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The Impact of the Euro on Equity and Government Bond Markets

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Abstract

This paper assesses whether the euro had an impact on the degree of integration of European financial markets. We propose two methodologies to measure integration: one relies on time-varying GARCH correlations, and the other one on a regression quantile-based co-dependence measure. We document an overall increase in co-movements in both equity and bond euro area markets, suggesting that integration has progressed since the introduction of the euro. However, while the correlations in bond markets reaches almost one for all euro area countries, co-movements in equity markets are much lower and the increase is limited to large euro area economies only.

KEY WORDS: Financial markets, euro, financial integration, volatility, conditional correlation

JEL CLASSIFICATION: F36, G15, C22

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1 Introduction

The launch of the euro in January 1999 has generated a large debate among researchers, policy makers and market participants about the impact of the single currency on European financial markets. By analysing return dynamics, this paper investigates whether the introduction of the euro has increased the degree of financial integration of stock and government bond markets.

There are a number of papers that study financial integration exploiting the implication of asset pricing models (see, for instance, Bekaert and Harvey, 1995, and Hardouvelis, Malliaropoulos and Priestley, 2006). A possible problem inherent in this approach is that the choice of the asset pricing model may affect the final results. We employ, instead, a factor model for market returns which distinguishes between global and local components. Differently from previous studies on integration, we do not estimate the model itself nor its loading factors, but rather exploit its implication in terms of return co-movements. We follow the intuition of Cappiello, Gérard, Kadareja and Manganelli (henceforth CGKM) (2005), who show how measures of co-movements are linked to the degree of financial integration. The idea is that, as trade barriers and capital controls are removed within an economic area, firms' cash flows will become more subject to common shocks. *Ceteris paribus* this, coupled with the elimination of exchange rate risk, implies an increase in co-movements of firms' returns.

We propose two methodologies to measure co-movements: (i) a time-varying GARCH-type correlation along the lines of Engle (2002) and Cappiello, Engle and Sheppard (2003); and (ii) a regression quantile-based co-dependence measure, as suggested by Cappiello, Gérard and Manganelli (2005). The two approaches are robust to the well-know heteroskedasticity problem that plagues naïve correlation measures (see, for instance, Forbes and Rigobon, 2002). The two methodologies are complementary in the sense that GARCH-based measures provide a high-frequency picture of the correlation evolution, while with the measures based on regression quantiles we can analyse changes in correlations over the long run.

We document an overall increase in co-movements in both equity and bond euro area markets, suggesting that integration has progressed since the introduction of the single currency. However, while the correlations in bond markets reaches almost one for all euro area countries, co-movements in equity markets are much lower and the increase is limited to large euro area economies only. We control for the impact of global factors by including in the analysis other non euro area countries,

in particular, Japan, the UK and the US. As for equity markets, our findings suggest the presence of a common “cross Atlantic” factor, in that co-movements across large EU countries and the US increase by a comparable magnitude. Co-movements with Japan and small EU economies, instead, remain generally very low. As for bond markets, we find strong evidence that the single currency was a major factor in fostering integration in the euro area. We emphasise two results. First, unlike the equity markets, bond markets almost reach the level of perfect integration in both small and large euro area economies. Second, while we continue to observe a “cross Atlantic” integration process, the increase in co-movements for non euro area economies is much less pronounced. Japan continues to exhibit weak links with the rest of the countries in our sample.

The paper is structured as follows. Section 2 explains the links between integration and co-movements. Section 3 describes the data. Section 4 presents the results of the GARCH model estimates, while section 5 those obtained with the regression quantile-based methodology. Section 6 concludes. Details about the two models used in the analyses can be found in the appendices.

2 Asset return correlation and financial integration

As shown by CGKM, there is a relationship between correlation and integration. The relationship is derived from a model for returns which distinguishes between common and idiosyncratic factors. Progress in integration is associated with an increase in the proportion of returns’ variance explained by the common factors *vis-à-vis* country-specific factors.

This reflects the intuition that, as a country moves from being closed to an open status, the impact of foreign factors on domestic firms’ cash flows increases. Hence the removal of trade barriers and the elimination of exchange rate risk within a region should be accompanied by an increase in co-movements of firms’ returns. In short, increased co-movements in financial asset returns are consistent with greater integration and economic interdependence.

In line with this discussion, we model returns in a national market as follows:

$$r_{it} = \beta_{ijt}G_{ijt} + e_{it}, \quad \forall i \text{ and } j, \quad (1)$$

where r_{it} is the return on asset i , β_{ijt} the exposure at time t of asset i to the common

factor G_{ijt} , and e_{it} the idiosyncratic risk of asset i assumed to be orthogonal to the common factor and to asset j idiosyncratic risk.

The volatility of country i 's returns can be decomposed as $\sigma_{rit}^2 = \beta_{ijt}^2 \sigma_{Gijt}^2 + \sigma_{eit}^2$. The share of variance explained by the common factor is $\phi_{it} \equiv \frac{\beta_{ijt}^2 \sigma_{Gijt}^2}{\sigma_{rit}^2}$. Consistently with this discussion, we adopt the following measure of integration between markets i and j :

$$\Phi_{ijt} \equiv \phi_{it} \phi_{jt}. \quad (2)$$

If markets are perfectly segmented the variance explained by the common factor is equal to zero and therefore $\Phi_{ijt} = 0$ (because either $\phi_{it} = 0$ and/or $\phi_{jt} = 0$). On the other hand, if markets are perfectly integrated, most of the source of variation will come from the common factor and $\Phi_{ijt} \simeq 1$. In general, higher values of Φ_{ijt} imply a higher degree of integration.

CGKM show that there is a precise link between standard correlation measures and integration indicator:

$$\rho_{ijt} = \text{sign}(\beta_{ijt}\beta_{jit})\sqrt{\Phi_{ijt}} \quad \forall i, j \text{ and } i \neq j. \quad (3)$$

The above decomposition indicates that the correlation is proportional to our integration indicators which, in turn, represent the amount of the total variance explained by the global component.

To assess the impact of the euro, it is necessary to test for changes in correlations. These tests need to account for time variation in the moments of the returns distribution and departure from normality. Since changes in volatilities before and after the introduction of the euro could result in an estimation bias, a simple comparison between correlations over the two periods could lead to a spurious outcome.

To solve this issue, we use two different, yet complementary, modelling strategies, both robust to heteroscedasticity problems. The first model is the Dynamic Conditional Correlation (DCC) Generalised Autoregressive Conditionally Heteroskedastic (GARCH) process introduced by Engle (2002). The second approach is based on the ‘‘co-movement box’’ of Cappiello, Gérard and Manganelli (2005). The DCC GARCH model allows us to check the behaviour of both volatilities and correlations over time, and in particular after the introduction of the euro. This model, however, is fully parametric, since it assumes a dynamic for second moments and a specific distribution for asset returns. The co-movement box, on the other hand, is

a semi-parametric approach and does not need any assumption on the distribution of returns. Differently from the DCC GARCH model, which estimates correlations at a relatively high frequency, co-movement box measures provide a direct test for changes in correlation before and after the introduction of the euro.

3 Data

We analyse returns on (i) equity market indices and (ii) ten-year government bonds. Equity indices include Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, as well as the Eurostoxx50. Data on 10-year government bonds are available for all the countries listed above, except Portugal. The sample covers the period from January 9th, 1987 to October 21st, 2005. Data on the Greek equity price index, and the Belgian and Finnish 10-year government bond are only available from January 10th 1992. Countries which do not belong to the euro area (such as Denmark, Japan, Sweden, the United Kingdom, and the United States) are also included in the analysis since they will be used as control.

We use Global Financial Data indices at weekly frequency. Equity indices are market-value-weighted and include dividends. As for government bonds, we use yields to maturities. The use of weekly data reduces the asynchronicity effects due to different opening hours, national holidays and administrative closures.

Equity and government bond returns are continuously compounded. Bond returns are computed with the following formula:

$$\begin{aligned} r_{bt} &= p_{bt} - p_{bt-1} \\ &= n(y_{t-1} - y_t), \end{aligned} \tag{4}$$

where r_{bt} denotes the (weekly) returns on bonds, p_{bt} the log price of the bond, $p_{bt} \equiv \ln(P_{bt})$, y_t the log of the gross yield to maturity, $y_t \equiv \ln(1 + Y_{bt})$, and n the maturity, which, in our case, is ten year.¹

Table 1 reports data summary statistics. As expected, equity markets exhibit higher average returns and standard deviations than bond markets. Both series tend to be negatively skewed and leptokurtic. Non-normality is confirmed by the Jera-Barque test statistics.

Tables 2a-2d report unconditional correlations for the full sample period, and

¹Yields are constructed to keep maturity constant at each observation.

three sub-periods: The first runs from January 1987 to December 1998, the second from January 1992 to December 1998 and the third from January 1999 to October 2005. This choice mirrors the samples used for estimating conditional correlations and long-run co-movements. Three stylised facts emerge from these tables. First, correlations over the full sample period are very low between equity and bond markets. However, the break-down by sub-periods reveals that correlations were positive before 1998 and turned negative afterwards. This could be related to the burst of the bubble in equity markets in early 2000s and the associated flight-to-quality phenomenon. Second, full sample intra-asset correlations are roughly comparable, but the sub-sample correlations increase remarkably since 1999, especially for bonds, where return correlations approach one. Third, the euro area asset returns are overall more correlated with the US than Japan and increasingly so after 1999.

4 Correlation dynamics

The DCC GARCH model of Engle (2002) exploits the decomposition of the covariance matrix, which can be written as the product of a correlation matrix and diagonal matrices of standard deviations. The estimation of the conditional second moments is based on a two step procedure. In the first step univariate volatility models are estimated for each asset return. The standard deviations obtained in the first stage are utilised to standardise asset returns, which, in the second step, will be used to estimate the conditional correlation matrix.² In line with Sheppard (2002) and Cappiello, Engle and Sheppard (2003), among others, we estimate a flexible version of the original scalar DCC GARCH process of Engle (2002). In our specification the dynamics of correlation is not parametrized with single news impact and smoothing parameters but with diagonal coefficient matrices. We also accommodate second moment asymmetries typical of financial time series. The formulae for conditional correlations and variances of asset returns are given in equations (10) and (11)-(13) of Appendix A , respectively. We refer to Appendix A for further technical details.

²In fact, there is an intermediate step which involves the estimation of the long run correlation matrix (see Cappiello, Engle and Sheppard, 2003, for further details).

4.1 Results

In this section we describe the estimation results obtained with the multivariate diagonal DCC GARCH model. We use weekly data from January 1987 to October 2005. We plot conditional correlations for equity and bond returns on EU countries. US and Japanese time varying second moments are also reported. We first analyse equity markets and next we move to bond markets.

Due to the multi-stage procedure of the DCC GARCH process, we first estimate three univariate volatility models for each return series, (i) the GARCH model of Bollerslev (1986), (ii) the Exponential GARCH (EGARCH) model of Nelson (1991), and (iii) the GJR-GARCH of Glosten, Jagannathan and Runkle (1993). Next, we select the model which best fit the data according to the Schwartz information criterion. Table 3 reports the selected GARCH specifications and their estimated parameters. Apart from Austria and Finland, all equity markets show asymmetry in conditional volatility. As for bonds, instead, only four markets out of 12 (France, Italy, Spain and the US) require asymmetric GARCH specifications. This is in line with previous findings (see, for instance, Cappiello, Engle and Sheppard, 2003). Parameter estimates for the correlation dynamics are reported in Table 4 and are almost all significantly different from zero. Correlation is highly persistent and, differently from the univariate models, *both* equities *and* bonds exhibit asymmetry.

4.1.1 Equities

Figure 1 plots, for euro area economies, weighted average conditional correlations between equity returns.³ We observe an overall increase in the level of conditional correlation in the second of the 1990s, with a major boost in 1998. This may be due to the considerable reduction in the exchange rate risk which occurred on 3 May 1998, when the announcement of irrevocable exchange rates was made. We also distinguish between “large” (France, Germany, Italy, the Netherlands and Spain) and “small” (Austria, Belgium, Finland, Ireland and Portugal) economies. This breakdown reveals that most of the increase in correlation is driven by the largest countries, while the correlation in the smallest remains roughly unchanged. Details about each country-pair time-varying correlations can be found in figures 2, 3 and 4 and confirm the results from the aggregate plots.

³Conditional correlations of each euro area country pair is weighted by the fraction of its GDP relative to the total euro area GDP. In the computation we use the 2003 GDP levels.

To understand whether this increase in correlations is euro area specific or reflects a more global phenomenon, figure 5 plots the conditional correlations between returns on Eurostoxx50 and selected non-euro area equity market indices (Denmark, Japan, Sweden, the UK and the US). We observe a similar increase in correlations starting in the second half of 1990s for the non-euro area EU countries and the US, while correlations with Japan remain low. This suggests that the stronger equity market co-movements are a cross-Atlantic feature rather than euro area specific.

4.1.2 Bonds

Euro area bond markets have witnessed a dramatic increase in integration with the introduction of the single currency. Figure 6 shows the weighted average conditional correlations between returns on 10-year government bonds for Germany and other euro area economies.⁴ Correlations, which hovered around 0.4 in the first half of the 1990s, steadily increased thereafter and reached almost one after 1999. Despite the elimination of exchange rate risk and the common monetary policy, government bond markets are not perfectly correlated. This reflects the existence of remaining domestic liquidity and credit risk premia.

A striking difference with respect to the equity market analysis is that the increase in correlations occurred for *both large and small* economies. Figure 7 reports single correlations for each country pair and confirm the overall results of figure 6. The international comparison proposed in figure 8 suggests another remarkable difference *vis-à-vis* the equity markets. Cross Atlantic correlations increase but not to the same extent as the euro area countries. After 1999 correlations between Sweden, Denmark and the UK versus Germany stabilize around 0.85. Correlations between Germany, the UK and the US reach a somewhat lower upper bound around 0.75. Finally, correlations involving Japan remain low and unchanged, similarly to equity markets.

5 Structural changes in co-movements

An alternative strategy to measure co-movements is the one proposed by Cappiello, Gèrard and Manganelli (2005). Let $\{r_{it}\}_{t=1}^T$ and $\{r_{jt}\}_{t=1}^T$ denote the time series

⁴Similarly to equity markets, conditional correlations of each euro area country pair is weighted by the fraction of its GDP relative to the total euro area GDP. In the computation we use the 2003 GDP levels.

returns of two different markets. Let $q_{\theta t}^{r_i}$ be the time t θ -quantile of the conditional distribution of r_{it} . Analogously, for r_{jt} , we define $q_{\theta t}^{r_j}$. The basic tool of analysis is the conditional probability $p_t(\theta) \equiv \Pr(r_{it} \leq q_{\theta t}^{r_i} \mid r_{jt} \leq q_{\theta t}^{r_j})$. For any given quantile, it gives the probability of observing a joint tail event in the two markets, which is a direct measure of market co-movement.⁵

The characteristics of $p_t(\theta)$ can be conveniently analysed in what we call the “co-movement box” (see Figure 9). The co-movement box is a square with unit side, where $p_t(\theta)$ is plotted against θ . The shape of $p_t(\theta)$ will generally depend on the characteristics of the joint distribution of the time series returns r_{jt} and r_{it} , and therefore for generic distributions it can be derived only by numerical simulation. There are, however, three important special cases that do not require any simulation: 1) perfect positive correlation, 2) independence and 3) perfect negative correlation. If two markets are independent, which implies $\rho_{ijt} = 0$, $p_t(\theta)$ will be piece-wise linear, with slope equal to one, for $\theta \in (0, 0.5)$, and slope equal to minus one, for $\theta \in (0.5, 1)$. When there is perfect positive correlation between r_{jt} and r_{it} (i.e. $\rho_{ijt} = 1$), $p_t(\theta)$ is a flat line that takes on unit value. Under this scenario, the two markets essentially reduce to one. The polar case occurs for perfect negative correlation, i.e. $\rho_{ijt} = -1$. In this case $p_t(\theta)$ is always equal to zero: when the realization of r_{it} is in the lower tail of its distribution, the realization of r_{jt} is always in the upper tail of its own distribution and conversely. We refer to the appendix for a more analytical description of the model.

This discussion suggests that the shape of $p_t(\theta)$ provides key insights about the dependence between two time series returns r_{jt} and r_{it} . Indeed, $p_t(\theta)$ satisfies some basic desirable properties (independence, co-monotonicity and counter-monotonicity), as summarized in Theorem 1 of Cappiello, Gérard and Manganeli (2005). In general, the higher $p_t(\theta)$ the higher the co-dependence between the two return series.

These conditional probabilities of co-movements can be estimated over different periods. In the present application, we consider the six years before and after the introduction of the euro. When the conditional probabilities for these two different periods are plotted in the same graph, differences in the intensity of co-movements can be identified directly. In particular, an upward shift of these curves would be consistent with an increased integration in the euro area after the introduction of the single currency.

⁵For $\theta > 0.5$ we consider $\Pr(r_{it} \geq q_{\theta t}^{r_{it}} \mid r_{jt} \geq q_{\theta t}^{r_{jt}})$, i.e., the probability of a joint upper tail event.

5.1 Results

In this section we describe the estimation results obtained with the co-movement box. We use weekly data from January 1992 to October 2005. The sample is split in two at 1 January 1999 to compare probabilities of co-movement before and after the introduction of the single currency. Like in the GARCH sub-section, we first plot co-movement boxes for equity and bond returns on EU countries. For international comparison, we also look at co-movements with US and Japanese markets. We first analyse equity markets and next we move to bond markets.

5.1.1 Equities

Figure 10 plots weighted average probabilities of co-movements between returns on equity market indices for the euro area economies. Overall, co-movements increase after the introduction of the single currency. The distinction between large and small euro area economies, however, reveals that most of the increase is driven by the large member states. Co-movements in small economies remain practically unchanged. This confirms the results obtained with the GARCH correlation analysis.

Details about each country-pair co-movements (together with 95% confidence bands) can be found in figures 11, 12 and 13. Table 5a quantifies these average probabilities of co-movements for each country pair, before and after 1999. Formal statistical tests for differences in probabilities of co-movements between the pre-euro and euro periods are reported in table 6a. For the sake of completeness, we show results for the left and right parts of the distribution, together with the entire quantile range. These results confirm that the visual increase in co-movement observed in figure 10 is statistically significant mainly for the large euro area country pairs.

A somewhat puzzling result is that some countries historically linked, such as the couples Austria-Germany or Belgium-Netherlands, show no significant increase in co-movement after 1999. A plausible explanation is that these country pairs already exhibited very low exchange rate volatility before the introduction of the single currency. At same time, within the group of “small” countries, Finland has made significant progress in integration with the large euro area economies. This could be due to the presence of multi-national companies (such as Nokia), which are particularly exposed to international shocks.⁶

⁶In 2004, Nokia’s market capitalisation represented about 60% of the whole Finnish stock exchange.

For international comparison, we plot in figure 14 probabilities of co-movements between returns on the Eurostoxx50 and non euro area equity market indices (Denmark, Japan, Sweden, the UK and the US). We observe a significant increase in co-movements between euro area, on the one side, and Sweden, the UK and the US, on the other, reaching levels comparable to those of the largest euro area economies. As for the pairs euro area-Japan and US-Japan, figures 14c and 14f show that there are no significant changes in co-movements before and after 1999. Tables 5b and 6b broadly confirm these results for pairs between large euro area economies, Japan, the UK and the US.

Overall, these results, in line with the GARCH findings, suggest that common “cross Atlantic” factors drive co-movements in equity markets. Although co-movements between Eurostoxx50, the UK or the US have increased after 1999, they tend to be higher within large euro area economies. For example, after the introduction of the euro, the co-movements for the pairs Germany-UK or Germany-US are smaller than each individual co-movement between Germany and the other large euro area economies (see table 5b). Co-movements with Japan, instead, remain very low with respect to all the other countries considered in the analysis.

5.1.2 Bonds

Figure 15 presents the average co-movements between the returns on 10-year government bonds of euro area economies and the German benchmark. We observe a sharp increase in co-movements after the introduction of the single currency. The fact that the probability of co-movement reaches almost one - the level of perfect integration - suggests that the euro has been a major driver of integration in this market. Differently from the equity markets, the increase in co-movement occurs for both large and small economies. Moreover, after 1999, the level of integration for bond markets is higher than that of (large) equity markets. These results are consistent with those found with the GARCH methodology in the previous sub-section. The fact that the probability of co-movement is not perfectly one may be due to remaining liquidity differentials and to different national credit risks. Details of each country pair can be found in figure 16 and table 8. Interestingly, the probability lines become flatter, suggesting that the introduction of the euro increased not only overall correlations, but also the degree of co-movement in the upper and lower tails of the distribution.

The impact of the euro appears even more evidently in international compar-

isons. Figure 17 and table 8 indicate that, despite an overall increase, co-movements are always higher within euro area economy pairs than between couples where non euro area countries are included. Consistently with the equity market results, Japanese bond market continues to show very weak links with the rest of the economies in our sample.

6 Conclusions

In this paper we investigate whether the introduction of the euro had an impact on the degree of integration of European financial markets.

Our results suggest an overall increase in the integration of both equity and bond euro area markets since the introduction of the single currency. However, while the integration is very advanced for all euro area government bond markets, as for equity markets it seems to lag behind, and progress limited to large euro area economies. Controlling for the impact of global factors, we find evidence of a common “cross Atlantic” component, in that integration across large EU countries and the US increases. Japan and small EU economies, instead, remain generally very little integrated with the other countries. As for bond markets, we find that the single currency was a major factor in fostering integration, which, unlike the equity markets, increases substantially in both small and large euro area economies. Moreover, while we continue to observe the presence of “cross Atlantic” factors, progress in integration for non euro area economies is less pronounced. Japan continues to exhibit weak links with the rest of the countries in our sample.

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A The Dynamic Conditional Correlation GARCH model

Multivariate GARCH models have been widely used to study second moment interrelations among economic and financial variables. Typically, in addition to volatilities, these specifications model the time evolution of asset return covariances. A well known example is given by the so-called Baba, Engle, Kraft and Kroner (or simply BEKK) GARCH process (see Engle and Kroner, 1995). Recently, Engle (2002) has introduced the Dynamic Conditional Correlation (DCC) GARCH model, which is particularly well suited to analyse correlation dynamics among asset returns.

Let $\mathbf{R}_t \equiv \{r_{i,t}\}$ be a $s \times 1$ vector of asset returns, which is assumed to be conditionally normal with mean zero and covariance matrix $\mathbf{H}_t \equiv \{h_{ij,t}\}$:

$$\mathbf{R}_t | \mathfrak{S}_{t-1} \sim N(\mathbf{0}, \mathbf{H}_t), \quad (5)$$

where \mathfrak{S}_{t-1} is the information set available at time $t - 1$.

The covariance matrix \mathbf{H}_t can be decomposed as follows (see, for instance, Bollerslev, 1990):

$$\mathbf{H}_t = \mathbf{D}_t \mathbf{P}_t \mathbf{D}_t, \quad (6)$$

where \mathbf{D}_t is a diagonal matrix containing the conditional standard deviations relative to the s asset returns, i.e. $\mathbf{D}_t \equiv \text{diag}\{\sqrt{h_{ii,t}}\}$, while \mathbf{P}_t is the time-varying correlation matrix. \mathbf{P}_t is a symmetric matrix with ones on the main diagonal and conditional correlation coefficients on the off-diagonal elements, i.e. $\mathbf{P}_t \equiv \{\rho_{ij,t}\}$.

The estimation of the conditional covariance matrix \mathbf{H}_t is based on a three step procedure. First, univariate volatility models $\sqrt{h_{ii,t}}$ are estimated for each asset return. Akaike and Schwartz information criteria permit to select the volatility model that fits the data best. In the second step asset returns are standardised by the estimated standard deviations resulting from the first stage:

$$\boldsymbol{\varepsilon}_t = \mathbf{D}_t^{-1} \mathbf{R}_t,$$

where $\boldsymbol{\varepsilon}_t$ is the $s \times 1$ vector of standardised residuals. Next unconditional correlations are estimated and used for the intercept parameters of the conditional correlation. Finally, coefficients of the correlation dynamics are estimated conditional on the correlation intercept coefficients. The conditional correlation matrix between standardised residuals will read as follows:

$$\mathbf{P}_t = E(\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t' | \mathfrak{S}_{t-1}).$$

In the original DCC model suggested by Engle (2002), when the system is covariance stationary (see Ding and Engle, 2001), the dynamics of correlation evolve as a scalar process with a single news impact parameter, a , and a single smoothing parameter, b :

$$\mathbf{Q}_t = \overline{\mathbf{Q}}(1 - a - b) + a\boldsymbol{\varepsilon}_{t-1}\boldsymbol{\varepsilon}_{t-1}' + b\mathbf{Q}_{t-1}, \quad (7)$$

$$\mathbf{P}_t = \text{diag}\{\mathbf{Q}_t\}^{-1/2} \mathbf{Q}_t \text{diag}\{\mathbf{Q}_t\}^{-1/2}, \quad (8)$$

where $\overline{\mathbf{Q}}$ is the unconditional correlation matrix of the standardised error terms, $\overline{\mathbf{Q}} = E(\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t')$, and $\text{diag}\{\mathbf{Q}_t\}$ is a diagonal matrix with the i th diagonal element of $\mathbf{Q}_t \equiv \{q_{ii,t}\}$ on its i th position. Provided that \mathbf{Q}_t is positive definite, $\text{diag}\{\mathbf{Q}_t\}^{1/2}$ guarantees \mathbf{P}_t be a correlation matrix with ones on the main diagonal and every other off-diagonal elements less than or equal to one in absolute value.

The specification described by equation (7) does not allow for asset specific news and smoothing parameters. A more flexible model, which however is parsimonious in the number of coefficients to estimate, is represented by the diagonal DCC GARCH model, where the scalars a and b are replaced by diagonal matrices \mathbf{A} and \mathbf{B} :

$$\mathbf{Q}_t = (\overline{\mathbf{Q}} - \mathbf{A}'\overline{\mathbf{Q}}\mathbf{A} - \mathbf{B}'\overline{\mathbf{Q}}\mathbf{B}) + \mathbf{A}'\boldsymbol{\varepsilon}_{t-1}\boldsymbol{\varepsilon}_{t-1}'\mathbf{A} + \mathbf{B}'\mathbf{Q}_{t-1}\mathbf{B},$$

or, equivalently,

$$\mathbf{Q}_t = \overline{\mathbf{Q}} \odot (\boldsymbol{\iota} \boldsymbol{\iota}' - \mathbf{a} \mathbf{a}' - \mathbf{b} \mathbf{b}') + \mathbf{a} \mathbf{a}' \odot \boldsymbol{\varepsilon}_{t-1} \boldsymbol{\varepsilon}_{t-1}' + \mathbf{b} \mathbf{b}' \odot \mathbf{Q}_{t-1}. \quad (9)$$

In equation (9) \odot is the Hadamard (element by element) product, $\boldsymbol{\iota}$ a vector of ones, and \mathbf{a} and \mathbf{b} are vectors containing the diagonal elements of the matrices \mathbf{A} and \mathbf{B} , respectively.

For $\overline{\mathbf{Q}}$, since expectations are infeasible, they are replaced by sample analogs, $T^{-1} \sum_{t=1}^T \boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t'$. Engle and Sheppard (2001) show that, given that $\rho_{ij,t} = q_{ij,t} / \sqrt{q_{ii,t} q_{jj,t}}$ is the typical element of \mathbf{P}_t , this matrix will necessarily be a correlation matrix by the Cauchy-Schwartz inequality.

A.1 Asymmetries

It is well documented that volatility of equity returns increases more after a negative shock than after a positive shock of the same magnitude. Asymmetric effects have also been recently found in conditional covariances and correlations. As for returns on bonds, the evidence about asymmetric second moments is, instead, mixed (see, for instance, Kroner and Ng, 1998, Bekaert and Wu, 2000, and Cappiello, Engle and Sheppard, 2003). In line with this literature, we enrich the process described by equation (9) introducing a term able to capture asymmetry in conditional correlations, $\mathbf{g}\mathbf{g}' \odot \boldsymbol{\eta}_{t-1}\boldsymbol{\eta}'_{t-1}$. \mathbf{g} is a vector of unknown parameters, whose elements can be thought of as the diagonal coefficients of a corresponding \mathbf{G} matrix. The generic i element of $\boldsymbol{\eta}_t$ is defined as $\eta_{it} \equiv I(\varepsilon_{it} < 0)\varepsilon_{it}$, where $I(\cdot)$ is an indicator function which takes on value one if the argument is true and zero otherwise. Assuming that the resulting covariance process is stationary, equation (9) can be written as:

$$\mathbf{Q}_t = \overline{\mathbf{Q}} \odot (\boldsymbol{\nu}\boldsymbol{\nu}' - \mathbf{a}\mathbf{a}' - \mathbf{b}\mathbf{b}') - \overline{\mathbf{H}} \odot \mathbf{g}\mathbf{g}' + \mathbf{a}\mathbf{a}' \odot \varepsilon_{t-1}\varepsilon'_{t-1} + \mathbf{b}\mathbf{b}' \odot \mathbf{Q}_{t-1} + \mathbf{g}\mathbf{g}' \odot \boldsymbol{\eta}_{t-1}\boldsymbol{\eta}'_{t-1}, \quad (10)$$

where $\overline{\mathbf{H}} = E(\boldsymbol{\eta}_t\boldsymbol{\eta}'_t)$. Similarly to $\overline{\mathbf{Q}}$, we replace $\overline{\mathbf{H}}$ with its sample analog, $T^{-1} \sum_{t=1}^T \boldsymbol{\eta}_t\boldsymbol{\eta}'_t$.

A.2 Univariate volatility models

As pointed out in Engle and Sheppard (2001), any univariate GARCH model which is covariance stationary and assumes normally distributed errors (irrespective of the true error distribution) can be used to model the variances, as the model is estimated in three steps. For each asset we select a univariate volatility model among three possible specifications: (i) the GARCH model of Bollerslev (1986), (ii) the Exponential GARCH (EGARCH) model of Nelson (1991) and (iii) the GJR-GARCH of Glosten, Jagannathan and Runkle (1993). While the symmetric traditional GARCH process elegantly captures volatility clustering, it does not allow negative and positive past shocks to have a different impact on conditional second moments. The effect of the sign of lagged innovations is accommodated with the EGARCH and GJR-GARCH models. In line with the assumptions on asset returns (see equation (5)), the three processes read as follows:

$$GARCH : h_{i,t} = \alpha_0 + \alpha_1 r_{i,t-1}^2 + \alpha_2 h_{i,t-1}, \quad (11)$$

$$EGARCH : \ln(h_{i,t}) = \alpha_0 + \alpha_1 (|v_{i,t-1}| - E|v_{i,t-1}|) + \gamma v_{i,t-1} + \alpha_2 \ln(h_{i,t-1}), \quad (12)$$

$$GJR - GARCH : h_{i,t} = \alpha_0 + \alpha_1 r_{i,t-1}^2 + \gamma I(r_{i,t-1} < 0) r_{i,t-1}^2 + \alpha_2 h_{i,t-1}. \quad (13)$$

In equation (12) the term $v_{i,t}$ is *i.i.d.* with zero mean and unit variance and can be thought of as the i th element of the $s \times 1$ vector $\mathbf{Y}_t = \mathbf{H}_t^{-1/2} \mathbf{R}_t$. The EGARCH parametrization accommodates the asymmetric relation between asset returns and volatility, since the conditional variance depends on both the size and the sign of $v_{i,t}$. Similar to the traditional GARCH representation (11), the term $\alpha_1 (|v_{i,t-1}| - E|v_{i,t-1}|)$ captures the magnitude effect. The term $\gamma v_{i,t-1}$, instead, allows the conditional variance to respond asymmetrically to the sign of lagged return innovations. Under the assumption that returns are normally distributed, $E|v_{i,t}| = \sqrt{2/\pi}$ (see Nelson, 1991, for further details).

In equation (13) $I(\cdot)$, as before, represents an indicator function. The only difference with the traditional GARCH process in (11) is the inclusion of the term $\gamma I(r_{i,t-1} < 0) r_{i,t-1}^2$, which accommodates the asymmetric volatility effect.

A.3 The likelihood function

Under the assumption of normality, the log likelihood function of the DCC GARCH model can be expressed as follows (see Engle, 2002, for further details):

$$\begin{aligned} L &= -\frac{1}{2} \sum_{t=1}^T [s \ln(2\pi) + \ln(|\mathbf{H}_t|) + \mathbf{R}_t' \mathbf{H}_t^{-1} \mathbf{R}_t] \\ &= -\frac{1}{2} \sum_{t=1}^T [s \ln(2\pi) + \ln(|\mathbf{D}_t \mathbf{P}_t \mathbf{D}_t|) + \mathbf{R}_t' \mathbf{D}_t^{-1} \mathbf{P}_t^{-1} \mathbf{D}_t^{-1} \mathbf{R}_t] \\ &= -\frac{1}{2} \sum_{t=1}^T [s \ln(2\pi) + 2 \ln(|\mathbf{D}_t|) + \ln(|\mathbf{P}_t|) + \boldsymbol{\varepsilon}_t' \mathbf{P}_t^{-1} \boldsymbol{\varepsilon}_t]. \end{aligned} \quad (14)$$

Since the estimation of the DCC GARCH model is based on a three step procedure, maximising the log likelihood function (14) gives consistent but inefficient estimates of the vector of unknown parameters. Engle and Sheppard (2001) provide the asymptotic theory associate with this estimation procedure. This is consistent with the Quasi Maximum Likelihood (QML) methodology of Bollerslev and Wooldridge (1992), which gives standard errors robust to departure from normality.

B The quantile regression approach for co-movements in asset returns

In this section we describe the formal framework that allows us to fill the “co-movement box”. Let $\{r_{it}\}_{t=1}^T$ and $\{r_{jt}\}_{t=1}^T$ denote the time series returns of two different markets. Let $q_{\theta t}^{r_i}$ be the time t θ -quantile of the conditional distribution of r_{it} . Analogously, for r_{jt} , we define $q_{\theta t}^{r_j}$.

Denote the conditional cumulative joint distribution of the two return series by $F_t(r_i, r_j)$. Define $F_t^-(r_i|r_j) \equiv \Pr(r_{it} \leq r_i \mid r_{jt} \leq r_j)$ and $F_t^+(r_i|r_j) \equiv \Pr(r_{it} \geq r_i \mid r_{jt} \geq r_j)$. Our basic tool of analysis is the following conditional probability:

$$p_t(\theta) \equiv \begin{cases} F_t^-(q_{\theta t}^{r_i}|q_{\theta t}^{r_j}) & \text{if } \theta \leq 0.5 \\ F_t^+(q_{\theta t}^{r_i}|q_{\theta t}^{r_j}) & \text{if } \theta > 0.5 \end{cases} \quad (15)$$

This conditional probability represents an effective way to summarize the characteristics of $F_t(r_i, r_j)$. For each quantile θ , $p_t(\theta)$ measures the probability that, at time t , the return on market i will fall below (or above) its θ -quantile, conditional on the same event occurring in market j .

$p_t(\theta)$ satisfies some basic desirable properties (such as independence, co-monotonicity and counter-monotonicity), as summarized in theorem 1 of Cappiello, Gérard and Manganeli (2005). While $p_t(\theta)$ can be used to measure the dependence between different markets, the interest of the researcher often lies in testing whether this dependence has changed over time. Market integration is an important case in point. If increased integration can be associated to stronger co-movements between markets, one can test for changes in integration by testing if the conditional probability of co-movements between two markets increases after institutional changes fostering greater openness and integration.

The framework of the co-movement box can be used to formalize this intuition. Let $p^B(\theta) \equiv B^{-1} \sum_{t < \tau} p_t(\theta)$ and $p^A(\theta) \equiv A^{-1} \sum_{t \geq \tau} p_t(\theta)$, where B and A denote the number of observations before and after a certain threshold date τ , respectively. We adopt the following working definition of increased integration:

Definition 1 (*Integration*) - *Integration increases if $\delta(0, 1) = \int_0^1 [p^A(\theta) - p^B(\theta)] d\theta > 0$.*

$\delta(0, 1)$ measures the area between the average conditional probabilities $p^A(\theta)$ and $p^B(\theta)$.

Constructing the co-movement box and testing for differences in the probability of co-movement requires several steps. First, we estimate the univariate quantiles associated to the return series of interest, using the CAViaR model by Engle and Manganelli (2004). Second, we construct, for each series and for each quantile, indicator variables which are equal to one if the observed return is lower than this quantile and zero otherwise. Finally, we regress the θ -quantile indicator variable of returns on market i on the θ -quantile indicator variable of returns on market j , interacted with time dummies which identify periods of greater integration. These regression coefficients will provide a direct estimate of the conditional probabilities of co-movements and of their changes across regimes.

The average conditional probability $p_t(\theta)$ can be estimated by running the following regression:

$$I_t^{r_i r_j}(\hat{\beta}_{\theta_i}) = \alpha_{\theta_i}^1 + \alpha_{\theta_i}^2 D_t + \tilde{\epsilon}_t. \quad (16)$$

where $I_t^{r_i r_j}(\hat{\beta}_{\theta_i}) \equiv I(r_{it} \leq q_t^{r_i}(\hat{\beta}_{\theta_i r_i})) \cdot I(r_{jt} \leq q_t^{r_j}(\hat{\beta}_{\theta_i r_j}))$ for each θ_l -quantile, $q_t^{r_i}(\hat{\beta}_{\theta_i r_i})$, for $l \in (0, 1)$, and $q_t^{r_j}(\hat{\beta}_{\theta_i r_j})$ denote the estimated quantiles, and D_t is the dummy for the test period $t > \tau$.⁷

Cappiello, Gérard and Manganelli (2004) show that the OLS estimators of regression (16) are asymptotically consistent estimators of the average conditional probability $p_t(\theta)$ in the two periods and provide estimators for their standard errors:

$$\begin{aligned} \hat{\alpha}_{\theta_l}^1 &\xrightarrow{p} E[p_t(\theta_l) | \text{period } B] \equiv p^B(\theta_l), \\ \hat{\alpha}_{\theta_l}^1 + \hat{\alpha}_{\theta_l}^2 &\xrightarrow{p} E[p_t(\theta_l) | \text{period } A] \equiv p^A(\theta_l), \end{aligned} \quad (17)$$

for $l = 1, \dots, m$. $\hat{\alpha}_{\theta_l}^1$ is the parameter associated with constant and, as such, it converges to the average probabilities in the benchmark period. Similarly, since $\hat{\alpha}_{\theta_l}^2$ is the coefficient of D_t , the sum of $\hat{\alpha}_{\theta_l}^1 + \hat{\alpha}_{\theta_l}^2$ converges in probability to the average co-movement likelihood in the test period. Testing for an increase in the conditional co-movement likelihood across two periods is equivalent to testing for the null that $\alpha_{\theta_l}^2$ is equal to zero. Indeed, it is only when $\alpha_{\theta_l}^2 = 0$ that the two conditional probabilities coincide. If $\alpha_{\theta_l}^2$ is greater than zero, the conditional probability during the test period will be higher than the conditional probability during the benchmark period.

⁷The ‘‘hat’’ denotes estimated coefficients.

Table 1: Descriptive statistics of returns on equity market indices and 10-year government bonds

This table reports summary statistics relative to weekly returns on 17 equity market indices and 14 10-year government bonds. The equity indices refer to Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), the United Kingdom (UK), the United States (US), as well as the Eurostoxx50 (EU). Data on 10-year government bonds are available for all the countries listed above, except Portugal. The sample covers the period from January 9th, 1987 to October 21st, 2005. Data on the Greek equity price index, and the Belgian and Finnish 10-year government bond are only available from January 10th 1992. Therefore, they are reported in the separate table 1b. The superscripts “S” and “B” stand for stocks and bonds, respectively. Equity market indices and 10-year government bond yields are from Global Financial Data. Mean and Standard Deviation are annualized and in percentage. Min. and Max represent the weekly minimum and maximum returns and are in percentage. The Jarque-Bera (J-B) test for normality combines excess skewness and kurtosis and is asymptotically distributed as χ_m^2 with $m = 2$ degrees of freedom.

Table 1a - Sample period: January 1987-October 2005

Asset	Mean	Max.	Min.	Std. Dev.	Skewness	Kurtosis	J-Bera
DE^S	3.53	11.21	-12.60	0.18	-0.45	5.40	268
FR^S	5.76	10.64	-12.71	0.17	-0.35	4.83	156
UK^S	5.52	9.51	-24.61	0.15	-1.69	21.14	13910
IT^S	3.95	15.95	-16.30	0.20	-0.18	5.82	330
NL^S	6.51	14.93	-14.17	0.17	-0.72	7.74	1001
ES^S	8.24	11.74	-19.20	0.19	-0.50	7.41	835
SE^S	9.50	17.06	-15.41	0.20	-0.29	6.37	478
AT^S	7.82	13.64	-13.74	0.16	-0.29	7.64	891
BE^S	6.69	11.13	-13.31	0.15	-0.50	7.31	800
DK^S	9.09	7.81	-12.68	0.14	-0.52	5.78	359
FI^S	9.75	16.84	-22.07	0.27	-0.42	6.09	420
IE^S	8.85	10.46	-19.79	0.18	-1.16	9.82	2120
PT^S	7.40	16.37	-18.02	0.20	0.18	11.32	2835
JP^S	-1.81	11.05	-12.50	0.20	-0.20	4.65	118
US^S	7.74	7.49	-13.01	0.15	-0.71	6.80	672
EU^S	6.77	13.59	-12.57	0.18	-0.30	5.69	310
DE^B	1.34	4.67	-5.37	0.07	-0.40	5.29	240
FR^B	2.51	15.85	-10.33	0.09	1.29	34.52	40854
UK^B	2.95	7.19	-5.34	0.10	0.07	5.14	188
IT^B	2.97	7.29	-9.17	0.11	-0.86	10.03	2141
NL^B	1.46	5.88	-4.13	0.06	-0.12	5.45	248
ES^B	4.28	9.76	-10.85	0.11	-0.86	12.12	3522
SE^B	4.18	8.22	-8.08	0.10	-0.49	6.80	629
AT^B	1.94	3.26	-4.22	0.06	-0.46	5.05	206
DK^B	4.07	8.53	-7.00	0.09	-0.20	8.48	1232
IE^B	4.39	6.72	-6.76	0.09	-0.41	7.00	682
JP^B	1.89	5.49	-5.08	0.07	-0.42	6.90	649
US^B	1.26	11.40	-5.45	0.09	0.31	8.67	1327

Table 1b - Sample period: January 1992-October 2005

Asset	Mean	Max.	Min.	Std. Dev.	Skewness	Kurtosis	J-Bera
BE^B	3.60	3.15	-4.31	0.27	0.41	7.89	738.09
FI^B	5.53	7.33	-8.96	0.07	-0.43	4.07	57.18
GR^S	9.72	22.22	-19.54	0.09	-0.84	8.84	1108.37

Table 2a: Return unconditional correlations over the whole sample period, January 1987 - October 2005

This table reports return unconditional correlations over the whole sample period, from January 9th, 1987 to October 21st, 2005. Correlations are computed on weekly returns of 16 equity market indices and 12 10-year government bonds. The equity indices refer to Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), the United Kingdom (UK), the United States (US), as well as the Eurostoxx50 (EU). Data on 10-year government bonds are available for all the countries listed above, except Belgium, Finland and Portugal. The superscripts “S” and “B” stand for stocks and bonds, respectively.

	DE ^S	FR ^S	UK ^S	IT ^S	NL ^S	ES ^S	SE ^S	AT ^S	BE ^S	DK ^S	FI ^S	IE ^S	PT ^S	JP ^S	US ^S	EU ^S
DE ^S		0.78	0.65	0.63	0.79	0.65	0.68	0.50	0.66	0.55	0.52	0.55	0.32	0.35	0.58	0.91
FR ^S			0.65	0.62	0.77	0.67	0.64	0.42	0.67	0.50	0.52	0.52	0.32	0.35	0.57	0.88
UK ^S				0.54	0.75	0.61	0.60	0.39	0.57	0.48	0.47	0.66	0.34	0.37	0.61	0.74
IT ^S					0.61	0.57	0.54	0.38	0.52	0.50	0.43	0.47	0.29	0.30	0.42	0.70
NL ^S						0.65	0.64	0.40	0.71	0.55	0.51	0.60	0.31	0.35	0.63	0.89
ES ^S							0.63	0.44	0.59	0.48	0.44	0.54	0.35	0.36	0.50	0.74
SE ^S								0.37	0.52	0.51	0.62	0.53	0.38	0.36	0.53	0.71
AT ^S									0.42	0.33	0.23	0.37	0.28	0.29	0.26	0.45
BE ^S										0.48	0.35	0.52	0.34	0.27	0.45	0.70
DK ^S											0.40	0.44	0.26	0.29	0.41	0.56
FI ^S												0.34	0.25	0.27	0.44	0.59
IE ^S													0.34	0.34	0.46	0.58
PT ^S														0.23	0.20	0.34
JP ^S															0.33	0.38
US ^S																0.65
DE ^B	-0.01	0.03	-0.02	0.04	-0.05	-0.01	-0.02	0.03	0.03	0.03	-0.06	-0.04	-0.06	-0.02	0.02	0.02
FR ^B	-0.02	0.12	-0.08	0.06	-0.04	0.04	-0.01	0.03	0.07	0.03	-0.04	-0.04	-0.12	-0.06	0.02	0.02
UK ^B	-0.02	0.05	0.15	0.06	-0.01	0.04	0.03	0.02	0.03	0.02	0.01	0.05	-0.01	0.00	0.06	0.03
IT ^B	0.06	0.07	0.07	0.23	0.05	0.11	0.09	0.06	0.08	0.11	0.05	0.06	0.00	0.02	0.04	0.11
NL ^B	-0.01	0.02	-0.04	0.04	-0.06	0.01	-0.02	0.03	0.04	0.05	-0.05	-0.05	-0.07	-0.05	0.01	0.01
ES ^B	0.03	0.08	0.08	0.13	0.02	0.14	0.08	0.09	0.07	0.10	0.07	0.04	0.03	0.02	0.04	0.07
SE ^B	0.06	0.10	0.06	0.14	0.03	0.13	0.20	0.08	0.08	0.09	0.07	0.04	0.05	0.02	0.05	0.09
AT ^B	-0.01	0.04	0.05	0.08	-0.03	0.06	0.02	0.08	0.07	0.06	0.00	0.04	0.00	0.00	0.02	0.03
DK ^B	0.08	0.13	0.09	0.14	0.06	0.16	0.08	0.08	0.18	0.26	0.04	0.11	0.05	0.05	0.06	0.13
IE ^B	0.05	0.08	0.10	0.12	0.03	0.08	0.08	0.11	0.11	0.12	0.01	0.12	0.09	0.07	0.07	0.08
JP ^B	-0.09	-0.02	-0.05	-0.07	-0.08	-0.08	-0.09	-0.06	-0.05	-0.02	-0.03	-0.07	-0.09	-0.04	0.01	-0.07
US ^B	-0.16	-0.09	-0.16	-0.10	-0.17	-0.11	-0.14	-0.02	-0.05	-0.06	-0.13	-0.11	-0.14	-0.07	0.04	-0.13

	FR ^B	UK ^B	IT ^B	NL ^B	ES ^B	SE ^B	AT ^B	DK ^B	IE ^B	JP ^B	US ^B
DE ^B	0.73	0.59	0.44	0.92	0.42	0.53	0.79	0.62	0.60	0.26	0.55
FR ^B		0.55	0.41	0.76	0.41	0.49	0.62	0.54	0.52	0.22	0.58
UK ^B			0.32	0.61	0.35	0.46	0.52	0.38	0.55	0.19	0.47
IT ^B				0.47	0.46	0.47	0.48	0.40	0.40	0.06	0.28
NL ^B					0.44	0.55	0.81	0.62	0.60	0.26	0.55
ES ^B						0.44	0.48	0.38	0.41	0.06	0.28
SE ^B							0.55	0.46	0.46	0.11	0.35
AT ^B								0.59	0.59	0.20	0.46
DK ^B									0.54	0.25	0.32
IE ^B										0.13	0.38
JP ^B											0.16

Table 2b: Return unconditional correlations and standard deviations for the period January 1987 – December 1998

This table reports return unconditional correlations as well as standard deviations (in bold) over the sample period January 9th, 1987 - December 30th, 1998. Correlations and standard deviations are computed on weekly returns of 16 equity market indices and 12 10-year government bonds. The equity indices refer to Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), the United Kingdom (UK), the United States (US), as well as the Eurostoxx50 (EU). Data on 10-year government bonds are available for all the countries listed above, except Belgium, Finland and Portugal. The superscripts “S” and “B” stand for stocks and bonds, respectively.

	DE ^S	FR ^S	UK ^S	IT ^S	NL ^S	ES ^S	SE ^S	AT ^S	BE ^S	DK ^S	FI ^S	IE ^S	PT ^S	JP ^S	US ^S	EU ^S
DE ^S	0.16	0.68	0.55	0.52	0.72	0.57	0.59	0.61	0.65	0.49	0.41	0.51	0.31	0.31	0.43	0.88
FR ^S		0.16	0.53	0.50	0.65	0.59	0.51	0.48	0.64	0.41	0.38	0.48	0.29	0.31	0.43	0.82
UK ^S			0.15	0.43	0.70	0.54	0.52	0.40	0.50	0.40	0.38	0.70	0.33	0.36	0.53	0.68
IT ^S				0.21	0.50	0.48	0.44	0.40	0.47	0.44	0.37	0.41	0.25	0.26	0.29	0.63
NL ^S					0.15	0.58	0.58	0.46	0.65	0.48	0.45	0.61	0.33	0.34	0.58	0.85
ES ^S						0.20	0.58	0.46	0.57	0.43	0.37	0.54	0.32	0.35	0.42	0.69
SE ^S							0.19	0.42	0.52	0.42	0.54	0.54	0.37	0.33	0.41	0.63
AT ^S								0.18	0.48	0.35	0.33	0.40	0.29	0.31	0.27	0.56
BE ^S									0.14	0.46	0.40	0.52	0.37	0.30	0.38	0.70
DK ^S										0.12	0.39	0.40	0.26	0.24	0.31	0.51
FI ^S											0.21	0.38	0.26	0.21	0.27	0.46
IE ^S												0.18	0.35	0.34	0.44	0.58
PT ^S													0.24	0.26	0.18	0.34
JP ^S														0.20	0.32	0.37
US ^S															0.14	0.54
EU ^S																0.15
DE ^B	0.16	0.19	0.06	0.14	0.10	0.07	0.11	0.06	0.12	0.11	0.04	0.04	-0.06	0.04	0.12	0.20
FR ^B	0.09	0.28	-0.05	0.13	0.08	0.10	0.08	0.05	0.15	0.09	0.03	0.01	-0.14	-0.02	0.09	0.15
UK ^B	0.05	0.15	0.26	0.13	0.10	0.08	0.11	0.04	0.08	0.07	0.07	0.12	-0.01	0.05	0.12	0.13
IT ^B	0.18	0.17	0.13	0.33	0.17	0.17	0.18	0.08	0.14	0.19	0.15	0.12	0.01	0.06	0.10	0.24
NL ^B	0.16	0.18	0.04	0.15	0.10	0.09	0.11	0.06	0.13	0.14	0.07	0.02	-0.07	0.00	0.11	0.20
ES ^B	0.14	0.20	0.15	0.21	0.14	0.21	0.17	0.11	0.14	0.18	0.20	0.11	0.05	0.06	0.10	0.20
SE ^B	0.18	0.21	0.12	0.21	0.15	0.20	0.34	0.11	0.15	0.15	0.19	0.09	0.06	0.06	0.11	0.22
AT ^B	0.20	0.24	0.19	0.22	0.19	0.18	0.20	0.15	0.22	0.17	0.18	0.17	0.02	0.09	0.13	0.27
DK ^B	0.21	0.24	0.16	0.23	0.18	0.24	0.17	0.11	0.28	0.42	0.15	0.19	0.06	0.10	0.13	0.26
IE ^B	0.21	0.23	0.21	0.22	0.19	0.17	0.21	0.14	0.21	0.22	0.12	0.23	0.11	0.15	0.17	0.25
JP ^B	-0.09	-0.02	-0.05	-0.06	-0.09	-0.10	-0.09	-0.06	-0.06	0.00	-0.05	-0.09	-0.11	0.02	0.04	-0.08
US ^B	-0.03	0.06	-0.10	-0.02	-0.04	-0.02	-0.02	0.01	0.02	0.01	-0.05	-0.06	-0.13	-0.02	0.20	0.02

	DE ^B	FR ^B	UK ^B	IT ^B	NL ^B	ES ^B	SE ^B	AT ^B	DK ^B	IE ^B	JP ^B	US ^B
DE ^B	0.07	0.66	0.51	0.32	0.89	0.29	0.43	0.68	0.55	0.48	0.29	0.45
FR ^B		0.10	0.48	0.31	0.69	0.30	0.40	0.49	0.47	0.40	0.22	0.52
UK ^B			0.11	0.24	0.54	0.27	0.39	0.41	0.30	0.49	0.20	0.41
IT ^B				0.13	0.36	0.39	0.41	0.37	0.32	0.30	0.04	0.18
NL ^B					0.06	0.32	0.46	0.70	0.55	0.47	0.30	0.46
ES ^B						0.13	0.36	0.37	0.30	0.32	0.04	0.18
SE ^B							0.12	0.45	0.38	0.36	0.09	0.26
AT ^B								0.05	0.51	0.45	0.21	0.29
DK ^B									0.10	0.47	0.25	0.23
IE ^B										0.10	0.12	0.27
JP ^B											0.08	0.17
US ^B												0.09

Table 2c: Return unconditional correlations and standard deviations for the period January 1992 – December 1998

This table reports return unconditional correlations as well as standard deviations (in bold) over the sample period January 2nd, 1992 - December 30th, 1998. Correlations and standard deviations are computed on weekly returns of 17 equity market indices and 14 10-year government bonds. The equity indices refer to Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), the United Kingdom (UK), the United States (US), as well as the Eurostoxx50 (EU). Data on 10-year government bonds are available for all the countries listed above, except Portugal. The superscripts “S” and “B” stand for stocks and bonds, respectively.

	DE ^S	FR ^S	UK ^S	IT ^S	NL ^S	ES ^S	SE ^S	AT ^S	BE ^S	DK ^S	FI ^S	GR ^S	IE ^S	PT ^S	JP ^S	US ^S	EU ^S
DE ^S	0.15	0.73	0.62	0.52	0.77	0.66	0.62	0.61	0.69	0.53	0.52	0.32	0.54	0.50	0.23	0.50	0.88
FR ^S		0.15	0.66	0.50	0.75	0.69	0.57	0.52	0.65	0.42	0.48	0.35	0.53	0.48	0.26	0.49	0.88
UK ^S			0.13	0.39	0.71	0.61	0.55	0.53	0.57	0.43	0.48	0.32	0.63	0.42	0.29	0.51	0.73
IT ^S				0.22	0.49	0.51	0.43	0.35	0.46	0.44	0.41	0.19	0.34	0.32	0.15	0.30	0.61
NL ^S					0.15	0.67	0.62	0.56	0.71	0.53	0.54	0.32	0.57	0.53	0.28	0.59	0.87
ES ^S						0.18	0.65	0.51	0.60	0.45	0.45	0.33	0.54	0.48	0.28	0.48	0.77
SE ^S							0.19	0.41	0.51	0.46	0.65	0.32	0.56	0.43	0.25	0.49	0.67
AT ^S								0.14	0.53	0.36	0.42	0.29	0.46	0.40	0.24	0.33	0.59
BE ^S									0.13	0.49	0.48	0.31	0.52	0.48	0.23	0.44	0.74
DK ^S										0.12	0.47	0.26	0.42	0.40	0.15	0.30	0.52
FI ^S											0.24	0.29	0.50	0.32	0.20	0.41	0.55
GR ^S												0.27	0.40	0.41	0.21	0.28	0.34
IE ^S													0.15	0.43	0.28	0.50	0.57
PT ^S														0.16	0.23	0.31	0.51
JP ^S															0.21	0.28	0.29
US ^S																0.12	0.58
EU ^S																	0.16
DE ^B	0.20	0.26	0.21	0.21	0.16	0.18	0.19	0.13	0.16	0.15	0.11	0.01	0.19	0.00	0.01	0.14	0.27
FR ^B	0.22	0.39	0.25	0.31	0.20	0.29	0.19	0.15	0.24	0.25	0.18	0.04	0.23	0.04	0.01	0.12	0.33
UK ^B	0.16	0.25	0.38	0.19	0.18	0.19	0.14	0.13	0.13	0.19	0.14	0.07	0.23	0.05	0.03	0.13	0.25
IT ^B	0.29	0.35	0.24	0.49	0.25	0.31	0.29	0.21	0.27	0.31	0.27	0.07	0.23	0.13	0.09	0.17	0.36
NL ^B	0.22	0.28	0.26	0.26	0.19	0.23	0.22	0.16	0.21	0.23	0.15	0.04	0.21	0.02	0.00	0.17	0.30
ES ^B	0.32	0.37	0.32	0.30	0.27	0.44	0.35	0.23	0.28	0.33	0.23	0.09	0.27	0.15	0.07	0.19	0.38
SE ^B	0.24	0.24	0.22	0.28	0.22	0.33	0.43	0.17	0.21	0.24	0.24	0.11	0.22	0.14	0.06	0.12	0.28
AT ^B	0.23	0.29	0.25	0.23	0.22	0.20	0.23	0.21	0.26	0.21	0.18	0.04	0.27	0.03	0.02	0.14	0.31
BE ^B	0.20	0.27	0.25	0.27	0.20	0.23	0.21	0.13	0.23	0.23	0.20	0.00	0.21	0.02	-0.01	0.12	0.28
DK ^B	0.24	0.31	0.24	0.29	0.21	0.30	0.25	0.17	0.29	0.40	0.25	0.02	0.23	0.10	0.03	0.08	0.31
FI ^B	0.18	0.19	0.23	0.19	0.17	0.23	0.33	0.18	0.18	0.25	0.32	0.12	0.24	0.15	0.08	0.11	0.21
IE ^B	0.27	0.32	0.29	0.28	0.25	0.29	0.23	0.21	0.27	0.35	0.18	0.06	0.32	0.11	0.11	0.22	0.32
JP ^B	-0.10	-0.10	-0.09	-0.13	-0.14	-0.17	-0.09	-0.03	-0.10	-0.07	-0.05	-0.07	-0.05	-0.12	-0.20	-0.06	-0.14
US ^B	-0.01	0.05	0.03	0.02	0.01	0.02	0.03	0.00	0.03	0.09	0.03	-0.02	0.06	-0.04	0.03	0.23	0.07

Table 2c - Continued

	DE ^B	FR ^B	UK ^B	IT ^B	NL ^B	ES ^B	SE ^B	AT ^B	BE ^B	DK ^B	FI ^B	IE ^B	JP ^B	US ^B
DE ^B	0.06	0.81	0.67	0.52	0.93	0.53	0.51	0.85	0.81	0.66	0.42	0.63	0.19	0.54
FR ^B		0.08	0.66	0.62	0.82	0.64	0.55	0.75	0.79	0.73	0.45	0.66	0.16	0.45
UK ^B			0.10	0.42	0.70	0.51	0.43	0.58	0.66	0.51	0.41	0.64	0.13	0.46
IT ^B				0.14	0.54	0.68	0.53	0.51	0.51	0.54	0.37	0.51	0.03	0.26
NL ^B					0.06	0.54	0.54	0.85	0.82	0.67	0.47	0.65	0.20	0.53
ES ^B						0.12	0.53	0.49	0.54	0.60	0.44	0.68	0.04	0.28
SE ^B							0.13	0.51	0.55	0.58	0.64	0.46	0.04	0.26
AT ^B								0.06	0.78	0.69	0.47	0.61	0.20	0.40
BE ^B									0.07	0.69	0.45	0.63	0.17	0.42
DK ^B										0.09	0.50	0.66	0.15	0.28
FI ^B											0.12	0.43	0.13	0.22
IE ^B												0.09	0.11	0.41
JP ^B													0.06	0.17
US ^B														0.09

Table 2d: Return unconditional correlations and standard deviations for the period January 1999 – October 2005

This table reports return unconditional correlations as well as standard deviations (in bold) over the sample period January 2nd, 1999 -October 21st, 2005. Correlations and standard deviations are computed on weekly returns of 17 equity market indices and 14 10-year government bonds. The equity indices refer to Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), the United Kingdom (UK), the United States (US), as well as the Eurostoxx50 (EU). Data on 10-year government bonds are available for all the countries listed above, except Belgium, Finland and Portugal. The superscripts “S” and “B” stand for stocks and bonds, respectively.

	DE^S	FR^S	UK^S	IT^S	NL^S	ES^S	SE^S	AT^S	BE^S	DK^S	FI^S	GR^S	IE^S	PT^S	JP^S	US^S	EU^S
DE^S	0.22	0.90	0.80	0.81	0.87	0.81	0.81	0.38	0.67	0.61	0.61	0.41	0.62	0.48	0.42	0.73	0.93
FR^S		0.19	0.84	0.83	0.89	0.81	0.82	0.33	0.70	0.62	0.66	0.40	0.59	0.54	0.41	0.73	0.96
UK^S			0.15	0.76	0.84	0.75	0.74	0.40	0.68	0.61	0.59	0.33	0.58	0.45	0.39	0.74	0.86
IT^S				0.19	0.80	0.79	0.72	0.36	0.61	0.61	0.53	0.38	0.60	0.50	0.39	0.63	0.83
NL^S					0.21	0.79	0.73	0.37	0.77	0.63	0.56	0.38	0.60	0.41	0.37	0.68	0.93
ES^S						0.17	0.74	0.39	0.64	0.57	0.58	0.38	0.54	0.56	0.37	0.64	0.86
SE^S							0.20	0.29	0.52	0.62	0.72	0.36	0.49	0.52	0.43	0.70	0.81
AT^S								0.12	0.36	0.34	0.14	0.24	0.32	0.23	0.25	0.29	0.33
BE^S									0.17	0.50	0.31	0.33	0.52	0.35	0.24	0.53	0.71
DK^S										0.16	0.42	0.31	0.52	0.38	0.36	0.52	0.61
FI^S											0.34	0.25	0.32	0.37	0.36	0.60	0.70
GR^S												0.26	0.28	0.29	0.21	0.30	0.38
IE^S													0.17	0.35	0.34	0.50	0.60
PT^S														0.11	0.19	0.31	0.50
JP^S															0.20	0.34	0.41
US^S																0.18	0.75
EU^S																	0.21
DE^B	-0.25	-0.22	-0.18	-0.16	-0.26	-0.17	-0.24	-0.06	-0.10	-0.09	-0.18	-0.13	-0.19	-0.07	-0.15	-0.12	-0.23
FR^B	-0.25	-0.23	-0.17	-0.15	-0.26	-0.15	-0.23	-0.03	-0.10	-0.08	-0.17	-0.13	-0.18	-0.07	-0.14	-0.12	-0.22
UK^B	-0.19	-0.17	-0.13	-0.14	-0.21	-0.10	-0.18	-0.08	-0.07	-0.09	-0.10	-0.11	-0.18	-0.02	-0.15	-0.06	-0.16
IT^B	-0.23	-0.21	-0.15	-0.13	-0.24	-0.13	-0.22	-0.03	-0.09	-0.06	-0.15	-0.11	-0.17	-0.05	-0.12	-0.11	-0.21
NL^B	-0.24	-0.22	-0.17	-0.16	-0.26	-0.16	-0.22	-0.05	-0.10	-0.07	-0.17	-0.13	-0.18	-0.07	-0.15	-0.12	-0.22
ES^B	-0.25	-0.23	-0.17	-0.15	-0.27	-0.15	-0.23	-0.03	-0.13	-0.08	-0.17	-0.14	-0.20	-0.06	-0.14	-0.13	-0.23
SE^B	-0.18	-0.15	-0.13	-0.10	-0.21	-0.13	-0.18	-0.02	-0.08	-0.04	-0.13	-0.07	-0.13	-0.02	-0.11	-0.08	-0.16
AT^B	-0.24	-0.22	-0.17	-0.15	-0.27	-0.15	-0.22	-0.06	-0.11	-0.08	-0.17	-0.15	-0.18	-0.06	-0.14	-0.12	-0.22
BE^B	-0.24	-0.22	-0.16	-0.14	-0.26	-0.14	-0.22	-0.01	-0.12	-0.07	-0.16	-0.13	-0.18	-0.04	-0.12	-0.13	-0.22
DK^B	-0.17	-0.13	-0.12	-0.11	-0.18	-0.08	-0.18	-0.06	-0.04	-0.08	-0.14	-0.07	-0.13	-0.01	-0.12	-0.09	-0.13
FI^B	-0.23	-0.21	-0.17	-0.14	-0.25	-0.15	-0.21	-0.05	-0.10	-0.06	-0.17	-0.13	-0.17	-0.06	-0.13	-0.11	-0.21
IE^B	-0.24	-0.23	-0.17	-0.15	-0.25	-0.17	-0.22	-0.03	-0.12	-0.06	-0.17	-0.13	-0.18	-0.07	-0.14	-0.13	-0.22
JP^B	-0.11	-0.03	-0.06	-0.09	-0.09	-0.04	-0.09	-0.07	-0.04	-0.07	-0.01	-0.06	-0.04	-0.02	-0.22	-0.04	-0.05
US^B	-0.36	-0.33	-0.28	-0.27	-0.34	-0.28	-0.35	-0.10	-0.18	-0.15	-0.23	-0.20	-0.22	-0.19	-0.16	-0.18	-0.33

Table 2d - Continued

	DE ^B	FR ^B	UK ^B	IT ^B	NL ^B	ES ^B	SE ^B	AT ^B	BE ^B	DK ^B	FI ^B	IE ^B	JP ^B	US ^B
DE ^B	0.06	0.98	0.85	0.97	0.98	0.98	0.89	0.98	0.97	0.88	0.98	0.94	0.19	0.74
FR ^B		0.07	0.84	0.97	0.98	0.98	0.88	0.97	0.97	0.86	0.97	0.94	0.19	0.74
UK ^B			0.07	0.83	0.84	0.83	0.79	0.84	0.83	0.77	0.83	0.79	0.15	0.68
IT ^B				0.06	0.96	0.98	0.86	0.97	0.97	0.87	0.97	0.94	0.17	0.72
NL ^B					0.07	0.97	0.89	0.97	0.97	0.87	0.97	0.94	0.18	0.72
ES ^B						0.06	0.87	0.97	0.98	0.86	0.97	0.94	0.17	0.73
SE ^B							0.07	0.88	0.87	0.85	0.88	0.85	0.19	0.65
AT ^B								0.06	0.98	0.88	0.97	0.94	0.20	0.73
BE ^B									0.06	0.86	0.97	0.94	0.17	0.72
DK ^B										0.06	0.89	0.83	0.21	0.63
FI ^B											0.07	0.93	0.17	0.73
IE ^B												0.07	0.19	0.70
JP ^B													0.05	0.17
US ^B														0.09

Table 3: Univariate GARCH models

This table reports, for each asset, the selected univariate GARCH specifications and the associated parameter estimates. We choose among the following three univariate GARCH processes:

$$\begin{aligned}
 GARCH & : h_{i,t} = \alpha_0 + \alpha_1 r_{i,t-1}^2 + \alpha_2 h_{i,t-1}, \\
 EGARCH & : \ln(h_{i,t}) = \alpha_0 + \alpha_1 (|v_{i,t-1}| - E|v_{i,t-1}|) + \gamma v_{i,t-1} + \alpha_2 \ln(h_{i,t-1}), \\
 GJR - GARCH & : h_{i,t} = \alpha_0 + \alpha_1 r_{i,t-1}^2 + \gamma I(r_{i,t-1} < 0) r_{i,t-1}^2 + \alpha_2 h_{i,t-1}.
 \end{aligned}$$

We use weekly returns on 16 equity market indices and 12 10-year government bonds. The equity indices refer to Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), the United Kingdom (UK), the United States (US), as well as the Eurostoxx50 (EU). Data on 10-year government bonds are available for all the countries listed above, except Belgium, Finland and Portugal. The sample covers the period from January 9th, 1987 to October 21st, 2005. The superscripts “S” and “B” stand for stocks and bonds, respectively. All parameters are significant at any conventional level, except those marked with the superscript “ns”.

Asset	Selected Model	α_0	α_1	γ	α_2
DE ^S	EGARCH	-0.69	0.25	-0.13	0.93
FR ^S	GJR - GARCH	0.00	0.03	0.14	0.85
UK ^S	GJR - GARCH	0.00	0.02	0.19	0.87
IT ^S	EGARCH	-0.44	0.25	-0.05	0.97
NL ^S	GJR - GARCH	0.00	0.10	0.14	0.81
ES ^S	EGARCH	-0.58	0.27	-0.10	0.95
SE ^S	EGARCH	-0.77	0.27	-0.12	0.92
AT ^S	GARCH	0.00	0.13		0.82
BE ^S	GJR - GARCH	0.00	0.10	0.25	0.70
DK ^S	EGARCH	-0.86	0.21	-0.07	0.91
FI ^S	GARCH	0.00	0.11		0.89
IE ^S	EGARCH	-0.75	0.27	-0.09	0.93
PT ^S	EGARCH	-0.75	0.49	-0.05	0.95
JP ^S	EGARCH	-0.58	0.11	-0.11	0.93
US ^S	EGARCH	-0.50	0.20	-0.12	0.96
EU ^S	EGARCH	-0.59	0.26	-0.13	0.95
DE ^B	GARCH	0.00	0.10		0.84
FR ^B	GJR - GARCH	0.00	0.04	0.11	0.84
UK ^B	GARCH	0.00	0.11		0.85
IT ^B	EGARCH	-0.64	0.34	-0.04	0.95
NL ^B	GARCH	0.00	0.12		0.78
ES ^B	EGARCH	-2.27 ^{ns}	0.32	-0.12	0.75
SE ^B	GARCH	0.00	0.14		0.84
AT ^B	GARCH	0.00	0.12		0.83
DK ^B	GARCH	0.00	0.11		0.86
IE ^B	GARCH	0.00	0.15		0.81
JP ^B	GARCH	0.00	0.16		0.82
US ^B	GJR - GARCH	0.00	0.04	0.11	0.72

Table 4: DCC GARCH model

This table reports estimate parameter estimates for the DCC GARCH model

$$\mathbf{Q}_t = \bar{\mathbf{Q}} \odot (\boldsymbol{\iota} \boldsymbol{\iota}' - \mathbf{a} \mathbf{a}' - \mathbf{b} \mathbf{b}') - \bar{\mathbf{H}} \odot \mathbf{g} \mathbf{g}' + \mathbf{a} \mathbf{a}' \odot \varepsilon_{t-1} \varepsilon_{t-1}' + \mathbf{b} \mathbf{b}' \odot \mathbf{Q}_{t-1} + \mathbf{g} \mathbf{g}' \odot \boldsymbol{\eta}_{t-1} \boldsymbol{\eta}_{t-1}'.$$

All parameters are significant at any conventional level, except those marked with the superscript “ns”. The log likelihood function is equal to -2330.90.

Asset	Parameters		
	a	b	g
DE^S	0.072	0.993	0.083
FR^S	0.089	0.993	0.102
UK^S	0.047	0.998	0.060
IT^S	0.069	0.994	0.087
NL^S	0.061	0.994	0.087
ES^S	0.053	0.995	0.091
SE^S	0.065	0.993	0.073
AT^S	0.053	0.984	0.070 ^{ns}
BE^S	0.064	0.991	0.096
DK^S	0.066	0.994	0.024
FI^S	0.057	0.996	0.051
IE^S	0.041	0.995	0.045
PT^S	0.029	0.997	0.069
JP^S	0.049	0.995	0.009
US^S	0.048	0.996	0.053
EU^S	0.070	0.994	0.089
DE^B	0.133	0.990	0.026
FR^B	0.142	0.989	0.034
UK^B	0.129	0.990	0.021
IT^B	0.122	0.991	0.089
NL^B	0.138	0.990	0.018
ES^B	0.113	0.990	0.096
SE^B	0.118	0.993	0.024
AT^B	0.131	0.990	0.024
DK^B	0.125	0.990	0.038
IE^B	0.134	0.989	0.024
JP^B	0.060	0.985	-0.018
US^B	0.102	0.993	0.014

Table 5a: Average probabilities of co-movements for returns on equity market indices - The EU economies

This table reports for each country pair average probabilities of co-movements over two periods. Average probabilities are computed across upper, lower and all the quantile ranges, for $\theta \in (0.05, 0.5)$, $\theta \in (0.55, 0.95)$, and $\theta \in (0.05, 0.95)$, respectively. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second sub-sample covers the monetary union period (January 1999 to October 2005). The equity indices refer to Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE) and the United Kingdom (UK).

		$\theta \in [0.05, 0.5]$												
Period		FR	UK	IT	NL	ES	SE	AT	BE	DK	FI	GR	IE	PT
<1999	DE	0.54	0.56	0.50	0.62	0.55	0.53	0.53	0.52	0.52	0.48	0.35	0.51	0.44
	FR		0.60	0.50	0.63	0.56	0.51	0.49	0.50	0.47	0.48	0.38	0.50	0.43
	UK			0.47	0.63	0.54	0.55	0.52	0.51	0.48	0.54	0.37	0.61	0.46
	IT				0.50	0.49	0.48	0.44	0.46	0.48	0.45	0.36	0.46	0.37
	NL					0.57	0.55	0.53	0.57	0.53	0.53	0.36	0.57	0.47
	ES						0.57	0.49	0.47	0.50	0.48	0.36	0.51	0.43
	SE							0.49	0.49	0.55	0.62	0.39	0.54	0.44
	AT								0.50	0.47	0.51	0.35	0.49	0.41
	BE									0.48	0.48	0.33	0.52	0.44
	DK										0.52	0.31	0.47	0.41
	FI											0.36	0.49	0.44
	GR												0.39	0.37
	IE													0.45
>1999	DE	0.78	0.67	0.68	0.76	0.71	0.67	0.49	0.59	0.57	0.58	0.49	0.54	0.48
	FR		0.73	0.70	0.79	0.71	0.69	0.48	0.60	0.57	0.62	0.51	0.54	0.49
	UK			0.68	0.73	0.66	0.62	0.49	0.59	0.53	0.57	0.47	0.53	0.49
	IT				0.69	0.67	0.60	0.48	0.59	0.54	0.54	0.47	0.52	0.48
	NL					0.70	0.63	0.48	0.62	0.57	0.58	0.47	0.53	0.47
	ES						0.64	0.50	0.55	0.55	0.57	0.47	0.53	0.54
	SE							0.45	0.53	0.58	0.62	0.48	0.48	0.49
	AT								0.45	0.45	0.38	0.41	0.42	0.41
	BE									0.50	0.43	0.50	0.53	0.45
	DK										0.48	0.45	0.48	0.47
	FI											0.43	0.42	0.45
	GR												0.43	0.39
	IE													0.43

Table 5a - Continued

		$\theta \in [0.55, 0.95]$													
Period		FR	UK	IT	NL	ES	SE	AT	BE	DK	FI	GR	IE	PT	
<1999	DE	0.56	0.50	0.42	0.58	0.46	0.51	0.49	0.57	0.47	0.46	0.33	0.45	0.41	
	FR		0.55	0.44	0.59	0.53	0.51	0.45	0.52	0.41	0.43	0.34	0.43	0.39	
	UK			0.40	0.55	0.50	0.52	0.46	0.48	0.46	0.46	0.34	0.55	0.37	
	IT				0.40	0.45	0.43	0.36	0.42	0.40	0.42	0.29	0.38	0.35	
	NL					0.54	0.56	0.49	0.54	0.46	0.47	0.33	0.49	0.41	
	ES						0.52	0.41	0.45	0.43	0.45	0.31	0.44	0.39	
	SE							0.39	0.46	0.42	0.58	0.31	0.46	0.38	
	AT									0.45	0.36	0.36	0.33	0.39	0.38
	BE										0.46	0.45	0.33	0.44	0.43
	DK											0.41	0.33	0.44	0.40
	FI												0.28	0.45	0.35
	GR													0.36	0.36
	IE														0.40
>1999	DE	0.75	0.62	0.64	0.68	0.61	0.66	0.41	0.56	0.46	0.57	0.44	0.54	0.43	
	FR		0.69	0.65	0.74	0.67	0.67	0.39	0.56	0.48	0.61	0.41	0.51	0.44	
	UK			0.55	0.62	0.58	0.59	0.37	0.51	0.46	0.57	0.36	0.49	0.40	
	IT				0.60	0.61	0.58	0.36	0.51	0.45	0.49	0.38	0.47	0.43	
	NL					0.60	0.58	0.40	0.57	0.50	0.51	0.42	0.52	0.40	
	ES						0.59	0.37	0.56	0.44	0.53	0.35	0.42	0.45	
	SE							0.34	0.46	0.46	0.61	0.39	0.47	0.40	
	AT								0.43	0.34	0.30	0.36	0.36	0.35	
	BE									0.43	0.43	0.35	0.46	0.41	
	DK										0.40	0.36	0.41	0.34	
	FI											0.34	0.42	0.41	
	GR												0.39	0.35	
	IE													0.39	

Table 5a - Continued

		$\theta \in [0.05, 0.95]$												
Period		FR	UK	IT	NL	ES	SE	AT	BE	DK	FI	GR	IE	PT
<1999	DE	0.55	0.53	0.46	0.60	0.51	0.52	0.51	0.54	0.50	0.47	0.34	0.48	0.43
	FR		0.58	0.47	0.61	0.54	0.51	0.47	0.51	0.44	0.46	0.36	0.47	0.41
	UK			0.43	0.59	0.52	0.54	0.49	0.50	0.47	0.50	0.36	0.58	0.42
	IT				0.45	0.47	0.45	0.40	0.44	0.44	0.43	0.32	0.42	0.36
	NL					0.56	0.55	0.51	0.56	0.49	0.50	0.34	0.53	0.44
	ES						0.55	0.45	0.46	0.46	0.46	0.33	0.48	0.41
	SE							0.44	0.47	0.49	0.60	0.35	0.50	0.41
	AT								0.48	0.42	0.44	0.34	0.44	0.40
	BE									0.47	0.47	0.33	0.48	0.43
	DK										0.47	0.32	0.46	0.40
	FI											0.32	0.47	0.40
	GR												0.37	0.36
	IE													0.42
>1999	DE	0.77	0.65	0.66	0.72	0.66	0.67	0.45	0.57	0.52	0.57	0.47	0.54	0.46
	FR		0.71	0.68	0.77	0.69	0.68	0.44	0.58	0.53	0.61	0.46	0.53	0.47
	UK			0.62	0.68	0.62	0.60	0.43	0.55	0.50	0.57	0.42	0.51	0.45
	IT				0.65	0.64	0.59	0.42	0.55	0.50	0.52	0.42	0.50	0.46
	NL					0.65	0.61	0.44	0.59	0.53	0.55	0.45	0.52	0.44
	ES						0.62	0.44	0.56	0.50	0.55	0.41	0.48	0.50
	SE							0.40	0.50	0.52	0.62	0.44	0.48	0.45
	AT								0.44	0.39	0.34	0.38	0.39	0.38
	BE									0.47	0.43	0.43	0.49	0.43
	DK										0.44	0.41	0.44	0.41
	FI											0.38	0.42	0.43
	GR												0.41	0.37
	IE													0.41

Table 5b: Average probabilities of co-movements for returns on equity market indices - The largest euro area economies, Japan, the UK and the US

This table reports for each country pair average probabilities of co-movements over two periods. Average probabilities are computed across all the quantile ranges, for $\theta \in (0.05, 0.95)$. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second sub-sample covers the monetary union period (January 1999 to October 2005). The equity indices refer to France (FR), Germany (DE), Italy (IT), the Netherlands (NL), Spain (ES), the United Kingdom (UK), Japan (JP) and the United States (US).

Period		FR	UK	IT	NL	ES	JP	US
<1999	DE	0.55	0.53	0.46	0.60	0.51	0.37	0.43
	FR		0.58	0.47	0.61	0.54	0.37	0.43
	UK			0.43	0.59	0.52	0.40	0.45
	IT				0.45	0.47	0.35	0.36
	NL					0.56	0.40	0.47
	ES						0.38	0.41
	JP							0.37
>1999	DE	0.77	0.65	0.66	0.72	0.66	0.46	0.64
	FR		0.71	0.68	0.77	0.69	0.45	0.65
	UK			0.62	0.68	0.62	0.43	0.61
	IT				0.65	0.64	0.43	0.55
	NL					0.65	0.43	0.59
	ES						0.43	0.58
	JP							0.43

Table 6a: Tests for differences in probabilities of co-movements between the pre-euro and the euro periods for returns on equity market indices - The EU economies

This table reports statistics to test whether the average probabilities of co-movements between a given country pair for a certain quantile range are different across two sample periods. The test statistic is estimated for $\theta \in (0.05, 0.5)$, $\theta \in (0.55, 0.95)$ and $\theta \in (0.05, 0.95)$. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second sub-sample covers the monetary union period (January 1999 to October 2005). Standard errors are reported in italics and statistics significant at the 5% level in bold. The equity indices refer to Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE) and the United Kingdom (UK).

$\theta \in [0.05, 0.5]$													
	FR	UK	IT	NL	ES	SE	AT	BE	DK	FI	GR	IE	PT
DE	2.38 <i>0.65</i>	1.12 <i>0.59</i>	1.79 <i>0.62</i>	1.34 <i>0.64</i>	1.59 <i>0.67</i>	1.45 <i>0.58</i>	-0.49 <i>0.61</i>	0.70 <i>0.70</i>	0.52 <i>0.57</i>	1.04 <i>0.57</i>	1.39 <i>0.54</i>	0.31 <i>0.57</i>	0.42 <i>0.60</i>
FR		1.30 <i>0.63</i>	2.02 <i>0.62</i>	1.60 <i>0.65</i>	1.51 <i>0.66</i>	1.77 <i>0.60</i>	-0.11 <i>0.59</i>	1.06 <i>0.67</i>	0.99 <i>0.57</i>	1.39 <i>0.59</i>	1.36 <i>0.55</i>	0.36 <i>0.58</i>	0.64 <i>0.56</i>
UK			2.16 <i>0.64</i>	0.97 <i>0.63</i>	1.21 <i>0.63</i>	0.72 <i>0.60</i>	-0.31 <i>0.57</i>	0.75 <i>0.74</i>	0.45 <i>0.53</i>	0.35 <i>0.60</i>	0.95 <i>0.54</i>	-0.79 <i>0.61</i>	0.38 <i>0.57</i>
IT				1.93 <i>0.60</i>	1.87 <i>0.64</i>	1.26 <i>0.58</i>	0.46 <i>0.59</i>	1.32 <i>0.66</i>	0.62 <i>0.57</i>	0.97 <i>0.54</i>	1.07 <i>0.54</i>	0.61 <i>0.59</i>	1.08 <i>0.55</i>
NL					1.29 <i>0.65</i>	0.82 <i>0.57</i>	-0.52 <i>0.56</i>	0.46 <i>0.67</i>	0.41 <i>0.56</i>	0.55 <i>0.58</i>	1.11 <i>0.52</i>	-0.42 <i>0.59</i>	-0.01 <i>0.58</i>
ES						0.65 <i>0.63</i>	0.04 <i>0.60</i>	0.83 <i>0.67</i>	0.50 <i>0.59</i>	0.91 <i>0.58</i>	1.16 <i>0.54</i>	0.18 <i>0.58</i>	1.07 <i>0.60</i>
SE							-0.31 <i>0.57</i>	0.45 <i>0.66</i>	0.30 <i>0.58</i>	0.01 <i>0.59</i>	0.96 <i>0.56</i>	-0.52 <i>0.58</i>	0.49 <i>0.59</i>
AT								-0.50 <i>0.65</i>	-0.28 <i>0.57</i>	-1.25 <i>0.54</i>	0.59 <i>0.55</i>	-0.73 <i>0.57</i>	-0.01 <i>0.57</i>
BE									0.22 <i>0.58</i>	-0.52 <i>0.56</i>	1.65 <i>0.55</i>	0.07 <i>0.63</i>	0.03 <i>0.59</i>
DK										-0.38 <i>0.58</i>	1.37 <i>0.52</i>	0.03 <i>0.54</i>	0.62 <i>0.56</i>
FI											0.65 <i>0.53</i>	-0.69 <i>0.53</i>	0.13 <i>0.57</i>
GR												0.38 <i>0.55</i>	0.22 <i>0.54</i>
IE													-0.18 <i>0.54</i>

Table 6a - Continued

$\theta \in [0.55, 0.95]$													
	FR	UK	IT	NL	ES	SE	AT	BE	DK	FI	GR	IE	PT
DE	1.72 <i>0.59</i>	1.10 <i>0.57</i>	1.98 <i>0.54</i>	0.93 <i>0.57</i>	1.36 <i>0.52</i>	1.33 <i>0.55</i>	-0.71 <i>0.50</i>	-0.16 <i>0.59</i>	-0.12 <i>0.55</i>	0.92 <i>0.57</i>	0.96 <i>0.52</i>	0.82 <i>0.55</i>	0.19 <i>0.54</i>
FR		1.27 <i>0.59</i>	1.85 <i>0.58</i>	1.43 <i>0.59</i>	1.21 <i>0.58</i>	1.42 <i>0.57</i>	-0.53 <i>0.51</i>	0.36 <i>0.56</i>	0.62 <i>0.53</i>	1.55 <i>0.55</i>	0.65 <i>0.51</i>	0.70 <i>0.54</i>	0.44 <i>0.51</i>
UK			1.40 <i>0.53</i>	0.62 <i>0.55</i>	0.74 <i>0.53</i>	0.54 <i>0.55</i>	-0.81 <i>0.49</i>	0.27 <i>0.55</i>	0.02 <i>0.52</i>	1.01 <i>0.55</i>	0.22 <i>0.52</i>	-0.51 <i>0.58</i>	0.30 <i>0.50</i>
IT				1.86 <i>0.53</i>	1.45 <i>0.55</i>	1.41 <i>0.56</i>	0.00 <i>0.48</i>	0.74 <i>0.56</i>	0.46 <i>0.52</i>	0.69 <i>0.54</i>	0.81 <i>0.50</i>	0.81 <i>0.51</i>	0.74 <i>0.50</i>
NL					0.48 <i>0.54</i>	0.23 <i>0.57</i>	-0.78 <i>0.49</i>	0.23 <i>0.57</i>	0.35 <i>0.54</i>	0.34 <i>0.55</i>	0.82 <i>0.48</i>	0.23 <i>0.55</i>	-0.12 <i>0.51</i>
ES						0.58 <i>0.56</i>	-0.31 <i>0.44</i>	1.05 <i>0.54</i>	0.15 <i>0.52</i>	0.73 <i>0.54</i>	0.35 <i>0.45</i>	-0.11 <i>0.50</i>	0.49 <i>0.50</i>
SE							-0.47 <i>0.44</i>	0.08 <i>0.52</i>	0.29 <i>0.51</i>	0.29 <i>0.58</i>	0.76 <i>0.48</i>	0.04 <i>0.52</i>	0.23 <i>0.49</i>
AT								-0.18 <i>0.51</i>	-0.26 <i>0.45</i>	-0.53 <i>0.44</i>	0.28 <i>0.47</i>	-0.27 <i>0.47</i>	-0.30 <i>0.46</i>
BE									-0.23 <i>0.53</i>	-0.25 <i>0.54</i>	0.23 <i>0.48</i>	0.11 <i>0.54</i>	-0.18 <i>0.52</i>
DK										-0.10 <i>0.49</i>	0.35 <i>0.47</i>	-0.30 <i>0.51</i>	-0.49 <i>0.51</i>
FI											0.50 <i>0.47</i>	-0.31 <i>0.56</i>	0.49 <i>0.52</i>
GR												0.33 <i>0.52</i>	-0.05 <i>0.54</i>
IE													-0.10 <i>0.52</i>

Table 6a - Continued

$\theta \in [0.05, 0.95]$													
	FR	UK	IT	NL	ES	SE	AT	BE	DK	FI	GR	IE	PT
DE	4.10 <i>0.55</i>	2.22 <i>0.56</i>	3.77 <i>0.59</i>	2.27 <i>0.54</i>	2.94 <i>0.59</i>	2.78 <i>0.52</i>	-1.20 <i>0.59</i>	0.55 <i>0.69</i>	0.40 <i>0.57</i>	1.96 <i>0.59</i>	2.34 <i>0.59</i>	1.13 <i>0.58</i>	0.61 <i>0.64</i>
FR		2.57 <i>0.55</i>	3.87 <i>0.60</i>	3.03 <i>0.53</i>	2.72 <i>0.59</i>	3.19 <i>0.55</i>	-0.64 <i>0.59</i>	1.42 <i>0.63</i>	1.61 <i>0.57</i>	2.94 <i>0.59</i>	2.01 <i>0.59</i>	1.06 <i>0.57</i>	1.08 <i>0.59</i>
UK			3.56 <i>0.61</i>	1.59 <i>0.53</i>	1.95 <i>0.56</i>	1.26 <i>0.57</i>	-1.11 <i>0.55</i>	1.03 <i>0.72</i>	0.47 <i>0.53</i>	1.36 <i>0.61</i>	1.17 <i>0.60</i>	-1.29 <i>0.62</i>	0.68 <i>0.59</i>
IT				3.78 <i>0.57</i>	3.32 <i>0.61</i>	2.67 <i>0.60</i>	0.46 <i>0.59</i>	2.07 <i>0.67</i>	1.08 <i>0.59</i>	1.66 <i>0.58</i>	1.88 <i>0.60</i>	1.42 <i>0.60</i>	1.82 <i>0.59</i>
NL					1.77 <i>0.57</i>	1.05 <i>0.54</i>	-1.30 <i>0.55</i>	0.69 <i>0.62</i>	0.76 <i>0.55</i>	0.90 <i>0.59</i>	1.93 <i>0.54</i>	-0.19 <i>0.59</i>	-0.13 <i>0.60</i>
ES						1.23 <i>0.59</i>	-0.27 <i>0.55</i>	1.87 <i>0.64</i>	0.65 <i>0.58</i>	1.63 <i>0.59</i>	1.51 <i>0.55</i>	0.07 <i>0.56</i>	1.56 <i>0.60</i>
SE							-0.78 <i>0.54</i>	0.53 <i>0.65</i>	0.59 <i>0.55</i>	0.30 <i>0.57</i>	1.72 <i>0.58</i>	-0.48 <i>0.58</i>	0.72 <i>0.61</i>
AT								-0.68 <i>0.64</i>	-0.54 <i>0.54</i>	-1.78 <i>0.54</i>	0.87 <i>0.58</i>	-1.00 <i>0.56</i>	-0.31 <i>0.58</i>
BE									-0.01 <i>0.58</i>	-0.77 <i>0.60</i>	1.88 <i>0.58</i>	0.18 <i>0.63</i>	-0.15 <i>0.61</i>
DK										-0.47 <i>0.60</i>	1.72 <i>0.57</i>	-0.27 <i>0.56</i>	0.13 <i>0.59</i>
FI											1.15 <i>0.58</i>	-0.99 <i>0.61</i>	0.61 <i>0.62</i>
GR												0.71 <i>0.60</i>	0.16 <i>0.62</i>
IE													-0.28 <i>0.58</i>

Table 6b: Tests for differences in probabilities of co-movements between the pre-euro and the euro periods for returns on equity market indices - The euro area largest economies, Japan, the UK and the US

This table reports statistics to test whether the average probabilities of co-movements between a given country pair for a certain quantile range are different across two sample periods. The test statistic is estimated for $\theta \in (0.05, 0.95)$. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second sub-sample covers the monetary union period (January 1999 to October 2005). Standard errors are reported in italics and statistics significant at the 5% level in bold. The equity indices refer to France (FR), Germany (DE), Italy (IT), the Netherlands (NL), Spain (ES), the United Kingdom (UK), Japan (JP) and the United States (US).

	FR	UK	IT	NL	ES	JP	US
DE	4.10 <i>0.55</i>	2.22 <i>0.56</i>	3.77 <i>0.59</i>	2.27 <i>0.54</i>	2.94 <i>0.59</i>	1.82 <i>0.52</i>	4.06 <i>0.56</i>
FR		2.57 <i>0.55</i>	3.87 <i>0.60</i>	3.03 <i>0.53</i>	2.72 <i>0.59</i>	1.61 <i>0.53</i>	4.18 <i>0.58</i>
UK			3.56 <i>0.61</i>	1.59 <i>0.53</i>	1.95 <i>0.56</i>	0.64 <i>0.54</i>	3.04 <i>0.63</i>
IT				3.78 <i>0.57</i>	3.32 <i>0.61</i>	1.48 <i>0.54</i>	3.62 <i>0.59</i>
NL					1.77 <i>0.57</i>	0.49 <i>0.55</i>	2.25 <i>0.59</i>
ES						1.04 <i>0.53</i>	3.19 <i>0.59</i>
JP							1.20 <i>0.58</i>

Table 7: Average probabilities of co-movements and tests for differences in probabilities of comovements between the pre-euro and the euro periods - Returns on equity market indices

This table reports for each country/region pair two items: (i) average probabilities of co-movements over two periods; and (ii) statistics to test whether the average probabilities of co-movements between a given country/region pair for a certain quantile range are different across two sample periods. Average probabilities and test statistics are computed across upper, lower and all the quantile ranges, for $\theta \in (0.05, 0.5)$, $\theta \in (0.55, 0.95)$, and $\theta \in (0.05, 0.95)$, respectively. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second sub-sample covers the monetary union period (January 1999 to October 2005). Standard errors are reported in italics and statistics significant at the 5% level in bold. The equity indices refer to Eurostoxx50 (EU), Japan (JP) and the United States (US).

Panel A : Average probabilities of comovements over the lower and upper quantile range					
Period		$\theta \in [0.05, 0.5]$		$\theta \in [0.55, 0.95]$	
		JP	US	JP	US
<1999	EU	0.44	0.45	0.34	0.49
	JP		0.39		0.35
>1999	EU	0.49	0.68	0.40	0.63
	JP		0.47		0.40

Panel B : Tests for differences in probabilities of comovements between the pre-euro and the euro periods over the lower and upper quantile range					
		$\theta \in [0.05, 0.5]$		$\theta \in [0.55, 0.95]$	
		JP	US	JP	US
EU		0.49	2.25	0.48	1.20
		<i>0.57</i>	<i>0.60</i>	<i>0.44</i>	<i>0.55</i>
JP			0.77		0.43
			<i>0.58</i>		<i>0.46</i>

Panel C : Average probabilities of comovements over the whole quantile range					
Period		$\theta \in [0.05, 0.95]$			
		JP	US	JP	US
<1999	EU	0.40	0.47		
	JP		0.37		
>1999	EU	0.45	0.65		
	JP		0.43		

Panel D : Tests for differences in probabilities of comovements between the pre-euro and the euro periods over the whole quantile range					
		$\theta \in [0.05, 0.95]$			
		JP	US	JP	US
EU		0.97	3.45		
		<i>0.54</i>	<i>0.56</i>		
JP			1.20		
			<i>0.58</i>		

Table 8: Average probabilities of co-movements and tests for differences in conditional probabilities of co-movements between the pre-euro and the euro periods - Returns on 10-year government bonds

This table reports for each country/region pair two items: (i) average probabilities of co-movements over two periods; and (ii) statistics to test whether the average probabilities of co-movements between a given country/region pair for a certain quantile range are different across two sample periods. Average probabilities and test statistics are computed across upper, lower and all the quantile ranges, for $\theta \in (0.05, 0.5)$, $\theta \in (0.55, 0.95)$, and $\theta \in (0.05, 0.95)$, respectively. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second sub-sample covers the monetary union period (January 1999 to October 2005). Standard errors are reported in italics and statistics significant at the 5% level in bold. Ten-year government bonds are for Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), Spain (ES), Sweden (SE), the United Kingdom (UK), and the United States (US).

Euro area economies, Japan and the US

Panel A : Average probabilities of comovements over the lower and upper quantile range														
$\theta \in [0.05, 0.5]$														
Period		FR	UK	IT	NL	ES	SE	AT	BE	DK	FI	IE	JP	US
1992-98	DE	0.68	0.61	0.50	0.81	0.56	0.55	0.70	0.70	0.58	0.52	0.60	0.30	0.47
1999-05	DE	0.91	0.77	0.85	0.93	0.87	0.78	0.91	0.90	0.77	0.90	0.87	0.34	0.65
$\theta \in [0.55, 0.95]$														
1992-98	DE	0.66	0.54	0.49	0.77	0.50	0.48	0.71	0.69	0.56	0.45	0.58	0.33	0.48
1999-05	DE	0.90	0.75	0.85	0.85	0.83	0.71	0.85	0.87	0.73	0.86	0.88	0.34	0.58
Panel B : Test for differences in probabilities of comovements between the pre-euro and the euro periods over the lower and upper quantile range														
$\theta \in [0.05, 0.5]$														
	DE	2.29	1.59	3.54	1.21	3.11	2.22	2.16	1.98	1.86	3.81	2.70	0.41	1.82
	Std	<i>0.69</i>	<i>0.65</i>	<i>0.66</i>	<i>0.72</i>	<i>0.66</i>	<i>0.64</i>	<i>0.70</i>	<i>0.72</i>	<i>0.65</i>	<i>0.68</i>	<i>0.68</i>	<i>0.46</i>	<i>0.61</i>
$\theta \in [0.55, 0.95]$														
	DE	2.15	1.85	3.24	0.73	2.95	2.09	1.26	1.58	1.54	3.66	2.74	0.11	0.91
	Std	<i>0.64</i>	<i>0.62</i>	<i>0.58</i>	<i>0.64</i>	<i>0.56</i>	<i>0.57</i>	<i>0.60</i>	<i>0.66</i>	<i>0.58</i>	<i>0.58</i>	<i>0.60</i>	<i>0.49</i>	<i>0.61</i>
Panel C : Average probabilities of comovements over the whole quantile range														
$\theta \in [0.05, 0.95]$														
1992-98	DE	0.67	0.58	0.50	0.79	0.53	0.52	0.70	0.69	0.57	0.48	0.59	0.31	0.47
1999-05	DE	0.90	0.76	0.85	0.89	0.85	0.75	0.88	0.88	0.75	0.88	0.87	0.34	0.62
Panel D : Test for differences in probabilities of comovements between the pre-euro and the euro periods over the whole quantile range														
$\theta \in [0.05, 0.95]$														
	DE	4.44	3.43	6.79	1.94	6.06	4.31	3.42	3.55	3.39	7.47	5.44	0.52	2.73
	Std	<i>0.51</i>	<i>0.57</i>	<i>0.53</i>	<i>0.47</i>	<i>0.51</i>	<i>0.55</i>	<i>0.45</i>	<i>0.56</i>	<i>0.53</i>	<i>0.55</i>	<i>0.50</i>	<i>0.54</i>	<i>0.63</i>

Table 8 - Continued

The UK and the US

<p>Panel A: Average probabilities of comovements over the lower and upper quantile range</p> <p style="text-align: center;">$\theta \in [0.05, 0.5]$</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Period</td> <td style="width: 40%;"></td> <td style="width: 30%; text-align: right;">US</td> </tr> <tr> <td>1992-98</td> <td style="text-align: right;">UK</td> <td style="text-align: right;">0.49</td> </tr> <tr> <td>1999-05</td> <td style="text-align: right;">UK</td> <td style="text-align: right;">0.63</td> </tr> </table> <p style="text-align: center;">$\theta \in [0.55, 0.95]$</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 40%;"></td> <td style="width: 30%; text-align: right;">0.47</td> </tr> <tr> <td>1992-98</td> <td style="text-align: right;">UK</td> <td style="text-align: right;">0.47</td> </tr> <tr> <td>1999-05</td> <td style="text-align: right;">UK</td> <td style="text-align: right;">0.54</td> </tr> </table>	Period		US	1992-98	UK	0.49	1999-05	UK	0.63			0.47	1992-98	UK	0.47	1999-05	UK	0.54	<p>Panel C : Average probabilities of comovements over the whole quantile range</p> <p style="text-align: center;">$\theta \in [0.05, 0.95]$</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 40%;"></td> <td style="width: 30%; text-align: right;">US</td> </tr> <tr> <td></td> <td></td> <td style="text-align: right;">0.48</td> </tr> <tr> <td></td> <td></td> <td style="text-align: right;">0.59</td> </tr> </table>			US			0.48			0.59
Period		US																										
1992-98	UK	0.49																										
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<p>Panel B : Test for differences in probabilities of comovements between the pre-euro and the euro periods over the lower and upper quantile range</p> <p style="text-align: center;">$\theta \in [0.05, 0.5]$</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 40%;"></td> <td style="width: 30%; text-align: right;">US</td> </tr> <tr> <td></td> <td style="text-align: right;">UK</td> <td style="text-align: right;">1.34</td> </tr> <tr> <td></td> <td style="text-align: right;">Std</td> <td style="text-align: right;">0.63</td> </tr> </table> <p style="text-align: center;">$\theta \in [0.55, 0.95]$</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 40%;"></td> <td style="width: 30%; text-align: right;">0.69</td> </tr> <tr> <td></td> <td style="text-align: right;">UK</td> <td style="text-align: right;">0.69</td> </tr> <tr> <td></td> <td style="text-align: right;">Std</td> <td style="text-align: right;">0.67</td> </tr> </table>			US		UK	1.34		Std	0.63			0.69		UK	0.69		Std	0.67	<p>Panel D : Test for differences in probabilities of comovements between the pre-euro and the euro periods over the whole quantile range</p> <p style="text-align: center;">$\theta \in [0.05, 0.95]$</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 40%;"></td> <td style="width: 30%; text-align: right;">US</td> </tr> <tr> <td></td> <td></td> <td style="text-align: right;">2.04</td> </tr> <tr> <td></td> <td></td> <td style="text-align: right;">0.71</td> </tr> </table>			US			2.04			0.71
		US																										
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		US																										
		2.04																										
		0.71																										

Figure 1: Weighted average conditional correlations between returns on equity market indices for euro area economies

This figure plots weighted average conditional correlations between returns on equity market indices for euro area member states. The lines “LARGE”, “SMALL”, “SMALL_LARGE” and “ALL” indicate average correlations between large, small, small versus large, and all the euro area economies, respectively. The data set covers the period from January 1987 to October 2005. The five largest euro area economies are France, Germany, Italy, the Netherlands and Spain. The small economies included in the analysis are Austria, Belgium, Finland, Ireland and Portugal. The conditional correlation of each euro area country pair is weighted by the fraction of its GDP relative to the total euro area GDP.

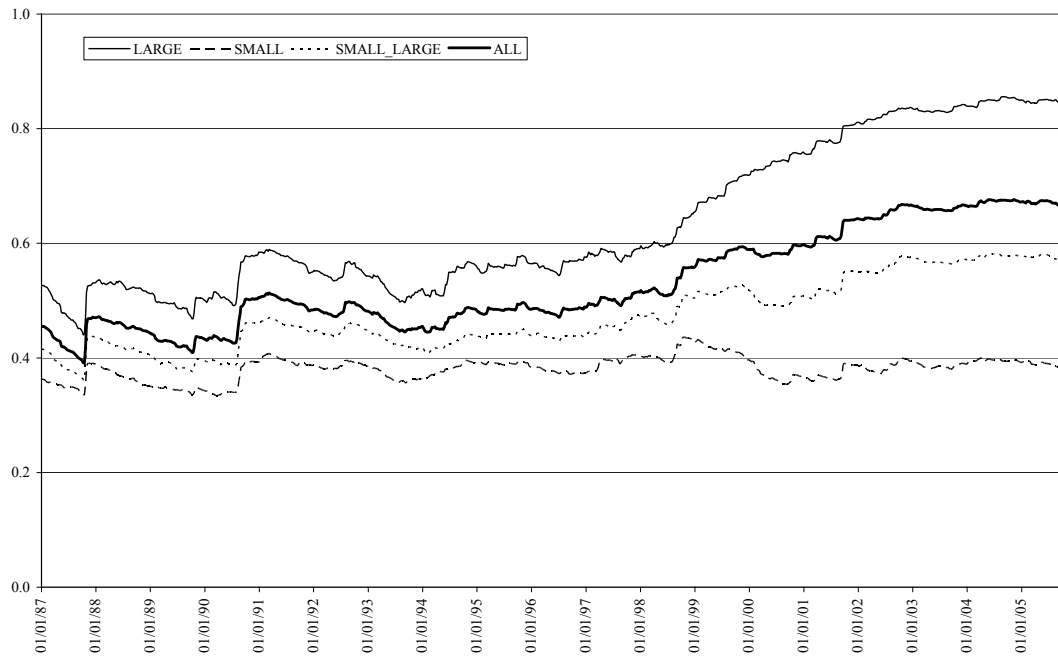


Figure 2: Conditional correlations between returns on equity market indices for the euro area large economies

This figure plots conditional correlations between returns on equity market indices for euro area large member states. The data set covers the period from January 1987 to October 2005. The five largest euro area economies are France (FR), Germany (DE), Italy (IT), the Netherlands (NL) and Spain (ES). For visual convenience, the resulting ten correlation pairs are represented in two different graphs, figure 2a and 2b.

Figure 2a

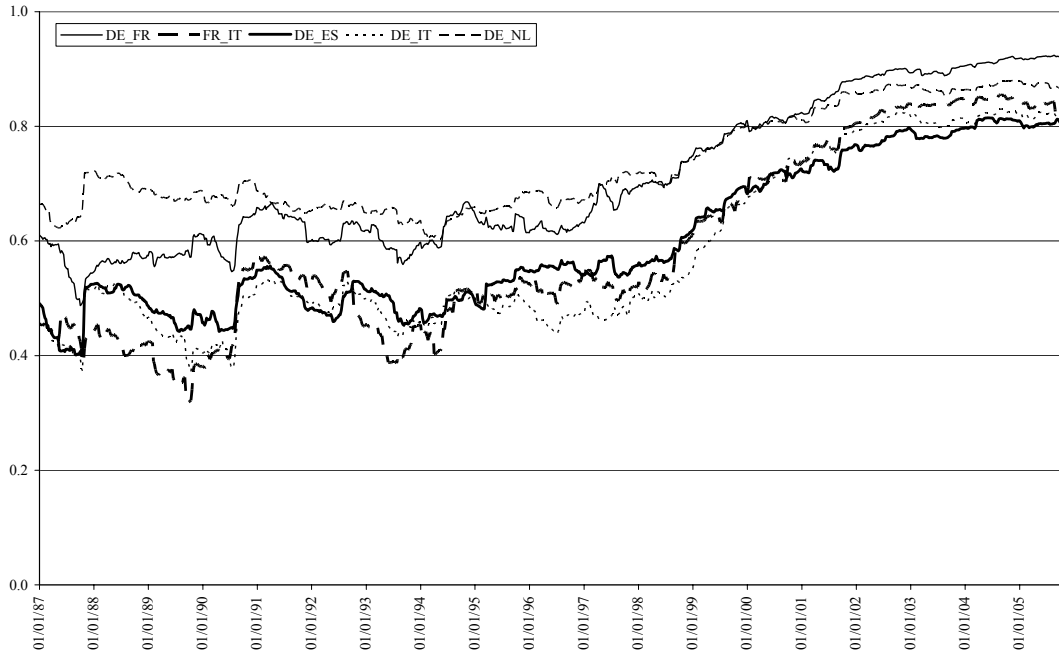


Figure 2b

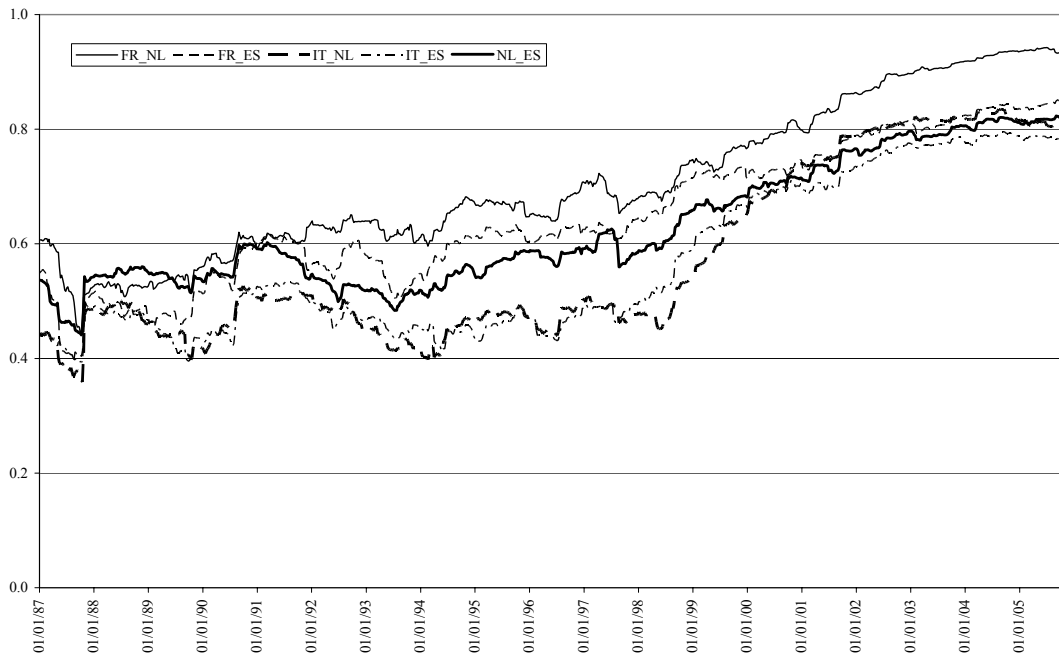


Figure 3: Conditional correlations between returns on equity market indices for euro area small economies

This figure plots conditional correlations between returns on equity market indices for euro area small member states. The data set covers the period from January 1987 to October 2005. The small euro area economies included in the analysis are Austria (AT), Belgium (BE), Finland (FI), Ireland (IE) and Portugal (PT). For visual convenience, the resulting ten correlation pairs are represented in two different graphs, figure 3a and 3b.

Figure 3a

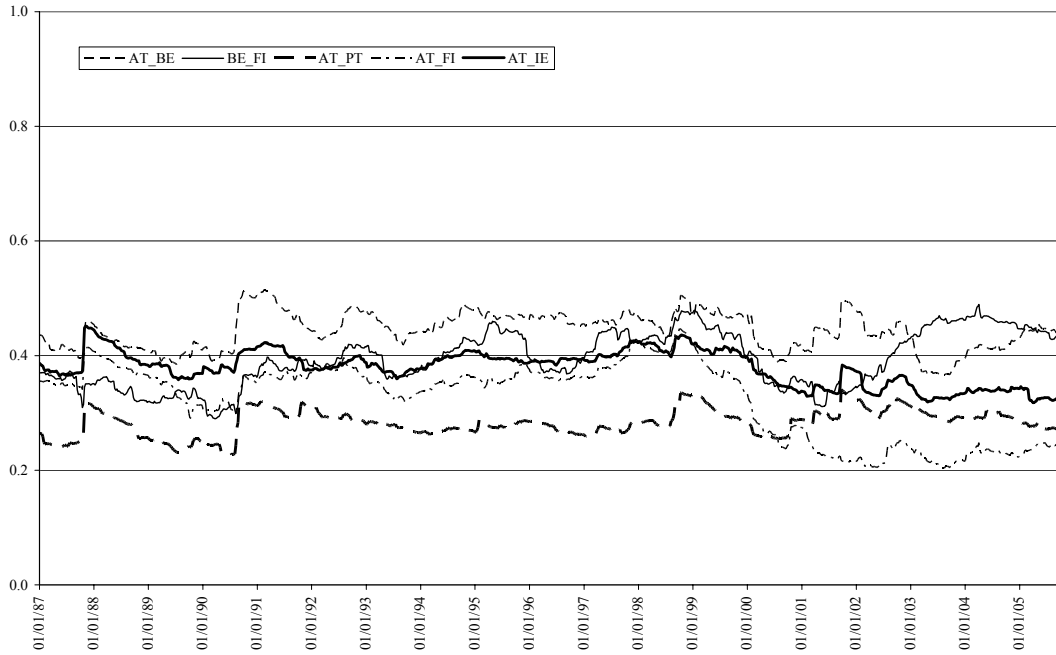


Figure 3b

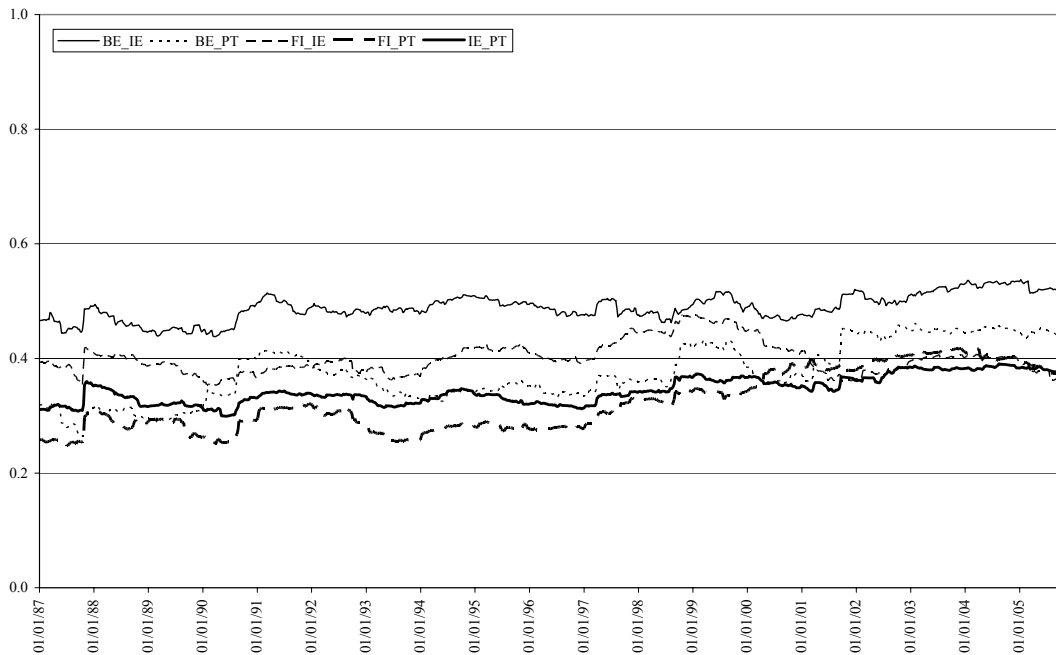


Figure 4: Conditional correlations between returns on equity market indices for euro area small and large economies

This figure plots conditional correlations between returns on equity market indices for selected euro area small and large member states. The data set covers the period from January 1987 to October 2005. The five largest euro area economies are France (FR), Germany (DE), Italy (IT), the Netherlands (NL) and Spain (ES). The small economies included in the analysis are Austria (AT), Belgium (BE), Finland (FI), Ireland (IE) and Portugal (PT). For visual convenience, the resulting ten correlation pairs are represented in two different graphs, figure 4a and 4b.

Figure 4a

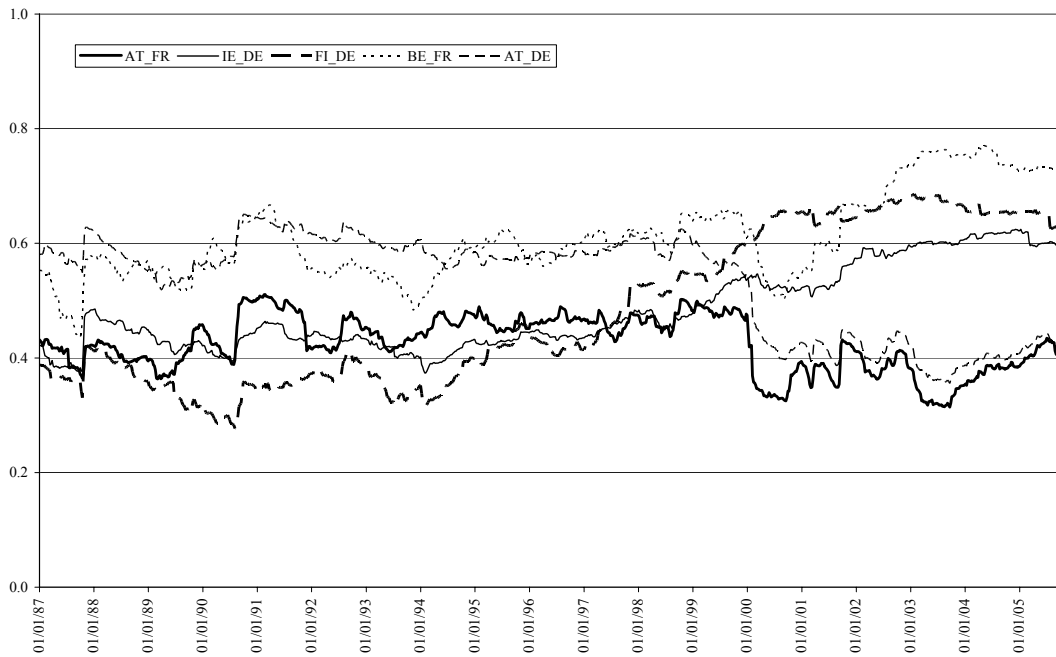


Figure 4b

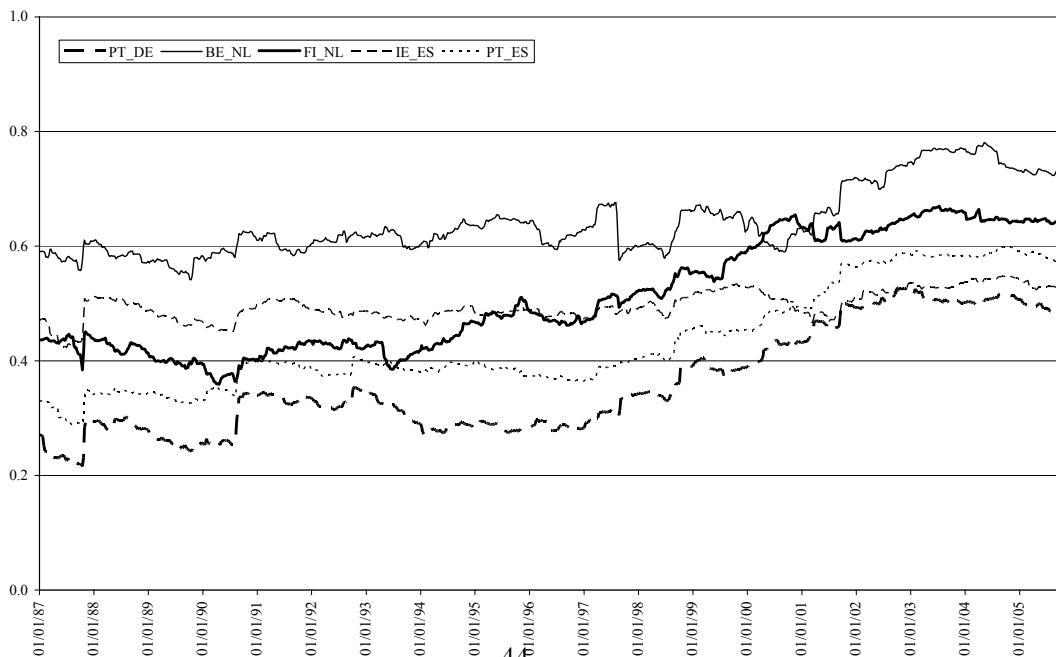


Figure 5: Conditional correlations between returns on Eurostoxx50 and non-euro area equity market indices

This figure plots conditional correlations between returns on Eurostoxx50 and non-euro area equity market indices. The data set covers the period from January 1987 to October 2005. The non euro area countries included in the analysis are Denmark (DK), Japan (JP), Sweden (SE), the United Kingdom (UK) and the United States (US).

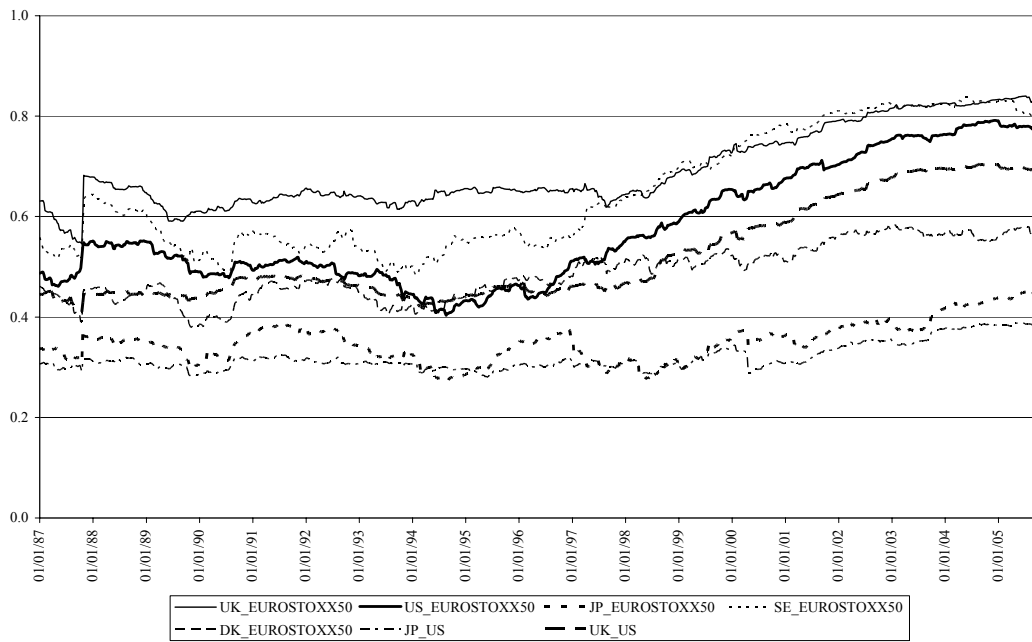


Figure 6: Weighted average conditional correlations between returns on 10-year government bonds for Germany versus other euro area economies

This figure plots weighted average conditional correlations between returns on 10-year government bonds for Germany versus other euro area member states. The lines “LARGE” and “SMALL” indicate average correlations between German versus large and small economy bond returns, respectively, while the line “ALL” stands for average correlations between German and all the other euro area bond returns. The data set covers the period from January 1987 to October 2005. The five largest euro area economies are France, Germany, Italy, the Netherlands and Spain. The small economies included in the analysis are Austria and Ireland. The conditional correlation of each euro area country pair is weighted by the fraction of its GDP relative to the total euro area GDP.

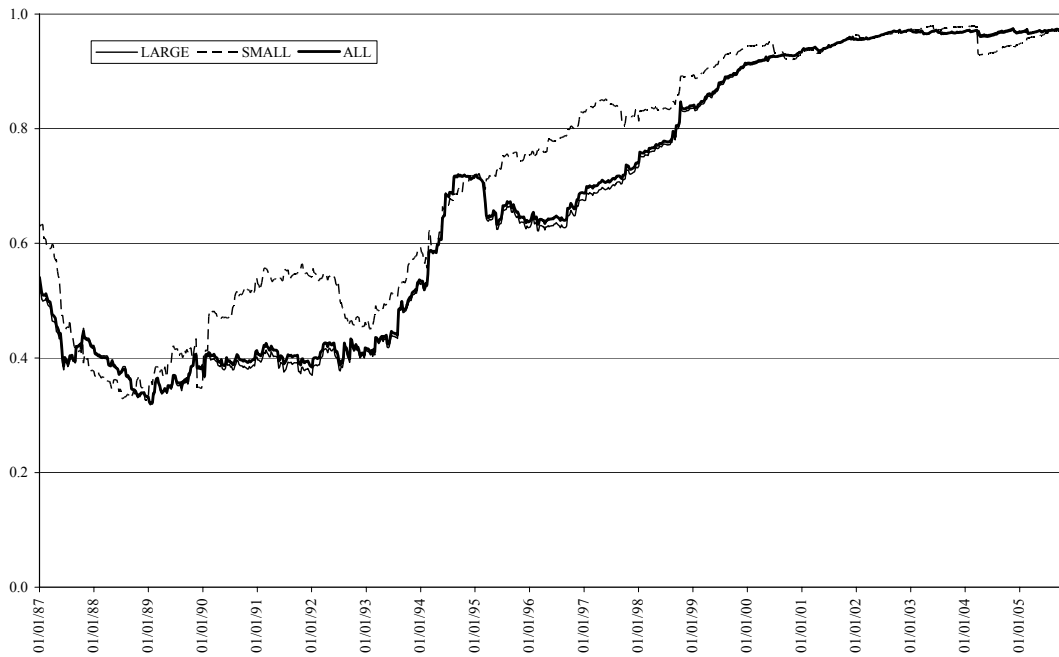


Figure 7: Conditional correlations between returns on on 10-year government bonds for Germany versus other euro area economies

This figure plots conditional correlations between returns on 10-year government bonds for Germany versus other euro area member states. The data set covers the period from January 1987 to October 2005. The countries included in the analysis are Austria (AT), France (FR), Germany (DE), Ireland (IE), Italy (IT), the Netherlands (NL) and Spain (ES).

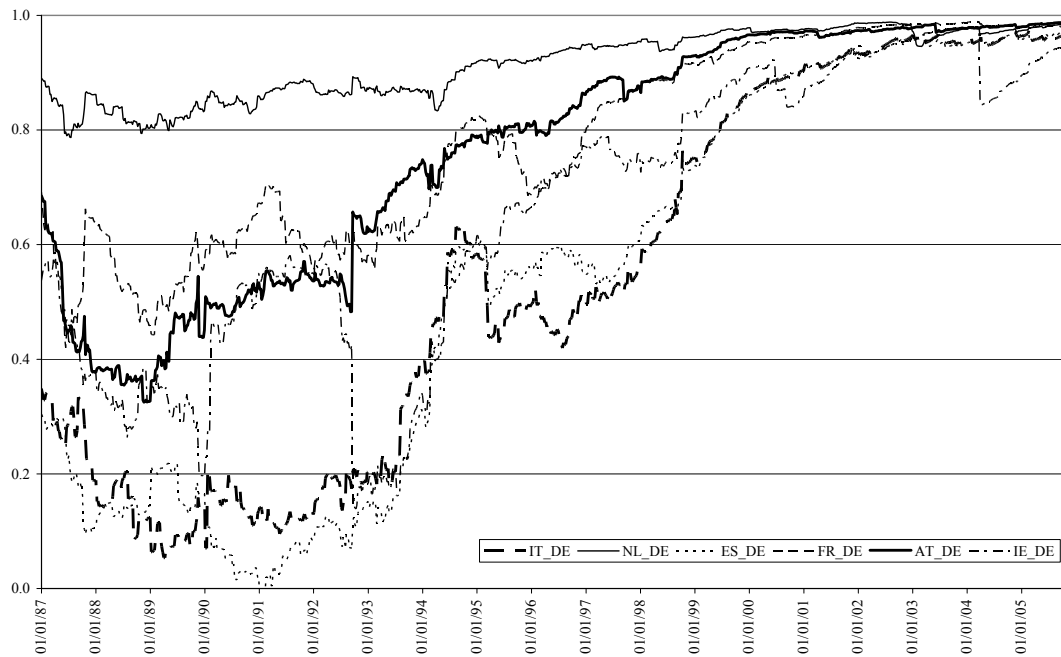


Figure 8: Conditional correlations between returns on 10-year government bonds for Germany and non-euro area economies

This figure plots conditional correlations between returns on 10-year government bonds for Germany versus non-euro area countries. The data set covers the period from January 1987 to October 2005. The non euro area countries included in the analysis are Denmark (DK), Japan (JP), Sweden (SE), the United Kingdom (UK) and the United States (US).

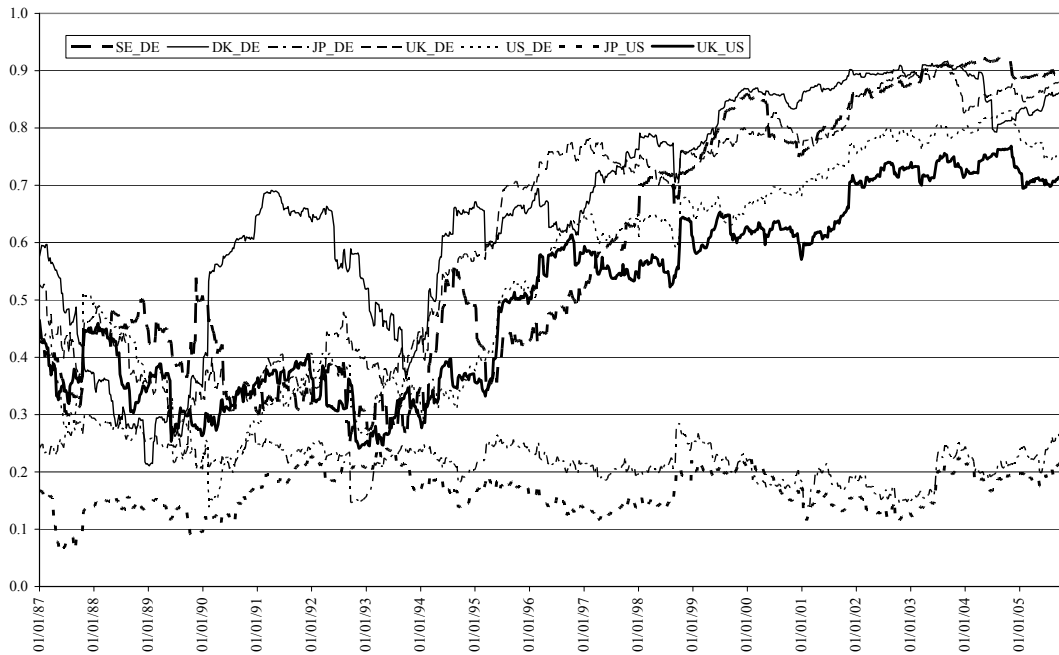


Figure 9: The co-movement box

This figure plots the probability that an asset return r_{it} falls below (above) its θ -quantile conditional on another asset return r_{jt} being below (above) its θ -quantile, for $\theta < 0.5$ ($\theta \geq 0.5$). The case of perfect positive correlation (co-monotonicity), independence, and perfect negative correlation (counter-monotonicity) are represented.

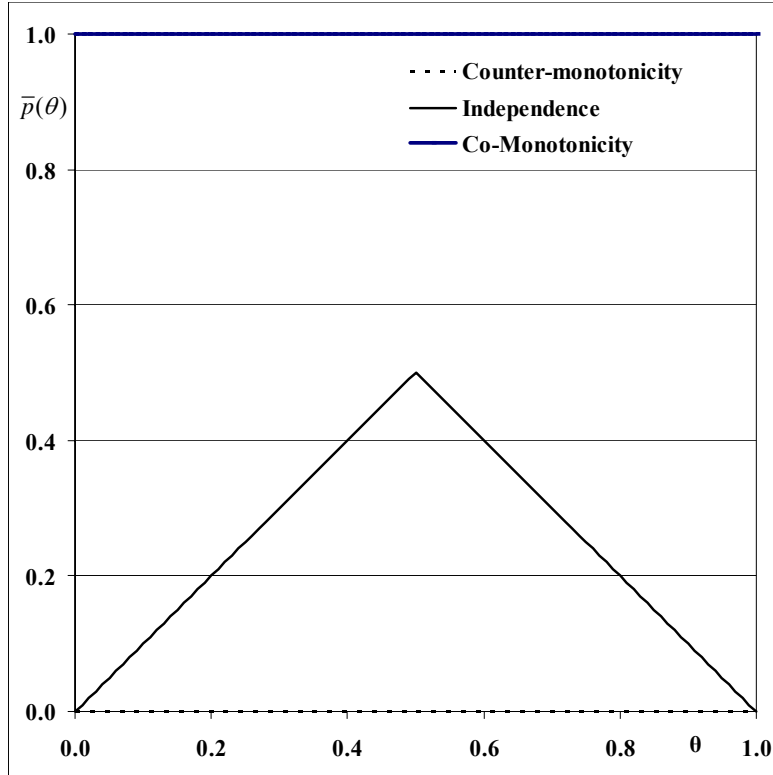


Figure 10: Weighted average probabilities of co-movements between returns on equity market indices for the euro area economies

Figures 10a-10d plot weighted average estimated probabilities of co-movements between returns on equity market indices for euro area member states over two periods. The first subsample covers the pre-monetary union period (January 1992 to December 1998), while the second the monetary union period (December 1999 to October 2005). The five largest euro area economies are France, Germany, Italy, the Netherlands and Spain. The small economies included in the analysis are Austria, Belgium, Finland, Greece, Ireland and Portugal. The probability of co-movement of each euro area country pair is weighted by the fraction of its GDP relative to the total euro area GDP.

Figure 10a: All euro area economies

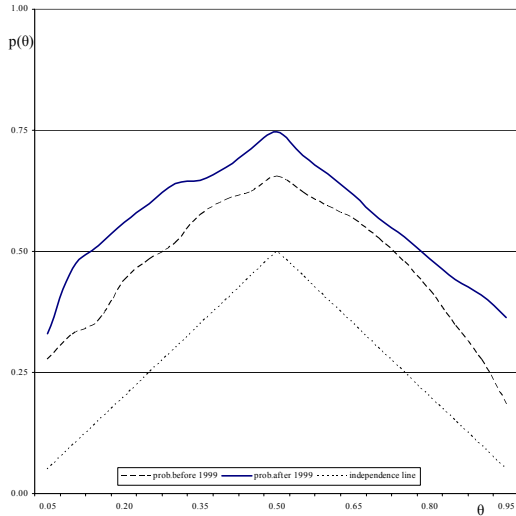


Figure 10b: Five largest economies

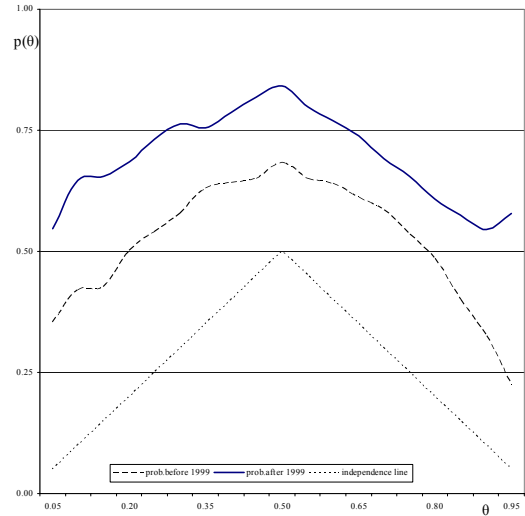


Figure 10c: Small economies

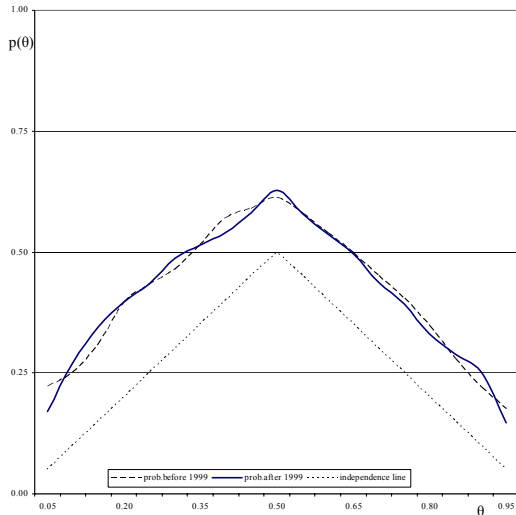


Figure 10d: Small vs. large economies

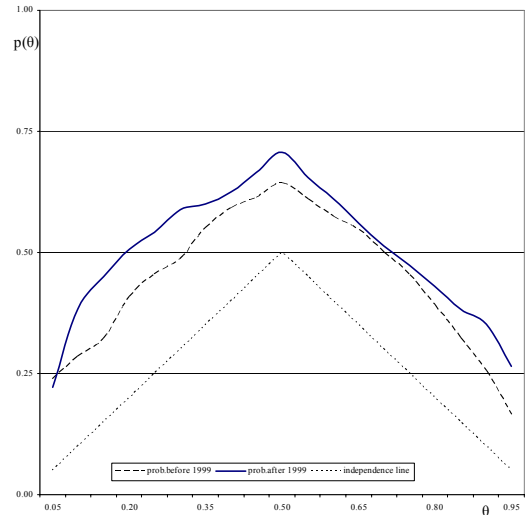


Figure 11: Probabilities of co-movements between returns on equity market indices for the large euro area economies

Figures 11a-11j plot the estimated probabilities of co-movements between returns on large euro area country pairs equity market indices over two periods. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second the monetary union period (January 1999 to October 2005). The five largest euro area economies are France, Germany, Italy, the Netherlands and Spain. The thin lines denote the two standard error bounds around the estimated co-movement likelihood in the monetary union period, while the dashed lines represent the probability of co-movement in the pre-monetary union period.

Figure 11a: France-Germany

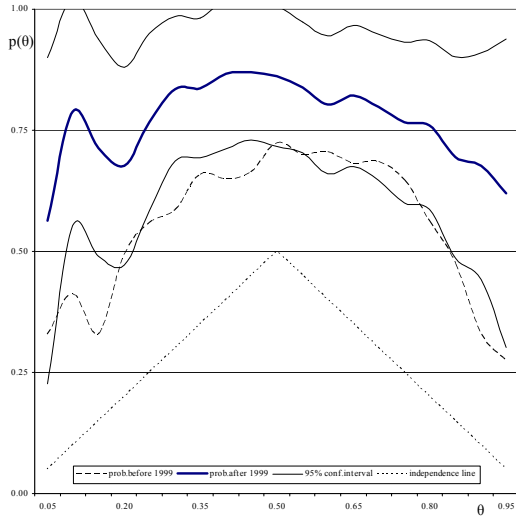


Figure 11b: France-Italy

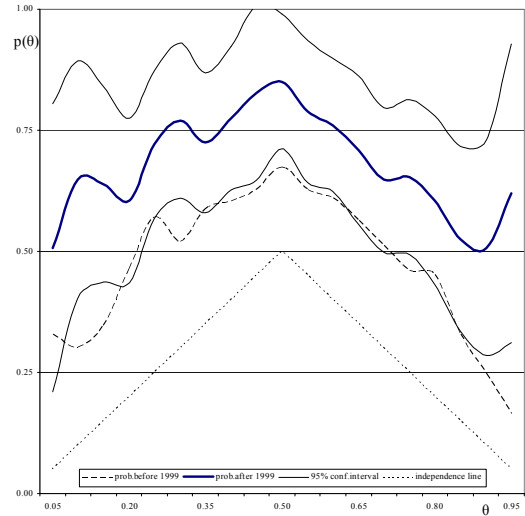


Figure 11c: France-Netherlands

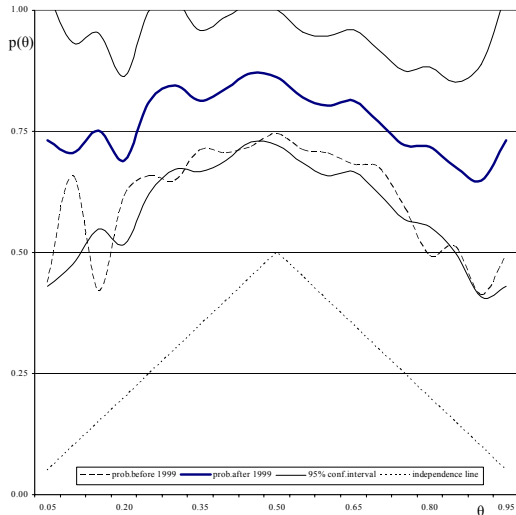


Figure 11d: France-Spain

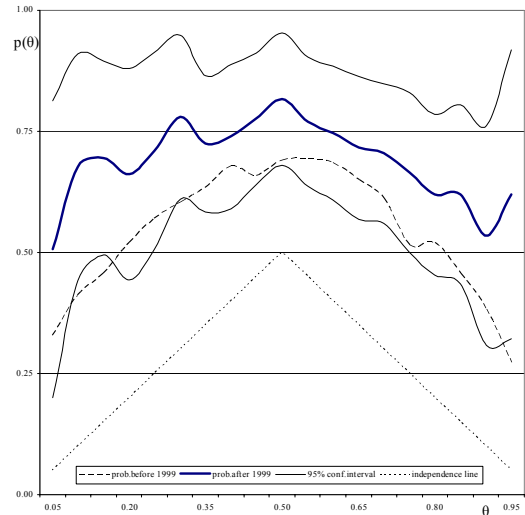


Figure 11 - Continued

Figure 11e: Germany-Italy

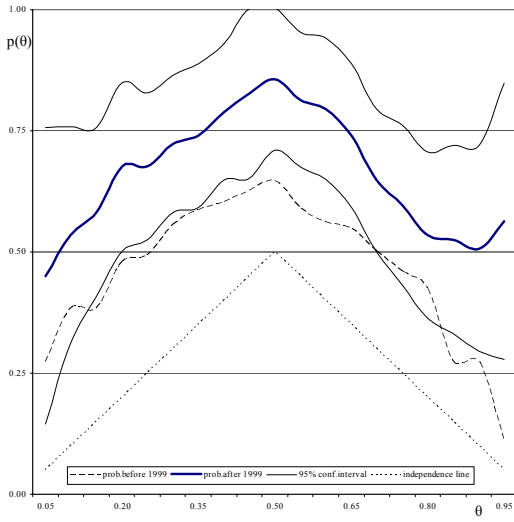


Figure 11f: Germany-Netherlands

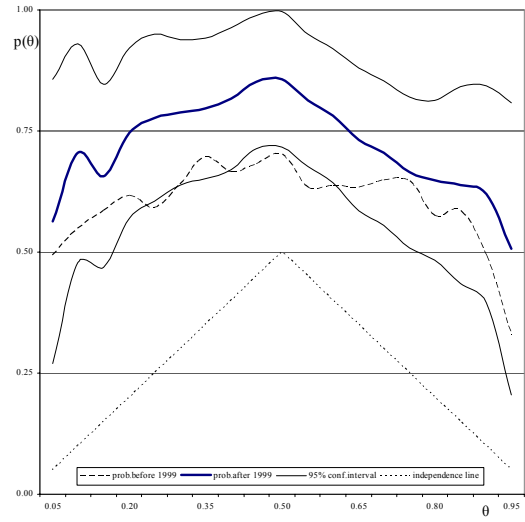


Figure 11g: Germany-Spain

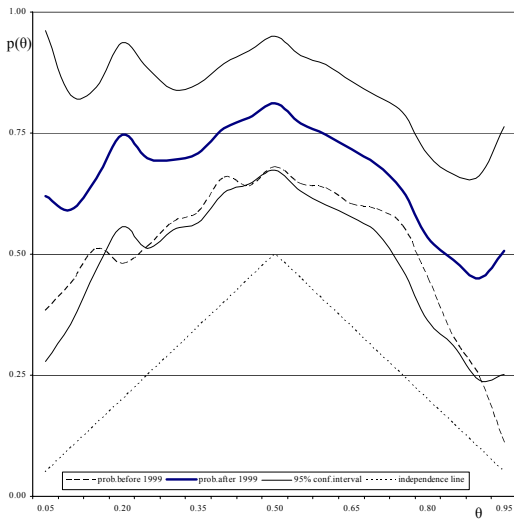


Figure 11h: Italy-Netherlands

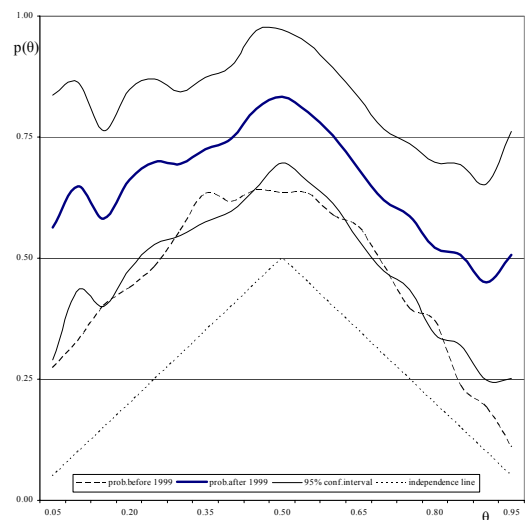


Figure 11i: Italy-Spain

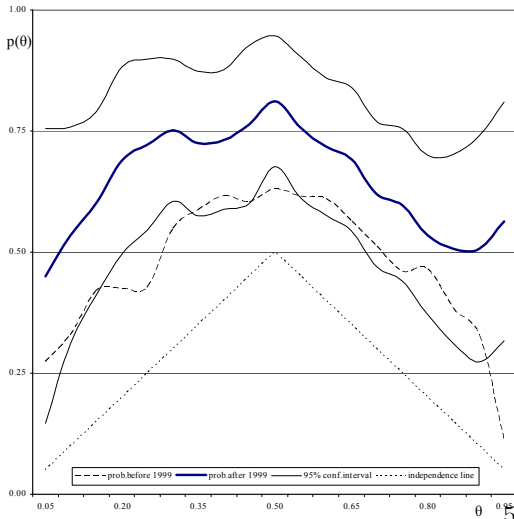


Figure 11j: Spain-Netherlands

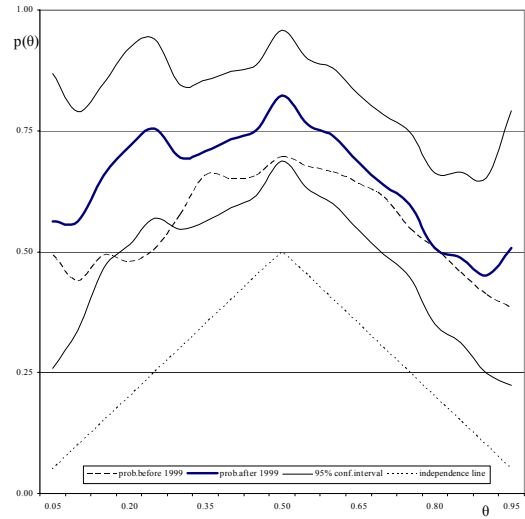


Figure 12: Probabilities of co-movements between returns on equity market indices for small euro area economies

Figures 12a-12o plot the estimated probabilities of co-movements between returns on small euro area country pairs equity market indices over two periods. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second the monetary union period (January 1999 to October 2005). The small euro area economies included in the analysis are Austria, Belgium, Finland, Greece, Ireland and Portugal. The thin lines denote the two standard error bounds around the estimated co-movement likelihood in the monetary union period, while the dashed lines represent the probability of co-movement in the pre-monetary union period.

Figure 12a: Austria-Belgium

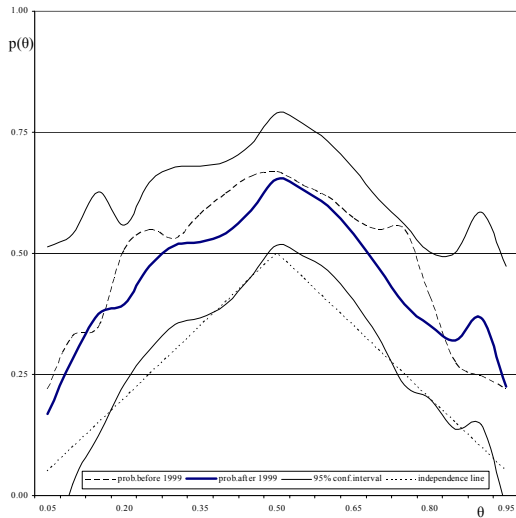


Figure 12b: Austria-Finland

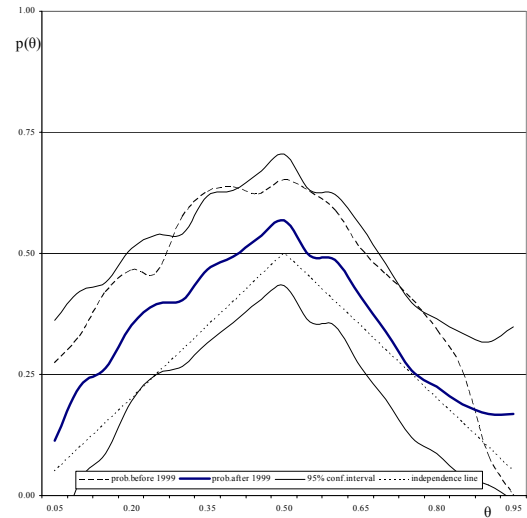


Figure 12c: Austria-Greece

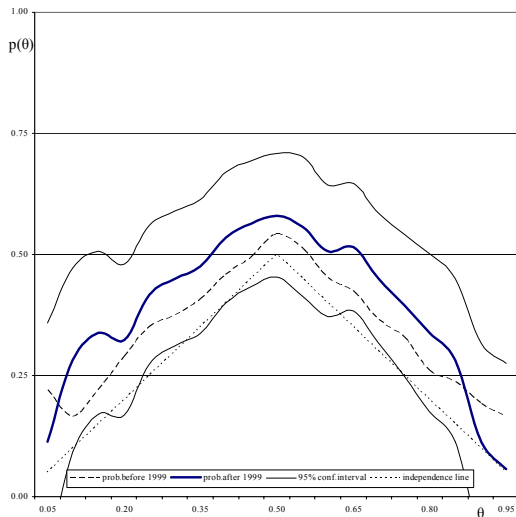


Figure 12d: Austria-Ireland

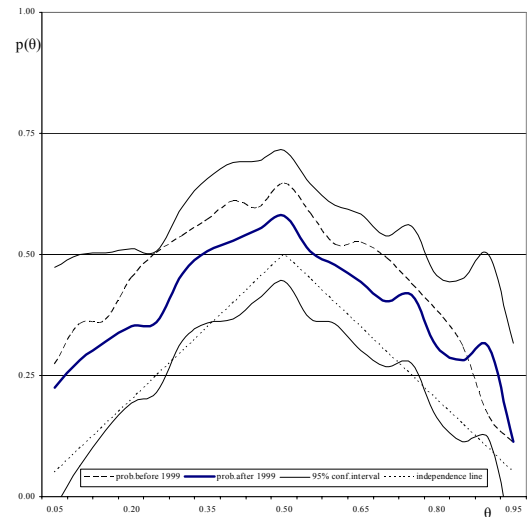


Figure 12 - Continued

Figure 12e: Austria-Portugal

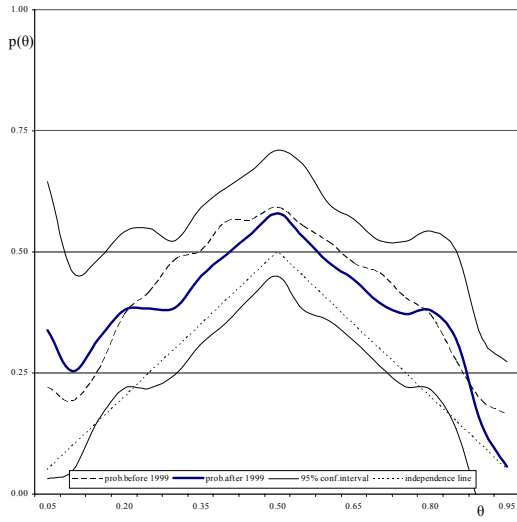


Figure 12f: Belgium-Finland

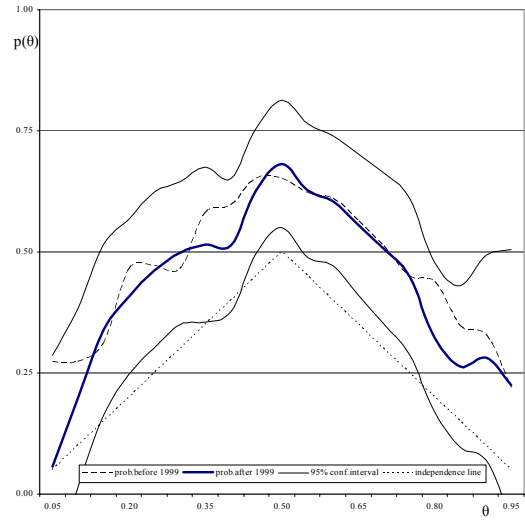


Figure 12g: Belgium-Greece

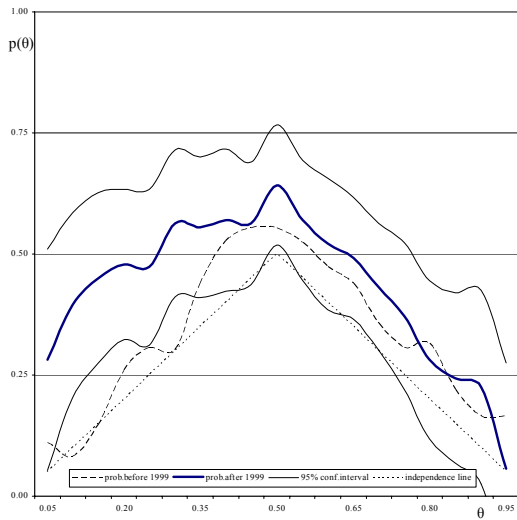


Figure 12h: Belgium-Ireland

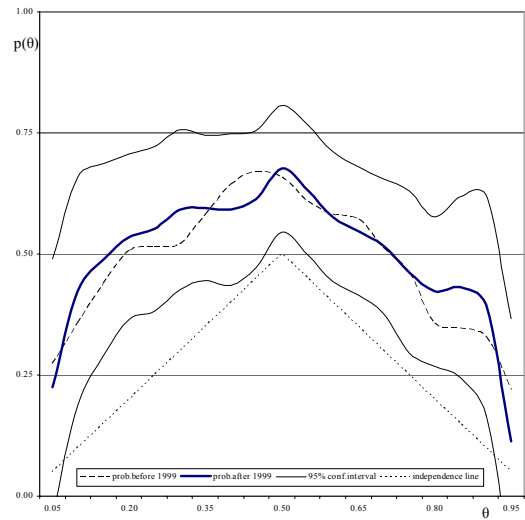


Figure 12i: Belgium-Portugal

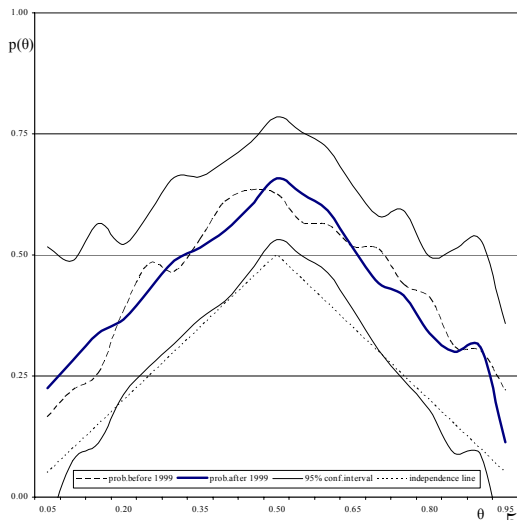


Figure 12j: Finland-Greece

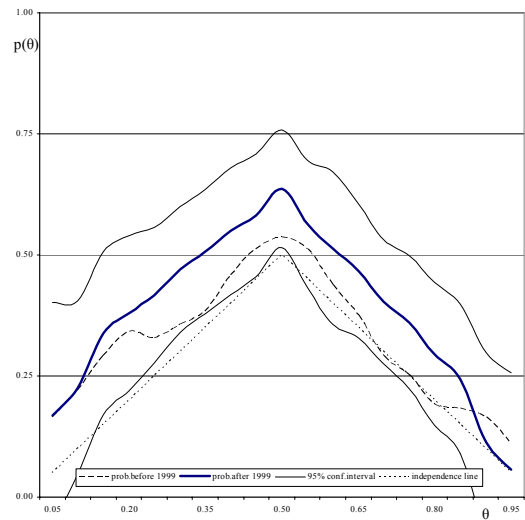


Figure 12 - Continued

Figure 12k: Finland-Ireland

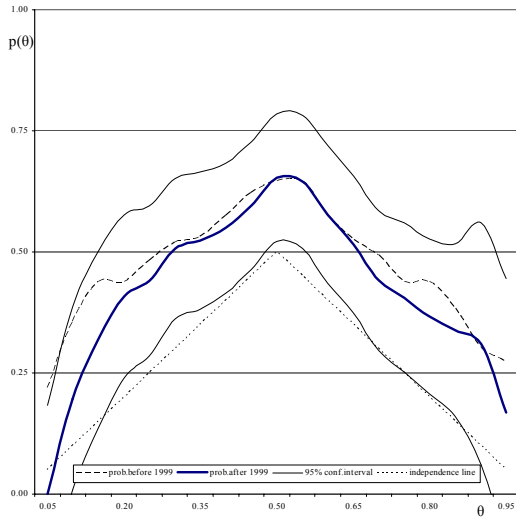


Figure 12l: Finland-Portugal

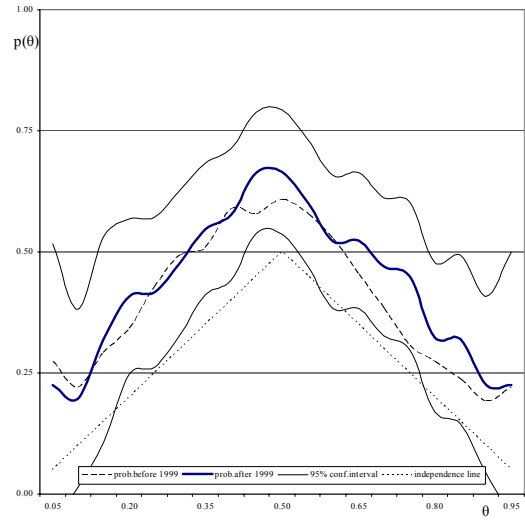


Figure 12m: Greece-Ireland

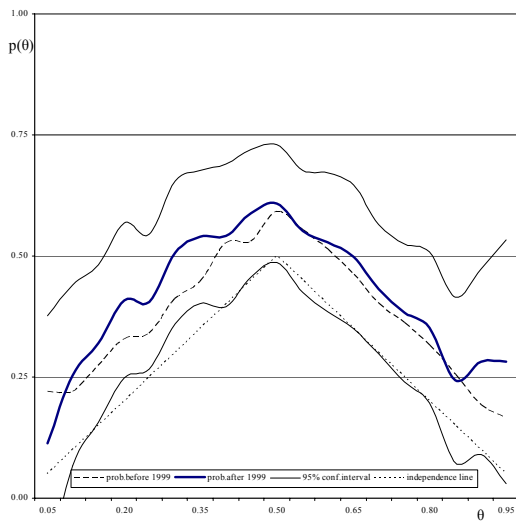


Figure 12n: Greece-Portugal

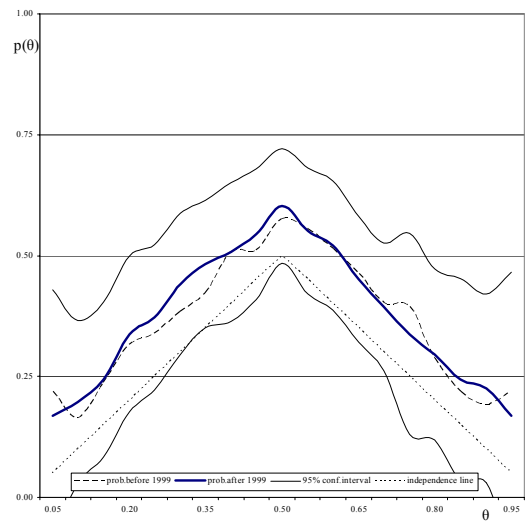


Figure 12o: Ireland-Portugal

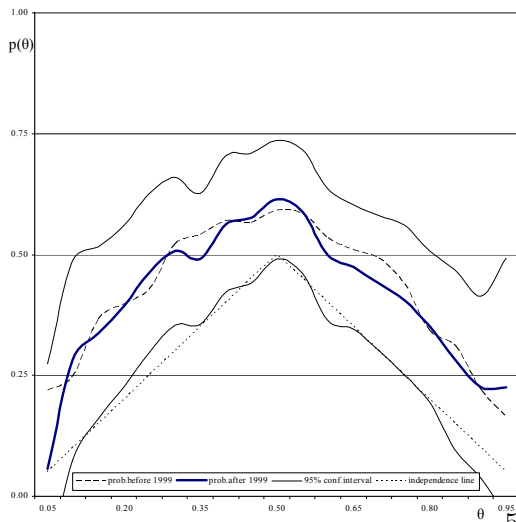


Figure 13: Probabilities of co-movements between returns on equity market indices for large and small euro area economies

Figures 13a-13l plot the estimated probabilities of co-movements between returns on large and small euro area country pairs equity market indices over two periods. The first subsample covers the pre-monetary union period (January 1992 to December 1998), while the second the monetary union period (January 1999 to October 2005). The five largest euro area economies are France, Germany, Italy, the Netherlands and Spain. The small economies included in the analysis are Austria, Belgium, Finland, Greece, Ireland and Portugal. The thin lines denote the two standard error bounds around the estimated co-movement likelihood in the monetary union period, while the dashed lines represent the probability of co-movement in the pre-monetary union period.

Figure 13a: Austria-France

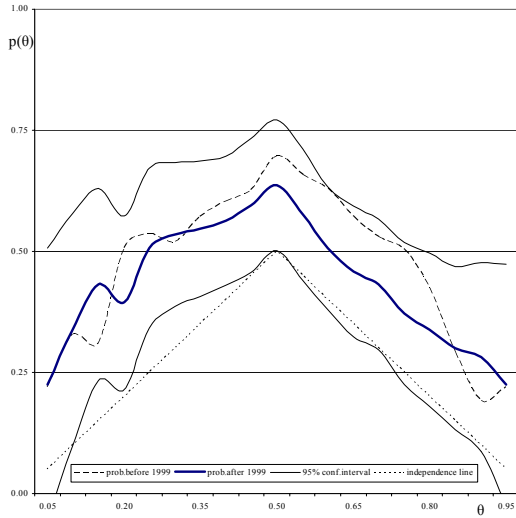


Figure 13b: Austria-Germany

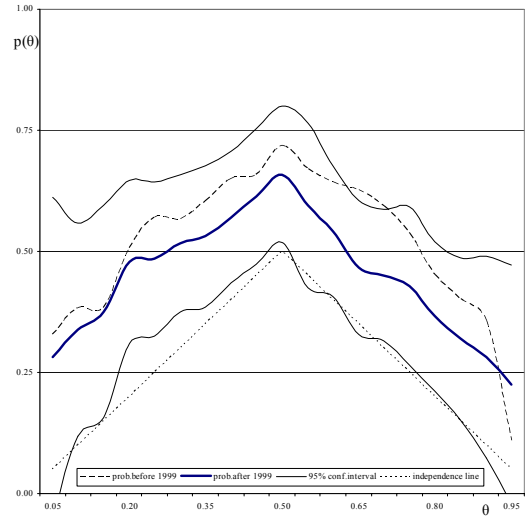


Figure 13c: Belgium-France

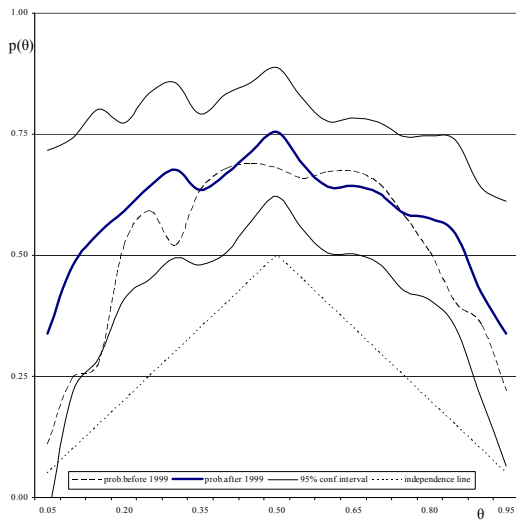


Figure 13d: Belgium-Netherlands

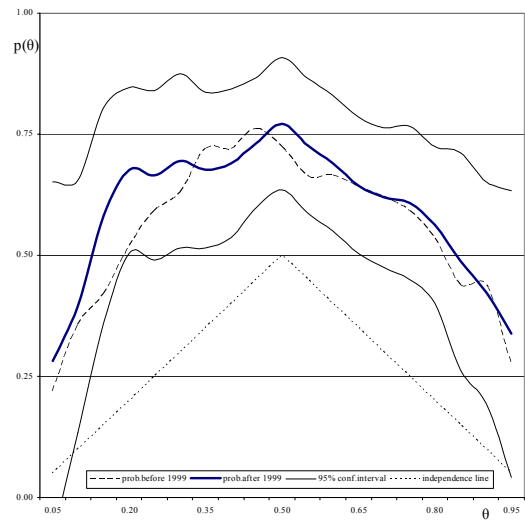


Figure 13 - Continued

Figure 13e: Finland-Germany

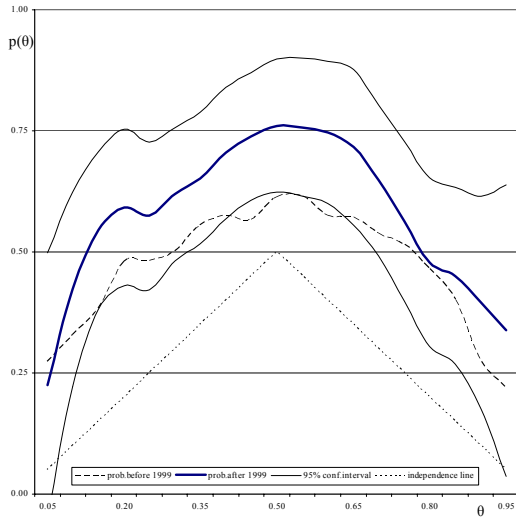


Figure 13f: Finland-Netherlands

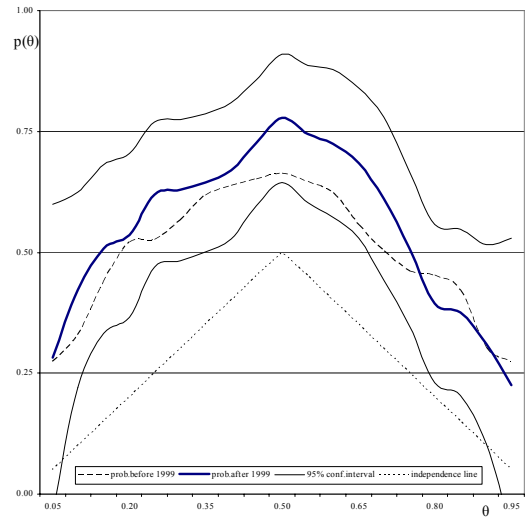


Figure 13g: Greece-France

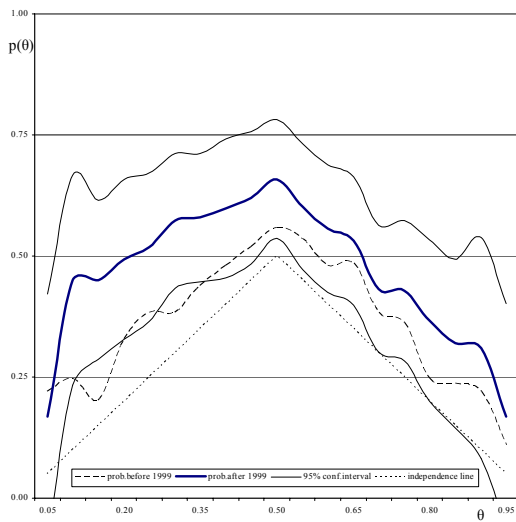


Figure 13h: Greece-Italy

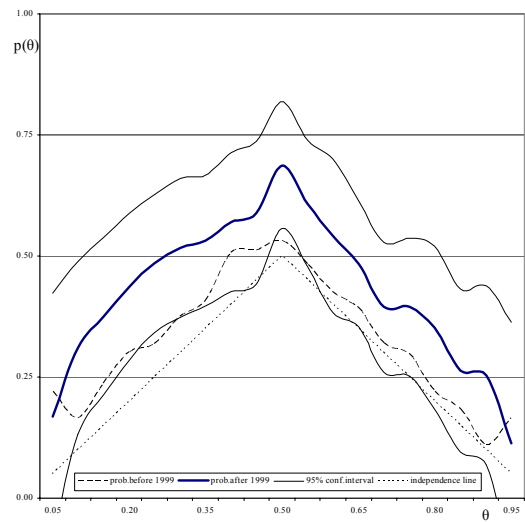


Figure 13i: Ireland-Germany

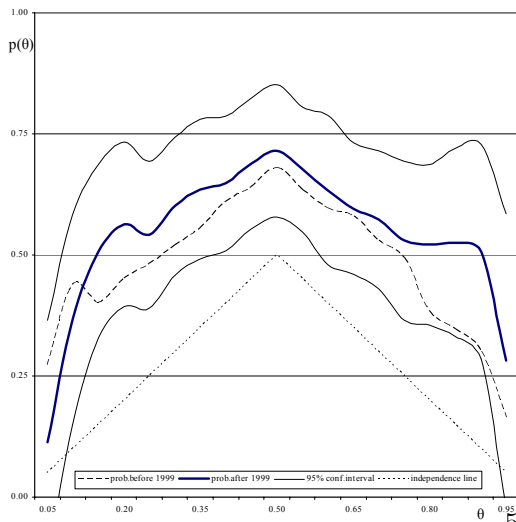


Figure 13j: Ireland-Spain

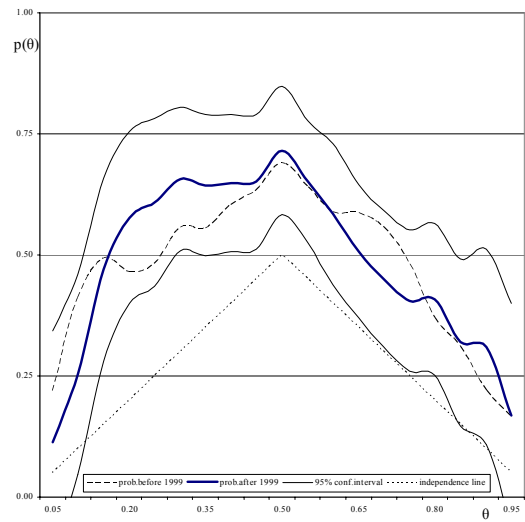


Figure 13 - Continued

Figure 13k: Germany-Portugal

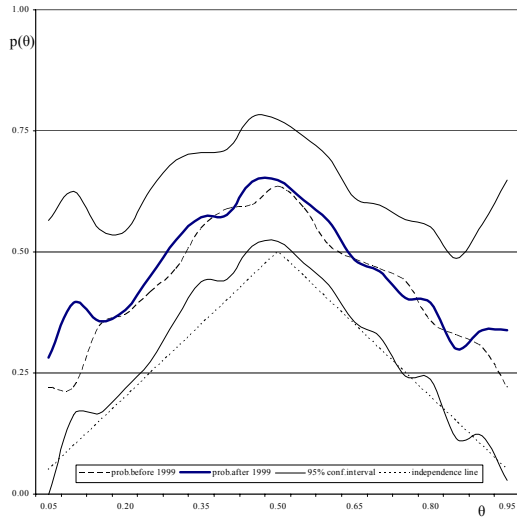


Figure 13l: Spain-Portugal

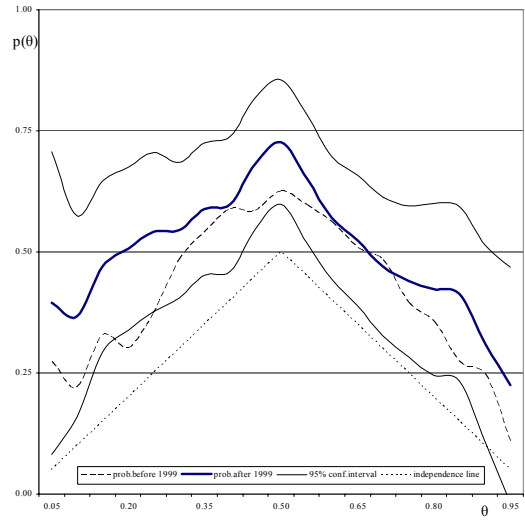


Figure 14: Probabilities of co-movements between returns on Eurostoxx50 and non-euro area equity market indices

Figures 14a-14g plot the estimated probabilities of co-movements between returns on Eurostoxx50 and non-euro area country pairs equity market indices over two periods. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second the monetary union period (January 1999 to October 2005). The non euro area countries included in the analysis are Denmark, Japan, Sweden, the United Kingdom and the United States. The thin lines denote the two standard error bounds around the estimated co-movement likelihood in the monetary union period, while the dashed lines represent the probability of co-movement in the pre-monetary union period.

Figure 14a: Euro area-UK

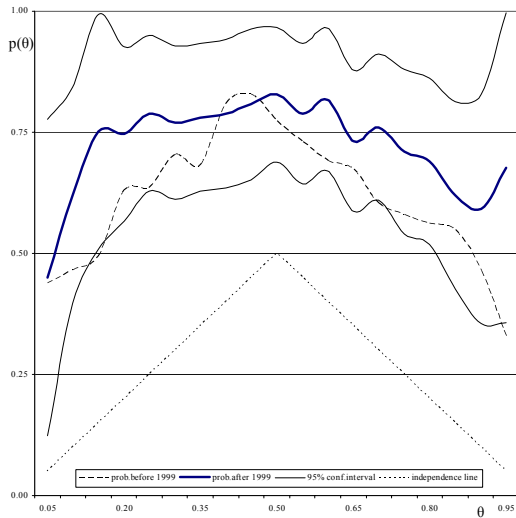


Figure 14b: Euro area-US

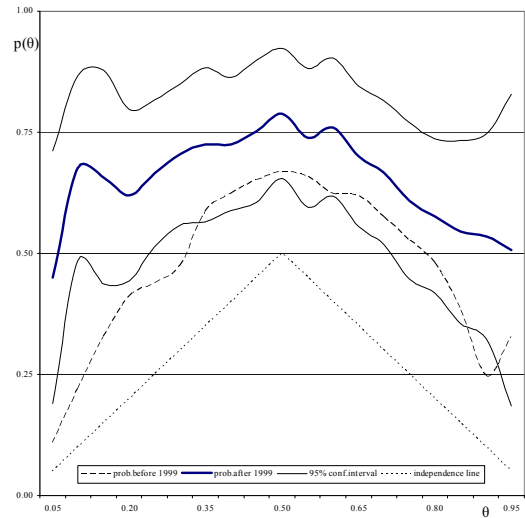


Figure 14c: Euro area-Japan

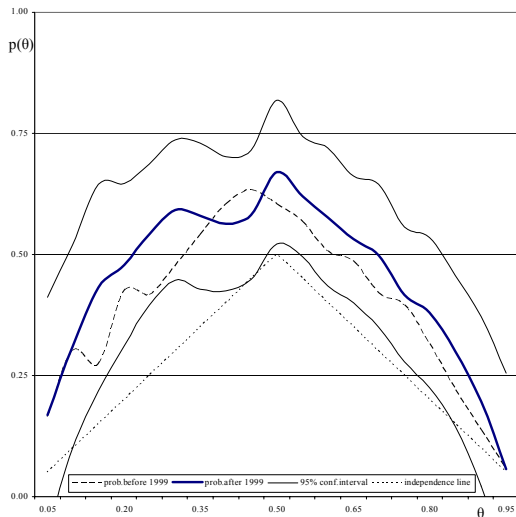


Figure 14d: Euro area-Sweden

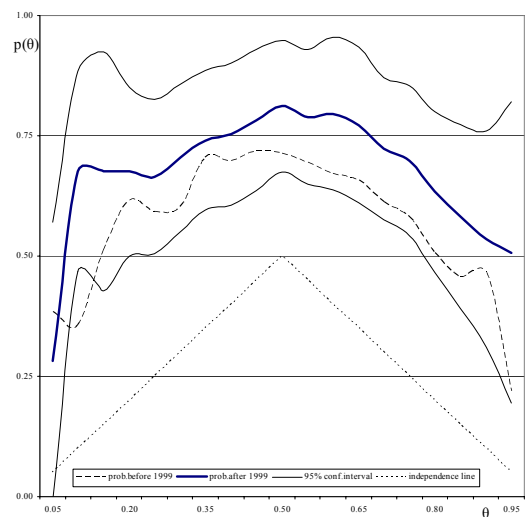


Figure 14 - Continued

Figure 14e: Euro area-Denmark

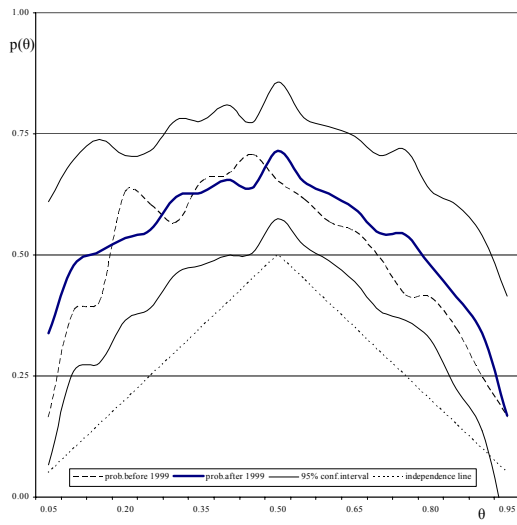


Figure 14f: US-Japan

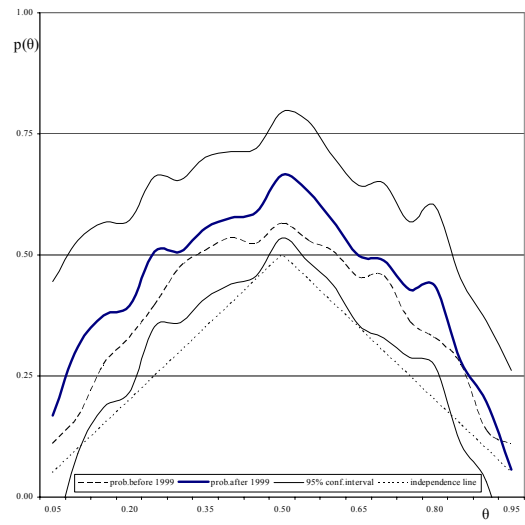


Figure 14g: US-UK

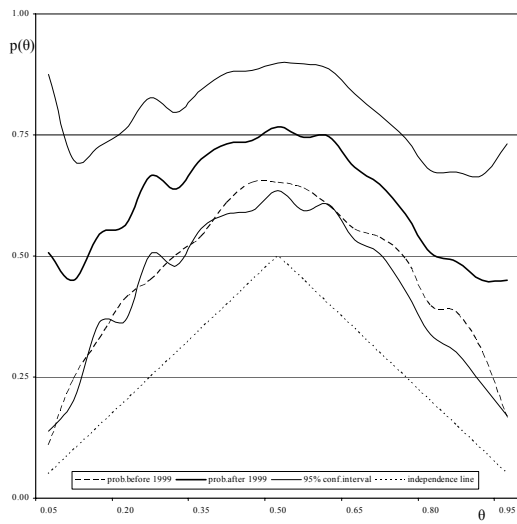


Figure 15: Weighted average probabilities of co-movements between returns on 10-year government bonds for Germany versus other euro area economies

Figures 15a-15c plot weighted average estimated probabilities of co-movements between returns on 10-year government bonds for Germany versus other euro area member states over two periods. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second the monetary union period (December 1999 to October 2005). The five largest euro area economies are France, Germany, Italy, the Netherlands and Spain. The small economies included in the analysis are Austria, Belgium, Finland and Ireland. The probability of co-movement of each euro area country pair is weighted by the fraction of its GDP relative to the total euro area GDP.

Figure 15a: All euro area economies

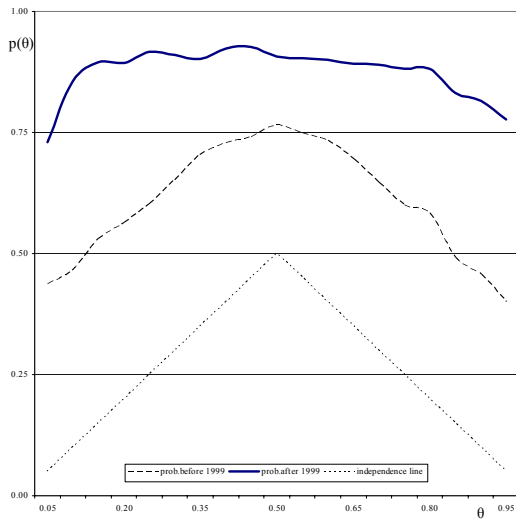


Figure 15b: Five largest economies

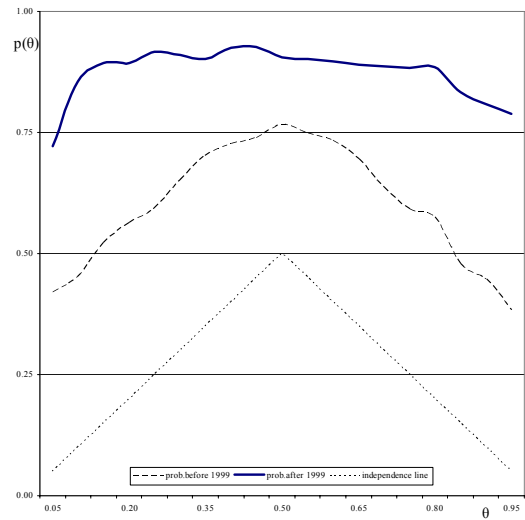


Figure 15c: Small economies

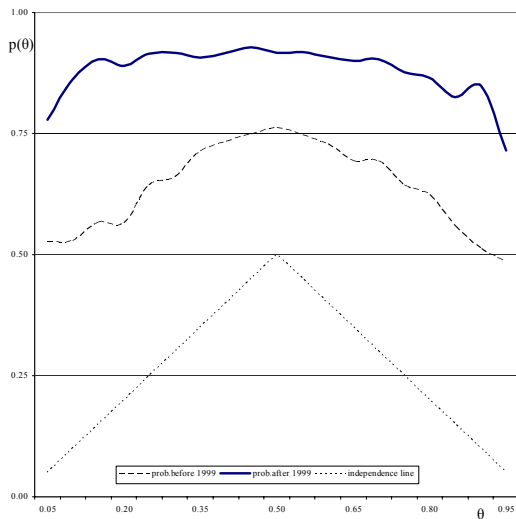


Figure 16: Probabilities of co-movements between returns on 10-year government bonds for Germany versus other euro area economies

Figures 16a-16h plot the estimated probabilities of co-movements between returns on 10-year government bonds for Germany versus other euro area member states over two periods. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second the monetary union period (December 1999 to October 2005). The countries included in the analysis are Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands and Spain. The thin lines denote the two standard error bounds around the estimated co-movement likelihood in the monetary union period, while the dashed lines represent the probability of co-movement in the pre-monetary union period.

Figure 16a: Germany-Austria

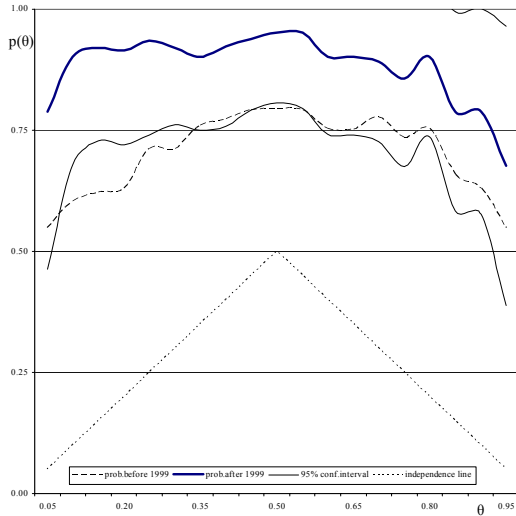


Figure 16b: Germany-Belgium

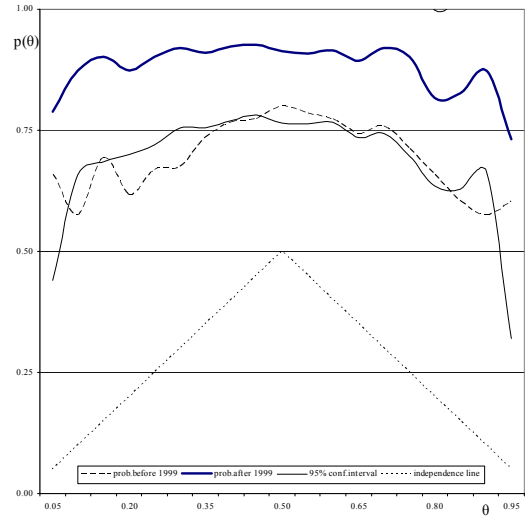


Figure 16c: Germany-Finland

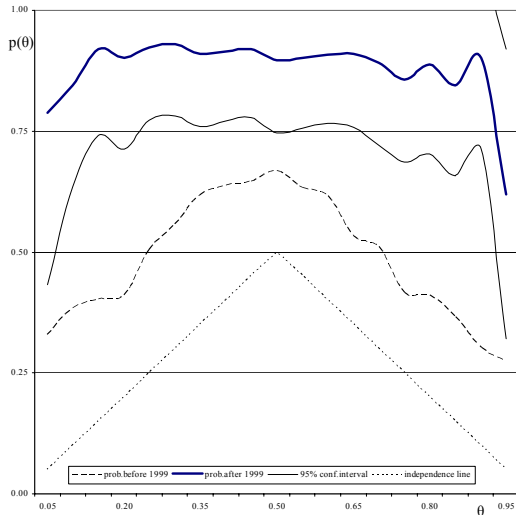


Figure 16d: Germany-France

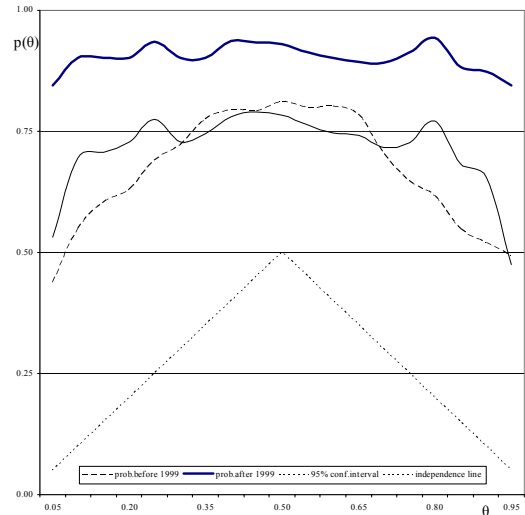


Figure 16 - Continued

Figure 16e: Germany-Ireland

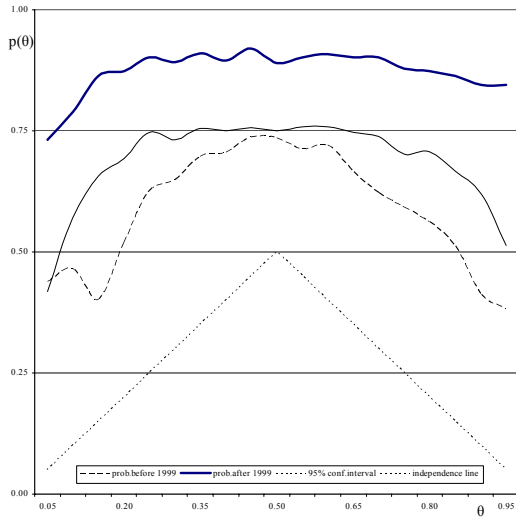


Figure 16f: Germany-Italy

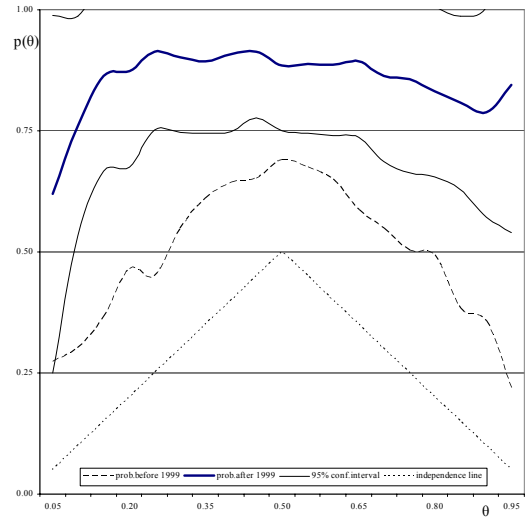


Figure 16g: Germany-Netherlands

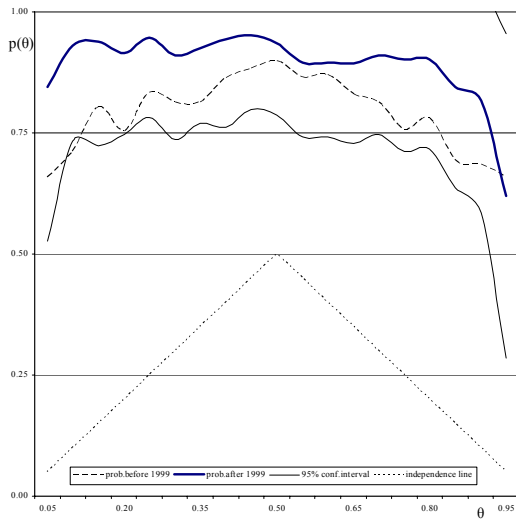


Figure 16h: Germany-Spain

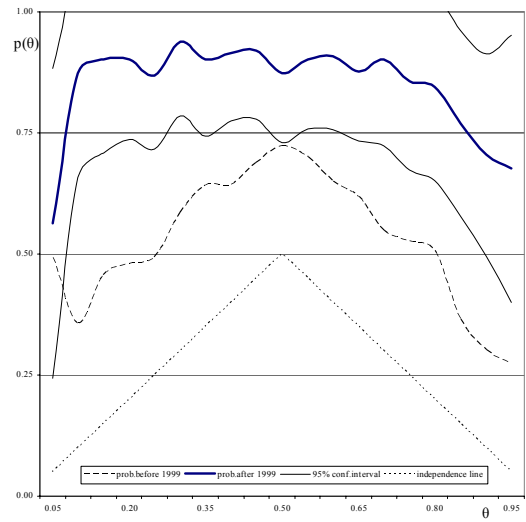


Figure 17: Probabilities of co-movements between returns on 10-year government bonds for Germany and non-euro area economies

Figures 17a-17g plot the estimated probabilities of co-movements between returns on German and non-euro area country pairs 10-year government bonds over two periods. The first sub-sample covers the pre-monetary union period (January 1992 to December 1998), while the second the monetary union period (January 1999 to October 2005). The non euro area countries included in the analysis are Denmark, Japan, Sweden, the United Kingdom and the United States. The thin lines denote the two standard error bounds around the estimated co-movement likelihood in the monetary union period, while the dashed lines represent the probability of co-movement in the pre-monetary union period.

Figure 17a: Germany-UK

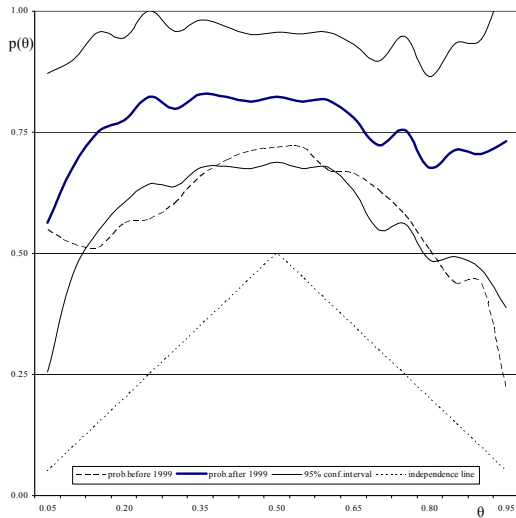


Figure 17b: Germany-US

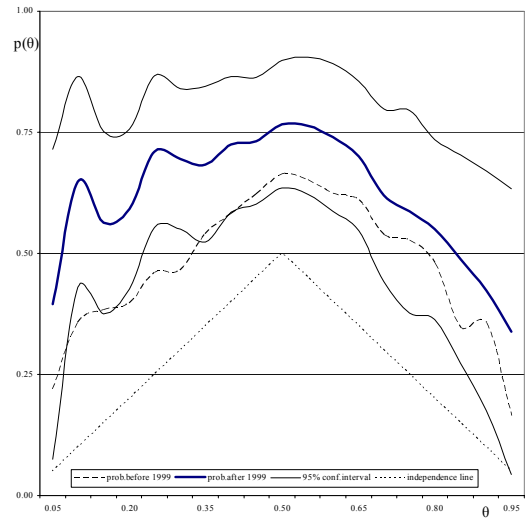


Figure 17c: Germany-Japan

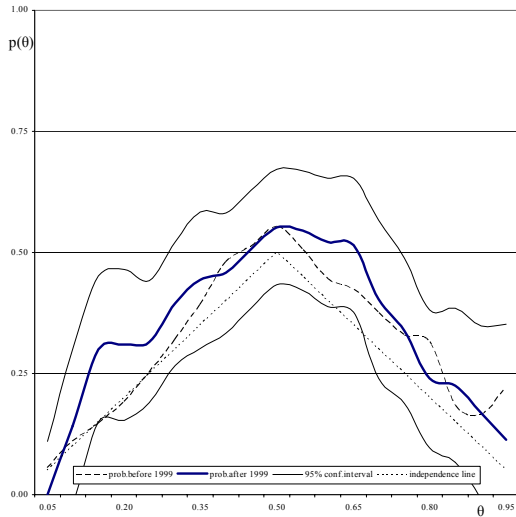


Figure 17d: Germany-Sweden

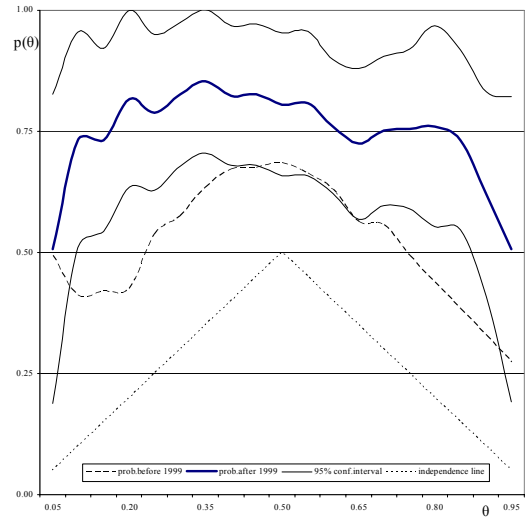


Figure 17 - Continued

Figure 17e: Germany-Denmark

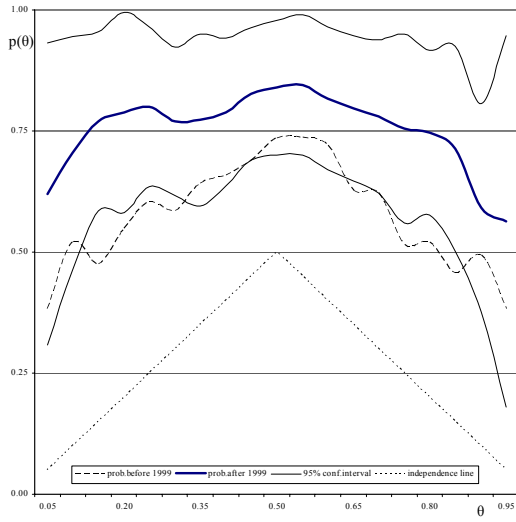


Figure 17f: US-UK

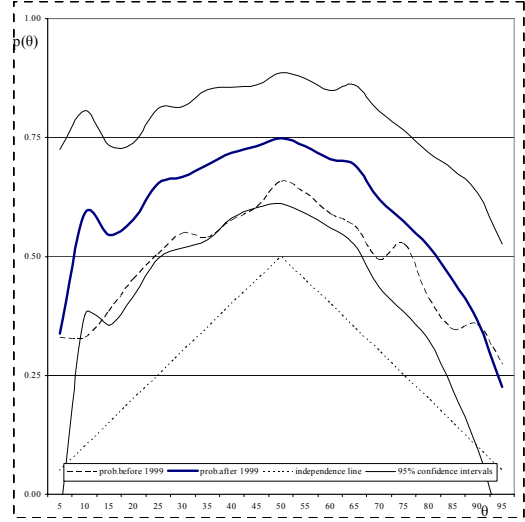


Figure 17g: US-Japan

