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FINANCIAL INTEGRATION OF NEW EU MEMBER STATES

by Lorenzo Cappiello, Bruno Gérard, Arjan Kadareja and Simone Manganelli

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In 2006 all ECB publications feature a motif taken from the €5 banknote.

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Abstract

This study assesses the degree of financial integration for a selected number of new EU member states between themselves and with the euro zone. Within the framework of a factor model for market returns, we measure integration as the amount of variance explained by the common factor relative to the local components. We show that this measure of integration coincides with return correlation. Correlations are proxied by comovements, estimated via a regression quantile-based methodology. We find that the largest new member states, the Czech Republic, Hungary and Poland, exhibit strong comovements both between themselves and with the euro area. As for smaller countries, only Estonia and to a less extent Cyprus show increased integration both with the euro zone and the block of large economies. In the bond markets, we document an increase in integration only for the Czech Republic versus Germany and Poland.

Keywords: Integration, new EU member states, regression quantile

JEL classification: C32, F30, G12

Executive Summary

The goal of this paper is to assess the degree of financial integration of a selected number of new EU member states, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Poland and Slovenia, amongst themselves and with the euro area.

Most empirical studies on integration have focused on developed markets and some recent papers have analysed emerging markets. Few studies, however, have exclusively analysed the new EU member states, despite their similar histories of rapid financial development, liberalization and integration in the global economy. Since the new EU member states will eventually join the European monetary union, it is important to monitor the development of the economic and financial links between these countries and the euro zone. On the real economy side, these countries went from centrally planned-, to market-, to fully open-economies, becoming members of a free trade area within the very short time span of about 12 years. In parallel, these economies had to evolve through a very quick development and liberalization of their financial markets. Lastly, all these countries went through these changes at a roughly similar pace.

There is no unanimous definition of integration in the literature. A quite general definition relates market and economic integration to a strengthening of the financial and real linkages between economies. The empirical analyses which refer to this background are usually conducted by investigating the changes in the comovements across countries between selected financial asset returns. In this paper we follow this approach.

We study integration between new EU member states and the euro zone across two different periods: the pre-convergence and the convergence periods. We employ a simple factor model for market returns which distinguishes between common and local components. The model allows us to adopt an intuitive measure of integration: the higher the amount of return variance explained by the common factor relative to the local components, the higher the degree of integration. The related economic intuition 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 implies an increase in comovements of firms' returns. Therefore, although we express market returns in terms of a factor model, 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 comovements.

Return comovements are estimated with the methodology introduced by Cappiello, Gérard and Manganelli (2005). This approach possesses, *inter alia*, two advantages. First, contrary to standard correlation measures, it is robust to time varying volatility and departure from normality. Second, it offers a simple and intuitive visual measure of integration. This methodology provides a long term average of the comovements between any two financial market returns across two distinct sub-periods.

We carry out our analysis on returns on equity market indices and ten-year government bonds. As for equity markets, evidence suggests that the degree of integration of the new EU member states with the euro zone has increased in their process towards EU accession. We find that the three new EU member states with the largest economies and most developed financial markets, the Czech Republic, Hungary and Poland, exhibit stronger return comovements both between themselves and with the euro area. For the four smaller countries, Cyprus, Estonia, Latvia and Slovenia, we document a very low degree of integration between themselves. However, Estonia and to a less extent Cyprus show increased integration both with the euro zone and the block of large accession economies. These results indicate that although all these countries have experienced rapid and substantial development in their financial markets, they exhibit different degrees of integration and different speed of convergence with the euro zone.

As for the bond markets, reliable data are available only for the largest countries. We find that integration increases only for the Czech Republic versus Germany (which is used as benchmark for the euro area) and Poland.

We also control for the impact of global factors using a measure of correlation among the major world equity and bond markets. This permits to assess the extent to which the degree of integration of new EU member states amongst themselves and with the Euro area is driven by the global factors relative to region specific components. Results show that, although in some cases the global factor significantly increases comovements, region specific components remain an important determinant of integration.

1 Introduction

The extent to which international goods and financial markets are integrated is an issue of continuing interest for policymakers and market participants, whether firms, investors, or financial intermediaries. On the one hand, a high degree of economic and financial integration is beneficial since it can foster economic growth, increasing risk sharing and allocating savings more efficiently. On the other hand, however, it may also lead to high cross border economic interdependence and transmission of shocks.

The goal of this paper is to assess the degree of financial integration of a selected number of new EU member states. There is no unanimous definition of integration in the literature. In financial economics (see, for example, Adler and Dumas, 1983, Stulz, 1981, Errunza and Losq, 1985, and Flood and Rose, 2005), markets are said to be integrated when only common risk factors are priced and (partially) segmented when local risk factors also determine equilibrium returns. Another, more general definition relates market and economic integration to a strengthening of the financial and real linkages between economies (see, *inter alia*, Dumas, Harvey and Ruiz, 2003). Typically, estimates of the first definition of integration require sophisticated asset pricing tests (examples are given by Bekaert and Harvey, 1995 and 1997, and Rockinger and Urga, 2001). Estimates of the second, instead, are usually conducted by investigating the changes in the comovements across countries between selected financial asset returns (see, for instance, Dumas, Harvey and Ruiz, 2003, and Aydemir, 2004). In this paper we focus on the second type of tests.

Most empirical studies on integration have focused on developed markets (see, for instance, Jorion and Schwartz, 1986, Korajczyk and Viallet, 1989, Campbell and Hamao, 1992, Carrieri, Errunza and Sarkissian, 2004, Baele *et al.*, 2004, and Flood and Rose, 2005), while some recent papers have analysed emerging markets (e.g. Bekaert and Harvey, 1995, Bekaert and Urias, 1996, Bekaert and Harvey, 1997, De Santis and İmrohoroğlu 1997, Bekaert *et al.* 1998, Bekaert, 1999, Bekaert and Harvey, 2000, Rockinger and Urga, 2001, Gérard, Thanyalapark and Batten, 2003, and de Jong and de Roon, 2005). However, few studies have exclusively analysed the new EU member states, despite their interesting characteristics (see, for instance, Dvorak and Geiregat, 2004, and Reininger and Walko, 2005, and the references therein). On the real economy side, these countries went from centrally planned-, to market-, to fully open-economies, becoming members of a free trade area within the very short time span of about 12 years. In parallel, these economies had to evolve through a very rapid development and liberalization of their financial markets. Lastly, all these countries went through these changes at a roughly similar pace. Moreover, since the new EU member states will eventually join the European monetary union, it is important to monitor the development of the economic and financial links between these countries and the euro zone.

We study integration between new EU member states and the euro zone across two different periods: the pre-convergence and the convergence periods. We employ a factor model for market returns which distinguishes between common and local components. Since economic fundamentals are typically reflected in financial market prices, factor models represent a natural tool to investigate to which extent these fundamentals have been converging over time. Although we express market returns in terms of a factor model, differently from previous studies on integration and comovements (see, for instance, Bekaert and Harvey, 1995, Rockinger and Urga, 2001, Bekaert, Hodrick and Zhang, 2005, and de Jong and de Roon, 2005) we do not estimate the model itself nor its loading factors, but rather exploit its implication in terms of return comovements. As trade barriers and capital controls are removed within an economic area, firms' cash flows become more subject to common shocks. *Ceteris paribus* this implies an increase in comovements of firms' returns.

The simple model we consider allows us to adopt an intuitive measure of integration between markets: the higher the amount of return variance explained by the common factor relative to the local components, the higher the degree of integration. We also show that this measure of integration coincides with return correlation.

Return comovements are estimated with the methodology introduced by Cappiello, Gérard and Manganelli (2005). This approach possesses, *inter alia*, two advantages. First, contrary to standard correlation measures, it is robust to time varying volatility and departure from normality. Second, it offers a simple and intuitive visual measure of integration. This methodology provides a long term average of the comovements between any two financial market returns across two distinct sub-periods.

We carry out our analysis on returns on equity market indices and ten-year government bonds. Bekaert, Hodrick and Zhang (2005), Carrieri, Errunza and Sarkissian (2004) and Sontchik (2003), for instance, underline the importance of investigating integration at the industry-level. It is possible that, although integration is found at a country and/or regional level, segmentation can still prevail in some industries. Similarly, it can occur that countries or regions which are (partially) segmented may have sectors that exhibit some degree of integration. For the new EU member states, however, data availability at the industry level is limited, which constrains us to use equity market indices.

For equity markets, the evidence suggests that the degree of integration of the new EU member states with the euro zone has increased in their process towards EU accession. We find that the three new EU member states with the largest economies and most developed financial markets, the Czech Republic, Hungary and Poland, exhibit stronger return comovements both between themselves and with the euro area. For the four smaller countries, Cyprus, Estonia, Latvia and Slovenia, we document a very low degree of integration between themselves. Estonia and to a less extent Cyprus show increased integration both with the euro zone and the block of large accession economies, while Latvia and Slovenia do not. These results indicate that although all these countries have experienced tremendous development in their financial markets, they exhibit different degrees of integration and different speed of convergence with the euro zone.

For the bond markets, reliable data are available only for the three largest accession countries. We find that integration increases only for the Czech Republic versus Germany (which is used as benchmark for the euro area) and Poland.

In a second step, we control for the impact of global factors using a measure of correlation among the major world equity and bond markets. This permits to assess the extent to which the change in the degree of integration of new EU member states amongst themselves and with the Euro area is driven by global factors relative to region specific components. Results show that, although in some cases the global factor significantly increases comovements, region specific components remain an important determinant of integration.

The paper is structured as follows. Section 2 provides a brief literature review that leads us to motivate the use of a particular integration indicator. In section 3, we describe the empirical methodology. Section 4 contains a brief description of the data and main developments in new EU member state equity and bond markets. In section 5 we discuss the empirical results, while the robustness analysis is reported is section 6. Section 7 concludes.

2 Measuring integration

2.1 Background and literature review

Consider first a closed economy with an efficient local financial market. In such an economy, firms' cash flows and equity returns depend on local factors only. Consider, in contrast, a set of fully open economies, without barriers to trade and financial transactions. In such a global environment, local firms' equity returns are a function not only of domestic but also of foreign factors. As a consequence, when a country moves from being closed to an open status, the impact of common factors on domestic firms' cash flows should increase. Therefore the transition to an open economy regime should be accompanied by an increase in comovements in equity prices.

Although the relation between cross-border correlations in equity returns and integration has a long tradition in finance and economics (see, for example, Bekaert and Harvey, 1995, and Ammer and Wei, 1996), there are few theoretical papers that provide a firm foundation for this inference. Dumas, Harvey and Ruiz (2003) calibrate a model of the real side of the economy to the observed industrial production and infer the degree of cross border correlations that real economic linkages would induce in stock returns. The study is carried out under the extreme cases of complete segmentation and perfect integration. The authors show that observed cross-border correlations should be higher under integrated markets than under segmented markets. However the analysis focuses only on developed economies and assumes that real linkages remain unchanged over the sample period. Aydemir (2004) derives a general equilibrium multi-country multi-good model and shows that, for a given level of country and industry shocks, cross-border equity return correlation increases when financial and goods markets become more integrated. However, the paper finds that the impact of financial integration is of an order of magnitude lower than the impact of good market integration.

Against this background, we adopt a simple model which permits us to measure integration and, at the same time, to show that an increase in correlation can be associated to an increase in integration.

2.2 An indicator of integration

In this section we derive a measure of integration.[1] Next we show how the indicator we propose is related to standard correlation measures.

If the researcher is interested in analysing the comovements between markets i and j, it is convenient to express asset returns in a national market, r_{it}, in terms of the following factor model:

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

where β_{ijt} is the exposure at time t to the common factor G_{ijt},[2] and e_{it} the local risk, assumed to be orthogonal to the common factor and to any other asset j local risk. The sufficient set of statistics for the factor model (1) can be summarised as follows: $E(G_{ijt}) = 0 \ \forall t$, $E\left(G_{ijt}^2\right) = \sigma_{G_{ijt}}^2$, $E(e_{it}) = E(e_{jt}) = 0 \ \forall t$, $E\left(e_{it}^2\right) = \sigma_{e_{it}}^2$, $E\left(e_{jt}^2\right) = \sigma_{e_{jt}}^2$, $E(e_{it}, e_{is}) = 0 \ \forall t \neq s$, $E(e_{it}, e_{js}) = 0 \ \forall i \neq j$ and $\forall t$ and s, $E(e_{it}, G_{ijt}) = E(e_{jt}, G_{ijt}) = 0 \ \forall t$.

[1] See Baele *et al.* (2004) and Bekaert *et al.* (2005) for similar indicators.

[2] G_{ijt} includes all the common components specific to markets i and j. Note that different market pairs may have distinct common factors.

It is possible, in principle, to explain the local risk in terms of local systematic factors and idiosyncratic risk, i.e. $e_{it} = \sum_{k=1}^{K} \gamma_{kt}^{i} F_{kt}^{i} + \varepsilon_{it}$. Markets i and j are perfectly integrated if only the loading factor β_{ijt} is different from zero and $\gamma_{kt}^{i} = 0$ for all k. On the other hand, markets would be perfectly segmented if $\beta_{ijt} = 0$ and (some) local systematic risk factors significantly explain returns r_{it}. This intuition is in line with the law of one price, according to which, in a perfectly integrated market, assets with identical cash flow should have the same price. Government bonds represent an interesting case in point. If a market is fully integrated, country factors, once credit and liquidity risks are taken into account, should not be priced and the price of identical sovereign bonds should be entirely determined by common factors. In the case of equities, it is impossible to find two different companies with identical cash flows (as they would reduce essentially to the same firm), and therefore the law of one price is of limited applicability. However, the intuition developed above in terms of factor model still applies. In the broader economic sense discussed earlier, increased integration induces stronger cross-market linkages, increased exposure to common factors and reduced impact of local shocks.

By noting that the variance of country i's returns can be decomposed as $\sigma_{r_{it}}^2 = \beta_{ijt}^2 \sigma_{Gijt}^2 + \sigma_{e_{it}}^2$, the share of volatility explained by the common factor is given by:

$$\phi_{ijt} \equiv \frac{\beta_{ijt} \sigma_{G_{ijt}}}{\sigma_{r_{it}}}. \tag{2}$$

Consistently with this discussion, we adopt the following measure of integration between market i and j:

$$\Phi_{ijt} \equiv \phi_{ijt} \phi_{jit} \tag{3}$$

If markets are perfectly segmented the volatility explained by the common factor is equal to zero and therefore $\Phi_{ijt} = 0$. On the other hand, if markets are perfectly integrated, all the local factor loadings will be equal to zero and most of the variation will come from the common factor, implying a strictly positive Φ_{ijt}.[3] For a given level of idiosyncratic volatility, higher values of Φ_{ijt} imply a higher degree of integration.

It is simple to show that our measure of integration (3) coincides with the linear correlation measure:

$$\begin{aligned} \rho_{ijt} &= \frac{\sigma_{r_i r_j t}}{\sigma_{r_{it}} \sigma_{r_{jt}}} \\ &= \Phi_{ijt}, \quad \forall i \neq j, \end{aligned} \tag{4}$$

[3] We assume that the factor loading coefficients of the common factor are positive. Analogous but opposite conclusion would hold if $sign\left(\beta_{ijt}\right) \neq sign\left(\beta_{jit}\right)$.

where $\sigma_{r_i r_j t} = \beta_{ijt}\beta_{jit}\sigma^2_{G_{ijt}}$. If the fraction of total volatility of market i and j attributable to common global factors increases, the two markets become more integrated, the correlation between returns on an asset in market i and j will increase.

3 The empirical approach

We test for changes in bilateral return codependences using the "comovement box" framework developed by Cappiello, Gérard and Manganelli (2005).

Tests for changes in comovements are usually conducted by correlations estimates. However these tests are sensitive to heteroskedasticity (see, for instance, Forbes and Rigobon, 2002) and departure from normality. Therefore, a simple comparison between correlations over time could lead to spurious results. The comovement box methodology, instead, is robust to time varying volatility and departure from normality.

3.1 The comovement box

We estimate codependence with the comovement box and regression quantile approach introduced by Cappiello, Gérard and Manganelli (2005). In this section we describe the formal framework behind the comovement 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 asset returns 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:

$$p_t(\theta) \equiv \begin{cases} F_t^-\left(q_{\theta t}^{r_i}|q_{\theta t}^{r_j}\right) & \text{if } \theta \leq 0.5 \\ F_t^+\left(q_{\theta t}^{r_i}|q_{\theta t}^{r_j}\right) & \text{if } \theta > 0.5 \end{cases}. \tag{5}$$

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

The characteristics of $p_t(\theta)$ can be conveniently analysed in what we call the comovement box (see Figure 1). The comovement 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_{it} and r_{jt}, 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 $\rho_{ijt} = 0 \; \forall t$, $p_t(\theta)$ 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_{it} and r_{jt} (i.e. $\rho_{ijt} = 1 \; \forall t$), $p_t(\theta)$ 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. $\rho_{ijt} = -1$ $\forall t$. In this case $p_t(\theta)$ is always equal to zero: when the realization of r_{jt} is in the lower tail of its distribution, the realization of r_{it} is always in the upper tail of its own distribution and conversely (for a more analytical description of the model see Cappiello, Gérard and Manganelli, 2005).

This discussion suggests that the shape of $p_t(\theta)$ provides key insights about the dependence between two asset returns r_{it} and r_{jt}. As summarized in Theorem 1 of Cappiello, Gérard and Manganelli (2005), $p_t(\theta)$ satisfies some basic desirable properties: independence, co-monotonicity (of which perfect positive correlation is a special case), and counter-monotonicity (of which perfect negative correlation is a special case). In general, the higher $p_t(\theta)$ the higher the codependence between the two time series returns.

While the conditional probabilities of comovements 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. It is possible to test for changes in integration by evaluating if the conditional probability of comovements between two markets increases, for instance, after institutional changes. In the present application we estimate $p_t(\theta)$ over two different periods. When the conditional probabilities for these two different periods are plotted in the same graph, differences in the intensity of comovements can be identified directly. In particular, an upward (downward) shift of these curves would be consistent with an increase (decrease) of integration.

The framework of the comovement 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* $\xi(0,1) = \int_0^1 [p^A(\theta) - p^B(\theta)] d\theta > 0$.

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

Constructing the comovement box and testing for differences in the probability of comovement requires several steps. First, we estimate the univariate time varying quantiles associated to the return series of interest, using the Conditional Autoregressive Value at Risk (CAViaR) model developed by Engle and Manganelli (2004). Second, we construct, for each series and for each quantile, indicator functions 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 j on the θ-quantile indicator variable of returns on market i, interacted with time dummies which identify periods of greater integration. These regression coefficients will provide a direct estimate of the conditional probabilities of comovements and of their changes across regimes.

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

$$I_t^{r_i r_j}(\hat{\beta}_\theta) = \alpha_\theta^1 + \alpha_\theta^2 D_t^T + \eta_t. \tag{6}$$

where $I_t^{r_i r_j}(\hat{\beta}_\theta) \equiv I\left(r_{it} \leq q_t^{r_i}(\hat{\beta}_{\theta r_i})\right) \cdot I\left(r_{jt} \leq q_t^{r_j}(\hat{\beta}_{\theta r_j})\right)$ for each θ-quantile, for $\theta \in (0,\ 1)$, $q_t^{r_i}(\hat{\beta}_{\theta r_i})$ and $q_t^{r_j}(\hat{\beta}_{\theta r_j})$ denote the estimated quantiles, and D_t^T is the dummy for the test period $t > \tau$.[4]

Cappiello, Gérard and Manganelli (2005) show that the OLS estimators of the above regression are asymptotically consistent estimators of the average conditional probability $p(\theta)$ in the two periods and provide estimators for their standard errors:

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

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

Rigorous joint tests for integration which follow from the Definition 1 can be constructed as follows:

[4] The "hat" denotes estimated coefficients.

$$\begin{aligned}\widehat{\xi}\left(\underline{\theta},\overline{\theta}\right) &= (\#\theta)^{-1}\sum_{\theta\in[\underline{\theta},\bar{\theta}]}[\widehat{p}^{A}(\theta)-\widehat{p}^{B}(\theta)] \\ &\equiv (\#\theta)^{-1}\sum_{\theta\in[\underline{\theta},\bar{\theta}]}\left(\widehat{\alpha}_{\theta}^{1}+\widehat{\alpha}_{\theta}^{2}\right)-\widehat{\alpha}_{\theta}^{1} \\ &= (\#\theta)^{-1}\sum_{\theta\in[\underline{\theta},\bar{\theta}]}\widehat{\alpha}_{\theta}^{2},\end{aligned} \tag{7}$$

where $\#\theta$ denotes the number of addends in the sum (see Cappiello, Gérard and Manganelli (2005) for the asymptotic distribution of this statistic).

4 Data

The empirical analysis is carried out on returns on (i) equity market indices and (ii) ten-year government bonds. All returns are denominated in local currencies. Equity indices include Eurostoxx350, which constitutes our euro area benchmark, and a selected number of new EU member states, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Poland and Slovenia. A world equity index without the euro area markets is also considered for the robustness tests (source: FTSE). As for government bonds, data at daily frequency are available only for the three largest member states, the Czech Republic, Hungary and Poland, as well as for Germany, which is used as benchmark. We use data on Japanese, UK and US government bond markets in our robustness checks.

Stock exchanges for the countries under consideration are approximately open over the same hours during the day, virtually ruling out any non synchronous trading effect. Nevertheless, asynchronicity may arise because there are instances in which markets are closed in one country and open in another, as national holidays and administrative closure do not fully coincide. To adjust for these non-simultaneous closures, we include only the returns for the days on which the markets under analysis were open that day and had been open the day before. Hence the daily returns we investigate are synchronous, avoiding the confounding effects that non synchronous returns can have on the measurement of integration. A similar adjustment is conducted on bond returns.

Equity returns are continuously compounded and computed from Global Financial Data indices, which are market-value-weighted and include dividends. The daily data set starts in 1994 for most countries, except for Estonia, which begins in July 1995, and Latvia, that starts in January 1997. Observations end on November 25th 2005.

Government bond returns are also continuously compounded and computed with the following formula:

$$
\begin{aligned}
r_{bt} &= p_{bt} - p_{bt-1} \\
&= n\left(y_{t-1} - y_t\right),
\end{aligned}
\tag{8}
$$

where r_{bt} denotes the (daily) returns on bonds, p_{bt} the log price of the bond, $p_{bt} \equiv \ln\left(P_{bt}\right)$, y_t the log of the gross yield to maturity, $y_t \equiv \ln\left(1+Y_{bt}\right)$, and n the maturity, which, in our case, is ten year.[5] Yields to maturities are obtained from Global Financial Data. The sample starts at the beginning of 2000, except for the Czech Republic, which begins on October 2000, and for Poland, that starts in September 2001. The data end on November 25th 2005.

4.1 Developments in the equity and bond markets

4.1.1 Equity markets

Equity markets of new EU member states developed along two different lines. The Czech Republic adopted mass privatization schemes, whereas Estonia, Hungary, Latvia, Poland and Slovenia first established a legal framework for trading and next listed the enterprises. By and large, the second approach gave a better outcome, as the first one resulted in a loss of confidence caused by the delisting of unsuccessful companies (see Caviglia, Krause and Thimann, 2002).

The importance of the stock exchanges can be measured by the market capitalization as a percentage of GDP. At the end of 2001, Central European countries and Estonia had a stock market capitalization equal to 20-30% of GDP, whereas Cyprus about 70%, and the remaining countries less than 10%. With the exception of Cyprus, these percentages are well below the euro area levels: for instance, at the end of 2001 the stock market capitalization for Germany was approximately equal to 60% of its GDP. In our sample, the three largest stock markets are Poland, the Czech Republic and Hungary. Their stock market capitalization approximately reflects their GDP weight in the region.

Descriptive statistics are reported in Table 1. Panel A, Table 1, shows the overall summary statistics for individual equity returns. There is strong evidence of skewness and excess kurtosis, a clear sign of non-normality. This is confirmed by the Jarque-Bera normality test. The sample size differs among markets: after adjusting for closing days, there are a maximum of 3047 and a minimum of 2344 return observations for Eurostoxx and Latvia, respectively.

Panels B-D, Table 1, report pair-wise correlations over three different samples: the full sample, the period up to end 1999, and the period after beginning 2000. For

[5] Yields are constructed to keep maturity constant at each observation.

each pair, we report sample correlations in the first line and bivariate sample size in the second line. For example, over the whole period, there are 2553 days for which both the Polish and the Czech equity markets were open simultaneously, and neither was closed on the previous day. Bivariate sample sizes vary from a maximum of 2823 for Eurostoxx and Hungary to a minimum of 1948 for Latvia and Cyprus. Panels C and D show that average correlations have increased between all markets and in particular between large new EU member states.[6]

4.1.2 Bond markets

For the new EU member states bond markets started later than stock exchanges. This might be due to the low level of inherited debt and the sound fiscal policy stance during the post communist period (see, for example, Caviglia, Krause and Thimann, 2002). We only focus on those countries where sufficiently long and reliable data on a secondary bond market exist, namely the Czech Republic, Hungary and Poland.

Panel A, Table 2, reports descriptive sample statistics for bond returns. Returns on bonds appear to be skewed and leptokurtic at 1% significance level. The Jarque-Bera test statistic confirms that data are not normal. Similarly to equity returns, the sample size differs among markets, ranging from 1079 (Poland) to 1498 observations (Germany).

Panels B-D, Table 2, report pair-wise correlations over three different samples: the full sample, the period up to end 2002, and the period after beginning 2003. For each pair, we report sample correlations in the first line and bivariate sample size in the second line. For example, over the whole period, there are 936 days for which both the Polish and Czech equity markets were open simultaneously, and neither was closed on the previous day. Bivariate sample sizes vary from a minimum of 901 for Hungary and Poland to a maximum of 1177 for Germany and Hungary. Panels C and D show that average correlations have increased between all markets, similarly to equity markets.

[6] Average correlations are computed by weighting the correlation of each market pair with the fraction of the GDP pair relative to the total GDP of the relevant group, i.e. $w_{ij} = (w_i + w_j) \Big/ \left[\sum_{k=1}^{N} \sum_{l>k}^{N} (w_k + w_l)\right]$, where $w_i = GDP_i \Big/ \sum_{k=1}^{N} GDP_k$.

5 Empirical Results

5.1 Comovements measures

We estimate the time-varying quantiles of the returns, r_{it}, using the following CAViaR specification:

$$q_t^{r_i}(\beta_\theta) = \beta_{\theta 0} + \beta_{\theta 1} D_t^T + \beta_{\theta 2} r_{it-1} + \beta_{\theta 3} q_{t-1}^{r_i}(\beta_\theta) - \beta_{\theta 2}\beta_{\theta 3} r_{it-2} + \beta_{\theta 4} |r_{it-1}| . \quad (9)$$

This parametrization is robust to presence of autocorrelation in our sample returns. Model (9) would be correctly specified if the true DGP were as follows:

$$r_{it} = \gamma_0 + \gamma_1 r_{it-1} + \varepsilon_{it} \qquad \varepsilon_{it} \sim i.i.d.\left(0, \sigma_{it}^2\right), \quad (10)$$

$$\sigma_{it} = \alpha_0 + \alpha_1 |r_{it-1}| + \alpha_2 \sigma_{it-1}.$$

We add the dummy variable D_t^T to the CAViaR specification to ensure that we have exactly the same proportion of quantile exceedences in both sub-periods. This will guarantee that $\Pr\left(r_{it} \leq q_t^{r_i}\left(\beta_{\theta r_i}^0\right) | r_{jt} \leq q_t^{r_j}\left(\beta_{\theta r_j}^0\right)\right) = \Pr\left(r_{jt} \leq q_t^{r_j}\left(\beta_{\theta r_j}^0\right) | r_{it} \leq q_t^{r_i}\left(\beta_{\theta r_i}^0\right)\right)$ will be satisfied.[7] For each market we estimate model (9) for 19 quantile probabilities ranging from 5% to 95%.

We compute the probabilities of comovements over two sample periods. For equities we distinguish between a pre-convergence (before December 1999) and a convergence period (after January 2000). For bonds, instead, due to lack of data, we analyse shorter sub-samples: the first covers the period from September 2001 to December 2002, while the second the period from January 2003 to November 2005. An increase in integration in the second period would be reflected by an upward shift in the probability of comovements.

5.1.1 Equity markets

Figure 2 shows the GDP-weighted averages of the estimated comovement probabilities between new EU member states and Eurostoxx over the two sub-samples under consideration. In figure 2a, which plots the probability averages relative to all countries, we observe an increase in the probability of comovements during the convergence period. This is consistent with an increase in the degree of integration. Before 2000 these economies showed weaker comovements *vis-à-vis* the euro area, probably due to the transition towards market economy in the aftermath of the collapse of the

[7] Asymptotically, correct specification would imply the same number of exceedances in both periods. However, in finite samples, this need not to be the case. Failure to account for this fact would affect the estimation of the conditional probabilities.

communist system. These markets were relatively new and had weak economic and financial ties with Western Europe.

Figures 2b and 2c present the breakdown of these average comovements by the economic size of the new member states. Most of the increase in comovements is driven by the large new member states (the Czech Republic, Hungary, and Poland), which, in 1999, made 86% of the total GDP in the region. Small new member states, instead, were almost independent before 1999 and exhibited a limited increase in comovements afterwards, mainly driven by Estonia and Cyprus. This could be explained by institutional factors, the sheer size of the economy, the geographical distance, the real convergence process, and weak economic linkages with the euro zone. These results are broadly confirmed by the market-pair analyses reported in figure 3, which includes 95% confidence bands. Notice that figure 3c shows that the increase in comovements between euro area and Hungary is not statistically significant. This may be due to the fact that Hungary, differently from the Czech Republic and Poland, started from a relatively higher level of integration before 1999.

Qualitatively similar conclusions can be inferred from Figure 4, where we analyse the probabilities of comovements among new member states. Figure 4a is supportive of an overall increase in the degree of integration. As before, most of it is due to the increase in comovements of large new member states (Figure 4b), while small countries remain virtually independent (Figure 4c). The probabilities of comovements before and during the convergence period for the large countries are higher than the corresponding probabilities which we observe when comparing Eurostoxx versus large new EU member states (see Figure 2b). The relatively high probabilities of comovements during the pre-convergence period may be explained by economic linkages which go back to the communist era. Market pair analyses once again confirm this outcome (see Figures 5a-5u). Particularly striking are the cases of Poland-Czech Republic, Hungary-Poland and Czech Republic-Hungary (Figures 5a, 5b, and 5g, respectively), which suggest that these economies are highly integrated. The fact that small countries are less (or not at all) integrated among themselves is not surprising. As discussed before, institutional factors, the size of the economies, geographical distance and feeble economic linkages are likely to be the main culprits. Among small member states only Estonia exhibits increased linkages with the largest economies.[8]

Tables 3 and 4 present statistics that summarize the content of the comovement boxes. Table 3 shows for each market pair the average probabilities of comovements over the lower, upper and all quantile ranges before and after December 1999. Table 4 reports formal tests for the difference in these probabilities (see formula 7).

[8]The presence of a currency board in Estonia may be responsible for its relatively higher level of integration.

An additional stylised fact that emerges from these tables is the presence of relevant asymmetries between the left and right parts of the distribution. This is most evident for the large new member states. Comovements are more pronounced in the left part than in the right quantiles ranges. This is in line with previous literature, which finds stronger comovements in down markets (see, for instance, Longin and Solnik, 2001, Cappiello, Engle and Sheppard, 2003, and Hartmann, Straetmans and de Vries, 2004).

5.1.2 Bond markets

As for bond returns, the analysis of comovements only concerns the three largest countries in the region, the Czech Republic, Hungary and Poland. The sample is divided in two sub-periods: the first spans from October 2000[9] until December 2002, and the second from January 2003 until January 2005. Figure 6 represents GDP-weighted average probability of comovements between the new member states and Germany, which is commonly used as benchmark for the euro area. Figures 7a-7c plot estimated probabilities of comovements and the related 95% confidence bands for large new EU member states *vis-à-vis* Germany. Similarly to Reininger and Walko (2005), we find that while the Czech Republic exhibits a significant probability increase in the second period, the remaining two countries do not. Several reasons could explain these results, like, for instance, the proportion of bond holding by foreign investors as well as the smoothness in the nominal convergence process. The share of security holdings by foreign investors also supports the findings of a higher degree of integration in equity than bond markets. At the end of 2004, in the three largest new EU member states, foreign investors held between 10% and 30% of the outstanding government debt. Conversely, in Hungary, for instance, at the end of 2004 foreign investors held nearly 80% of quoted equity shares (see Reininger and Walko, 2005). Moreover, whereas real convergence to the euro zone (which is mainly reflected in equity markets) has been relatively smooth in the new EU member states, reversals in nominal convergence and exchange rate pressures may have hindered the degree of bond return comovements with the euro area.

Figure 8 plots the average probabilities of comovements among the three new member states of the analysis. Figures 9a-9c show estimated probabilities for new EU member states country pairs: only the pair Czech Republic-Poland presents some increase in the probability of comovements.

[9] In fact for Germany and Czech Republic the sample starts in October 2000, whereas for Hungary and Poland in September 2001.

Summary statistics of these pictures can be found in Table 5. Table 6 reports tests of significance for differences in comovements across sub-periods.

6 Influence of a global factor

In the factor model described by equation (1) returns on a national market asset are a function of a common and, possibly, country-specific factors. In principle the common factor can be divided in two distinct components: (i) a regional and (ii) a world factor. This decomposition permits to evaluate the progress in integration which, on the one hand, is due to the process towards accession, and that which, on the other hand, is driven by global factors. Under this assumption equation (1) can be written as:

$$r_{it} = \beta^R_{ijt} G^R_{ijt} + \beta^W_{it} G^W_t + \eta_{it}, \quad \forall i \text{ and } j, \tag{11}$$

where β^R_{ijt} and β^W_{it} represent the exposure at time t to the regional and world factors G^R_{ijt} and G^W_t, respectively, and η_{it} the idiosyncratic risk, which is assumed to be orthogonal to both G^R_{ijt} and G^W_t, as well as to any other asset j idiosyncratic risk. The sufficient set of statistics for the two factor model (11) can be summarised as follows: $E\left(G^R_{ijt}\right) = 0\ \forall t$, $E\left[\left(G^R_{ijt}\right)^2\right] = \sigma^2_{G^R_{ijt}}$, $E\left(G^W_t\right) = 0\ \forall t$, $E\left[\left(G^W_t\right)^2\right] = \sigma^2_{G^W_t}$, $E\left(\eta_{it}\right) = E\left(\eta_{jt}\right) = 0\ \forall t$, $E\left(\eta^2_{it}\right) = \sigma^2_{\eta_{it}}$, $E\left(\eta^2_{jt}\right) = \sigma^2_{\eta_{jt}}$, $E\left(\eta_{it}, \eta_{is}\right) = 0\ \forall t \neq s$, $E\left(\eta_{it}, \eta_{js}\right) = 0\ \forall i \neq j$ and $\forall t$ and s, $E\left(\eta_{it}, G^R_{ijt}\right) = E\left(\eta_{jt}, G^R_{ijt}\right) = 0$ as well as $E\left(\eta_{it}, G^W_t\right) = E\left(\eta_{jt}, G^W_t\right) = 0\ \forall t$, and finally $E\left(G^R_{ijt}, G^W_t\right) = 0$.

Following the reasoning of section 2.2, we can define the share of volatility explained by the regional and global factor as

$$\phi^R_{ijt} \equiv \frac{\beta^R_{ijt} \sigma_{G^R_{ijt}}}{\sigma_{r_{it}}}, \tag{12}$$

and

$$\phi^W_{it} \equiv \frac{\beta^W_{it} \sigma_{G^W_t}}{\sigma_{r_{it}}}. \tag{13}$$

In this case integration between markets i and j explained by regional factors is measured by:

$$\Phi^R_{ijt} \equiv \phi^R_{ijt} \phi^R_{jit}, \tag{14}$$

and, analogously, the share of integration due to the global factor is given by:

$$\Phi^W_{ijt} \equiv \phi^W_{it} \phi^W_{jt}. \tag{15}$$

The linear correlation measure is now equal to the sum of (14) and (15):

$$\rho_{ijt} = \Phi^{R}_{ijt} + \Phi^{W}_{ijt}. \tag{16}$$

In the next subsection we describe how we take into account global factors in the context of the comovement box methodology.

6.1 The comovement box with a global factor

The comovement box methodology discussed in section 3.1 can include, in addition to the temporal dummy D^T_t, other dummies. While the coefficient associated with the temporal dummy indicates whether comovements between two asset returns change after a certain time, other dummies may accommodate the impact on codependences due to other factors. We introduce a new dummy, D^C_t, which controls for global factors that may also be responsible for changes in integration. We take as a control variable the correlation between average returns on the equities' market pair under study and on a world equity market index excluding the euro area.[10] We compute correlations as an Exponentially Weighted Moving Average (EWMA) with decay coefficient equal to 0.94. Next we construct D^C_t so that it takes on value one when the underlying correlation variable is larger than a certain threshold ρ^* and zero otherwise, i.e. $D^C_t \equiv I\left(\rho^{EWMA}_t > \rho^*\right)$. ρ^* is chosen so that the two dummies D^T_t and D^C_t have the same number of ones.[11] In this way we can control how much of the change in correlation over the accession period is due to the global correlation factor.

When the D^C_t dummy is introduced, equation (6) reads as follows:

$$I^{r_i r_j}_t(\hat{\beta}_\theta) = a^1_\theta + a^2_\theta D^T_t + a^3_\theta D^C_t + \zeta_t. \tag{17}$$

We analyse four cases: (i) the comovements over the benchmark period when the global factor correlation is low, $p^{BL}(\theta)$; (ii) the comovements over the test period when the global factor correlation is low, $p^{AL}(\theta)$; (iii) the comovements over the benchmark period when the global factor correlation is high, $p^{BH}(\theta)$; and (iv) the comovements over the test period when the global factor correlation is high, $p^{AH}(\theta)$. It

[10] Since our interest lies in the evolution over time of correlations, we use simple averages of the assets' returns which will next provide the time series to calculate EWMA correlations. When we analyse the bond markets, we compute time varying correlations between average returns on government bonds' country pair, on the one hand, and average returns on Japan, UK and US government bonds, on the other hand.

[11] If the number of times D^C_t is equal to one were quite limited (and signficantly smaller than the number of times D^T_t is equal to one), the control dummy would not possess sufficient explanatory power.

can be shown that OLS estimators of the equation (17) enjoy the following asymptotic properties:

$$\begin{aligned}
\widehat{a}_\theta^1 \xrightarrow{p} E[p_t(\theta)|\text{ period } B \text{ and low global correlation}] &\equiv p^{BL}(\theta), \\
\widehat{a}_\theta^1 + \widehat{a}_\theta^2 \xrightarrow{p} E[p_t(\theta)|\text{ period } A \text{ and low global correlation}] &\equiv p^{AL}(\theta), \\
\widehat{a}_\theta^1 + \widehat{a}_\theta^3 \xrightarrow{p} E[p_t(\theta)|\text{ period } B \text{ and high global correlation}] &\equiv p^{BH}(\theta), \quad (18) \\
\widehat{a}_\theta^1 + \widehat{a}_\theta^2 + \widehat{a}_\theta^3 \xrightarrow{p} E[p_t(\theta)|\text{ period } A \text{ and high global correlation}] &\equiv p^{AH}(\theta).
\end{aligned}$$

Standard errors for the estimated parameters can be computed as suggested by Cappiello, Gérard and Manganelli (2005). Similarly to the case when the dummy D_t^C was not included, we are interested in testing whether $\widehat{a}_\theta^2$ is significantly different from zero. When this occurs, integration between returns on assets' market pair can be attributed also to region-specific factors. Tests for region-specific integration are constructed in line with equation (7):

$$\begin{aligned}
\widehat{\delta}\left(\underline{\theta}, \overline{\theta}\right) &= (\#\theta)^{-1} \sum_{\theta \in [\underline{\theta}, \bar{\theta}]} [\widehat{p}^{AL}(\theta) - \widehat{p}^{BL}(\theta)] \quad (7') \\
&= (\#\theta)^{-1} \sum_{\theta \in [\underline{\theta}, \bar{\theta}]} [\widehat{p}^{AH}(\theta) - \widehat{p}^{BH}(\theta)] \\
&= (\#\theta)^{-1} \sum_{\theta \in [\underline{\theta}, \bar{\theta}]} \widehat{\alpha}_\theta^2,
\end{aligned}$$

By the same token, it is possible to compute joint tests for the control variable:

$$\begin{aligned}
\widehat{\psi}\left(\underline{\theta}, \overline{\theta}\right) &= (\#\theta)^{-1} \sum_{\theta \in [\underline{\theta}, \bar{\theta}]} [\widehat{p}^{BH}(\theta) - \widehat{p}^{BL}(\theta)] \quad (19) \\
&= (\#\theta)^{-1} \sum_{\theta \in [\underline{\theta}, \bar{\theta}]} [\widehat{p}^{AH}(\theta) - \widehat{p}^{AL}(\theta)] \\
&= (\#\theta)^{-1} \sum_{\theta \in [\underline{\theta}, \bar{\theta}]} \widehat{\alpha}_\theta^3,
\end{aligned}$$

where $\#\theta$ denotes the number of addends in the sum.

Returns' conditional quantiles are estimated employing a CAViaR specification similar to that of equation (9), but with the inclusion of the new dummy D_t^C:

$$q_t^{r_i}(\beta_\theta) = \beta_{\theta 0} + \beta_{\theta 1} D_t^T + \beta_{\theta 2} D_t^C + \beta_{\theta 3} q_{t-1}^{r_i}(\beta_\theta) + \beta_{\theta 4} r_{it-1} - \beta_{\theta 4}\beta_{\theta 3} r_{it-2} + \beta_{\theta 5} \left| r_{it-1} \right|. \quad (20)$$

6.2 Results

6.2.1 Equity markets

Table 7 summarises the estimates for average probability of comovements when controlling for the global factor. Similarly to previous tables, we compute estimates for the left and right parts of the distribution (tables 7a and 7b, respectively) as well as for the whole quantile range (table 7c). Within each table, we report estimates of the dummy coefficients relative to equation (17) corresponding to the four possible combinations described in (18). We observe an overall increase in comovements associated to the time and global dummies, which is more pronounced for the large new member states.

Tables 8a-8c report tests of significance for the dummies, with a breakdown analogous to tables 7a-7c. The results show that the time dummy is always significant for the large new member states between themselves and *vis-à-vis* the euro area, with the notable exception of the couple euro area-Hungary. The global factor, instead, turns out to be significant only among the largest new member states. As for the small new member states, both the time and global dummies are almost always not significant. The exceptions regard Estonia and Cyprus, whose linkages with the euro area increased after January 2000.[12]

Figures 10-12 illustrate three representative market pairs, euro area-Poland, euro area-Hungary and Czech Republic-Poland.[13] Each figure has three parts, reporting all the possible combinations for the probabilities and relative standard errors associated to the time and global dummies. Consistently with the test statistics discussed before, we observe that there is no increase in comovements for the couple euro area-Hungary, while the opposite is true for the pairs euro area-Poland and Czech Republic-Poland.

Overall, the results confirm the findings of section 5, and suggest that the increase in comovements involving large new member states cannot be (entirely) explained by increased global correlations.

6.2.2 Bond markets

Results for bond markets when controlling for the global factor are summarised in tables 9 and 10. The structure of these tables is identical to that of tables 7 and 8 relative to equity markets (see section 6.2.1).

The results are perfectly in line with the findings when only the time dummy is included (section 5.1.2). Comovement increases are statistically significant only for

[12] In fact Cyprus exhibits increased comovements also with Hungary, while Estonia with Czech Republic.

[13] Figures relative to the remaining couples are available from the authors upon request.

the couples Germany-Czech Republic and Czech Republic-Poland. This increase in comevement cannot be explained by the global dummy.

Figures 13-14 provide a visual illustration of comovements for the couples Germany-Czech Republic and Czech Republic-Poland. The graphical analysis is consistent with the test statistics of table 10.

7 Summary of results and conclusions

In this paper we evaluate the degree of integration between a selected number of new EU member states and with the euro zone. The analysis is conducted on returns on equity market indices and ten-year government bonds. As for equity markets, evidence suggests that the degree of integration between the new EU member states and with the euro area has increased in their process towards EU accession. A more refined investigation, however, indicates the existence of closer links between the three largest new member states, the Czech Republic, Hungary and Poland. Among the four smaller countries, Cyprus, Estonia, Latvia and Slovenia, we find a very low degree of integration between themselves. However, Estonia and to a less extent Cyprus show increased integration both with the euro zone and the block of large economies. Institutional factors, the sheer size of the economy, geographical distance and weak economic linkages with the euro area could be responsible for these results. Although all the considered countries have experienced tremendous development in their stock markets, their degrees of integration and speed of convergence with the euro zone differ quite markedly. As for the bond markets, we observe that the Czech Republic exhibits signs of increased comovements *vis-à-vis* Germany (our bond market benchmark for the euro area) and Poland.

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Table 1: Descriptive statistics of returns on equity market indices

This table reports summary statistics relative to daily returns on nine equity market indices. The equity indices refer to the Eurostoxx350 (EA), Poland (PL), the Czech Republic (CZ), Hungary (HU), Estonia (EE), Latvia (LV), Cyprus (CY), Slovenia (SI), and a world equity index which excludes the euro area (WexEA). The daily data set starts in 1994 for most countries, except for Estonia, which begins in July 1995, and Latvia, that starts in January 1997. Observations end on November 25th 2005. Equity market indices are from Global Financial Data, except for WexEA which is from FTSE. For each return series, Mean and Standard Deviation (SD) are annualized and in percentage. "Max" and "Min" represent the daily maximum and minimum returns and are in percentage. "Skew" and "Kurt" stand for skewness and Kurtosis, respectively, while "Obs" is the total number of observations. The Jarque-Bera (J-B) test for normality combines excess skewness and kurtosis and is asymptotically distributed as χ^2_m with $m = 2$ degrees of freedom. The acronyms "NEUMS", "LNEUMS", and "SNEUMS" refer, respectively, to all the seven, the three largest (Poland, the Czech Republic and Hungary) and the four smallest (Estonia, Latvia, Cyprus and Slovenia) new EU member states. * denote significance at 1% confidence level. Panel A reports summary statistics, while Panels B, C and D report pairwise correlations over three different samples: the full sample, the period up to end 1999, and the period after beginnig 2000. For each pair, we report sample correlations in the first line and bivariate sample size in the second line.

Panel A: Summary statistics

	Mean	Median	Max	Min	SD	Skew	Kurt	J-B	Starting date	Obs
EA	8.95	0.09	6.15	-6.60	19.34	-0.20	6.33	1429*	04/01/94	3047
PL	11.41	0.05	8.59	-14.47	26.54	-0.29	8.14	3113*	04/1094	2787
CZ	5.99	0.04	5.82	-7.08	19.12	-0.23	5.16	562*	20/09/94	2761
HU	22.15	0.02	13.25	-17.94	26.86	-0.74	16.07	22391*	04/01/94	3106
EE	28.95	0.11	12.87	-21.58	30.15	-0.97	21.77	39183*	04/07/95	2642
LV	8.89	0.00	13.36	-10.31	23.22	0.46	12.65	9173*	15/01/97	2344
CY	6.09	0.00	23.68	-10.08	24.70	1.88	33.48	11206*	09/03/94	2851
SI	11.55	0.04	18.93	-11.61	19.15	0.80	36.33	12924*	04/10/94	2786
WexEA	7.53	0.05	4.42	-5.24	12.99	-0.20	6.33	1457*	04/01/94	3106

Table 1 - Continued

Panel B: Unconditional correlations - Overall sample period

	PL	CZ	HU	EE	LV	CY	SI
EA	0.31 2678	0.40 2646	0.42 2823	0.15 2547	0.00 2121	0.11 2572	0.04 2671
PL		0.32 2553	0.38 2702	0.18 2472	0.05 2060	0.05 2483	0.05 2624
CZ			0.40 2672	0.15 2440	0.07 2046	0.08 2462	0.05 2556
HU				0.16 2585	0.03 2149	0.06 2606	0.08 2704
EE					0.11 2109	0.05 2350	0.06 2467
LV						0.03 1948	0.06 2067
CY							0.02 2482

Average correlations

	EA	NEUMS	LNEUMS	SNEUMS
NEUMS	0.20	0.16		
LNEUMS	0.37		0.36	0.08
SNEUMS	0.07			0.05

Table 1 - Continued

Panel C: Unconditional correlations - Sample period: from the starting date up to December 31 1999

	PL	CZ	HU	EE	LV	CY	SI
EA	0.27 1259	0.37 1242	0.44 1351	0.13 1103	-0.04 716	-0.01 1198	0.07 1265
PL		0.27 1190	0.35 1266	0.16 1064	0.07 693	0.02 1136	0.04 1233
CZ			0.34 1252	0.10 1053	0.05 693	0.04 1130	0.06 1197
HU				0.15 1115	0.03 723	-0.02 1211	0.09 1275
EE					0.12 707	0.02 985	0.058 1069
LV						0.04 628	0.06 707
CY							0.02 1143

Average correlations

	EA	NEUMS	LNEUMS	SNEUMS
NEUMS	0.18	0.14		
LNEUMS	0.36		0.31	0.07
SNEUMS	0.04			0.05

Table 1 - Continued

Panel D: Unconditional correlations - Sample period: January 1 2000 - November 25 2005

	PL	CZ	HU	EE	LV	CY	SI
EA	0.39 1419	0.42 1404	0.43 1472	0.23 1444	0.04 1405	0.17 1374	0.03 1406
PL		0.42 1363	0.44 1434	0.25 1408	0.03 1367	0.10 1347	0.06 1391
CZ			0.50 1420	0.26 1387	0.09 1353	0.12 1332	0.06 1359
HU				0.21 1470	0.03 1426	0.15 1395	0.06 1429
EE					0.09 1402	0.12 1365	0.05 1398
LV						0.03 1320	0.06 1360
CY							0.03 1339

Average correlations

	EA	NEUMS	LNEUMS	SNEUMS
NEUMS	0.24	0.21		
LNEUMS	0.41		0.44	0.11
SNEUMS	0.12			0.06

Table 2: Descriptive statistics of returns on 10-year government bonds

This table reports summary statistics relative to daily returns on 10-year government bonds for the three largest new EU member states, the Czech Republic (CZ), Hungary (HU) and Poland (PL) as well as Germany (DE), UK, USA and Japan (JP). The daily data set starts at the beginning of 2000, except for the Czech Republic, which begins on October 2000, and for Poland, that starts in September 2001. The data end on November 25th 2005. Yields to maturities are obtained from Global Financial Data. For each return series, Mean and Standard Deviation (SD) are annualized and in percentage. "Max" and "Min" represent the daily maximum and minimum returns and are in percentage. "Skew" and "Kurt" stand for skewness and Kurtosis, respectively, while "Obs" is the total number of observations. The Jarque-Bera (J-B) test for normality combines excess skewness and kurtosis and is asymptotically distributed as χ^2_m with $m = 2$ degrees of freedom. The acronyms "NEUMS", "LNEUMS", and "SNEUMS" refer, respectively, to all the seven, the three largest (Poland, the Czech Republic and Hungary) and the four smallest (Estonia, Latvia, Cyprus and Slovenia) new EU member states. * denote significance at 1% confidence level. Panel A reports summary statistics, while Panels B, C and D report pairwise correlations over three different samples: the full sample, the period up to end 2002, and the period after beginnig 2003. For each pair, we report sample correlations in the first line and bivariate sample size in the second line.

Panel A: Summary statistics

	Mean	Median	Max	Min	SD	Skew	Kurt	J-B	Starting date	Obs
DE	3.30	0.00	1.25	-1.82	5.97	-0.37	4.27	135*	04/01/00	1498
PL	14.01	0.04	4.08	-4.07	11.25	-0.06	7.54	925*	14/09/01	1079
CZ	6.39	0.00	2.56	-2.01	7.30	0.01	5.92	464*	03/10/00	1306
HU	2.27	0.00	0.08	-0.07	13.63	-0.34	18.14	11594*	03/01/01	1211
USA	3.48	0.00	2.58	-2.40	9.28	-0.33	4.49	163*	04/01/00	1475
UK	2.10	0.00	2.11	-1.70	6.90	-0.11	4.36	116*	04/01/00	1475
JP	0.40	0.00	1.58	-2.18	4.91	-0.66	8.38	1883*	04/01/00	1475

Panel B: Unconditional correlations - Overall sample period

	PL	CZ	HU
DE	0.19 964	0.41 1173	0.06 1177
PL		0.22 936	0.25 901
CZ			0.09 1049

	DE	LNEUMS
LNEUMS	0.22	0.21

Panel C: Unconditional correlations - Sample period: from the starting date until December 31 2002

	PL	CZ	HU
DE	0.07 292	0.31 524	0.09 424
PL		0.10 298	0.12 253
CZ			0.09 420

	DE	LNEUMS
LNEUMS	0.16	0.11

Panel D: Unconditional correlations - Sample period: January 1 2003 - November 25 2005

	PL	CZ	HU
DE	0.26 672	0.55 649	0.05 653
PL		0.31 648	0.32 648
CZ			0.10 629

	DE	LNEUMS
LNEUMS	0.29	0.27

Table 3: Average probabilities of comovements for returns on equity market indices

This table reports for each country pair two average probabilities of comovements: (i) the comovements over the pre-convergence period, $p^B(\theta)$; and (ii) the comovements over the convergence period, $p^A(\theta)$. 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 pre-convergence period runs from the beginning of the sample to December 1999, while the convergence period from January 2000 to November 2005. The equity indices refer to the Eurostoxx350 (EA), Poland (PL), the Czech Republic (CZ), Hungary (HU), Estonia (EE), Latvia (LV), Cyprus (CY) and Slovenia (SI).

Panel A: average probabilities across the lower quantile ranges

$\theta \in$ [0.05 , 0.50]								
		PL	**CZ**	**HU**	**EE**	**LV**	**CY**	**SI**
$p^B(\theta)$	**EA**	0.36	0.41	0.43	0.30	0.29	0.28	0.29
	PL		0.35	0.38	0.34	0.31	0.28	0.29
	CZ			0.39	0.30	0.27	0.28	0.32
	HU				0.33	0.26	0.27	0.31
	EE					0.33	0.30	0.32
	LV						0.26	0.30
	CY							0.28
$p^A(\theta)$	**EA**	0.47	0.46	0.45	0.37	0.28	0.34	0.30
	PL		0.47	0.48	0.37	0.30	0.32	0.32
	CZ			0.48	0.38	0.31	0.30	0.29
	HU				0.37	0.31	0.32	0.29
	EE					0.32	0.34	0.30
	LV						0.29	0.29
	CY							0.30

Table 3 - Continued

Panel B: average probabilities across the upper quantile ranges

$\theta \in [0.55, 0.95]$								
		PL	CZ	HU	EE	LV	CY	SI
$p^B(\theta)$	EA	0.32	0.32	0.37	0.30	0.23	0.23	0.26
	PL		0.33	0.35	0.26	0.26	0.27	0.26
	CZ			0.34	0.28	0.26	0.26	0.26
	HU				0.30	0.29	0.25	0.27
	EE					0.28	0.25	0.28
	LV						0.24	0.26
	CY							0.27
$p^A(\theta)$	EA	0.39	0.41	0.40	0.35	0.24	0.31	0.27
	PL		0.41	0.44	0.33	0.26	0.28	0.27
	CZ			0.43	0.34	0.27	0.30	0.29
	HU				0.33	0.27	0.31	0.28
	EE					0.27	0.28	0.29
	LV						0.27	0.28
	CY							0.25

Table 3 - Continued

Panel C: average probabilities across the all quantile ranges

θ ∈ [0.05 , 0.95]								
		PL	**CZ**	**HU**	**EE**	**LV**	**CY**	**SI**
$p^B(\theta)$	**EA**	0.34	0.37	0.40	0.30	0.26	0.25	0.28
	PL		0.34	0.37	0.30	0.28	0.28	0.28
	CZ			0.37	0.29	0.26	0.27	0.29
	HU				0.31	0.27	0.26	0.29
	EE					0.31	0.27	0.30
	LV						0.25	0.28
	CY							0.27
$p^A(\theta)$	**EA**	0.43	0.44	0.43	0.36	0.26	0.33	0.28
	PL		0.44	0.46	0.35	0.28	0.30	0.30
	CZ			0.45	0.36	0.29	0.30	0.29
	HU				0.35	0.29	0.32	0.29
	EE					0.29	0.31	0.29
	LV						0.28	0.29
	CY							0.28

Table 4: Tests for differences in probabilities of comovements for returns on equity market indices

This table reports statistics to test whether the average probabilities of comovements between a given market 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-convergence period (beginning of sample to December 1999), while the second sub-sample covers the convergence period (January 2000 to October 2005). Standard errors are reported in italics and significant statistics in bold. * and ** denote 5% and 10% significance level, respectively. The equity indices refer to the Eurostoxx350 (EA), Poland (PL), the Czech Republic (CZ), Hungary (HU), Estonia (EE), Latvia (LV), Cyprus (CY) and Slovenia (SI).

Panel A: average probabilities across the lower quantile ranges

$\theta \in$ [0.05 , 0.50]							
	PL	**CZ**	**HU**	**EE**	**LV**	**CY**	**SI**
EA	**0.11*** *0.03*	**0.06*** *0.03*	0.03 *0.03*	**0.07*** *0.03*	-0.00 *0.03*	**0.07*** *0.02*	0.01 *0.02*
PL		**0.11*** *0.03*	**0.10*** *0.03*	0.04 *0.03*	-0.01 *0.03*	**0.04*** *0.02*	0.02 *0.02*
CZ			**0.08*** *0.03*	**0.08*** *0.03*	0.04 *0.03*	0.02 *0.02*	-0.03 *0.02*
HU				0.04 *0.03*	**0.05** *0.03*	**0.05*** *0.02*	-0.02 *0.02*
EE					-0.02 *0.03*	0.04 *0.03*	-0.02 *0.03*
LV						0.03 *0.03*	-0.01 *0.03*
CY							0.02 *0.02*

Table 4 - Continued

Panel B: average probabilities across the upper quantile ranges

θ ∈ [0.55 , 0.95]							
	PL	**CZ**	**HU**	**EE**	**LV**	**CY**	**SI**
EA	**0.07*** *0.03*	**0.09*** *0.03*	0.03 *0.03*	**0.05*** *0.03*	0.01 *0.03*	**0.08*** *0.02*	0.00 *0.02*
PL		**0.08*** *0.03*	**0.09*** *0.03*	**0.07*** *0.03*	-0.00 *0.03*	0.01 *0.02*	0.02 *0.02*
CZ			**0.08*** *0.03*	**0.06*** *0.03*	0.02 *0.03*	**0.04**** *0.03*	0.04 *0.02*
HU				0.03 *0.03*	-0.02 *0.03*	**0.07*** *0.02*	0.01 *0.02*
EE					-0.01 *0.03*	0.03 *0.02*	0.01 *0.03*
LV						0.03 *0.03*	0.02 *0.03*
CY							-0.01 *0.02*

Panel C: average probabilities across the all quantile ranges

θ ∈ [0.05 , 0.95]							
	PL	**CZ**	**HU**	**EE**	**LV**	**CY**	**SI**
EA	**0.09*** *0.03*	**0.07*** *0.03*	0.03 *0.03*	**0.06*** *0.03*	0.00 *0.03*	**0.07*** *0.02*	0.00 *0.02*
PL		**0.10*** *0.03*	**0.09*** *0.03*	**0.05**** *0.03*	-0.00 *0.03*	0.02 *0.02*	0.02 *0.02*
CZ			**0.08*** *0.03*	**0.07*** *0.03*	0.03 *0.03*	0.03 *0.02*	0.00 *0.02*
HU				0.03 *0.03*	0.02 *0.03*	**0.05*** *0.02*	-0.00 *0.02*
EE					-0.01 *0.03*	0.04 *0.02*	-0.01 *0.02*
LV						0.03 *0.03*	0.01 *0.03*
CY							0.01 *0.02*

Table 5: Average probabilities of comovements for returns on 10-year government bonds

This table reports for each country pair two average probabilities of comovements: (i) the comovements over a benchmark period, $p^B(\theta)$; and (ii) the comovements over a test period, $p^A(\theta)$. 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 benchmark period runs from the beginning of the sample to December 2002, while the test period from January 2003 to November 2005. Ten-year government bonds' returns refer to Poland (PL), the Czech Republic (CZ), Hungary (HU) and Germany (DE).

Panel A: average probabilities across the lower quantile ranges

$\theta \in$ [0.05 , 0.50]				
		PL	**CZ**	**HU**
$p^B(\theta)$	**DE**	0.33	0.40	0.29
	PL		0.28	0.34
	CZ			0.31
$p^A(\theta)$	**DE**	0.39	0.57	0.30
	PL		0.43	0.41
	CZ			0.33

Panel B: average probabilities across the upper quantile ranges

$\theta \in$ [0.55 , 0.95]				
		PL	**CZ**	**HU**
$p^B(\theta)$	**DE**	0.27	0.38	0.28
	PL		0.31	0.28
	CZ			0.31
$p^A(\theta)$	**DE**	0.37	0.50	0.27
	PL		0.39	0.34
	CZ			0.31

Table 5 - Continued

Panel C: average probabilities across the all quantile ranges

$\theta \in [0.05, 0.95]$				
		PL	CZ	HU
$p^{B}(\theta)$	DE	0.30	0.39	0.29
	PL		0.30	0.32
	CZ			0.31
$p^{A}(\theta)$	DE	0.38	0.54	0.29
	PL		0.41	0.38
	CZ			0.32

Table 6: Tests for differences in probabilities of comovements for returns on 10-year government bonds

This table reports statistics to test whether the average probabilities of comovements between a given market 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 period from the beginning of sample to December 2002, while the second sub-sample covers the period form January 2003 to November 2005. Standard errors are reported in italics and significant statistics in bold. * and ** denote 5% and 10% significance level, respectively. Ten-year government bonds' returns refer to Poland (PL), the Czech Republic (CZ), Hungary (HU) and Germany (DE).

Panel A: average probabilities across the lower quantile ranges

θ ∈ [0.05 , 0.50]			
	PL	**CZ**	**HU**
DE	0.07 *0.05*	**0.17*** *0.04*	0.01 *0.04*
PL		**0.14*** *0.05*	0.07 *0.05*
CZ			0.02 *0.04*

Panel B: average probabilities across the upper quantile ranges

θ ∈ [0.55 , 0.95]			
	PL	**CZ**	**HU**
DE	**0.10*** *0.05*	**0.13*** *0.05*	-0.01 *0.04*
PL		**0.08**** *0.05*	0.06 *0.05*
CZ			0.00 *0.04*

Panel C: average probabilities across the all quantile ranges

θ ∈ [0.05 , 0.95]			
	PL	**CZ**	**HU**
DE	0.08 *0.06*	**0.15*** *0.04*	-0.00 *0.04*
PL		**0.11*** *0.05*	0.06 *0.05*
CZ			0.01 *0.04*

Table 7: Average probabilities of comovements for returns on equity market indices - Do global factors play a role?

This table reports for each country pair four average probabilities of comovements: (i) the comovements over the pre-convergence period when the global factor correlation is low, $p^{BL}(\theta)$; (ii) the comovements over the convergence period when the global factor correlation is low, $p^{AL}(\theta)$; (iii) the comovements over the pre-convergence period when the global factor correlation is high, $p^{BH}(\theta)$; and (iv) the comovements over the convergence period when the global factor correlation is high, $p^{AH}(\theta)$. 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 pre-convergence period covers the beginning of sample to December 1999, while the convergence period runs from January 2000 to November 2005. The equity indices refer to the Eurostoxx350 (EA), Poland (PL), the Czech Republic (CZ), Hungary (HU), Estonia (EE), Latvia (LV), Cyprus (CY) and Slovenia (SI).

Panel A: average probabilities across the lower quantile ranges

$\theta \in$ [0.05 , 0.50]								
		PL	CZ	HU	EE	LV	CY	SI
$p^{BL}(\theta)$	EA	0.35	0.40	0.42	0.29	0.29	0.27	0.28
	PL		0.31	0.35	0.33	0.28	0.29	0.27
	CZ			0.34	0.28	0.28	0.28	0.31
	HU				0.28	0.29	0.27	0.30
	EE					0.35	0.30	0.32
	LV						0.28	0.30
	CY							0.28
$p^{AL}(\theta)$	EA	0.43	0.44	0.45	0.35	0.30	0.34	0.27
	PL		0.39	0.43	0.34	0.27	0.34	0.26
	CZ			0.41	0.34	0.32	0.29	0.28
	HU				0.31	0.34	0.32	0.28
	EE					0.34	0.33	0.30
	LV						0.32	0.28
	CY							0.30
$p^{BH}(\theta)$	EA	0.40	0.43	0.43	0.31	0.27	0.27	0.31
	PL		0.43	0.43	0.36	0.32	0.27	0.35
	CZ			0.44	0.33	0.27	0.29	0.32
	HU				0.37	0.25	0.27	0.30
	EE					0.32	0.31	0.32
	LV						0.24	0.31
	CY							0.28
$p^{AH}(\theta)$	EA	0.48	0.47	0.45	0.38	0.27	0.34	0.30
	PL		0.50	0.51	0.38	0.30	0.32	0.34
	CZ			0.51	0.40	0.31	0.30	0.29
	HU				0.40	0.30	0.32	0.28
	EE					0.31	0.34	0.30
	LV						0.27	0.29
	CY							0.31

Table 7 - Continued

Panel B: average probabilities across the upper quantile ranges

θ ∈ [0.55 , 0.95]								
		PL	CZ	HU	EE	LV	CY	SI
$p^{BL}(\theta)$	EA	0.32	0.30	0.34	0.29	0.26	0.20	0.27
	PL		0.30	0.33	0.25	0.25	0.28	0.25
	CZ			0.33	0.28	0.26	0.27	0.25
	HU				0.29	0.30	0.25	0.27
	EE					0.26	0.26	0.28
	LV						0.25	0.28
	CY							0.28
$p^{AL}(\theta)$	EA	0.40	0.39	0.35	0.35	0.27	0.29	0.28
	PL		0.37	0.40	0.30	0.24	0.28	0.25
	CZ			0.41	0.33	0.27	0.32	0.29
	HU				0.31	0.28	0.31	0.28
	EE					0.25	0.30	0.28
	LV						0.29	0.30
	CY							0.27
$p^{BH}(\theta)$	EA	0.31	0.34	0.43	0.29	0.22	0.25	0.25
	PL		0.36	0.39	0.30	0.27	0.28	0.28
	CZ			0.36	0.29	0.26	0.24	0.26
	HU				0.31	0.28	0.24	0.28
	EE					0.28	0.23	0.28
	LV						0.23	0.25
	CY							0.25
$p^{AH}(\theta)$	EA	0.39	0.43	0.44	0.35	0.24	0.33	0.26
	PL		0.43	0.46	0.34	0.26	0.28	0.28
	CZ			0.44	0.35	0.27	0.30	0.30
	HU				0.34	0.26	0.30	0.29
	EE					0.27	0.27	0.29
	LV						0.27	0.27
	CY							0.25

Table 7 - Continued

Panel C: average probabilities across the all quantile ranges

$\theta \in [0.05, 0.95]$								
		PL	**CZ**	**HU**	**EE**	**LV**	**CY**	**SI**
$p^{BL}(\theta)$	**EA**	0.34	0.35	0.38	0.29	0.28	0.24	0.27
	PL		0.31	0.34	0.29	0.27	0.28	0.26
	CZ			0.33	0.28	0.27	0.27	0.28
	HU				0.28	0.30	0.26	0.28
	EE					0.30	0.28	0.30
	LV						0.27	0.29
	CY							0.28
$p^{AL}(\theta)$	**EA**	0.42	0.42	0.40	0.35	0.28	0.32	0.27
	PL		0.38	0.42	0.32	0.26	0.31	0.26
	CZ			0.41	0.34	0.30	0.31	0.29
	HU				0.31	0.32	0.32	0.28
	EE					0.30	0.32	0.29
	LV						0.30	0.29
	CY							0.29
$p^{BH}(\theta)$	**EA**	0.36	0.39	0.43	0.30	0.25	0.26	0.28
	PL		0.40	0.41	0.33	0.29	0.27	0.31
	CZ			0.40	0.31	0.26	0.27	0.29
	HU				0.34	0.26	0.26	0.29
	EE					0.30	0.27	0.30
	LV						0.24	0.28
	CY							0.27
$p^{AH}(\theta)$	**EA**	0.44	0.45	0.45	0.36	0.26	0.34	0.28
	PL		0.47	0.49	0.36	0.28	0.30	0.31
	CZ			0.48	0.38	0.29	0.30	0.29
	HU				0.37	0.28	0.31	0.29
	EE					0.29	0.30	0.29
	LV						0.27	0.28
	CY							0.28

Table 8: Tests for differences in probabilities of comovements for returns on equity market indices - Do global factors play a role?

This table reports, for a certain quantile range and a given market pair, two sets of statistics: the first, $\widehat{\delta}\left(\underline{\theta},\overline{\theta}\right)$, equation (7'), tests whether the average probabilities of comovements are different across two sample periods when we control for global correlation; the second, $\widehat{\psi}\left(\underline{\theta},\overline{\theta}\right)$, equation (19), tests whether the average probabilities of comovements differ according to the level of global correlation. 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-convergence period (beginning of sample to December 1999), while the second sub-sample covers the convergence period (January 2000 to October 2005). Standard errors are reported in italics and significant statistics in bold. * and ** denote 5% and 10% significance level, respectively. The equity indices refer to the Eurostoxx350 (EA), Poland (PL), the Czech Republic (CZ), Hungary (HU), Estonia (EE), Latvia (LV), Cyprus (CY) and Slovenia (SI).

Panel A: average probabilities across the lower quantile ranges

$\theta \in$ [0.05 , 0.50]								
		PL	CZ	HU	EE	LV	CY	SI
EA	$\hat{\delta}(\underline{\theta},\bar{\theta})$	**0.08***	0.04	0.02	**0.06***	0.01	**0.07***	-0.01
		0.03	*0.03*	*0.03*	*0.03*	*0.03*	*0.02*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$	0.06	0.03	0.01	0.02	-0.02	0.00	0.03
		0.04	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
PL	$\hat{\delta}(\underline{\theta},\bar{\theta})$		**0.07***	**0.08***	0.02	-0.01	**0.05****	-0.01
			0.03	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$		**0.12***	**0.08***	0.04	0.03	-0.02	**0.08***
			0.04	*0.03*	*0.04*	*0.03*	*0.03*	*0.03*
CZ	$\hat{\delta}(\underline{\theta},\bar{\theta})$			**0.07***	**0.06***	0.04	0.01	-0.03
				0.03	*0.03*	*0.03*	*0.03*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$			**0.10***	**0.05****	-0.01	0.01	0.01
				0.03	*0.03*	*0.03*	*0.03*	*0.03*
HU	$\hat{\delta}(\underline{\theta},\bar{\theta})$				0.03	0.05	**0.05***	-0.02
					0.03	*0.03*	*0.02*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$				**0.09***	-0.05	0.00	0.00
					0.03	*0.03*	*0.03*	*0.03*
EE	$\hat{\delta}(\underline{\theta},\bar{\theta})$					-0.01	0.03	-0.02
						0.03	*0.03*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$					-0.02	0.01	0.00
						0.04	*0.03*	*0.03*
LV	$\hat{\delta}(\underline{\theta},\bar{\theta})$						0.04	-0.01
							0.03	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$						-0.04	0.01
							0.03	*0.03*
CY	$\hat{\delta}(\underline{\theta},\bar{\theta})$							0.02
								0.02
	$\hat{\psi}(\underline{\theta},\bar{\theta})$							0.01
								0.03

Table 8 - Continued

Panel B: average probabilities across the upper quantile ranges

$\theta \in$ [0.50 , 0.95]								
		PL	CZ	HU	EE	LV	CY	SI
EA	$\hat{\delta}(\underline{\theta},\bar{\theta})$	**0.08***	**0.09***	0.01	**0.06***	0.01	**0.08***	0.01
		0.03	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$	-0.01	0.04	**0.09***	0.00	-0.03	**0.04****	-0.01
		0.03	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
PL	$\hat{\delta}(\underline{\theta},\bar{\theta})$		**0.07***	**0.07***	0.04	-0.01	0.00	0.01
			0.03	*0.03*	*0.03*	*0.03*	*0.03*	*0.02*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$		**0.06***	**0.06***	0.04	0.01	0.00	0.03
			0.03	*0.03*	*0.03*	*0.03*	*0.03*	*0.02*
CZ	$\hat{\delta}(\underline{\theta},\bar{\theta})$			**0.09***	**0.06***	0.01	**0.05****	0.04
				0.03	*0.03*	*0.03*	*0.03*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$			0.03	0.02	0.00	-0.02	0.01
				0.03	*0.03*	*0.03*	*0.03*	*0.03*
HU	$\hat{\delta}(\underline{\theta},\bar{\theta})$				0.02	-0.01	**0.06***	0.01
					0.03	*0.03*	*0.02*	*0.02*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$				0.03	-0.02	-0.01	0.01
					0.03	*0.03*	*0.02*	*0.02*
EE	$\hat{\delta}(\underline{\theta},\bar{\theta})$					0.00	0.04	0.01
						0.03	*0.02*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$					0.02	-0.03	0.01
						0.03	*0.02*	*0.03*
LV	$\hat{\delta}(\underline{\theta},\bar{\theta})$						0.04	0.02
							0.03	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$						-0.02	-0.03
							0.03	*0.03*
CY	$\hat{\delta}(\underline{\theta},\bar{\theta})$							0.00
								0.02
	$\hat{\psi}(\underline{\theta},\bar{\theta})$							-0.02
								0.02

Table 8 - Continued

Panel C: average probabilities across the all quantile ranges

		PL	CZ	HU	EE	LV	CY	SI
		$\theta \in$ **[0.05 , 0.95]**						
EA	$\hat{\delta}(\underline{\theta},\bar{\theta})$	**0.08***	**0.07***	0.02	**0.06****	0.01	**0.08***	0.00
		0.03	*0.03*	*0.03*	*0.03*	*0.03*	*0.02*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$	0.02	0.04	0.05	0.01	-0.03	0.02	0.01
		0.04	*0.03*	*0.04*	*0.03*	*0.03*	*0.03*	*0.03*
PL	$\hat{\delta}(\underline{\theta},\bar{\theta})$		**0.07***	**0.08***	0.03	-0.01	0.03	0.00
			0.03	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$		**0.09***	**0.07***	0.04	0.02	-0.01	0.06
			0.03	*0.03*	*0.04*	*0.03*	*0.03*	*0.03*
CZ	$\hat{\delta}(\underline{\theta},\bar{\theta})$			**0.08***	**0.06***	0.03	0.03	0.00
				0.03	*0.03*	*0.03*	*0.03*	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$			**0.07***	0.04	0.00	-0.01	0.01
				0.03	*0.03*	*0.03*	*0.02*	*0.03*
HU	$\hat{\delta}(\underline{\theta},\bar{\theta})$				0.03	0.02	**0.06***	0.00
					0.03	*0.03*	*0.02*	*0.02*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$				**0.06***	-0.03	0.00	0.01
					0.03	*0.03*	*0.02*	*0.02*
EE	$\hat{\delta}(\underline{\theta},\bar{\theta})$					-0.01	0.03	-0.01
						0.03	*0.03*	*0.02*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$					0.00	-0.01	0.00
						0.03	*0.03*	*0.02*
LV	$\hat{\delta}(\underline{\theta},\bar{\theta})$						0.04	0.00
							0.03	*0.03*
	$\hat{\psi}(\underline{\theta},\bar{\theta})$						-0.03	-0.01
							0.03	*0.03*
CY	$\hat{\delta}(\underline{\theta},\bar{\theta})$							0.01
								0.02
	$\hat{\psi}(\underline{\theta},\bar{\theta})$							-0.01
								0.02

Table 9: Average probabilities of comovements for returns on 10-year government bonds - Do global factors play a role?

This table reports for each country pair four average probabilities of comovements: (i) the comovements over the benchmark period when the global factor correlation is low, $p^{BL}(\theta)$; (ii) the comovements over the test period when the global factor correlation is low, $p^{AL}(\theta)$; (iii) the comovements over the benchmark period when the global factor correlation is high, $p^{BH}(\theta)$; and (iv) the comovements over the test period when the global factor correlation is high, $p^{AH}(\theta)$. 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 the benchmark period runs from the beginning of the sample to December 2002, while the test period from January 2003 to November 2005. Ten-year government bonds' returns refer to Poland (PL), the Czech Republic (CZ), Hungary (HU) and Germany (DE).

Panel A: average probabilities across the lower quantile ranges

$\theta \in$ [0.05 , 0.50]				
		PL	**CZ**	**HU**
$p^{BL}(\theta)$	**DE**	0.29	0.40	0.28
	PL		0.26	0.30
	CZ			0.30
$p^{AL}(\theta)$	**DE**	0.35	0.56	0.31
	PL		0.38	0.35
	CZ			0.31
$p^{BH}(\theta)$	**DE**	0.35	0.41	0.28
	PL		0.32	0.38
	CZ			0.32
$p^{AH}(\theta)$	**DE**	0.41	0.57	0.30
	PL		0.44	0.43
	CZ			0.33

Table 9 - Continued

Panel B: average probabilities across the upper quantile ranges

$\theta \in$ [0.55 , 0.95]				
		PL	**CZ**	**HU**
$p^{BL}(\theta)$	**DE**	0.31	0.38	0.29
	PL		0.35	0.29
	CZ			0.30
$p^{AL}(\theta)$	**DE**	0.41	0.46	0.29
	PL		0.45	0.33
	CZ			0.30
$p^{BH}(\theta)$	**DE**	0.25	0.44	0.29
	PL		0.28	0.30
	CZ			0.32
$p^{AH}(\theta)$	**DE**	0.35	0.53	0.28
	PL		0.38	0.34
	CZ			0.32

Panel C: average probabilities across the all quantile ranges

$\theta \in$ [0.05 , 0.95]				
		PL	**CZ**	**HU**
$p^{BL}(\theta)$	**DE**	0.30	0.39	0.29
	PL		0.30	0.30
	CZ			0.30
$p^{AL}(\theta)$	**DE**	0.38	0.51	0.30
	PL		0.41	0.35
	CZ			0.30
$p^{BH}(\theta)$	**DE**	0.30	0.42	0.29
	PL		0.30	0.34
	CZ			0.32
$p^{AH}(\theta)$	**DE**	0.38	0.55	0.29
	PL		0.41	0.39
	CZ			0.33

Table 10: Tests for differences in probabilities of comovements for returns on 10–year government bonds - Do global factors play a role?

This table reports, for a certain quantile range and a given market pair, two sets of statistics: the first, $\widehat{\delta}\left(\underline{\theta},\overline{\theta}\right)$, equation (7'), tests whether the average probabilities of comovements are different across two sample periods when we control for global correlation; the second, $\widehat{\psi}\left(\underline{\theta},\overline{\theta}\right)$, equation (19), tests whether the average probabilities of comovements differ according to the level of global correlation. 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 period from the beginning of sample to December 2002, while the second sub-sample covers the period form January 2003 to November 2005. Standard errors are reported in italics and significant statistics in bold. * denotes 5% significance level. Ten-year government bonds' returns refer to Poland (PL), the Czech Republic (CZ), Hungary (HU) and Germany (DE).

Panel A: average probabilities across the lower quantile ranges

$\theta \in$ [0.05 , 0.50]				
		PL	**CZ**	**HU**
DE	$\hat{\delta}\left(\underline{\theta},\overline{\theta}\right)$	0.06 *0.05*	**0.17*** *0.05*	0.02 *0.04*
	$\hat{\psi}\left(\underline{\theta},\overline{\theta}\right)$	0.06 *0.05*	0.01 *0.06*	-0.00 *0.04*
PL	$\hat{\delta}\left(\underline{\theta},\overline{\theta}\right)$		**0.12*** *0.05*	0.05 *0.05*
	$\hat{\psi}\left(\underline{\theta},\overline{\theta}\right)$		0.05 *0.05*	0.08 *0.06*
CZ	$\hat{\delta}\left(\underline{\theta},\overline{\theta}\right)$			0.01 *0.04*
	$\hat{\psi}\left(\underline{\theta},\overline{\theta}\right)$			0.03 *0.05*

Table 10 - Continued

Panel B: average probabilities across the upper quantile ranges

$\theta \in$ [0.55 , 0.95]		PL	CZ	HU
DE	$\hat{\delta}(\underline{\theta},\overline{\theta})$	**0.11*** *0.05*	0.09 *0.06*	-0.01 *0.04*
	$\hat{\psi}(\underline{\theta},\overline{\theta})$	-0.06 *0.05*	0.07 *0.06*	-0.00 *0.04*
PL	$\hat{\delta}(\underline{\theta},\overline{\theta})$		**0.10*** *0.05*	0.04 *0.05*
	$\hat{\psi}(\underline{\theta},\overline{\theta})$		-0.07 *0.05*	0.01 *0.05*
CZ	$\hat{\delta}(\underline{\theta},\overline{\theta})$			-0.00 *0.04*
	$\hat{\psi}(\underline{\theta},\overline{\theta})$			0.02 *0.04*

Panel C: average probabilities across the all quantile ranges

$\theta \in$ [0.05 , 0.95]		PL	CZ	HU
DE	$\hat{\delta}(\underline{\theta},\overline{\theta})$	0.08 *0.05*	**0.13*** *0.05*	0.01 *0.04*
	$\hat{\psi}(\underline{\theta},\overline{\theta})$	0.00 *0.05*	0.04 *0.05*	-0.00 *0.04*
PL	$\hat{\delta}(\underline{\theta},\overline{\theta})$		**0.11*** *0.05*	0.05 *0.05*
	$\hat{\psi}(\underline{\theta},\overline{\theta})$		-0.00 *0.05*	0.05 *0.06*
CZ	$\hat{\delta}(\underline{\theta},\overline{\theta})$			0.00 *0.04*
	$\hat{\psi}(\underline{\theta},\overline{\theta})$			0.02 *0.04*

Figure 1: The comovement 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.

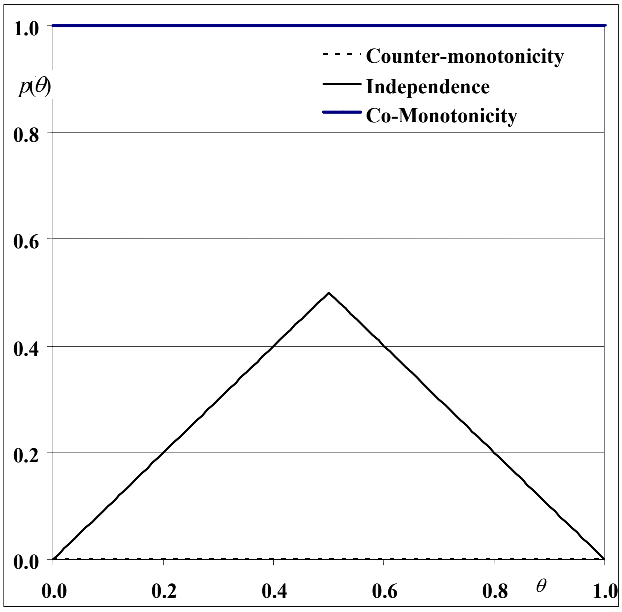


Figure 2: Weighted average probabilities of comovements between returns on equity market indices - Euro area vs new EU member states

Figures 2a-2c plot weighted average estimated probabilities of comovements between returns on equity market indices for new EU member states and the euro area over two periods. The first sub-sample covers the pre-convergence period (beginning of the sample to December 1999), while the second the convergence period (January 2000 to November 2005). The acronyms “EA”, “NEUMS”, “LNEUMS”, and “SNEUMS” refer, respectively, to the euro area, the all the seven, the three largest (Poland, the Czech Republic and Hungary) and the four smallest (Estonia, Latvia, Cyprus and Slovenia) new EU member states. The probability of comovement of each market pair is weighted with the fraction of the GDP pair relative to the total GDP of the relevant group.

Figure 2a: EA vs NEUMS

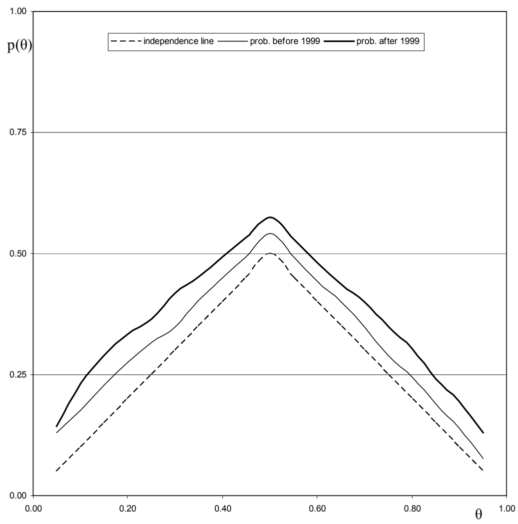


Figure 2b: EA vs LNEUMS

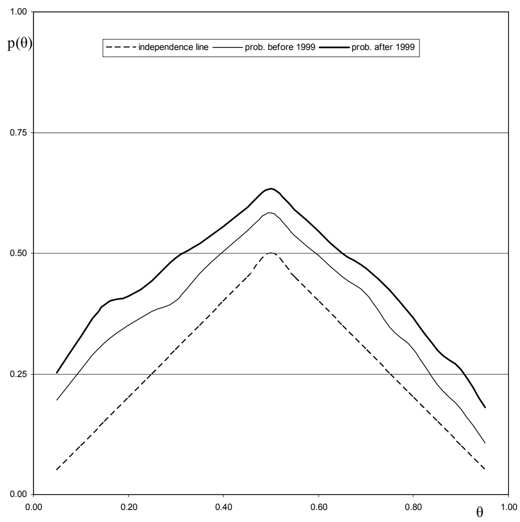


Figure 2c: EA vs SNEUMS

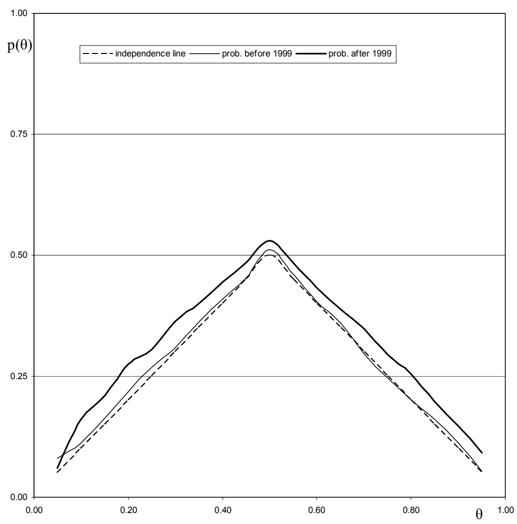


Figure 3: Probabilities of comovements between returns on equity market indices - Euro area vs new EU member states

Figures 3a-3g plot the estimated probabilities of comovements between returns on new EU member states and the euro area equity market indices over two periods. The first sub-sample covers the pre-convergence period (beginning of the sample to December 1999), while the second the convergence period (January 2000 to November 2005). The dashed lines denote the two standard error bounds around the estimated comovement likelihood in the convergence period, while the thin line represents the probability of comovement in the pre-convergence period.

Figure 3a: Euro area vs Poland

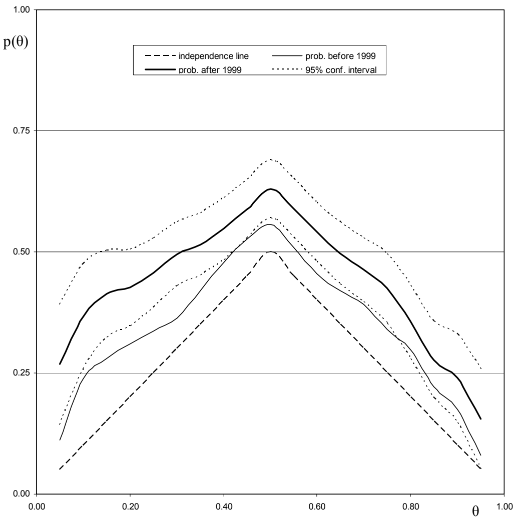


Figure 3b: Euro area vs Czech Republic

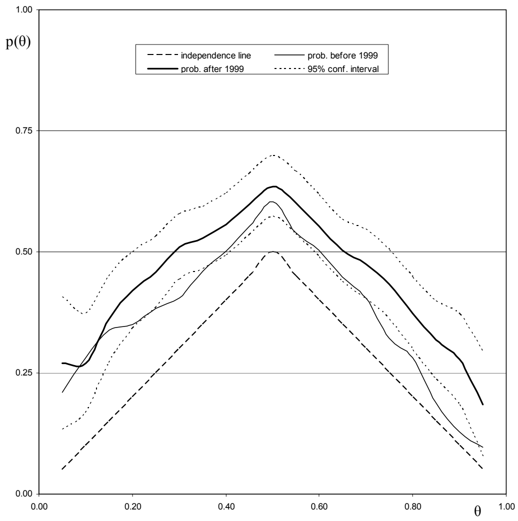


Figure 3c: Euro area vs Hungary

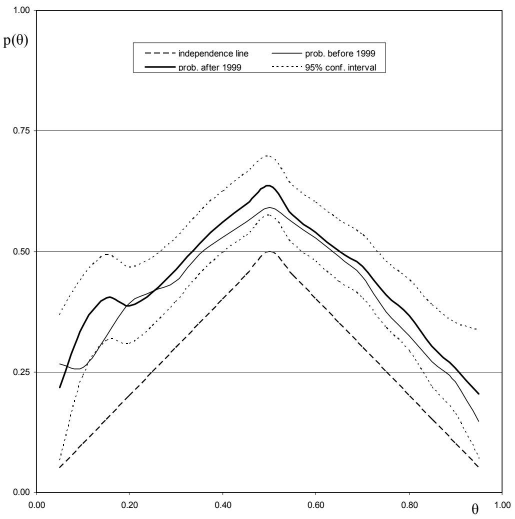


Figure 3d: Euro area vs Estonia

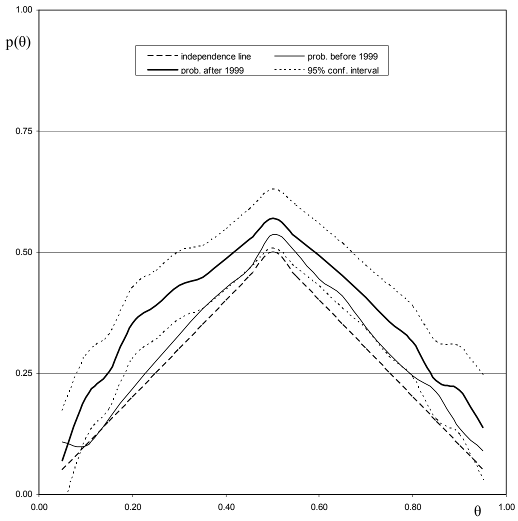


Figure 3 - Continued

Figure 3e: Euro area vs Latvia

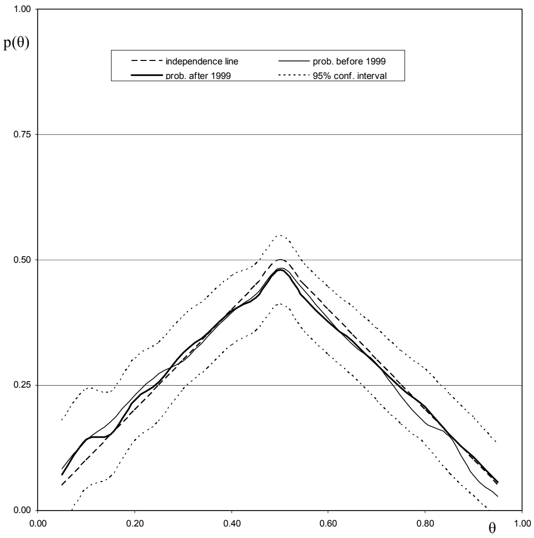


Figure 3f: Euro area vs Cyprus

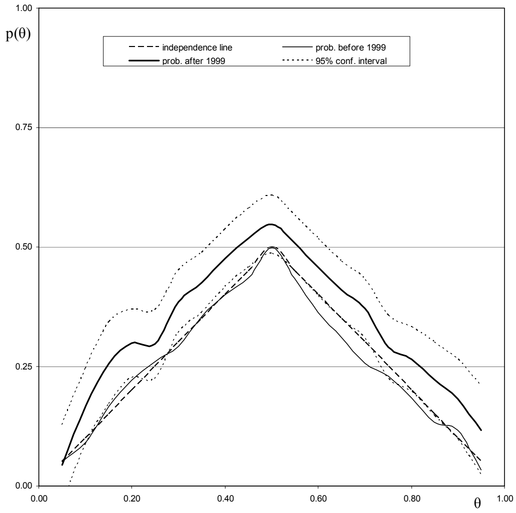


Figure 3g: Euro area vs Slovenia

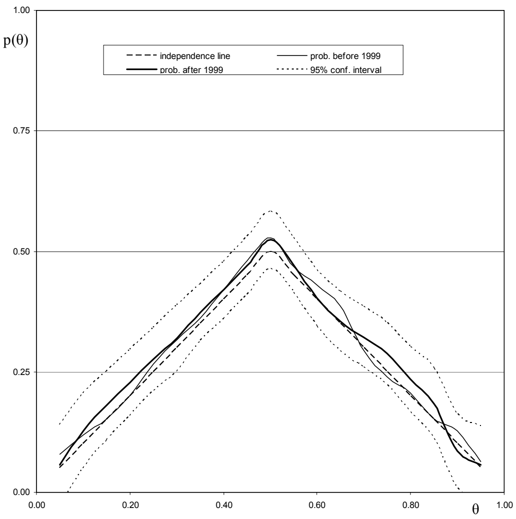


Figure 4: Weighted average probabilities of comovements between returns on equity market indices - New EU member states

Figures 4a-4c plot weighted average estimated probabilities of comovements between returns on new EU member states equity market indices over two periods. The first sub-sample covers the pre-convergence period (beginning of the sample to December 1999), while the second the convergence period (January 2000 to November 2005). The acronyms "NEUMS", "LNEUMS", and "SNEUMS" refer, respectively, to the all the seven, the three largest (Poland, the Czech Republic and Hungary) and the four smallest (Estonia, Latvia, Cyprus and Slovenia) new EU member states. The probability of comovement of each market pair is weighted with the fraction of the GDP pair relative to the total GDP of the relevant group.

Figure 4a: All NEUMS

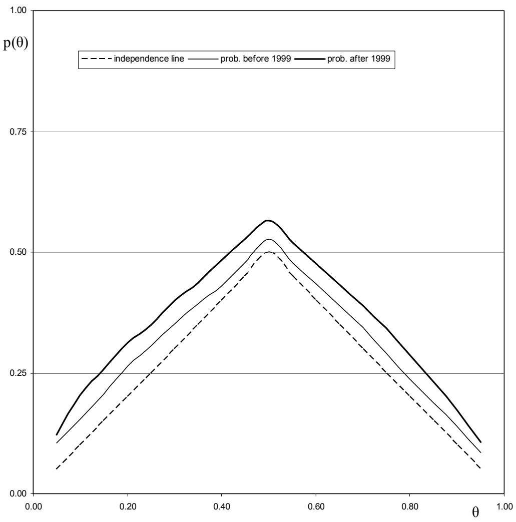


Figure 4b: LNEUMS

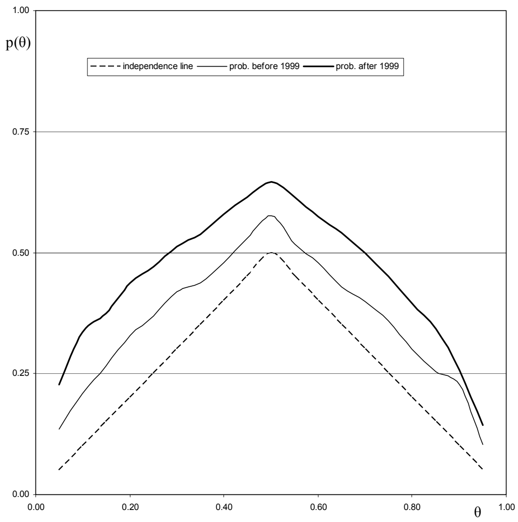


Figure 4c: SNEUMS

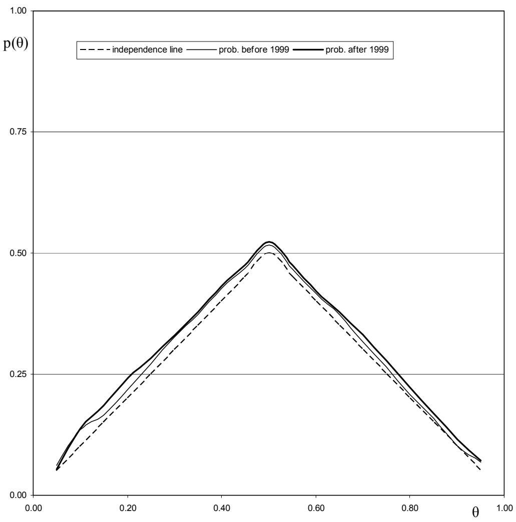


Figure 4d: LNEUMS vs SNEUMS

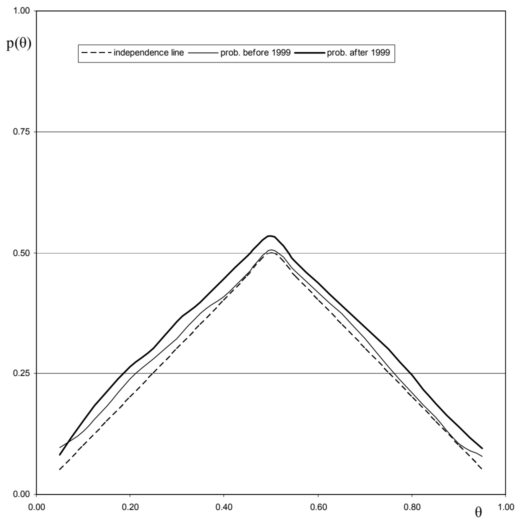


Figure 5: Probabilities of comovements between returns on equity market indices - New EU member states

Figures 5a-5u plot estimated probabilities of comovements between returns on new EU member states market pairs equity market indices over two periods. The first sub-sample covers the pre-convergence period (beginning of the sample to December 1999), while the second the convergence period (January 2000 to November 2005). The dashed lines denote the two standard error bounds around the estimated comovement likelihood in the convergence period, while the thin line represents the probability of comovement in the pre-convergence period.

Figure 5a: Poland vs Czech Republic

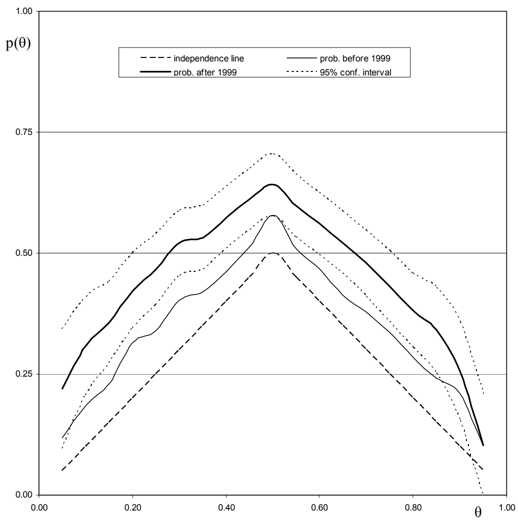


Figure 5b: Poland vs Hungary

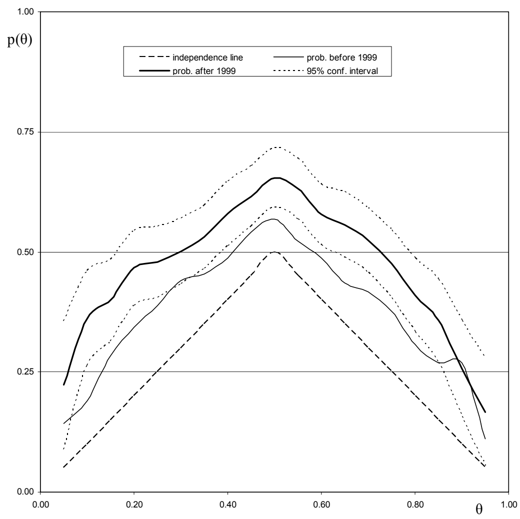


Figure 5c: Poland vs Estonia

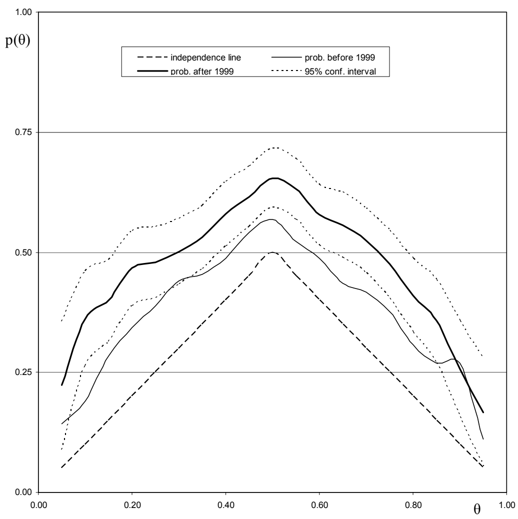


Figure 5d: Poland vs Latvia

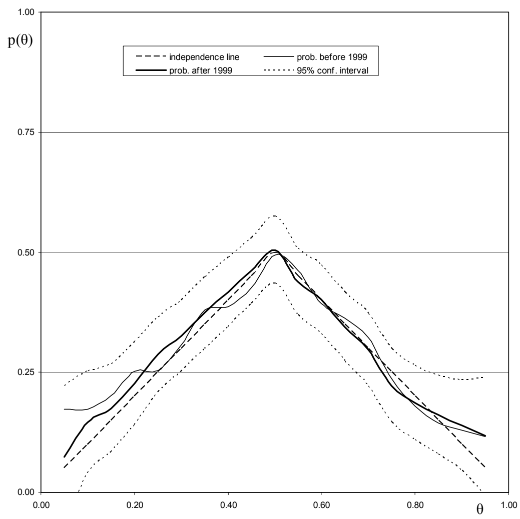


Figure 5 - Continued

Figure 5e: Poland vs Cyprus

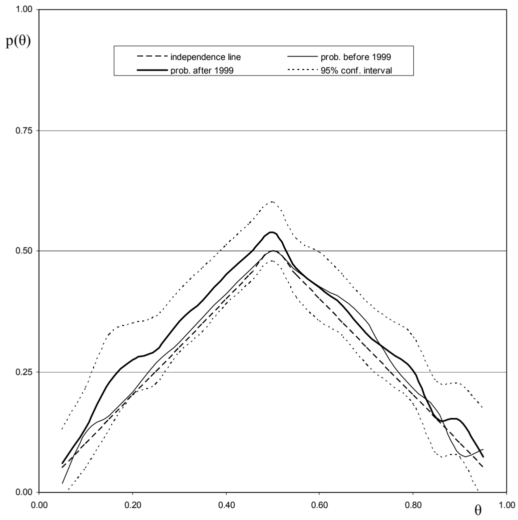


Figure 5f: Poland vs Slovenia

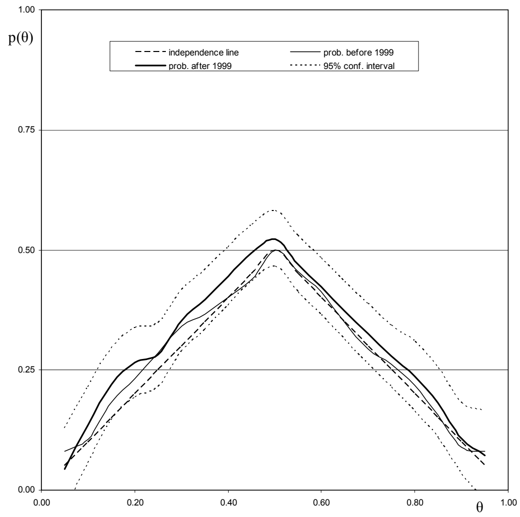


Figure 5g: Czech Republic vs Hungary

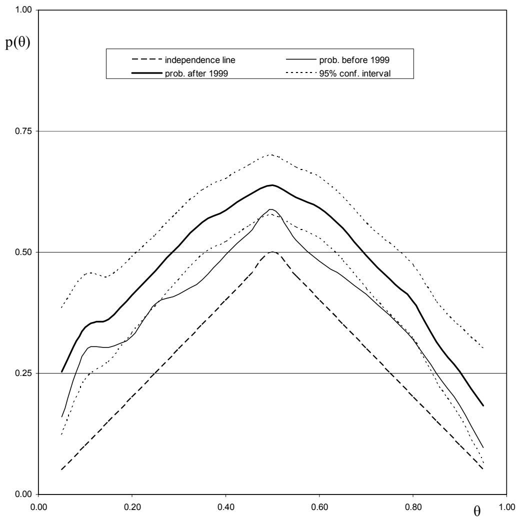


Figure 5h: Czech Republic vs Estonia

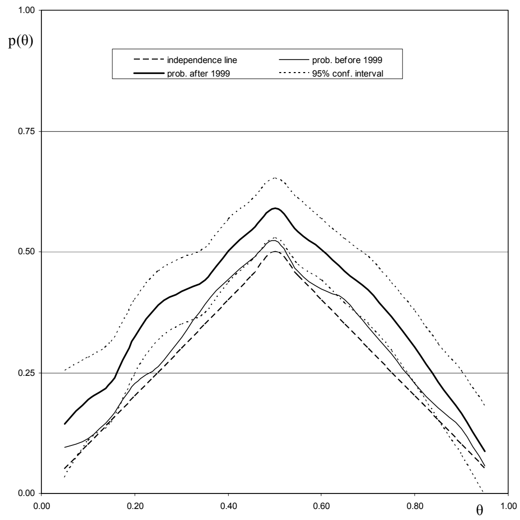


Figure 5i: Czech Republic vs Latvia

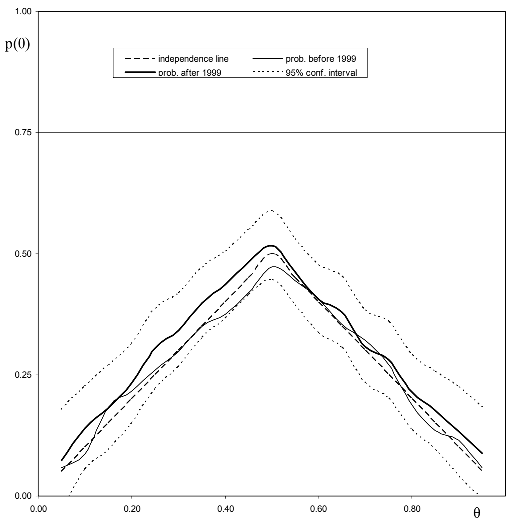


Figure 5j: Czech Republic vs Cyprus

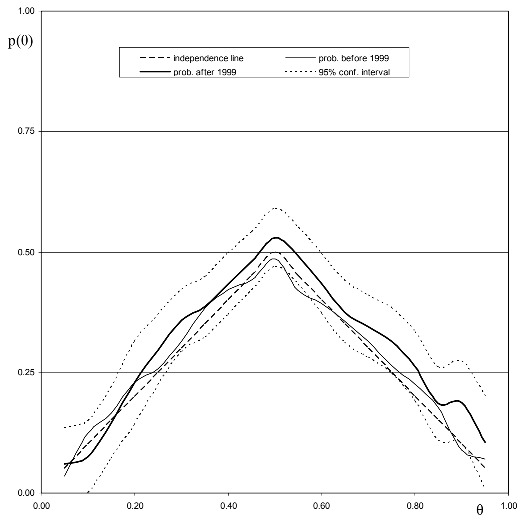


Figure 5 - Continued

Figure 5k: Czech Republic vs Slovenia

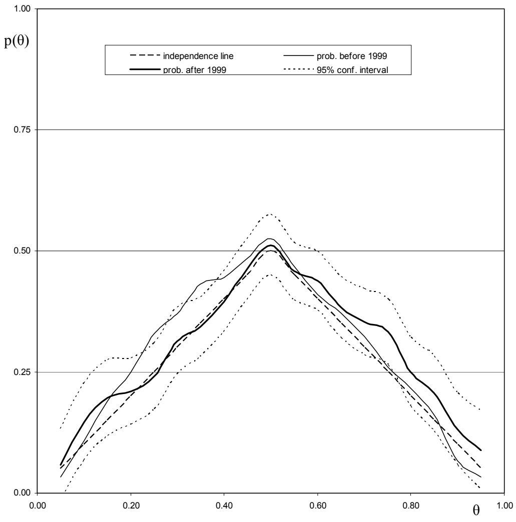


Figure 5l: Hungary vs Estonia

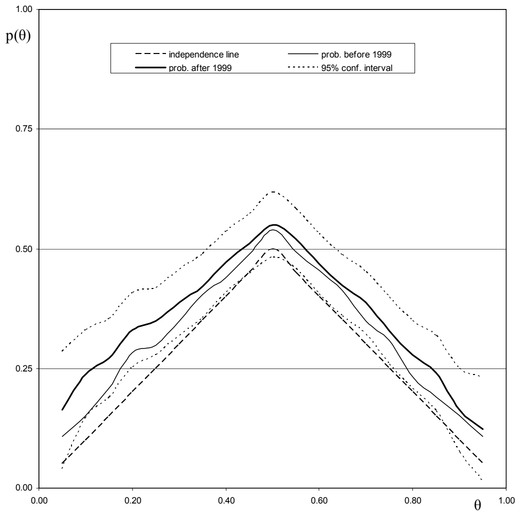


Figure 5m: Hungary vs Latvia

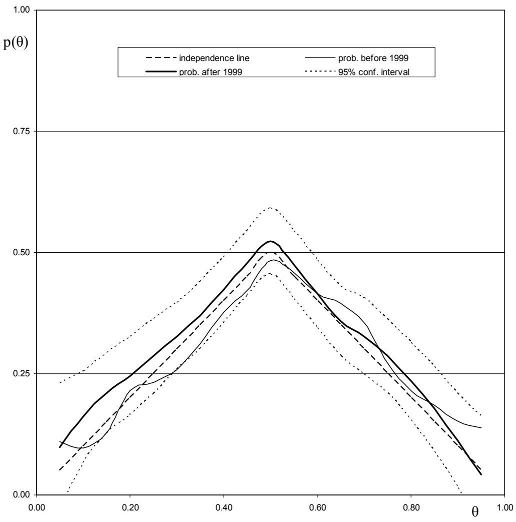


Figure 5n: Hungary vs Cyprus

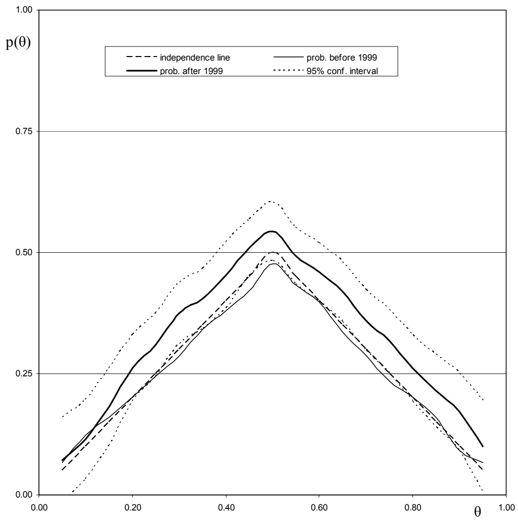


Figure 5o: Hungary vs Slovenia

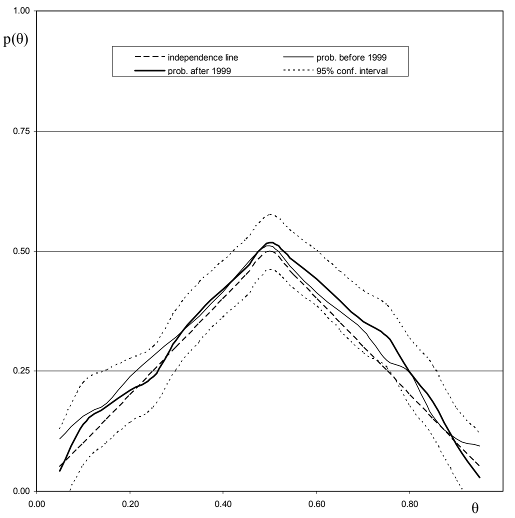


Figure 5p: Estonia vs Latvia

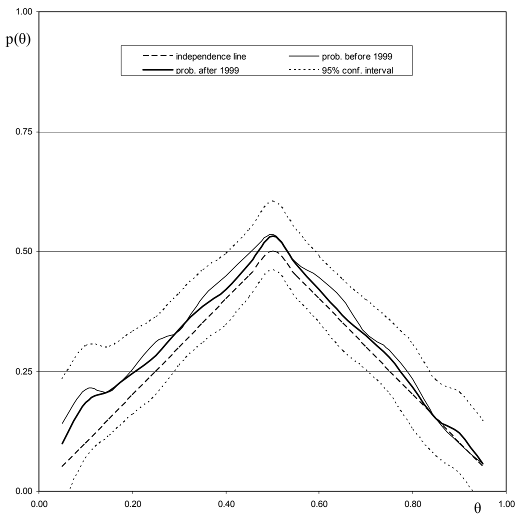


Figure 5 - Continued

Figure 5q: Estonia vs Cyprus

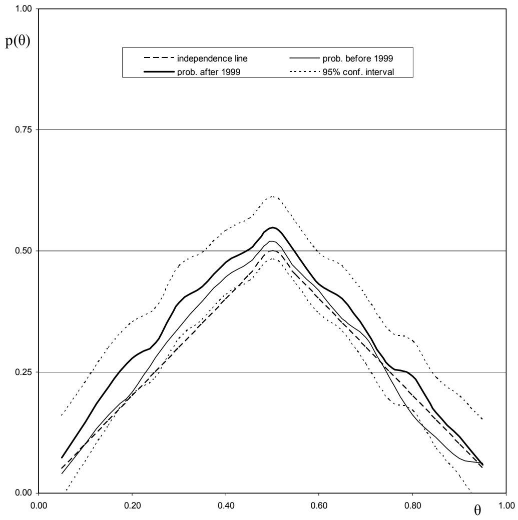


Figure 5r: Estonia vs Slovenia

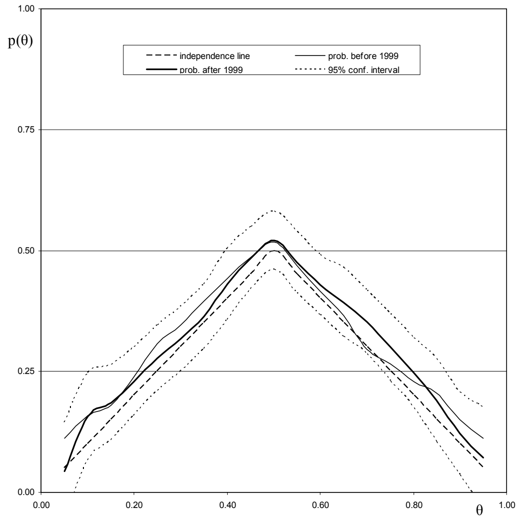


Figure 5s: Latvia vs Cyprus

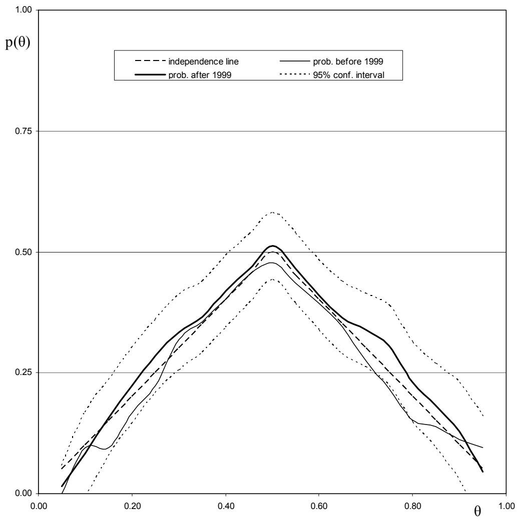


Figure 5t: Latvia vs Slovenia

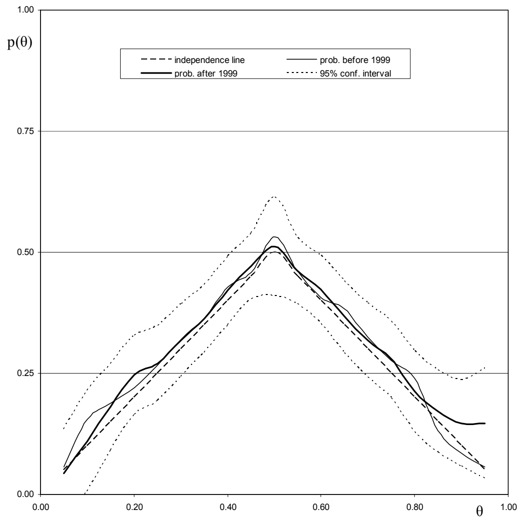


Figure 5u: Cyprus vs Slovenia

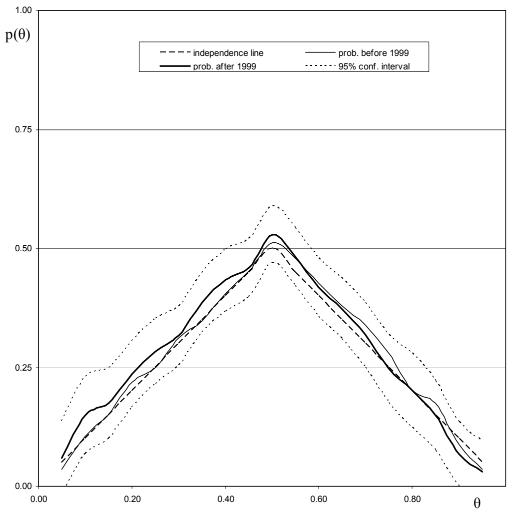


Figure 6: Weighted average probabilities of comovements between returns on 10-year government bonds - Germany vs new EU member states

Figures 6 plots weighted average estimated probabilities of comovements between returns on new EU member states and Germany government bonds over two periods. The first sub-sample covers the benchmark period (beginning of the sample to December 2002), while the second the test period (January 2003 to November 2005). The acronyms "NEUMS" refers to the all the seven new EU member states (Poland, the Czech Republic, Hungary, Estonia, Latvia, Cyprus and Slovenia). The probability of comovement of each market pair is weighted with the fraction of the GDP pair relative to the total GDP of the relevant group.

Figure 6: Germany vs all NEUMS

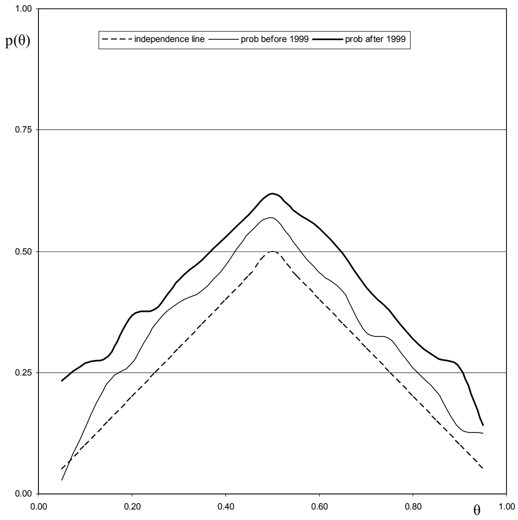


Figure 7: Probabilities of comovements between returns on 10-year government bonds - Germany vs new EU member states

Figures 7a-7c plot the estimated probabilities of comovements between returns on the large new EU member states and Germany 10-year government bonds over two periods. The first sub-sample covers the benchmark period (beginning of the sample to December 2002), while the second the test period (January 2003 to November 2005). The dashed lines denote the two standard error bounds around the estimated comovement likelihood in the convergence period, while the thin line represents the probability of comovement in the pre-convergence period.

Figure 7a: Germany vs Poland

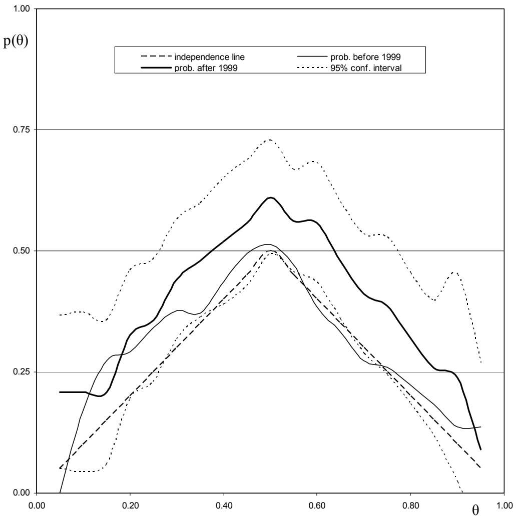


Figure 7b: Germany vs Czech Republic

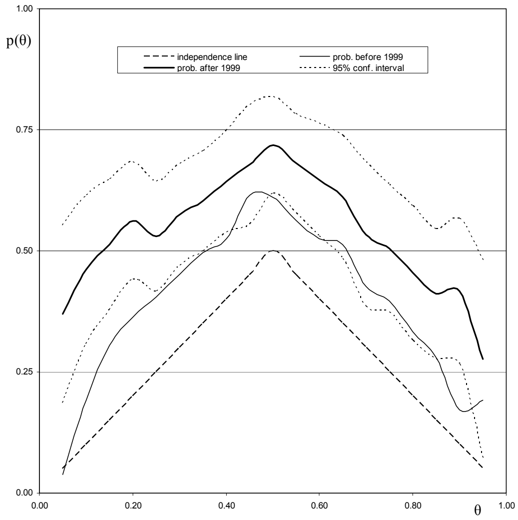


Figure 7c: Germany vs Hungary

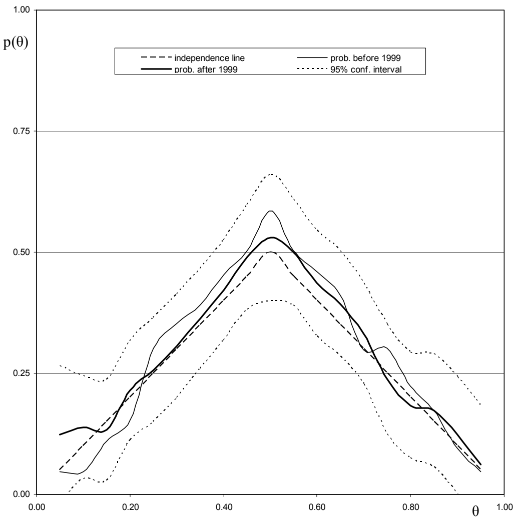


Figure 8: Weighted average probabilities of comovements between returns on 10-year government bonds - New EU member states

Figures 8 plots weighted average estimated probabilities of comovements between returns on new EU member states market pairs government bonds over two periods. The first subsample covers the benchmark period (beginning of the sample to December 2002), while the second the test period (January 2003 to November 2005). The acronyms "LEUMS" refers to the three large new EU member states (Poland, the Czech Republic and Hungary). The probability of comovement of each market pair is weighted with the fraction of the GDP pair relative to the total GDP of the relevant group.

Figure 8: LNEUMS

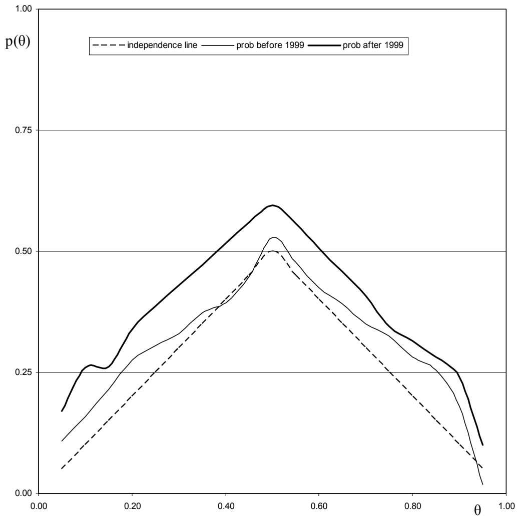


Figure 9: Probabilities of comovements between returns on 10-year government bonds - New EU member states

Figures 9a-9c plot the estimated probabilities of comovements between returns on the large new EU member states 10-year government bonds over two periods. The first sub-sample covers the benchmark period (beginning of the sample to December 2002), while the second the test period (January 2003 to November 2005). The dashed lines denote the two standard error bounds around the estimated comovement likelihood in the convergence period, while the thin line represents the probability of comovement in the pre-convergence period.

Figure 9a: Poland vs Czech Republic

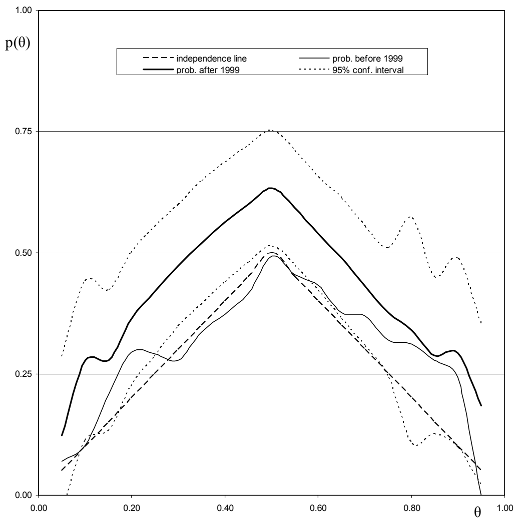


Figure 9b: Poland vs Hungary

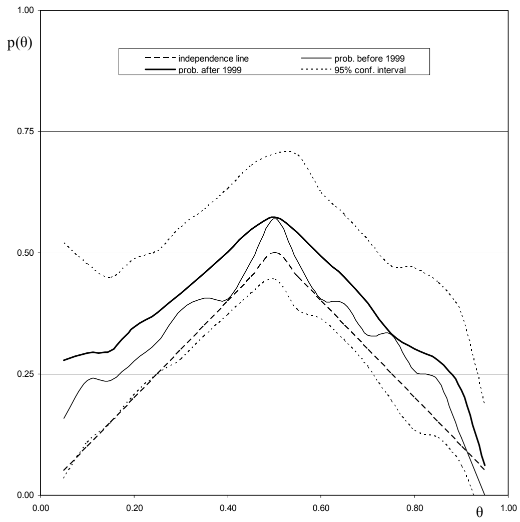


Figure 9c: Czech Republic vs Hungary

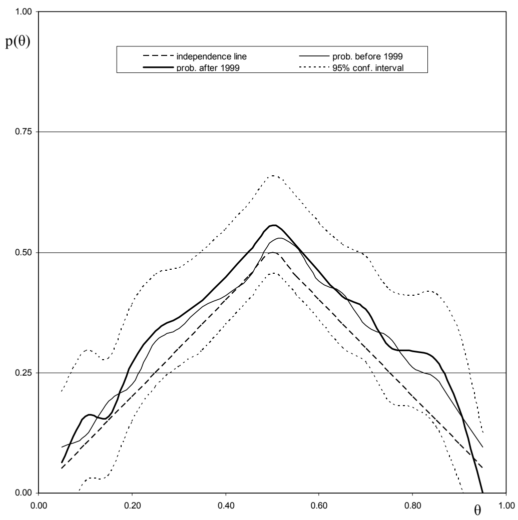


Figure 10: Robust probabilities of comovements between returns on equity market indices - Euro area vs Poland

Figures 10a-10c plot four average probabilities of comovements: (i) the comovements over the pre-convergence period when the global factor correlation is low; (ii) the comovements over the convergence period when the global factor correlation is low; (iii) the comovements over the pre-convergence period when the global factor correlation is high; and (iv) the comovements over the convergence period when the global factor correlation is high. In terms of equation (17), (i) corresponds to $p^{BL}(\theta)$, (ii) to $p^{AL}(\theta)$, (iii) to $p^{BH}(\theta)$, and (iv) to $p^{AH}(\theta)$. Probabilities of comovements are estimated between returns on Poland and the euro area equity market indices. The pre-convergence period runs from the beginning of the sample to December 1999, while the convergence period from January 2000 to November 2005.

Figure 10a: $p^{BL}(\theta)$ *and* $p^{AL}(\theta)$

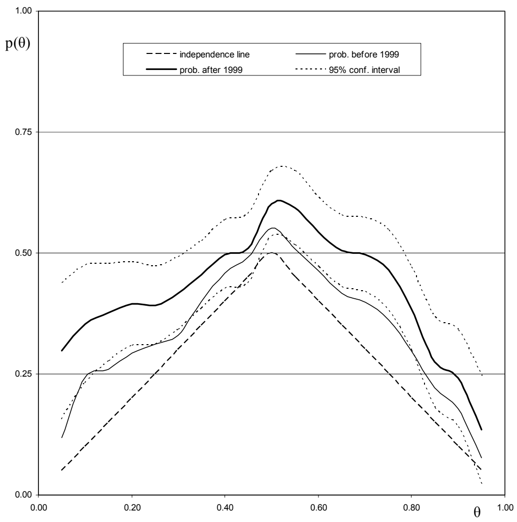


Figure 10b: $p^{BH}(\theta)$ *and* $p^{AH}(\theta)$

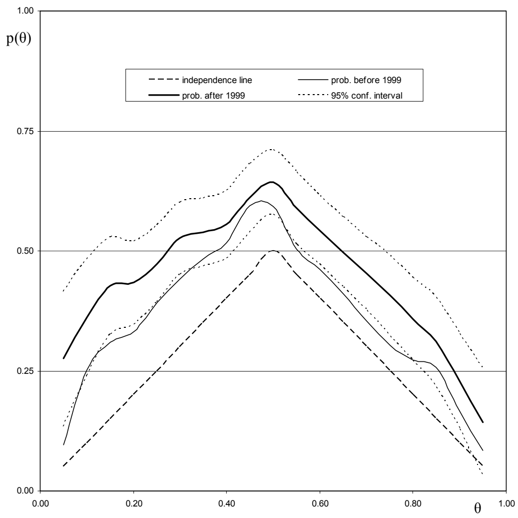


Figure 10c: $p^{AL}(\theta)$ *and* $p^{AH}(\theta)$

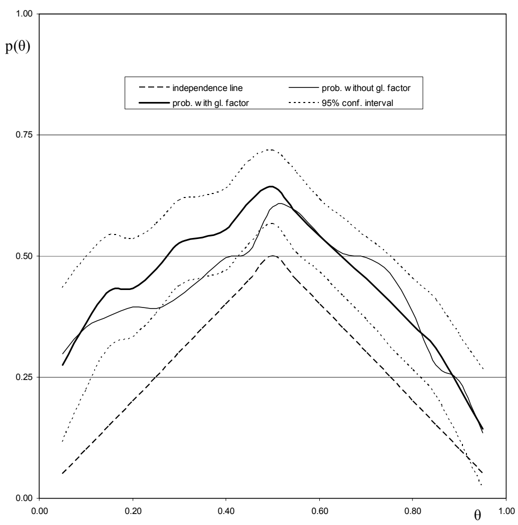


Figure 11: Robust probabilities of comovements between returns on equity market indices - Euro area vs Hungary

Figures 11a-11c plot four average probabilities of comovements: (i) the comovements over the pre-convergence period when the global factor correlation is low; (ii) the comovements over the convergence period when the global factor correlation is low; (iii) the comovements over the pre-convergence period when the global factor correlation is high; and (iv) the comovements over the convergence period when the global factor correlation is high. In terms of equation (17), (i) corresponds to $p^{BL}(\theta)$, (ii) to $p^{AL}(\theta)$, (iii) to $p^{BH}(\theta)$, and (iv) to $p^{AH}(\theta)$. Probabilities of comovements are estimated between returns on Hungary and the euro area equity market indices. The pre-convergence period runs from the beginning of the sample to December 1999, while the convergence period from January 2000 to November 2005.

Figure 11a: $p^{BL}(\theta)$ *and* $p^{AL}(\theta)$

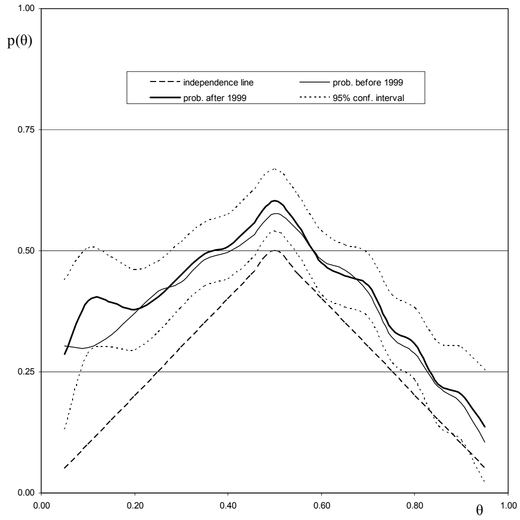


Figure 11b: $p^{BH}(\theta)$ *and* $p^{AH}(\theta)$

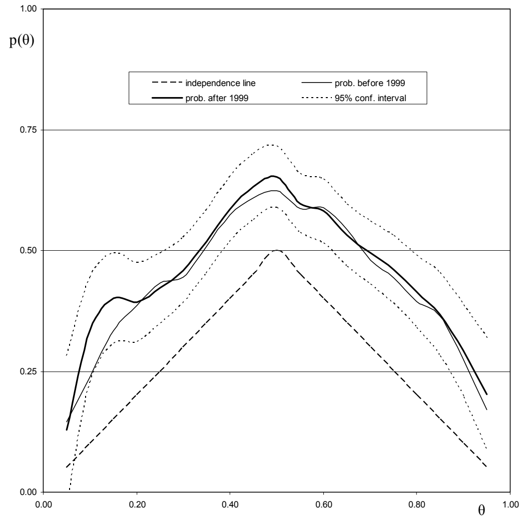


Figure 11c: $p^{AL}(\theta)$ *and* $p^{AH}(\theta)$

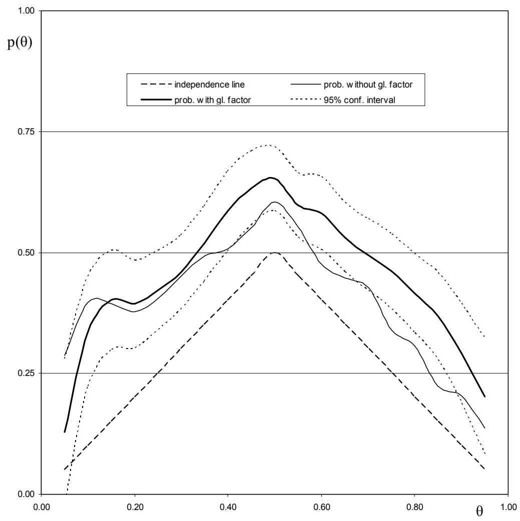


Figure 12: Robust probabilities of comovements between returns on equity market indices - Poland vs Czech Republic

Figures 12a-12c plot four average probabilities of comovements: (i) the comovements over the pre-convergence period when the global factor correlation is low; (ii) the comovements over the convergence period when the global factor correlation is low; (iii) the comovements over the pre-convergence period when the global factor correlation is high; and (iv) the comovements over the convergence period when the global factor correlation is high. In terms of equation (17), (i) corresponds to $p^{BL}(\theta)$, (ii) to $p^{AL}(\theta)$, (iii) to $p^{BH}(\theta)$, and (iv) to $p^{AH}(\theta)$. Probabilities of comovements are estimated between returns on Poland and the Czech Republic equity market indices. The pre-convergence period runs from the beginning of the sample to December 1999, while the convergence period from January 2000 to November 2005.

Figure 12a: $p^{BL}(\theta)$ *and* $p^{AL}(\theta)$

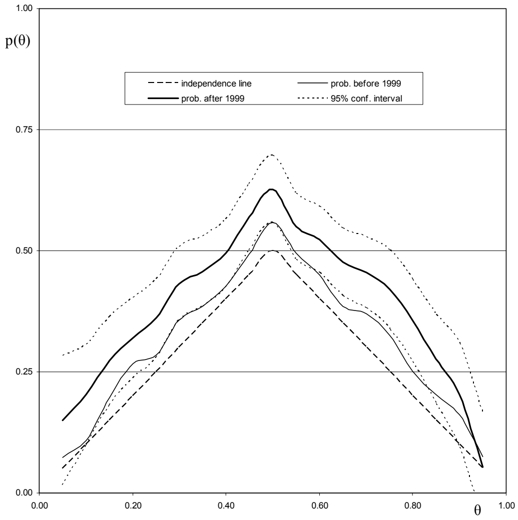


Figure 12b: $p^{BH}(\theta)$ *and* $p^{AH}(\theta)$

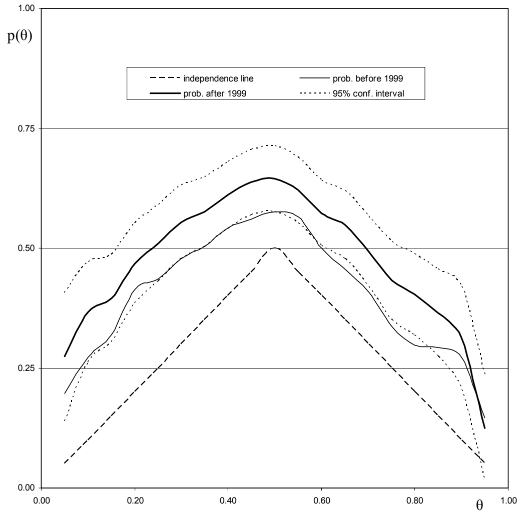


Figure 12c: $p^{AL}(\theta)$ *and* $p^{AH}(\theta)$

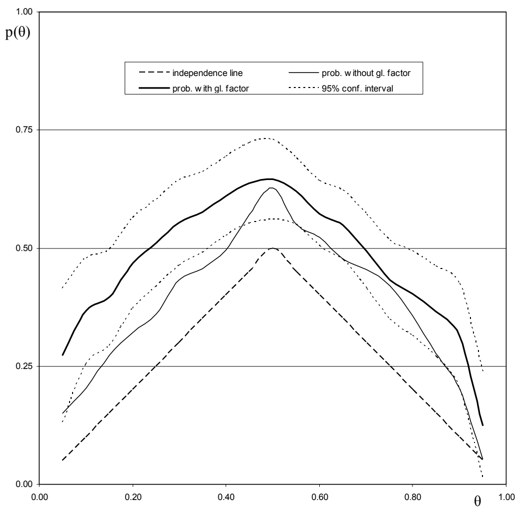


Figure 13: Robust probabilities of comovements between returns on 10-year government bonds - Germany vs Czech Republic

Figures 13a-13c plot four average probabilities of comovements: (i) the comovements over the benchmark period when the global factor correlation is low; (ii) the comovements over the test period when the global factor correlation is low; (iii) the comovements over the benchmark period when the global factor correlation is high; and (iv) the comovements over the test period when the global factor correlation is high. In terms of equation (17), (i) corresponds to $p^{BL}(\theta)$, (ii) to $p^{AL}(\theta)$, (iii) to $p^{BH}(\theta)$, and (iv) to $p^{AH}(\theta)$. Probabilities of comovements are estimated between returns on Germany and the Czech Republic equity market indices. The benchmark period runs from the beginning of the sample to December 2002, while the convergence period from January 2003 to November 2005.

Figure 13a: $p^{BL}(\theta)$ and $p^{AL}(\theta)$

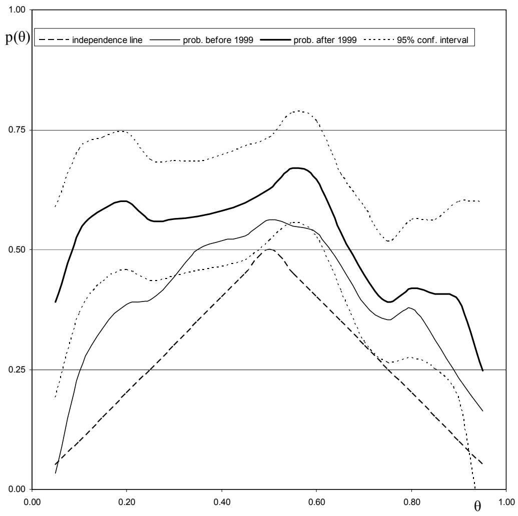


Figure 13b: $p^{BH}(\theta)$ and $p^{AH}(\theta)$

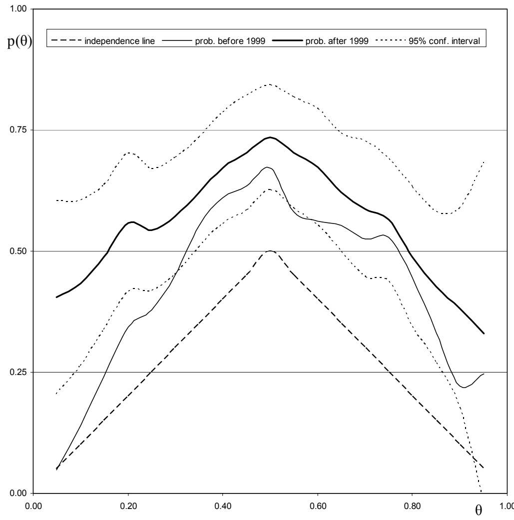


Figure 13c: $p^{AL}(\theta)$ and $p^{AH}(\theta)$

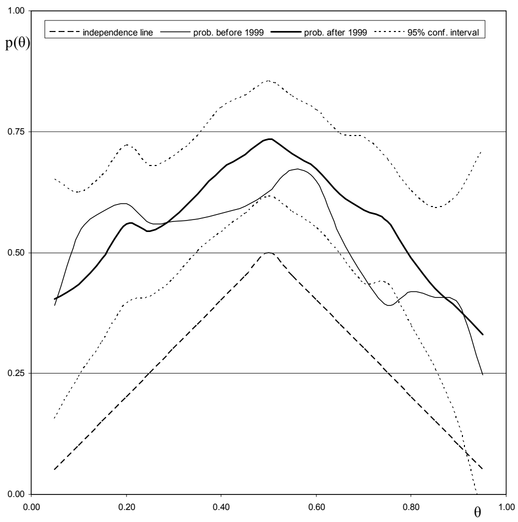


Figure 14: Robust probabilities of comovements between returns on 10-year government bonds - Poland vs Czech Republic

Figures 14a-14c plot five average probabilities of comovements: (i) the comovements over the benchmark period when the global factor correlation is low; (ii) the comovements over the test period when the global factor correlation is low; (iii) the comovements over the benchmark period when the global factor correlation is high; and (iv) the comovements over the test period when the global factor correlation is high. In terms of equation (17), (i) corresponds to $p^{BL}(\theta)$, (ii) to $p^{AL}(\theta)$, (iii) to $p^{BH}(\theta)$, and (iv) to $p^{AH}(\theta)$. Probabilities of comovements are estimated between returns on Poland and the Czech Republic equity market indices. The benchmark period runs from the beginning of the sample to December 2002, while the convergence period from January 2003 to November 2005.

Figure 14a: $p^{BL}(\theta)$ and $p^{AL}(\theta)$

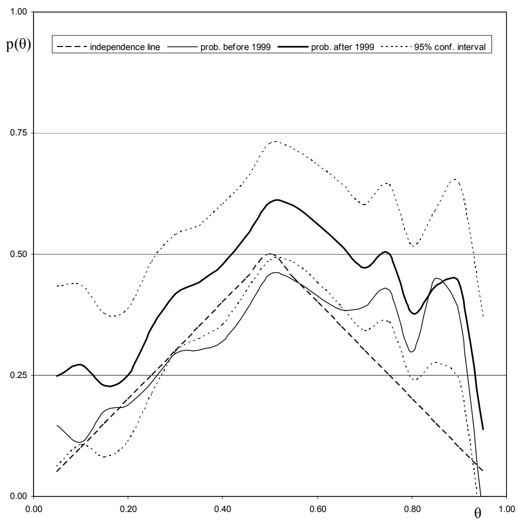


Figure 14b: $p^{BH}(\theta)$ and $p^{AH}(\theta)$

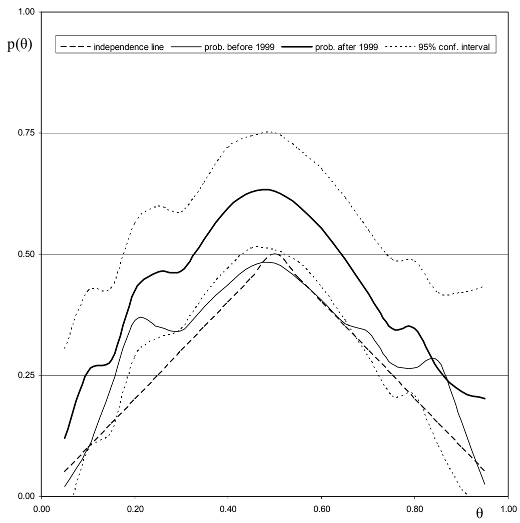
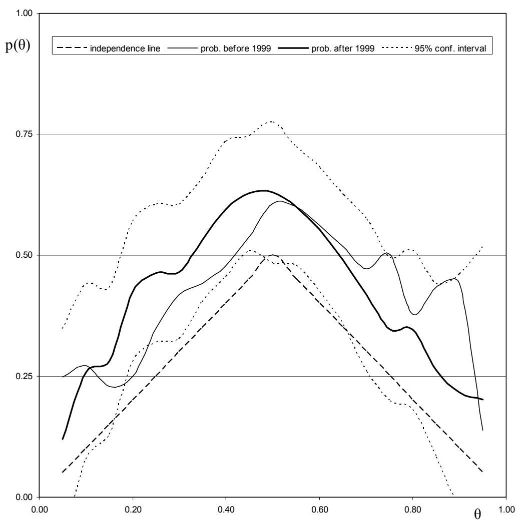


Figure 14c: $p^{AL}(\theta)$ and $p^{AH}(\theta)$



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