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DYNAMICS OF EQUITY MARKET INTEGRATION IN EUROPE: IMPACT OF POLITICAL-ECONOMY EVENTS

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Dynamics of Equity Market Integration in Europe: Impact of Political-Economy Events

Abstract

Unlike most prior literature in finance and economics, this paper focuses on events in the political economy and examines the integration of European equity markets over the 1988 through 2002 period using three innovative techniques that assesses how the level of integration in equity price levels changes over time. The results show that notwithstanding the rising interdependencies between the European and US equity market until the mid-1990s, the long run integrative relationships governing the European markets began to strengthen only in the late 1990s and in particular since 1997. This evidence suggests that despite several years of political willingness by European leaders to integrate economies, it was not until the Treaty of Amsterdam and the establishment of the European Central Bank that the markets deemed that European integration would in fact occur.

1. Introduction

The economic, monetary, and political unification of Europe is clearly a major historic process of much interest. Prior to the current twentieth century attempts at European unification, which began with the Treaty of Rome (1957) and proceeded with increasing efforts throughout the 1960s and 1970s, there had been centuries of intrigue, discord, and warfare amongst the European powers including two world wars and decades of cold war between socialist and capitalist states in Europe. Thus, the union of European states has a great deal of history to overcome and this unification has understandably been a slow and a deliberate process. Efforts at European integration sometimes foundered on the economic uncertainty of the early 1980's. Nevertheless, in 1979 came the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS) and in 1987 the Single European Act was adopted. This provided a legal basis for the four freedoms of movement in the EEC (European Economic Community) – capital, goods, people and services.

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 (see Aggarwal (1999)). In

this environment, European countries face significant pressures to integrate their economies even if only to compete with the large North American and Japanese economies. It is widely recognised that financial markets are also undergoing a prolonged, if discontinuous, process of integration. While it is clear that there is now substantial monetary integration in Europe¹, the extent of equity market integration is less clear. This paper investigates the process of European equity market integration. It is concerned with two main issues: *firstly* the evolution and extent of European equity market integration and *secondly* the extent to which European equity market integration has reflected the legislative and political initiatives towards EMU (European Monetary Union).

The received literature provides three overall conclusions concerning international equity market integration. *Firstly*, it reflects the potential for real net economic benefits via the process of equity market integration, given prudent macroeconomic management and the availability of high quality factors of production (see Bekaert & Harvey (1997, 2003), Levine & Zervos (1998), Henry (2000a, 2000b) and Bekaert et al. (2005)). This strand of the literature serves to motivate the examination of international equity market integration. *Secondly*, the extant literature draws attention to a set of factors which determine the evolution of international equity market integration (see Bracker (1999), Bracker et al. (1999), Pretorius (2002), and Hardouvelis et al (2006)). These factors include low and convergent inflation and interest rates as well as rising international trade and declining fiscal imbalances and production growth differentials. The process of moving to the EMU strengthens these factors hence motivating the underlying calendar of events relating to that process employed in this paper. *Thirdly*, several measures of co-movement, between the equity markets, are adopted to gauge the level of time varying equity market integration (see Erb, Harvey and Viskanta (1994), Longin and Solnik (1995), Rangvid (2001), Forbes & Rigobon (2002), Hardouvelis et al. (2002), Sentana (2002), Capiello, Bekaert and Harvey (2003), Capiello, Engle and Sheppard (2003), Baele (2005), Kearney and Poti (2005), Kim et al. (2005)). This literature motivates the measurement of European equity market integration in this paper, from complementary perspectives.² Taken together, these contributions

¹ See, for example, Baele et al. (2004a, 2004b).

² Specifically, this article examines evolving interdependencies amongst continental European and important world equity markets. While rising interdependencies are neither necessary nor sufficient to infer rising integration they do tend to coincide with integration (see the cited articles for details).

indicate the real macroeconomic benefits of international equity market integration, the importance of EMU as a determinant of that process, and provide a justification for the measurement of co-movements as an insightful approximation for the changing level of equity market integration over time.

The preponderance of the previously cited articles with respect to the measurement of equity market integration focus primarily on the European equity markets. A specific weakness of several of these studies is that a focus on comparative statics or, at best, dissipative short run interdependencies, 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 premia of equities are indeed time-varying. Thus, any attempt to model the integration of markets without taking account of this time variation, including a reference to a long run perspective, may yield confusing and partial results. In the same vein, another weakness of the research in the literature on international equity market integration is that, in respect to interdependencies, it focuses almost exclusively on short-term conditional and unconditional correlations. Investors tend to have relatively longer investment time horizons, and hence the importance of short term correlations from the perspective of an investor seeking diversification is not well established. As the prior literature fails to take account of dynamic long run interdependencies amongst European equity markets and the US equity market, this paper aims to fill this gap.

Unlike much prior literature, this paper focuses on events in the political economy and using three complementary techniques, which overcome the aforementioned salient weaknesses of the methodologies used in the literature to date, this paper documents important new findings with respect to European equity market integration over the 1988 through 2002 period. The three techniques adopted to measure changes in integration over time include a dynamic robust eigenvalue analyses, i.e., multilateral robust correlations, the Haldane and Hall (1991) Kalman filter based approach and the Hansen and Johansen (1999) recursive cointegration procedure. These techniques generate time varying statistics which are plotted against the dates of selected key events in the formation of the EMU. 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 endorsement of the Treaty of Amsterdam and the establishment of the ECB that the markets deemed that European integration would in fact occur.

Finally, our estimation of long run and short run time varying interdependencies amongst the equity markets studied also helps to resolve a significant discrepancy between the findings reported in two recent contributions: namely those of Baele (2005) and Kim et al. (2005). In particular, Baele (2005) shows that the shock spillover intensities increased, significantly in the late 1980s and the early 1990s, while Kim's investigation points to a clear increase in equity market co-movements in the 2-year period prior to the introduction of the euro, in January 1999 (Hardouvelis et al (2006) also confirm these findings). Using a Granger causality test Kim et al. (2005) find that the causal process ran from EMU to European stock market integration. Baele (2005) employs a regime-switching model and accounts for asymmetries while Kim et al. (2005) use a thick tailed likelihood function to investigate Europe's equity markets' conditional correlations. These papers share a focus on short run interdependencies while they point to different periods of intense activity with respect to integration. It is precisely this inconsistency that constitutes the main motivation for this paper. This timing inconsistency is of much importance. If the intensity of European equity market integration heightened in the late 1980s and the early 1990s then this coincides with the influence of underlying legal innovations e.g. the Single European Act. However, if the late 1990s experienced this relative heightening of equity market integration then it means that the culmination of the process to EMU exerts the greater influence on the process of European equity market integration. The resolution of this issue has significant implications regarding our understanding of, in particular, the European, and more importantly, the regional integration process in general.

The paper is structured as follows. We begin, in Section 2, by introducing the sample data studied. At this point the paper turns to Section 3 and describes the methodologies adopted to study the dynamic process that is European equity market integration. Section 4 presents the results generated by the aforementioned statistical methodologies. Section 5 provides a concise summary of the empirical findings, highlights implications for the literature, and draws together the main conclusions. The final section summarises the paper and concludes.

2 Data

Daily data for the largest stock markets of the EU (European Union), namely those of France, Germany, Italy, the Netherlands, Spain, Sweden and the UK are analyzed. All data are integrated of order 1, $I(1)$, in levels³. We estimate systems that include the EU FTSE country level indices only and those that also include a US FTSE country level index⁴. The first system shows the extent of Intra-EU integration, while the second shows the extent of EU market integration with the world market effects. Specifically, the various sub-systems consist of: *first* the European equity markets expressed in euro, *second* the same system expressed in US dollar; and *third* and *fourth* both systems augmented to include the US equity market denominated in the aforementioned currencies. We use two numeraire currencies, the euro and the US dollar, in order to capture the perspectives of both the ‘domestic’ and the ‘international’ investors. The dataset covers the period of the process to EMU and commences on 31 December 1987 and ends on 30 September 2002, providing 3847 data points in total.

3 Econometric Estimates of Integration over Time

The complex combination of market forces and specifically designed protective measures as well as more common place differences in regulatory frameworks make it an extraordinarily difficult task to calibrate the extent to which markets are *de facto* integrated, and quite impossible to directly measure this property as it varies over time. Therefore, researchers in this area adopt indirect routes that either inspect the direction, magnitude and nature of interdependencies amidst the equity market indices or the extent to which market participants pursue dynamic strategies of international diversification to calibrate the time varying nature of international equity market integration. The former approach suffers the weakness, as noted in Forbes and Chinn (2004) that economic and industrial structures in countries differ and therefore cash flow and discount rate determinants will not necessarily converge even in the context of an absence of

³ For reasons of brevity the results have not been included in the body of the text.

⁴ FTSE All-World indices are used here. 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. The indices adopted here are designed to be consistent across countries and thus they allow for comparative studies.

regulatory impediments. Against this, it is well established⁵ that, correlations tend to rise during a phase of equity market integration. In the light of these findings, we conclude that increasing correlations are consistent with, although naturally not sufficient to infer, an ongoing process of integration. In this vein, this paper follows the extant literature when referring to increased integration while in fact it is referring to increasing co-movements between the equity market indices or equity market index returns. The following sub-sections provide an overview of the econometric methodologies adopted to examine these co-movements.

3.1 Dynamic Eigenvalue Analysis

This approach extracts the most important uncorrelated sources of information from a multivariate system. In this spirit, components extracted are constructed such that the explanatory power of the incremental component is maximized given the restriction of orthogonality. This is equivalent to an inquiry into the eigenvalues and vectors of the data matrix. In this context, the eigenvalues may be understood as the unconditional variances of the projections of points on each of the components. The eigenvectors are the direction cosines showing how far the original variable space is to be rotated. In order to find the eigenstructure of the standardised data matrix X ($X \sim (0, 1)$), of equity market returns, we perform a singular value decomposition

$$X = P\Delta U' \quad (1)$$

The P variable contains the matrix of eigenvectors of XX' and U contains the matrix of eigenvectors of $X'X$. The Δ matrix contains the square roots of the eigenvalues of XX' or equivalently of $X'X$. The eigenvalues are ranked according to size. The larger e.g. the first eigenvalue estimate, the higher the estimate of multilateral correlation in the system. An inspection of the evolution of this estimate therefore provides an outline of the evolution of the level of multilateral linear interdependencies in the system. Complementary to cointegration analysis which considers comovements in the levels of the equity market indices; an eigenvalue

analysis inquires after comovements in their returns. Hence, a dynamic eigenvalue analysis serves to complement the cointegration analyses by capturing interdependencies of a relatively short-term nature.

3.2 The Haldane and Hall Kalman Filter Procedure

The Haldane and Hall (1991) methodology estimates a simple equation of the following specification via Kalman filter estimation.

$$\ln\left(\frac{\mathbf{E}_{j,t}}{\mathbf{E}_{B,t}}\right) = \alpha_t + \beta_t \ln\left(\frac{\mathbf{E}_{j,t}}{\mathbf{E}_{X,t}}\right) + \varepsilon_{j,t} \quad (2)$$

With respect to specification (2) the market in price levels, $\mathbf{E}$, subscripted B is the pre-imposed internal base market, the market, $\mathbf{E}$, subscripted X is the pre-imposed external market and the pre-imposed local market, $\mathbf{E}$, is subscripted j . The question broached by means of specification (2), in conjunction with the Kalman filter methodology, is: does the variation in the j^{th} European equity market relative to some external market X (the daily percentage relative performance) systematically capture variation between the j^{th} European equity market and some internal market of reference B (the daily percentage relative performance), when other determinants are partialled out. Equivalently, the question posed is ‘do the risk factors of the external or the internal equity market index exert the greater influence on the local equity market index?’. If the beta coefficient point estimate is zero then none of the variation relative to the internal base market is explained by variation relative to the external market. This outcome is consistent with *de facto* convergence internally. The temporal path of the beta coefficient tending to zero is also consistent with a process of convergence to the internal reference market. Significant and non-zero values of beta indicate divergence from the internal reference market. If the beta coefficient is significant and negative then there is a systematic relation established such that on average over (under) reaction to the external market is associated with under (over) reaction relative to the internal market. Caveats regarding this approach include its inability to establish the direction or a *de facto* causality between the regressand and a set of regressors. It is also worthwhile noting that if the local market and the external markets are perfectly collinear the

beta coefficient is necessarily zero, implying convergence while in fact divergence is the *defacto* case⁶. Hence, once the modeller is alert to these caveats, this methodology is useful to calibrate ongoing processes such as the process of European equity market integration.

The specification (2) is a time-varying parameter regression-type model i.e. the coefficients α and β follow a random process over time, t . In this way, the use of a stochastic parameter model enables the modeler to circumvent many of the statistical problems which otherwise emerge if a least squares procedure is used to estimate the parameters. For example, the intercept, α , is a stochastic parameter such that systematic influences on the regressand are partialled out except for those emanating from the regressors (i.e. the influence of potentially omitted variables is partialled out). In effect, the cost of a detachment from an explicit economic model of the determinants of the regressand provides an offsetting benefit in circumventing the omitted variable dilemma. Moreover, the specification also allows for a gradual adjustment path of the temporal correlation coefficient between the variables. It permits an entirely endogenous estimation of the timing of any potential equity market regime shifts, as reflected in the temporal path of the estimated coefficients. In brief, it provides information with respect to both the degree and timing of structural change between the regressand and the regressor.

The Kalman filter methodology estimates the specification (2) over an initial period, to initialize the coefficients and related information. Thereafter, the estimation is updated with the addition of each daily data point. Let $Y_t = \alpha_t + X_t\beta_t + \varepsilon_t$, $\text{var}(\varepsilon_t) = \eta_t$ ⁷ be the measurement equation of interest and if we set β_t as the coefficient of interest at time t , then the transition equation is given by $\beta_t = \beta_{t-1} + \nu_t$, $\text{var}(\nu_t) = M_t$. The disturbances, ε_t and ν_t , are assumed to be independent while the variances of these disturbances, η_t and M_t , are assumed to be known. 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 (3), (4) and (5).

⁶ This conclusion assumes that the internal and external markets are not perfectly collinear.

⁷ Interpret Y_t and X_t as $\frac{E_{j,t}}{E_{B,t}}$ and $\frac{E_{j,t}}{E_{X,t}}$, respectively.

$$S_t = \Sigma_{t-1} + M_t \quad (3)$$

$$\Sigma_t = S_t - S_t X_t' (X_t S_t X_t' + \eta_t)^{-1} X_t S_t \quad (4)$$

$$\beta_{t|t} = \beta_{t-1|t-1} + S_t X_t' (X_t S_t X_t' + \eta_t)^{-1} (Y_t - X_t \beta_{t-1|t-1}) \quad (5)$$

3.3 Time Varying Cointegration Analysis

This methodology is used to explore the evolution of the quantity of common stochastic trends in the various systems of EU and US equity markets considered. Initially, all series are shown to have a unit root (i.e. a stochastic trend). Subsequently, it is investigated whether any of the stochastic trends are common across the indices. To commence, we take a vector Y_t that contains a set of variables, i.e., a set of equity market index price levels. We invoke the Granger representation theorem. The theorem states *first* that if all the variables are integrated of order one, $I(1)$, (i.e. they each contain a unit root) and *second* if there exists a cointegrating relationship (i.e. the long-run information matrix, π , has a reduced rank) between the variables, then the VAR(p) process may be written in the error correction format as

$$\Delta Y_t = \pi Y_{t-1} + \sum_{i=1}^{k-1} \pi_i \Delta Y_{t-i} + u_t + \varepsilon_t \quad (6)$$

The symbol μ is a vector of constants. The errors, ε_t , are assumed to be independent and Gaussian with mean zero. The order of the model is determined parsimoniously, by multivariate Akaike and Bayesian Information Criteria, following Richards (1995)⁸ Furthermore, in the light of Granger's representation theorem, the information matrix can be decomposed into the loading

⁸ Richards (1995) points to the inappropriate use a long lag structure to capture mean reversion and induce error terms consistent with the Gaussian assumption under which the Johansen methodology is derived. Particularly, the removal of non-normalities, is inappropriate if stock price changes are fundamentally fat-tailed or otherwise non-normal. Moreover, if the long lag structure implies a small sample problem it is likely that the null hypothesis of no cointegration is rejected too frequently i.e. a size problem. Small samples may arise due to long lag structures, in conjunction with low periodicity data, over a time period of insufficient length. It is in the light of this discussion that this paper parsimoniously estimates the vector error correction model and studies large samples of data.

coefficients, α , and the linearly independent cointegration relations, β' . The symbols α and β represent $(p \times r)$ matrices and the matrix, π , has rank equal to r ; and it can be written as

$$\pi = -(1 - \sum_{i=1}^k A_i); \text{ and the matrix } \pi_i = - \sum_{j=i+1}^k A_j.$$

In order to observe the evolution of the number of stochastic trends, this article adopts the recursive cointegration approach of Hansen and Johansen (1999), Rangvid (2001) and Rangvid and Sorensen (2002), which has been successfully used in the analysis of integration and interdependencies by Yang et al (2004), Phylaktis and Ravazzolo (2005a, b), Yang (2005) and Kim et al (2006).

The starting point adopted is the relationship between the number of cointegration vectors and the number of common trends in a multivariate system. Specifically, the number of common trends is calculated via an estimation of the rank of the information matrix and subtracting this estimate from the number of non-stationary integrated series in the system. Therefore, the number of common stochastic trends is easily deducible from the number of cointegration relations asserted and the dimension of the multivariate process investigated. A set of time-series that are in the process of converging will show increasing numbers of cointegrating vectors or equivalently a declining number of common stochastic trends.

To implement this methodology, analysis is performed on the parameters of the long-run information matrix, using a sequential extension of the sample. The aim is to assert the number of cointegrating vectors and therefore the number of stochastic trends. In particular, graphical procedures are adopted based on recursively calculated eigenvalues, to evaluate the constancy of the parameters over time.

In order to accomplish this analysis, we adopt the traditional Likelihood based cointegration approach which generates two statistics of primary interest concerning the rank of the long run

information matrix, π . The first is the λ_{trace} statistic and the second is the λ_{max} statistic⁹. The λ_{trace} statistic is (in the context of this paper) a test of the general question of whether there exist one or more cointegrating vectors. The associated null hypothesis is that there are no cointegrating vectors. The λ_{max} statistic allows testing of the precise number of cointegrating vectors. In a recursive study these test statistics can be plotted over time to examine the time varying nature of stock market integration.¹⁰

The use of test statistics, with respect to the eigenvalues, to detect possible instabilities requires no prior knowledge of structural breaks or time dependencies. Indeed, an important property of this methodology is that we do not have to impose *a priori* restrictions on the timing of structural breaks. In this paper, we adopt this approach to help identify the evolution of the linkages between these capital markets.

If there is a static number of cointegrating vectors then recursive estimation will simply lead to an upward trend in the λ_{trace} statistic (i.e. less imprecision). Therefore, as the sample period is extended, if the number of cointegration vectors increases, this provides evidence consistent with the hypothesis that the series are increasingly inter-linked, that they are increasingly driven by the same common stochastic trends i.e. the markets are increasingly driven by the same common shocks with a permanent effect. This is tantamount to the strengthening of the long run relationship governing the evolution of the process.

Intuitively, this makes sense. Consider a set of p series which have n cointegrating 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. The phenomenon of declining numbers of common trends may be

⁹ $\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \lambda_i)$ and $\lambda_{max}(r) = -T \ln(1 - \lambda_{r+1})$ where λ_i is the estimated value of the i^{th} characteristic root and is obtained from the estimated pi matrix provided by the familiar vector error correction model, specified in equation 1.6.

¹⁰ 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.

interpreted as tantamount to increasing levels of arbitrage activity that interlinks the stock markets in the long-term.

4 Results

In the light of the importance of stock market integration, it is worthwhile examining how alleged salient events and policies appear to influence, or at least coincide with changes in the level of equity market integration amongst the continental European and the important world equity markets. To commence, therefore, the selected underlying key events in the process to EMU are presented in Table 1. For additional details regarding these events see one of the many books on European integration, e.g., Gillingham (2003). This section proceeds to provide, compare and contrast the empirical results generated by the three aforementioned methodologies.

4.1 Dynamic Eigenvalue Results

The evolution of the explanatory power of the first eigenvalue over a 12-month (250 observations) moving window beginning on the 1st of January 1988 and ending on the 30th September 2002 for the full set of various systems of European equity market indices 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. In each estimation window, to correct for the potential presence of time varying volatility¹¹, we initially filter the data using a GARCH (1, 1) model. The series are then standardized $\sim (0, 1)$ prior to the eigenvalue analysis. In this sense the eigenvalue estimates are robust to heteroscedasticity. 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. Shown in Table 2 and Figure 1 are the results of the robust eigenvalue analyses.

¹¹ See Forbes and Rigobon (2002) concerning the bias induced by heteroscedasticity on correlation estimates.

[PLEASE INSERT TABLE 1 HERE]

Overall, we observe a gradual but uneven increase in the degree of common variance explained by the first eigenvalue. 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 clear peaks. The first occurs in the 1991 through 1993 period (for the \$ denominated series only) coinciding with the referenda on the Treaty of Maastricht, the Edinburgh declaration and the inception of the Single European Market. The second peak, 1997 through 1999 spans the establishment of the European Central Bank and the launch of the Euro. We note from Table 3 that it appears, on average, that quantitatively distinct results are found when one measures in euro or US dollar terms, or when one uses the UK equity index alone or both the UK and the USA equity indices as world proxies in the system. In particular, it is noteworthy that the sub-system containing the US market, the UK market and the continental European markets, when expressed in euro terms, exhibits the lowest degree of multilateral correlations throughout the sample period, and that this regularity is markedly pronounced during the post 2000 period. This suggests a relative potential for diversification amidst the European markets and the US market when expressed in euro, at least for short term investors.

[PLEASE INSERT TABLE 2 AND FIGURE 1 HERE]

4.2 Haldane and Hall 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 the methodology of Manning (2002), using the Haldane-Hall equations, we calculate the unweighted average (i.e. arithmetic mean) convergence factor of the various indices¹². Shown in Figures 2 and 3 are the Haldane-Hall convergence factors to the Frankfurt, London and New York equity markets expressed in dollar and euro

¹² Manning (2002), in testing for integration amongst Southeast Asian equity markets, 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 are interpreted as indicative of divergence from the local market, as does a tendency for this parameter to move further from zero.

terms, respectively. When the internal market is that of Frankfurt, the external market selected is that of London and vice-versa. When convergence to New York is measured, the external market used is that of London. The striking feature of these Figures is that, dependent on which numeraire currency is adopted, the nature and extent of convergence is quite different. While in both cases the convergence parameters are rapidly tending towards zero, the convergence benchmark, in domestic euro terms the markets begin from a perceived high relative level of integration, while in terms of the dollar the starting point is one of a relative lack of integration.

Looking at the evolutions of the convergence parameters, it appears qualitatively at least, that with a few minor exceptions the process of convergence was substantially completed by the mid 1990's. The evidence indicates that the markets had substantially converged by March 1994, in euro terms, after the establishment of the European Monetary Institute, while convergence is substantially achieved, in US dollar terms, by 1995, after the Madrid Declaration. However, an inspection of the results contained in Table 3 indicates that in no case do the average Haldane-Hall convergence factors measure as being statistically equal to zero in the post January 1 1993 period. Nor do the individual convergence factors for any single country. We conclude, therefore, from the Haldane-Hall factors that the European markets, while converging, have not yet entirely converged either internally or externally. However, the convergence appears to be closer, on average, in the aforementioned period, to New York than to London or Frankfurt in euro terms, the average for the New York convergence being closer to zero than either the London or Frankfurt average convergences. In contrast, once the data are denominated in US dollars average levels of convergence are closer to Frankfurt, than to London or New York. That said, in this numeraire currency, it is apparent that the EU markets are converging most convincingly to London in the period, 2000 to 2002.

4.3 Evolutionary Cointegration Results

The recursive cointegration approach involves a traditional cointegration analysis for an initial period (4th January 1988 to 7th March 1988 for the Intra-EU analyses and to 21st March 1988 for the World analyses), and thereafter updates as new data are added. A lag length of 1 is selected via the multivariate AIC and BIC criteria. The procedure derives the statistics of interest,

namely the λ_{trace} and λ_{max} statistics 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 let $j =$ 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 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.

[PLEASE INSERT FIGURE 2, FIGURE 3 AND TABLE 3 HERE]

Shown in Figure 4 is a plot of the recursively estimated global λ_{trace} statistics and Figure 5 shows the number of cointegration vectors. The λ_{trace} statistic has been normalized to be equal to 1 at the 90% critical value. A number of points are evident from these Figures. For the majority of the time period under investigation, we can be confident that the EU market was integrated internally and with the world market irrespective of the numeraire currency selected, the λ_{trace} statistic exceeding the 90% critical value. At no stage was there an absence of cointegration between the EU and the USA, using either numeraire currency. Second, in general, there is an increase in the λ_{trace} statistic and in the number of cointegrating vectors, particularly since 1997. This indicates that a process of increased convergence is in operation. This period saw the Treaty of Amsterdam, the declaration of 11 nations as eligible for consideration for EMU membership, the creation of the European Central Bank (ECB) and the launch of the euro.

Examination of the two plots in more detail yields further insights. There are a number of periods where the λ_{trace} statistic does fall below the 90% level. However, this event pertains only to the sub-system that excludes the US market index. These are June to September 1988, December 1989 to August/September 1990 (the period of non-cointegration being slightly longer when measured in dollar terms), December 1990 to March 1992 (as measured in US dollar terms), February 1996 to December 1996 (only when measured in € terms) and February and May 2000 (as measured in euro excluding the US market). One of the major events of the first period, which occurred at the end of the phase of no-cointegration, was Margaret Thatcher's euro

skeptical Bruges Speech. The second period commences with the collapse of the communist regimes in Eastern Europe and ends with German reunification. The third phase commences with the Rome Declaration and only ends in the run-up to the implementation of the first round of referenda on the Treaty of Maastricht. The fourth phase of no-cointegration 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. The largest fall in the λ_{trace} statistic occurs during the fifth period, 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.

Periods of rapid increase in the λ_{trace} statistic include April to August 1997 and January to April 1998 when, in the first period, the mechanics of implementation of the Treaty of Amsterdam were being made public, and in the second period, the run-up to the notification of final membership of EMU is spanned.

5 Empirical Findings and Literature Contributions

The dynamic multilateral robust correlation analyses indicate that when the indices are expressed in US dollar terms, interdependencies rise both in the 1991-93 period and in the 1997-99 period. However, on using the euro as a numeraire currency, correlations tend to rise markedly only in the latter period. Moreover, the 1991-93 peak is incongruent with the recursive cointegration analyses demonstrating the presence of transient rather than long run interdependencies; nonetheless, it is consistent with the heightening of activity reported by the Haldane-Hall equations during that period. Furthermore, the dynamic multilateral robust correlations provide evidence that reflects different hierarchies of groupings with respect to the criterion of interdependence, than those suggested by the recursive cointegration analyses. For example, in stark contrast to the results provided in the dynamic multilateral robust correlations analyses, the recursive cointegration analyses suggest that the highest degree of long run correlations occur amongst the UK, US and European markets when expressed in euro terms since the mid-1990s. The dynamic multilateral robust correlation analyses suggest that this grouping, denominated in this currency, exhibits the smallest short-run correlations during this latter period. This further

underscores the importance of considering long run correlations when accounting for the perspective of an investor with a long run time horizon, rather than relying on short run correlations alone.

[PLEASE INSERT FIGURE 4 AND FIGURE 5 HERE]

Taken together, the results of the three methodologies are approximately congruent concerning the importance of the late 1990s as a period that experienced relatively heightened equity market integration – while the Haldane and Hall (1991) analyses indicates a high degree of convergence, the recursive cointegration and the multilateral robust correlation analyses indicate strengthening short and long run interdependencies, during this late 1990s period. While our analyses also reflect periods of heightened integration in the early 1990s these periods are relatively precarious; they are sensitive to the numeraire currency adopted and, moreover, the number of long run relationships governing the evolution of the systems of equity market indices examined is stable and low during this period. Overall, the evidence suggests that the continental European and important world markets examined become increasingly intertwined until the mid-1990s at which point European integration begins to strengthen and shortly thereafter other relationships governing the evolution of the long run process in Europe also strengthen.

These findings have important implications for the extant literature. A number of specific points should be noted. The first two core contributions of this paper concern short and long run interdependencies. The final three core contributions pertain to the timing of phases of heightened equity market integration. *Firstly*, the six most important European equity markets showed increasing interdependencies with respect to both long and short run dynamics. *Secondly*, the timing of short run interdependencies is not necessarily consistent with that of long run interdependencies and this diminishes their significance from the diversification perspective of an investor with a long run investment horizon. *Thirdly*, in euro terms until the mid-1990s the European markets are showing marked signs of having converged more to the New York than to the Frankfurt or London markets. *Fourthly*, in US dollar terms – in the early 1990s – most convergent activity occurred with respect to the London and the New York markets, while convergence with respect to the Frankfurt market was already relatively developed.

Convergence to the New York and the Frankfurt markets was not quite accomplished throughout the sample period, but since 1995 convergence to the London market is more accomplished. *Finally*, from the recursive cointegration relations perspective, it is evident that the long run relationships governing equity market integration strengthened largely in the late 1990s rather than during the early 1990s.

6 Summary and Conclusions

There is a discrepancy in the received literature concerning the timing of periods of heightened equity market integration in Europe. The importance of this discrepancy stems from a resulting confusion regarding the relative influence exerted by underlying events on the duration and intensity of periods of heightened equity market integration in that region. In this paper, with a view to resolving this outstanding discrepancy, we focus on the equity market integrative impact of political economy events and have built on prior research by measuring the extent of time-varying integration of European equity markets over the 1988 through 2002 period. We adopted a relatively new set of three complementary techniques that measured the time varying integration in equity price levels and returns to evaluate the dynamic process of stock market integration in Europe. The three techniques were employed to study behaviour amidst various important sub-systems of equity market indices. This paper also provided a time line of the key political and economic events of the EMU process, in the context of which the time varying statistics generated by the adopted techniques were discussed.

Although, our various measures differed somewhat as to the extent and speed of integration, the evidence presented is broadly in agreement on the importance of the 1997-98 period demonstrating greatly increased long run and short run integration amongst the continental European and important world equity market indices. Specifically, the evidence gathered portrays a process of developing and then stabilizing interdependencies until the mid-1990s. Shortly thereafter, during the late 1990s, the number of long run relationships governing the evolution of the systems of equity market indices examined, began to grow. Interestingly, this evidence 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 as reflected in equity market behaviour.

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

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

Table 2: Statistical Analysis of Eigenvalue and Recursive Lambda Parameters

Hypotheses tests are performed using the student's t-test. The null hypothesis is that the difference between parameter values is equal to zero. The test statistics correspond to the full sample periods used for estimation.

Series	Pair being tested	Mean Difference	t-value	p-value
Lambda Trace Statistics, λ	λ in € terms with UK as world proxy = λ in € terms with UK and USA as world proxy	-0.45	122.61	0.00
	λ in \$ terms with UK as world proxy = λ in \$ terms with UK and USA as world proxy	-0.37	116.17	0.00
	λ in € terms with UK as world proxy = λ in \$ terms with UK as world proxy	0.09	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	50.77	0.00
Eigenvalues/Multilateral Correlations (MCs)	MCs in € terms with UK as world proxy = MCs in € terms with UK and USA as world proxy	-0.01	12.62	0.00
	MCs in \$ terms with UK as world proxy = MCs in \$ terms with UK and USA as world proxy	0.18	88.05	0.00
	MCs in € terms with UK as world proxy = MCs in \$ terms with UK as world proxy	-0.12	223.57	0.00
	MCs in € terms with UK and USA as world proxy = MCs in \$ terms with UK and USA as world proxy	0.04	31.39	0.00

Figure 1: Evolution of First Eigenvalue

Figure 2: Haldane And Hall Convergence Factors - \$ Terms

Figure 3: Haldane And Hall Convergence Factors - €Terms

Table 3: Statistical Analysis of Haldane and Hall Convergence Factors

All statistics are calculated over the period January 1st 1993 to September 30 2002. T-statistics are calculated to test the null hypothesis 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

Figure 4: Recursive Lambda-Trace Statistic

Figure 5: Min. Number of Cointegrating Vectors