistics are calculated over the period January 1st 1993 to September 30 2002. T-statistics are calculated using the student's t-test. The null hypothesis is that the mean parameter value is equal to zero.

Equity Market	Convergence to	Currency	Mean Difference	t-value	p-value
France	Frankfurt	Euro	0.02	54.01	0.00
	Frankfurt	Dollar	-0.01	- 181.05	0.00
	London	Euro	0.01	44.60	0.00
	London	Dollar	-0.04	-34.87	0.00
	New York	Euro	-0.00	-30.69	0.00
	New York	Dollar	-0.12	-54.01	0.00
Italy	Frankfurt	Euro	0.05	33.51	0.00
	Frankfurt	Dollar	0.01	23.20	0.00
	London	Euro	0.03	27.48	0.00
	London	Dollar	-0.03	-33.76	0.00
	New York	Euro	-0.00	-23.90	0.00
	New York	Dollar	-0.02	-19.08	0.00
Netherlands	Frankfurt	Euro	0.01	76.41	0.00
	Frankfurt	Dollar	-0.01	- 142.37	0.00
	London	Euro	0.03	65.02	0.00
	London	Dollar	-0.01	-33.11	0.00
	New York	Euro	-0.01	-11.51	0.00
	New York	Dollar	-0.08	-46.16	0.00
Spain	Frankfurt	Euro	0.02	69.53	0.00
	Frankfurt	Dollar	-0.03	- 170.46	0.00
	London	Euro	0.04	27.99	0.00
	London	Dollar	-0.06	-39.50	0.00
	New York	Euro	0.00	5.25	0.00
	New York	Dollar	-0.14	- 119.58	0.00
Sweden	Frankfurt	Euro	0.01	12.25	0.00
	Frankfurt	Dollar	-0.04	- 123.35	0.00
	London	Euro	0.01	15.97	0.00
	London	Dollar	-0.02	-39.46	0.00
	New York	Euro	-0.00	-4.06	0.00
	New York	Dollar	-0.10	- 128.70	0.00
Average	Frankfurt	Euro	0.02	45.21	0.00
	Frankfurt	Dollar	-0.02	- 191.92	0.00
	London	Euro	0.02	38.97	0.00
	London	Dollar	-0.03	-40.32	0.00
	New York	Euro	-0.00	-15.28	0.00
	New York	Dollar	-0.09	-80.55	0.00

Table 3: Statistical Analysis of Eigenvalue and Recursive Lambda Parameters

All statistics are calculated using the student's t-test. The null hypothesis is that the mean parameter value is equal to zero. Test is whether the calculated parameters are different (ho=0)

Series	Pair being tested	Mean Difference	St Dev	t-value	p-value
Lambda Statistics	λ in € terms with UK as world proxy = λ in € terms with UK and USA as world proxy	-0.45	0.22	-122.61	0.00
	λ in $ terms with UK as world proxy = λ in $ terms with UK and USA as world proxy	-0.37	0.20	-116.17	0.00
	λ in € terms with UK as world proxy = λ in $ terms with UK as world proxy	0.09	0.17	31.52	0.00
	λ in € terms with UK and USA as world proxy = λ in $ terms with UK and USA as world proxy	0.16	0.19	50.77	0.00
Eigenvalues	eigenvalue in € terms with UK as world proxy = eigenvalue in € terms with UK and USA as world proxy	-0.01	0.07	-12.62	0.00
	eigenvalue in $ terms with UK as world proxy = eigenvalue in $ terms with UK and USA as world proxy	0.18	0.12	88.05	0.00
	eigenvalue in € terms with UK as world proxy = eigenvalue in $ terms with UK as world proxy	-0.12	0.03	-223.57	0.00
	eigenvalue in € terms with UK and USA as world proxy = eigenvalue in $ terms with UK and USA as world proxy	0.04	0.09	31.39	0.00

Figure 1 : Recursive Lambda-Trace Statistic

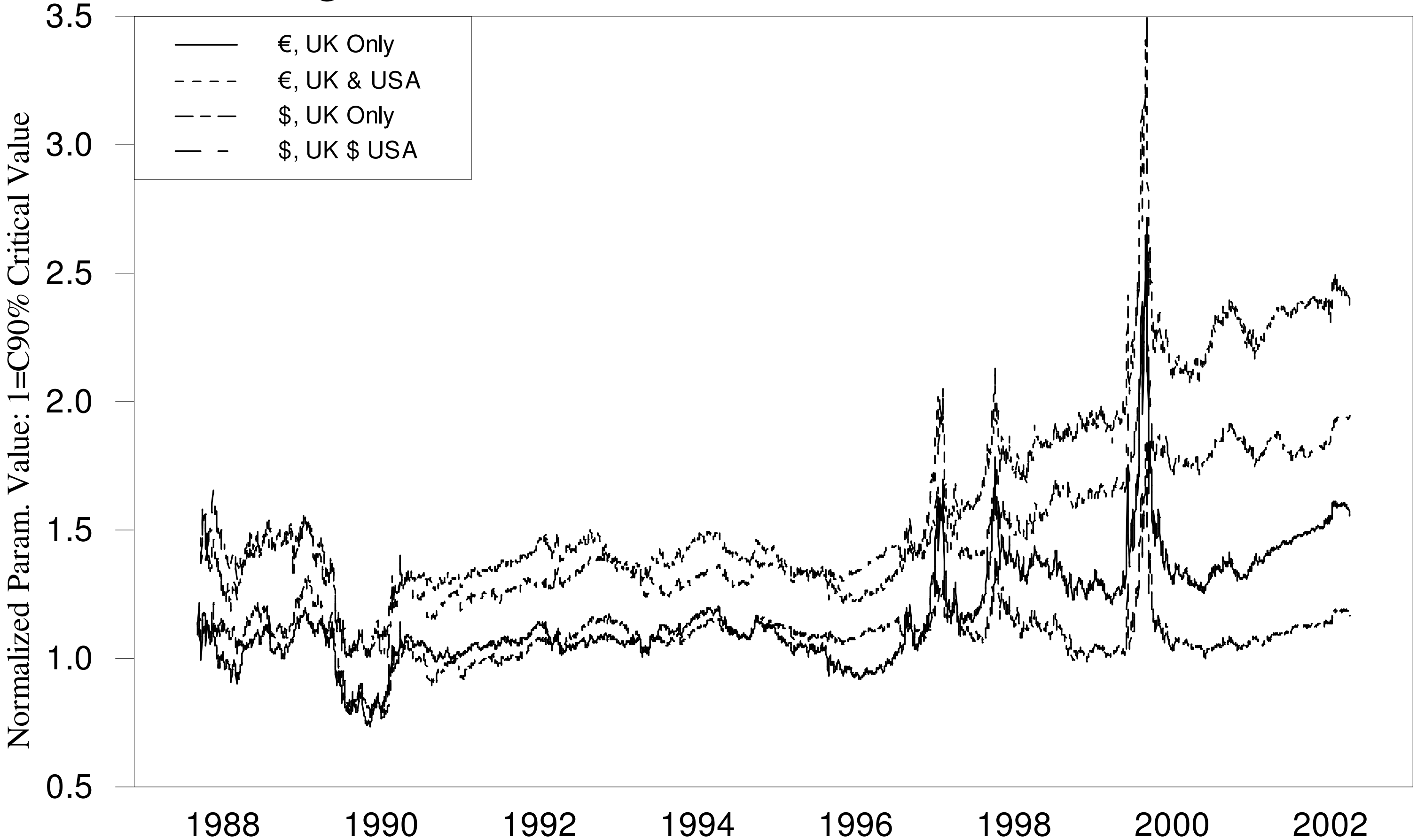


Figure 2: Min. Number of Cointegrating Vectors

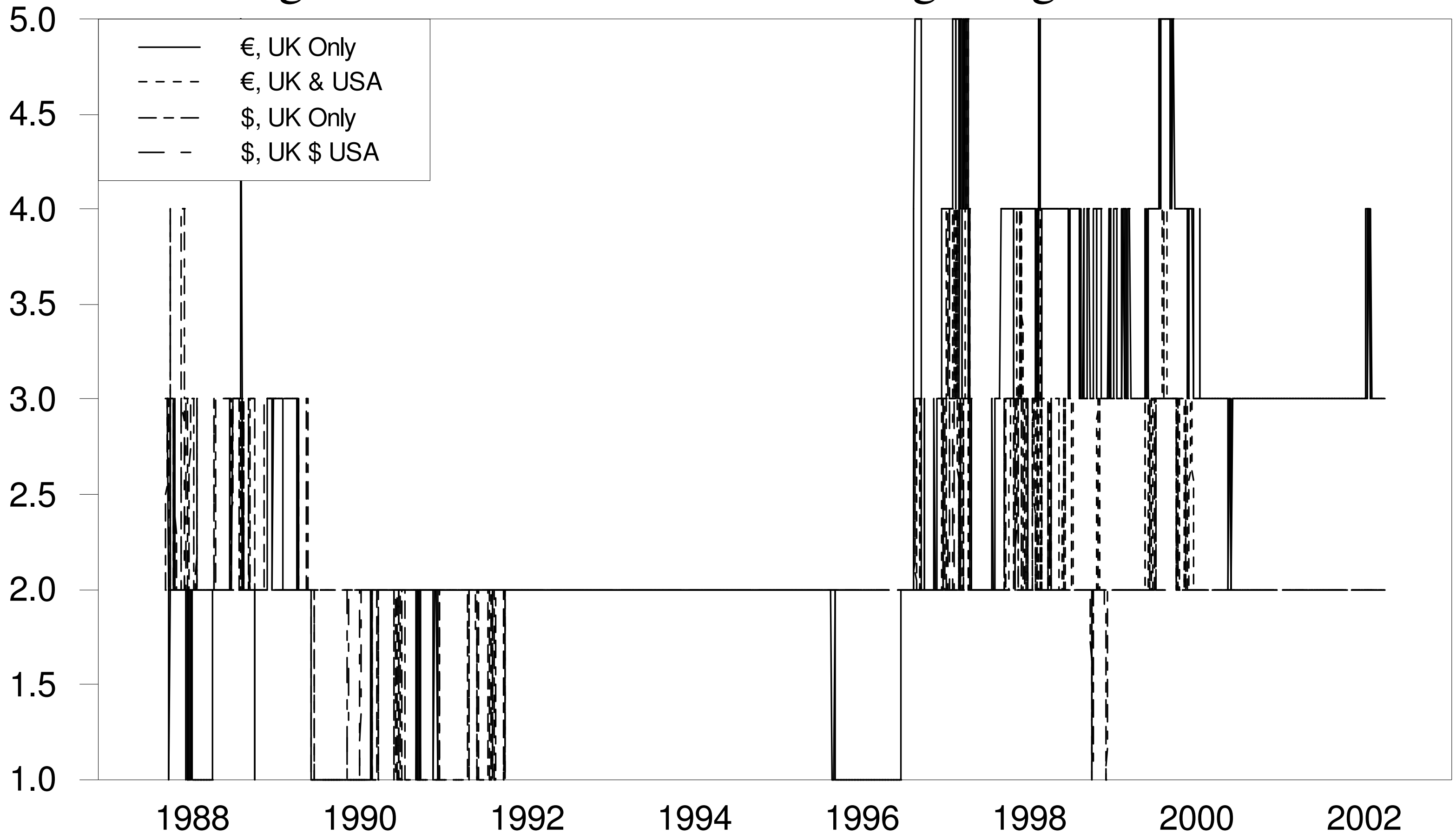


Figure 3: Haldane And Hall Convergence Factors - € Terms

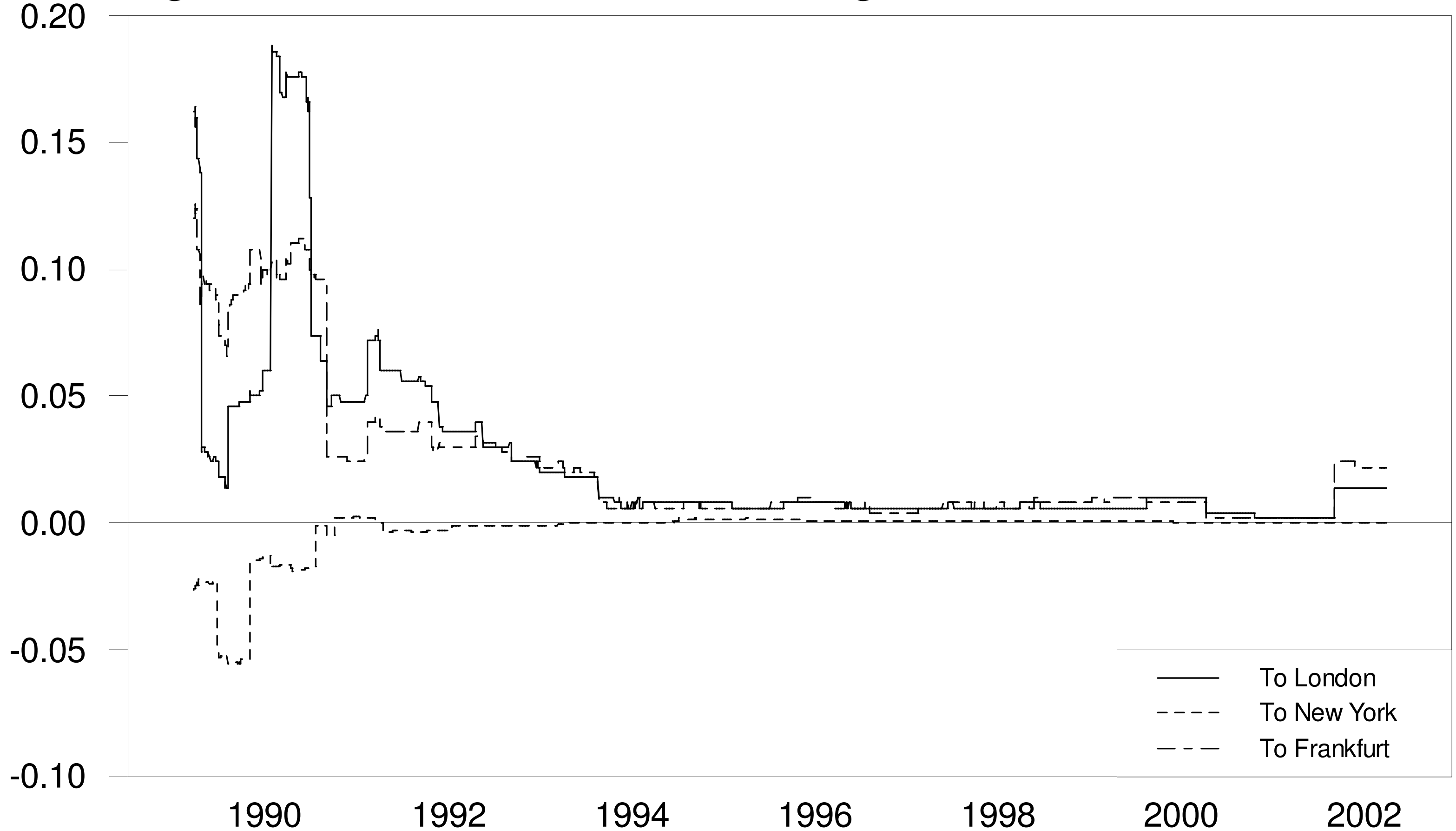


Figure 4: Haldane And Hall Convergence Factors - $ Terms

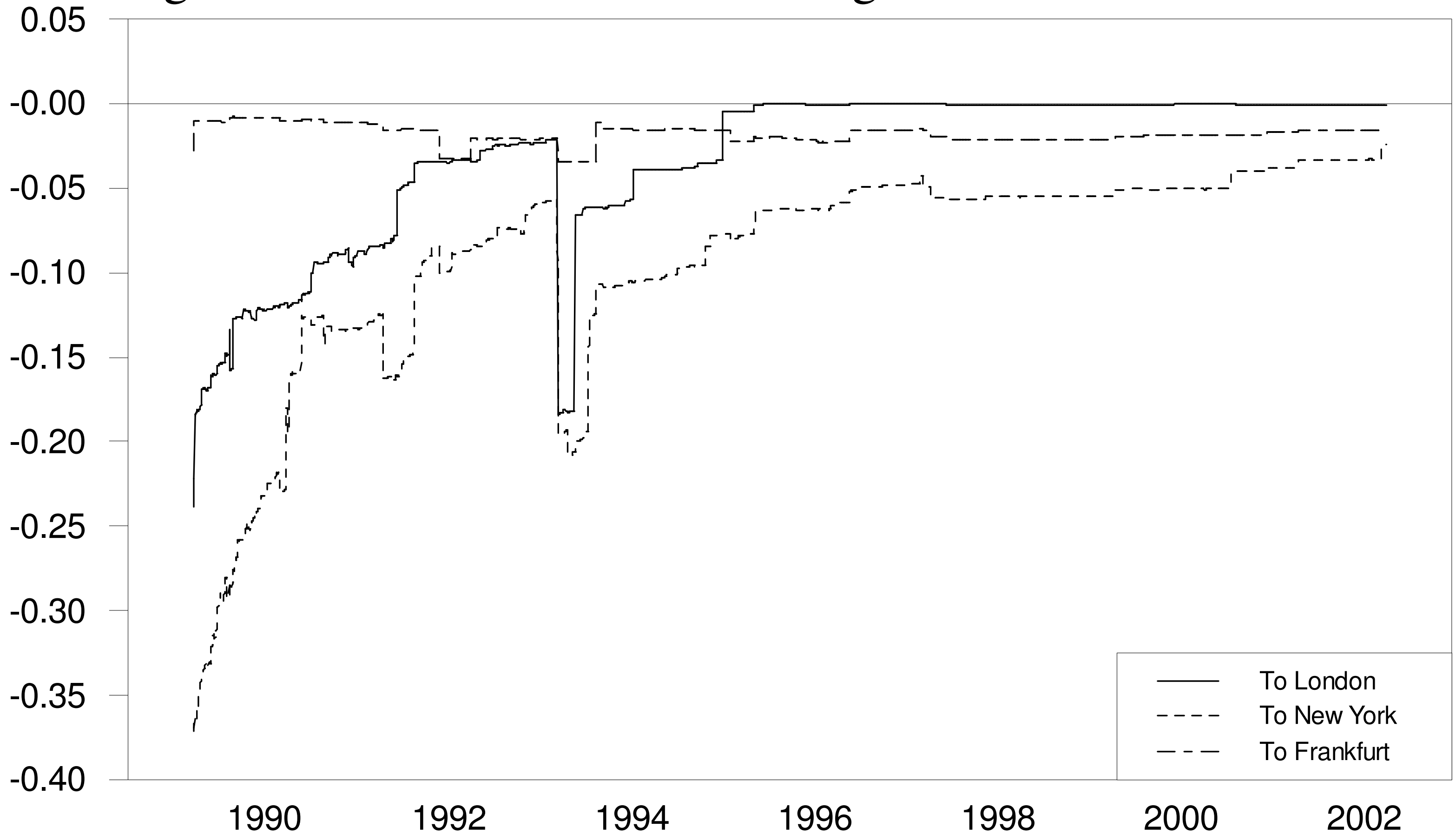
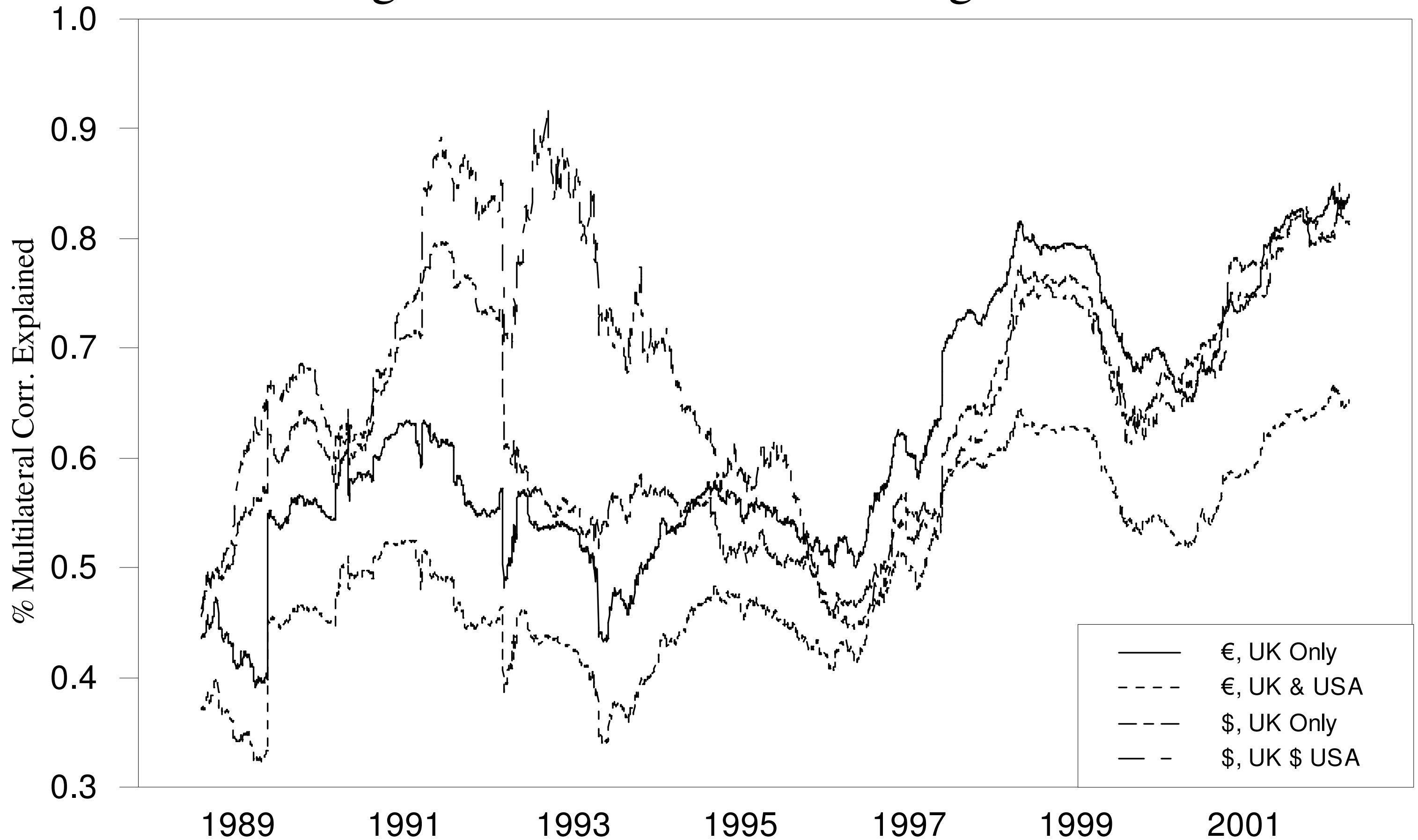


Figure 5: Evolution of First Eigenvalue



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