Bond Market and Stock Market Integration in Europe:A Smooth Transition Approach

Berben, Robert-Paul; Jansen, W. Jos

Bond Market and Stock Market Integration in Europe: A Smooth Transition Approach

Journal:	*Applied Economics*
Manuscript ID:	APE-06-0361.R1
Journal Selection:	Applied Economics
Date Submitted by the Author:	23-Jan-2007
Complete List of Authors:	Berben, Robert-Paul; De Nederlandsche Bank, Economics and Research Division jansen, w. jos; Ministry of Social Affairs and Employment, Economic Policy Department
JEL Code:	C22 - Time-Series Models < C2 - Econometric Methods: Single Equation Models < C - Mathematical and Quantitative Methods, G10 - General < G1 - General Financial Markets < G - Financial Economics, G15 - International Financial Markets < G1 - General Financial Markets < G - Financial Economics
Keywords:	financial integration, comovement, smooth transition, European integration

Bond Market and Stock Market Integration in Europe: A Smooth Transition Approach

Bond Market and Stock Market Integration in Europe

This paper investigates whether there has been a structural increase in financial market integration in nine European countries and the US in the period 1980-2003. We employ a GARCH model with a smoothly time-varying correlation to estimate the date of change and the speed of the transition between the low and high correlation regimes. Our test produces strong evidence of greater comovement across the board for both stock markets and government bond markets. Dates of change and speeds of adjustment vary widely across country linkages. Stock market integration is a more gradual process than bond market integration. The impact of European monetary union (EMU) is rather limited, as it has mainly affected the timing of bond market correlation gains (but hardly their size) and has had little discernible effect on stock market integration.

1. Introduction

The process towards European Economic and Monetary Union (EMU) has given a tremendous impetus to financial market integration in Europe. Capital controls were completely eliminated in the course of the 1980s and 1990s. The introduction of the euro on 1 January 1999 removed all remaining exchange rate risk among the EMU participants, and marked the beginning of a single monetary policy for the euro area. As a consequence, the money market became fully integrated. It is widely believed that EMU will also greatly affect European capital markets (Danthine, Giavazzi and von Thadden 2000). Cross-country differences in long-term interest rates fell sharply as long-run inflation expectations declined in countries with historical records of high inflation, and fiscal discipline improved. The degree of comovement among European equity markets seems to have increased as well. However, a substantial degree of segmentation continues to exist in European capital markets. To address this problem, the European Union has drawn up the Financial Services Action Plan (FSAP).

Although EMU has clearly been an important driver for change, financial market developments in Europe are part of a global phenomenon. Financial integration has been spurred on a global scale by advances in information technology, the world-wide liberalization of cross-border financial flows, financial innovation as well as growing economic integration due to intensifying international trade relations and the internationalization of production through foreign direct investment. Over the past twenty years, the importance of financial markets in many industrialized economies has grown sharply, while at the same time asset returns tend to display a more synchronized behavior. This observation holds for both stock markets and bond markets.

An accurate assessment of the degree of comovement among international financial markets is important for investors, supervisory authorities, and central bankers alike. An important empirical issue is whether the apparent rise in the degree of comovement among national financial markets is a structural phenomenon. It is conceivable that this idea is colored by a biased reading of the data. Empirical tests for changes in correlation usually involve some sort of two-step approach, where in the first step correlations are calculated over either fixed or moving subsamples, and in the second step the presence of level shifts or trends is assessed. These tests may suffer from two statistical deficiencies. First, Boyer, Gibson and Loretan (1999) show that changes in correlations over time or across regimes cannot be detected reliably by splitting a sample according to the realized values of the data. Tests of changes in correlations are therefore often severely biased. Put differently, it is not possible to assess the presence of an upward trend in correlations by looking at the (trending) behavior of subsample estimates of correlations. A second weakness, which particularly applies to the sample-splitting approach, is that such tests will lack power if the selected subsamples do not closely match the true correlation regimes. For these reasons, Berben and Jansen (2005) introduce a multivariate GARCH model with smoothly time-varying correlations, and derive a novel test for the constant correlation hypothesis that avoids the statistical weaknesses discussed above. Their set-up allows not only to endogenously determine the date of change, but also whether the transition to the new regime was abrupt or gradual.

In this paper, we attempt to find out whether there has been a structural increase in financial market integration in Europe, and if so, in which years the bulk of the gain was achieved. One of our aims is to investigate what influence the emergence of the monetary union has had on the process of financial market integration in Europe. Has it led to substantial gains in stock market integration, or has its impact been rather limited, as Baele (2005) claims? Our focus is on the dominant trends in the evolution of financial integration, which we measure by the conditional correlation between weekly returns. We employ a data set covering almost a quarter of a century (1980-2003). Our sample comprises ten countries: five countries from the euro area (Germany, France, Italy, the Netherlands and Belgium), the three EU-members that have not adopted the euro (Denmark, Sweden and the United Kingdom), Switzerland and the United States. Unlike most studies, which focus on either equity market or bond market integration, we contrast the different experiences of the stock market and the government bond market.[1] Differences in integration trends across markets or (groups of) countries may provide valuable clues about the forces that appear to drive financial market integration.

The remainder of this paper is organized as follows. Section 2 offers a brief survey of the literature. Section 3 discusses our time-varying correlation GARCH model and the Lagrange Multiplier test for the null-hypothesis of a constant correlation over time. Section 4 describes the data and Section 5 presents the empirical results. Section 6 contains a summary and some concluding remarks.

2. Overview of the literature

Although there is general agreement that correlations between equity markets are not constant over time, it is less clear whether correlations are actually trending upward.[2] For instance, Roll (1989), surveying a number of papers published in the 1980s, concludes that the increase in international stock return correlations in the 1980s compared to the 1970s is only of a small magnitude. Similarly, King, Sentana and Wadhwani (1994) find little support for a trend increase in correlations among stock markets for the 1970-90 period. They conclude that authors who argue that markets have become increasingly integrated on the basis of data immediately around the crash in 1987 might confuse a transitory (ie. around the crash) with a permanent increase in correlations. By contrast, Longin and Solnik (1995), who explicitly model the conditional

[1] Exceptions are Cappiello, Engle and Sheppard (2003), Christiansen (2004) and Kim, Moshirian and Wu (2006).
[2] Karolyi and Stulz (2003) offer a comprehensive survey of the literature on comovement among international equity markets.

multivariate distribution of international equity returns, are able to show that, for the period 1960-90, correlations between stock returns in the US and in France, Switzerland, Japan, and the UK, respectively, have increased significantly. Similarly, Berben and Jansen (2005) find a statistically significant, broad-based increase in stock market comovement among Germany, the UK and the US in the period 1980-2000, whereas the trend towards stock market integration seems to have bypassed Japan. Taking a long-term perspective, Goetzmann, Li and Rouwenhorst (2005) document that international equity correlations have changed dramatically through time, with peaks in the late 19th Century, the Great Depression, and the late 20th Century.

The arrival of EMU has stimulated interest into the issue whether (the process leading up to) EMU has led to increased integration of the national equity markets within the euro area. Having similar inflation rates and interest rates, a common monetary policy and constraints on fiscal policy (Stability and Growth Pact) can be expected to translate into greater similarity of the discount rates used to value future cash flows, and hence, a higher degree of stock market comovement. Hardouvellis, Malliaropulos and Priestley (1999) analyze the pre-EMU experience with an asset pricing model with a time-varying degree of integration. They conclude that the degree of a country's stock market integration (with the global European index) is positively related to the markets' perception of the probability that the country will join EMU. According to their estimates, stock market integration made large leaps after 1995. Similarly, Fratzscher (2002), investigating stock market integration among European equity markets in the years 1986-2000, concludes that stock markets in the euro area appear to be highly integrated since 1996 only. Theses results are generally seen as supporting the view that the European unification process is promoting greater integration of European stock markets. By contrast, Baele (2005) takes a different view on the link between stock market integration and the emergence of EMU. Employing longer time series than the papers cited above (1980-2000), his analysis based on a regime-switching GARCH model shows that the rise in European integration took mainly place in the second half of the 1980s and the first half of the 1990s. This finding suggests that further economic integration (boosted by the 1986 Single European Act) as well as efforts to further liberalize European capital markets were more important in bringing markets closer together than the process towards monetary integration and the introduction of the single currency.

Empirical work on international bond market integration is relatively scarce. Using data from the period of the EMS (1989-1994) for several European countries, Bodart and Reding (1999) find that a decrease in exchange rate volatility is accompanied by a rise in the correlation among bond markets. Christiansen (2006) estimates volatility spillover models in which volatility depends on global, regional and local effects. Her results for nine European bond markets show that bond market volatility in Europe is mainly affected by common European factors and own market effects before EMU. After the introduction of the euro, however, the influence of idiosyncratic factors appears to have decreased dramatically, while the importance of the European factor has sharply risen. Skintzi and Refenes (2004) study the time-varying correlation structure between twelve individual European bond market indices, the aggregate Euro area bond market index and the US bond market index in the years 1991-2002. Their findings suggest significant volatility spillovers from the US bond market to all individual European bond markets. Moreover, spillovers from the Euro area index have significantly increased for individual EMU-participants after the start of the monetary union. Estimates by Cappiello, Engle and Sheppard (2003) of a dynamic conditional correlation GARCH model show a rapid change to a near-perfect correlation among EMU bond markets in the second half of the 1990s. They also found an increase in correlation between the European and US bond markets.

3. The model

The empirical analysis focuses on the (bilateral) correlations between returns for all possible country pairs among the 10 countries (45 cases in all) for both stock returns and bond returns. The asset returns are modeled as a Smooth-Transition Correlation GARCH (STC-GARCH) process, which we developed in an earlier paper (Berben and Jansen 2005). The bivariate observed time series of asset returns y_t ($t = 1, \dots, n$), with elements $y_{1,t}$ and $y_{2,t}$, is described by the following model

$$y_t = \mu_{t-1} + \varepsilon_t \quad (1)$$

$$\mu_{t-1} = E[y_t | \Psi_{t-1}] \quad (2)$$

$$\varepsilon_t | \Psi_{t-1} \sim N(0, H_t) \quad (3)$$

where Ψ_{t-1} is the information set consisting of all relevant information up to and including time $t-1$, $E[.]$ is the expectation operator, ε_t is the unexpected part of the returns, and $N(.)$ denotes the bivariate normal distribution. H_t, the conditional covariance matrix of ε_t, is assumed to follow a time-varying structure given by

$$H_t = E[\varepsilon_t \varepsilon_t' | \Psi_{t-1}] \quad (4)$$

$$h_{11,t} = \omega_1 + \alpha_1 \varepsilon_{1,t-1}^2 + \beta_1 h_{11,t-1} \quad (5)$$

$$h_{22,t} = \omega_2 + \alpha_2 \varepsilon_{2,t-1}^2 + \beta_2 h_{22,t-1} \quad (6)$$

$$h_{12,t} = \rho_t (h_{11,t} h_{22,t})^{1/2} \quad (7)$$

$$\rho_t = \rho_0 (1 - G(s_t; \gamma, c)) + \rho_1 G(s_t; \gamma, c) \quad (8)$$

The conditional variances $h_{11,t}$ and $h_{22,t}$ both follow a GARCH(1,1) specification. The model allows for a smooth transition between two correlation regimes, which are characterized by ρ_0 and ρ_1. $G(s_t;\gamma,c)$ is the logistic function

$$G(s_t;\gamma,c) = \frac{1}{1+\exp(-\gamma(s_t - c))} \quad (9)$$

where s_t is the transition variable, and γ and c determine the smoothness and location, respectively, of the transition between the two correlation regimes. As our focus is on dominant, long-run trends in correlations among stock returns, there is one change in correlation regime and the transition variable is specified as a function of time: $s_t = t/n$.

The Smooth-Transition Correlation GARCH (STC-GARCH) model is able to capture a wide variety of patterns of change. The model allows for both structural increases and decreases. The pace of change between correlation regimes is abrupt for large values of γ, while the transition can be made arbitrarily gradual for small values of γ.[3] Bollerslev's (1990) constant correlation model is a special case of the STC-GARCH model. It obtains if either $\rho_0 = \rho_1$ or $\gamma = 0$.

Assuming normality, the log-likelihood of the observation at time *t* is given by (ignoring constants)

$$l_t(\theta) = -\frac{1}{2}\ln|H_t| - \frac{1}{2}\varepsilon_t^{'}H_t^{-1}\varepsilon_t \quad (10)$$

where θ is the vector of all the parameters to be estimated. The log-likelihood for the whole sample from time 1 to *n*, $L(\theta)$, is given by

$$L(\theta) = \sum_{t=1}^{n} l_t(\theta) \quad (11)$$

This log-likelihood is maximized with respect to all parameters simultaneously, employing numerical derivatives of the log-likelihood. Robust standard errors of the parameter estimates are computed using the procedure proposed by Bollerslev and Wooldridge (1992).

[3] Note that if $\gamma \to \infty$, the transition between ρ_0 and ρ_1 becomes a step at $t = cn$.

Before we estimate the STC-GARCH model, we first formally test whether it outperforms the constant correlation GARCH model. As discussed above, the constant correlation GARCH model can be obtained from the STC-GARCH model by either setting $\gamma = 0$ or $\rho_0 = \rho_1$. This illustrates that any test of the constant correlation hypothesis in the STC-GARCH model will suffer from unidentified nuisance parameters under the null hypothesis, which is typical for tests of structural change.[4] Berben and Jansen (2005) derive a Lagrange Multiplier test that deals with this problem.

4. Data

We use weekly holding period returns on stocks and government bonds for 10 countries: Belgium, Denmark, France, Germany, Italy, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States.[5] Stock returns refer to the Datastream broad stock market index; bond returns refer to the J.P. Morgan government bond index. All data are from Datastream. Weekly returns are calculated from daily price indices (closing values), as weekly log first differences from Thursday to Thursday, multiplied by one hundred. We use weekly data to avoid spurious spillover effects due to non-synchronous trading hours.[6] Furthermore, from the perspective of a policy maker concerned with financial stability, correlations at a high frequency are more relevant than correlations over long horizons.[7] Our exact concept of return is chosen such that it matches, as closely as possible, price developments as they are perceived by policy makers and in the financial press. That means first of all that we focus on returns denominated in local currency. This amounts to analyzing returns on portfolios that are fully hedged against exchange rate risk. Furthermore, stock price indices are not corrected for dividend payments. Our definition of the bond return does include coupon payments, however, as the J.P. Morgan government bond indices are constructed by assuming that coupon payments and redemptions are reinvested in new government bond issues.

Subject to data availability, we collected weekly data spanning 24 years (3 January 1980 through 24 December 2003). In a number of cases data were available for shorter time-spans. Table 1 presents information on the sample, the number of observations and some descriptive statistics of the time series of the weekly returns. According to Richardson and Smith's (1994) robust test for first order autocorrelation, the stock return series do not show evidence of serial correlation. The bond return series displays statistically significant autocorrelation (at the 10% level) for Denmark, Germany, the Netherlands, Switzerland, the United Kingdom and the United States. The statistical model therefore includes autoregressive terms in the mean equation (1) in these cases. Results on Engle's ARCH test (allowing for five lags), suggest that second

[4] Hansen (1996) presents a general treatment of the issue of unidentified nuisance parameters in econometric tests.
[5] We did not include Japan, because Berben and Jansen (2005) found that the LM test indicated that stock market correlations between Japan and the UK, the US and Germany respectively did not change in the years 1980-2000.
[6] Burns, Engle and Mezrich (1998) show that aggregation to weekly returns largely solves the problems caused by non-synchronous trading hours.
[7] Monthly correlations display the same trending behavior as weekly correlations.

moments are heavily autocorrelated with long lags for all returns, pointing towards an ARCH parameterization for the second moments. We model the conditional variances in our multivariate GARCH model as GARCH(1,1) processes, as the empirical literature has found that this specification adequately captures the persistence in second moments of high frequency asset returns.

5. When and how quickly did correlations change?

In this section, we investigate whether a structural change has occurred in the correlations among the financial markets of our 10 countries. We first formally test the hypothesis of an unchanged correlation for each country pair and financial market (90 tests in all), applying the LM test of Berben and Jansen (2005). The null hypothesis of no change is rejected at the 1% significance level in 89 out of 90 cases.[8] In fact, the marginal significance level of the test statistic is essentially zero for the large majority of country pairs. As the LM test produces overwhelming evidence in favor of change, we subsequently estimate the STC-GARCH model to determine the date and speed of these changes, obtaining a profile of the correlation's evolution over time. We also contrast the experiences with stock market integration and these with government bond market integration in the past twenty years or so. This may shed light on the interesting issue of which fundamental forces seem to shape the integration process in financial markets, and to what extent these forces may differ between stock markets and government bond markets.

Bond return correlations

We first estimate the STC-GARCH model for bond returns, using all available observations for each country pair. Table 2 presents the main characteristics of the time profile of the bond market correlations that can be derived from the estimates.[9] We first show the estimated values of the correlation at the start of the sample and in December 2003. Next we present the change in the correlation over this time-span. Under the heading 'break date' we report the month that corresponds to the parameter c, which determines the location of the inflection point of the transition curve. This is the point in time at which the correlation changed at the fastest pace. The next column reports by how much the correlation changed during the year surrounding the break date (six months before through six months after the break date). The final column expresses the change during this twelve months period as a percentage of the total change over the complete sample. The larger this percentage, the more abrupt the transition has been. Plots of all estimated time profiles are available from the authors upon request. The rows of the table refer to the 45 possible country pairs, which are grouped together in the following way. The first ten rows present the results for all possible pairs within the euro zone. The next 15 rows involve the pairs between our five euro area countries and the three EU-members that did not adopt the euro. We then present the results for the three pairs among the latter three

[8] The one exception is the stock return correlation between Germany and Switzerland (p-value 0.025). The results of the LM test are available from the authors upon request.

countries. Links between Switzerland and EU-countries are next, and the table closes with all the country pairs involving the US.

A glance through Table 2 immediately makes clear that dates of change and speeds of adjustment vary widely across country linkages. Among the shapes of the transition curve are abrupt steps, steep S-shapes, elongated curves and (virtually) straight lines. Moreover, all changes involve increases. The main message of Table 2 is that bond market integration among the ten industrialized countries of our sample underwent a sea change in the past 20 years. To an important extent this is a global phenomenon. However, significant differences in the size, and pace and timing of correlation changes can be observed between different groups of countries.

As expected, the five countries from the euro area display the most dramatic changes in bond market integration. The average estimated correlation among the EMU members is around 0.97 at the end of 2003. The most extreme transitions involve Italy. In a very short time, Italy's bond return correlations with the other EMU participants increased by 0.50 to 0.60 points to a level of about 0.95. In fact, 55% to 70% of this tremendous gain was accomplished within the span of a year (mid-1997 through mid-1998). The correlations among the other EMU members also show large gains, and much of these can be dated to the second half of the 1990s. In these cases the transition appears to have been fairly swift as well, with the twelve months of fastest change typically accounting for around 30% of the total increase. The one exception is the Dutch-German link, for which the break is pinpointed in the middle of 1990 and much of the gain was accomplished by 1995 already. The correlation was comparatively large in 1980 (over 0.60) and only rose gradually over time. The Dutch and German bond markets were the best integrated pair within the euro area in the pre-EMU years.

Correlations between euro area countries and Denmark, Sweden and the UK have also greatly increased between 1988 and 2003. In fact, many correlations display a larger gain than the correlations within the euro area, pointing to a catch-up of the three countries with the rest of the EU. The average value of these 15 correlations was about 0.93 at the end of 2003, indicating a very high degree of integration, albeit not so close as within the euro area. Interestingly, the increase in bond market integration between EMU members and non-EMU members within the European Union seems to have been a much more gradual process than that among the euro area countries. Break dates are more scattered through time, and the differences between the average pace of change and that around the break date are mostly rather small.

Turning to the correlations between EU countries and non-EU countries, we also see large gains in bond market comovement. Linkages with the Swiss government bond market have intensified in a very gradual

[9] As the parameters of the model are difficult to interpret, we report the estimates of the model in an appendix that is available from the authors upon request.

fashion for all EU countries. The introduction of the euro does not appear to have had any visible impact on the integration process. Despite large gains since 1980, correlation values hover in the range 0.75-0.80 at the end of 2003 for all EU countries except the UK (0.69), which is substantially lower than the correlations prevailing within the European Union. In contrast to linkages between EU countries and Switzerland, linkages between EU and US bond markets show a remarkable intensification in the second half of the 1990s. Breakdates mostly fall in the pre-EMU years 1996-1998, with fairly steep transitions for several linkages. The average value of the eight EU-US correlations is around 0.75 in 2003, pointing to a significantly lower degree of integration of the US and European bond markets compared to that within the European Union.

As a summary, Figure 1 depicts the evolution of the average bond return correlation for three country groupings: (1) that among EMU-members Germany, France, Italy, the Netherlands and Belgium (10 correlations); (2) that between the euro area countries and Denmark, Sweden and the UK (15 correlations); and (3) that between the EU countries and the United States (8 correlations). Figure 1 clearly demonstrates that the bond market integration process has a large global component. This component may partly be determined by the ever-intensifying relationships among countries in the areas of international trade, foreign direct investment and cross-border portfolio investment. As a result, business cycles display an increasing degree of comovement over time.[10] In 2001, the dispersion of economic growth rates across the industrialized economies even fell to its lowest level in over 30 years. Moreover, the emergence of low and stable inflation around the globe has played a crucial part, as has the consensus that central banks should strive for low and stable inflation. Finally, government finances are in better shape today than in the late 1980s and early 1990s.

Figure 1 also conveys the impression that there is a European component, as correlations among EU bond markets are greater than those between EU bond markets and non-EU bond markets (Switzerland and the US). This can be explained by the fact that the forces that underlie the global trend towards greater interdependence are even more pronounced within Europe due to the Single Market program. Although the introduction of the euro triggered a tremendous acceleration of the integration trend in the years 1996-1998 among the countries that adopted the single currency, it has had no discernible effects on integration after 1999 (see also Baele et al. 2004). By contrast, bond market integration outside the euro area has continued to make advances after 1999. The rather small differences at the end of 2003 between linkages among euro countries themselves on the one hand, and those between euro countries and non-euro countries on the other hand, in combination with the finding that the latter group of linkages has evolved more smoothly over time, suggest that the arrival of EMU has mainly affected the timing of the rise in integration.

[10] Recent empirical evidence on increasing business cycle comovement is provided by Lumsdaine and Prasad (2003) and Helbling and Bayoumi (2003), among others.

The patterns of change within the European Union suggest that exchange rate stability (credibility of pegs) may be an important driving factor of bond market integration. This is consistent with research by Bodart and Reding (1999), who found that a decrease in exchange rate volatility is associated with a rise in bond market correlation. The integration process started off with Germany and the Netherlands, which maintained the most credible peg in the EMS, in the late 1980s. After the turbulence of the EMS crises in 1992-93 had died down and the move towards the monetary union was envisaged, integration with Belgium and France, which belonged to the core of the EMS, began to make great strides forward. By contrast, bond market linkages with Italy, with its history of exchange rate crises, remained tenuous until 1997, when financial markets apparently became convinced that Italy would join EMU from the start in 1999, thereby definitely making devaluations a thing of the past. Looking at the linkages between EMU-members and the non-euro EU-members the same pattern emerges. Denmark, which maintains a fixed exchange rate versus the euro, has the closest bond market links with the euro area in 2003 (correlations exceeding 0.95). Bond market correlations are significantly lower for the UK (still 0.90 though), which lets its currency freely float against the euro.

Stock market return correlations

Turning now to the stock market experience, Table 3 presents the main characteristics of the time profile of the stock market correlations in the period 1980-2003. Like for bond market integration, we find that dates of change and speeds of adjustment vary widely across country pairs, and that all changes are increases. Among the shapes of the transition curve are abrupt steps, steep S-shapes, elongated curves and (virtually) straight lines. The degree of stock market comovement in the industrialized world has greatly increased since 1980. As a global measure of the shift: the simple average of the 45 stock return correlations went up from 0.19 in 1980 to 0.71 in 2003. Many break dates are located in the second half of the 1980s, implying that much of the total change happened in the 1980s. Hence, with the benefit of hindsight, we may conclude that the conjecture by King, Sentana and Wadhwani (1994) that much of the observed gain in stock market integration in the late 1980s involved a transitory shift, has turned out to be wrong.

Comparing the profiles in Tables 2 and 3, it appears that stock market integration evolves in a more gradual fashion than bond market integration. Bond market correlations typically show larger gains than stock market correlations in the year around the break date, when the speed of change is at its maximum. Linkages involving Denmark are the main exception to this pattern. In the year of fastest change, the average bond market correlation increases by 0.106 (averaged over the 45 bilateral linkages), against 0.065 for the average stock market correlation.

In the euro area, stock market integration has progressed at a fairly constant pace. Relatively swift transitions only occur for Belgium, but these transitions are still rather modest by bond market standards. Episodes with the most rapid change are generally located in the late 1980s or early 1990s, preceding the convergence phase prior to EMU by a wide margin. Our results corroborate those of Baele (2005), who finds that the largest increase in stock market integration took place in the period 1985-1995. In 2003, the average stock market correlation within the euro area equaled 0.79 (compared to 0.97 for the government bond markets). Euro area bond markets thus exhibit a much larger tendency to move together than euro area stock markets. Moreover, stock markets display larger differences in integration than bond markets. Belgium is the least integrated stock market in the euro area.

Looking at the linkages between the five euro area countries and Denmark, Sweden and the United Kingdom, we also find that break dates are often located in the 1980s. Within this country grouping, Denmark went through very abrupt changes in integration at the time of the 1987 stock market crash. At the end of 2003, stock market correlations between euro area countries on the one hand, and Denmark, Sweden and the United Kingdom on the other were on average 0.70, somewhat lower that its counterpart among the EMU members (0.79). However, this number hides a sizable difference between Denmark and the other two non-euro EU countries. The Danish stock market shows a much lower degree of integration with the euro area stock markets than Sweden and the UK.

Stock market linkages between EU countries and Switzerland typically intensified in a very gradual fashion. Only the German-Swiss link, which is historically a strong one, displays a sudden transition in the aftermath of the stock market downturn after 2000. Finally, coming to the links between Europe and the US, we find break dates mostly fall in the second half of the sample. Transitions are generally smooth, with the exception of Belgium (jump in 1987), Switzerland and the Netherlands (steep increase after 2000). Compared to the dating of structural change within Europe, changes in linkages between Europe and the US have taken place a couple of years later. By the end of 2003, linkages between most European stock markets and the US stock market have become quite similar in strength. In terms of correlations, countries such as France and Italy have caught up with the Netherlands and Switzerland, which always have had relatively close stock market links with the US. US stock market linkages with Belgium and Denmark are still quite weak, however.

As the counterpart to Figure 1, Figure 2 summarizes the evolution of stock return correlations between 1980 and 2003. Once again, the global factor jumps to the fore. There is also a euro area factor. At the end of 2003, correlations within the euro area are the largest, and they also display the largest gains between 1980 and 2003. Since the late 1980s, comovement among euro area markets has developed at a faster pace than in the rest of the European Union. However, the introduction of the common currency as such does not appear to have had a significant impact on the pace and timing of stock market integration. This is a notable difference with the recent experience with bond market integration. The invisibility of the EMU-event in the time profiles suggests that stock market integration is less driven by factors such as monetary policy convergence, better fiscal policy coordination and greater exchange rate stability, and more by slow-moving underlying trends such as ever closer trade linkages, continuous capital market liberalization and intensifying foreign direct investment relations (see also Baele 2005). Correlation patterns at the end of 2003 also suggest that exchange rate stability has a minor influence on stock market integration, which is in accordance with the empirical findings of Bodart and Reding (1999). For example, stock market linkages between the euro area and UK are much tighter than those between the euro area and Denmark, despite the peg between the Danish krone and the euro, whereas for government bond market linkages the reverse pattern is observed.

Stock market return correlations, 1988-2003

As explained in section 3, our STC-GARCH model estimates the dominant trend of the correlation over the period 1980-2003. Our finding that stock market integration in the euro area did not accelerate in the run-up to EMU should be interpreted in the context of this relatively long sample. It is conceivable that European stock market integration did get a boost from monetary union, but that our model fails to pick this up because the change is not big enough compared to what happened in the 1980s. To further investigate this issue, we have rerun the LM-test for structural change and re-estimated the STC-GARCH models, using data from 1988-2003. Table 4 presents the main characteristics of the time profiles of the stock market correlations in this period, while Figure 3 plots the evolution of stock return correlations among country groups. In a large number cases Table 4 indeed offers evidence of structural change at a relatively late point of time in the shorter sample. Within the euro area, this holds for eight out of the ten linkages (exceptions are the pairs Germany-Netherlands and Germany-Belgium). Figure 3 shows that the average correlation within the euro area increased at a faster pace in the years 1996-2001, which at first sight appears to be supportive evidence for the notion that the introduction of the euro has directly affected the stock market integration process within Europe. However, taking a closer look, it is mainly the Italian linkages that are consistent with this hypothesis. The Belgian correlations only go up quickly from 2001 onward, well after the start of the monetary union. Moreover, Figure 3 makes clear that correlations between US (and Swiss) markets and European markets went up as well in the second half of the 1990s, and posted gains of comparable magnitude. This suggests that the recently observed rise in stock market integration in the euro area probably reflects a global factor, for example the global stock market bubble and its aftermath.

6. Conclusion

This paper investigates whether there has been a structural increase in financial market integration in nine European countries and the US. We focus on the dominant trend of conditional cross-country correlations in both stock and bond markets in the period 1980-2003. Employing a series of bivariate GARCH models with a smoothly time-varying correlation, we first formally test the constant-correlation hypothesis directly by way of a Lagrange Multiplier (LM) test. Our procedure treats both the date of change and the speed of the transition as being endogenous, and thus avoids the statistical deficiencies which often afflict other approaches in the literature.

Our main findings can be summarized as follows. The LM-test produces very strong evidence of greater comovement across the board for both stock markets and bond markets. Dates of change and the speeds of the transition between low and high correlation regimes vary widely across country linkages. This finding suggests that the observed structural shift towards a greater degree of comovement among international financial markets is not solely governed by global factors – such as advances in information technology, financial innovation, greater trade interdependence and convergence of inflation rates to a low level – but that country-specific factors also have a substantial impact. Relevant country-specific factors may be exchange rate risk, market size, differences in economic policies and financial market regulation, and differences in transaction costs and information costs. Apart from the large global component, the integration process in Europe contains a substantial common factor. For euro area countries, the highest correlations are found among themselves, and the lowest with the US and Switzerland.

Comparing the correlation time profiles across type of market, we find that stock market integration is a more gradual process than bond market integration. Moreover, exchange rate stability and monetary (and fiscal) policy convergence appear to be more important drivers for bond market integration than stock market integration. Regarding the emergence of the European monetary union on 1 January 1999, our results suggest that its impact has been rather limited. For government bond markets, EMU has affected the timing of the integration advances rather than the size of them. The run-up to EMU in the years 1996-1998 coincides with a sudden and large increase in bond market correlations among euro area countries to near-perfect levels, translating into a large gap between correlations among euro adopters on the one hand and correlations between euro adopters and non-adopters on the other hand at the beginning of 1999. However, this gap has not persisted, as over the next five years bond market linkages between EMU members and non-EMU members have continued to strengthen. As for stock markets, EMU appears to have hardly influenced the pace of stock market integration within Europe. Much of the gains were realized in the late 1980s and early 1990s. Although an acceleration of the integration trend in the euro area was detected in the late 1990s when we focused on a shorter sample, this appears to reflect a global factor.

Our finding of widely varying dates and speeds of structural change is a strong reminder that a flexible approach to modeling structural change really pays dividends. However, our methodology still contains some important restrictive elements, in particular the strict monotonicity of correlation change and the limitation to two correlation regimes. As our research provides some preliminary evidence that stock market integration may have advanced in two stages (late 1980s and late 1990s), relaxing these restrictions is an interesting topic for future research. An alternative set-up would be not to use time as the transition variable, but a measure of interdependence, for instance international trade patterns. As such variables may not be necessarily monotonic, this also introduces the possibility of non-monotonic change. An additional advantage of this approach is that it may shed some light on the underlying causes of long-run changes in the degree of financial market comovement.

References

Baele, L. (2005), Volatility spillover effects in European equity markets, *Journal of Financial and Quantitative Analysis* **40**, 509-530.

Baele, L., A. Ferrando, P. Hördahl, E. Krylova and C. Monnet (2004), Measuring European financial integration, *Oxford Review of Economic Policy* **20**, 509-530.

Berben, R.P. and W.J. Jansen (2005), Comovement in international equity markets: A sectoral view, *Journal of International Money and Finance* **24**, 832-857.

Bodart, V. and P. Reding (1999), Exchange regime, volatility and international correlations on bond and stock markets, *Journal of International Money and Finance* **18**, 133-151.

Bollerslev, T. (1990), Modeling the coherence in short-run nominal exchange rates: a multivariate generalized ARCH approach, *Review of Economics and Statistics* **72**, 498-505.

Bollerslev, T. and J.M. Wooldridge (1992), Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances, *Econometric Reviews* **11**, 143-172.

Boyer, B.H., M.S. Gibson and M. Loretan (1999), Pitfalls in tests for changes in correlations, International Finance Discussion Paper 597, Federal Reserve Board, Washington, DC.

Burns, P., R.F. Engle and J. Mezrich (1998), Correlation and volatilities of asynchronous data, *Journal of Derivatives* **4**, 1-12.

Cappiello, L., R.F. Engle and K. Sheppard (2003), Asymmetric dynamics in the correlations of global equity and bond markets, ECB Working Paper 204 (January).

Christiansen, C. (2004), Decomposing European bond and equity volatility, Finance Research Group Working Paper F-2004-01, University of Aarhus.

Christiansen, C. (2006), Volatility-spillover effects in European bond markets, forthcoming in *European Financial Management.*

Danthine, J.-P., F. Giavazzi and I.-L. von Thadden (2000), European financial markets after EMU: A first assessment, NBER Working Paper no. 8044 (December).

Fratzscher, M. (2002), Financial market integration in Europe: On the effects of EMU on stock markets, *International Journal of Finance and Economics* **7**, 165-193.

Goetzmann, W.N., L. Li and K.G. Rouwenhorst (2005), Long-term global market correlations, *Journal of Business* **78**, 1-38.

Hansen, B.E. (1996), Inference when a nuisance parameter is not identified under the null hypothesis, *Econometrica* **64**, 413-430.

Helbling, T. and T. Bayoumi (2003), Are they all in the same boat? The 2002-2001 growth slowdown and the G-7 business cycle linkages, IMF Working Paper 03/46 (March), International Monetary Fund.

Karolyi, G.A. and R.M. Stulz (2003), Are financial assets priced locally or globally?, in *Handbook of the Economics of Finance* (eds.) G.M. Constantinidis, M. Harris and R.M. Stulz, Elsevier.

Kim, S. J., F. Moshirian and E. Wu (2006), Evolution of international stock and bond market integration: influence of the European Monetary Union, *Journal of Banking & Finance* **30**, 1507-1534.

King, M., E. Sentana and S. Wadhwani (1994), Volatility and links between national stock markets, *Econometrica* **62**, 901-933.

Longin, F. and B. Solnik (1995), Is the correlation in international equity returns constant: 1960-1990?, *Journal of International Money and Finance* **14**, 3-26.

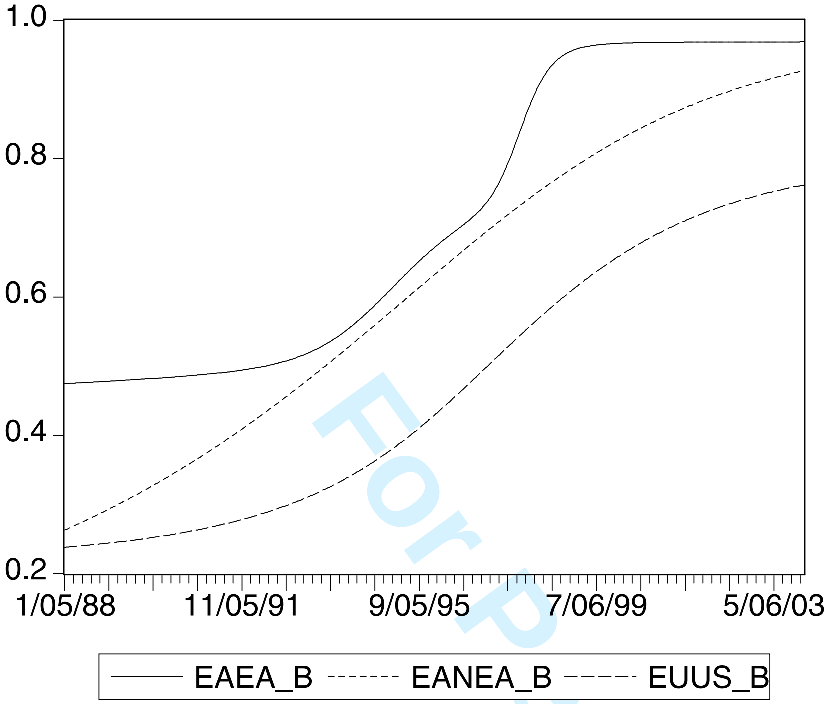
Lumsdaine, R.L. and E.S. Prasad (2003), Identifying the common component of international economic fluctuations: A new approach, *Economic Journal*, 113, 101-127.

Richardson, M. and T. Smith (1994), A unified approach to testing for serial correlation in stock returns, *Journal of Business* **67**, 371-399.

Roll, R. (1989), Price volatility, international market links, and their implications for regulatory policies, *Journal of Financial Services Research* **3**, 211-246.

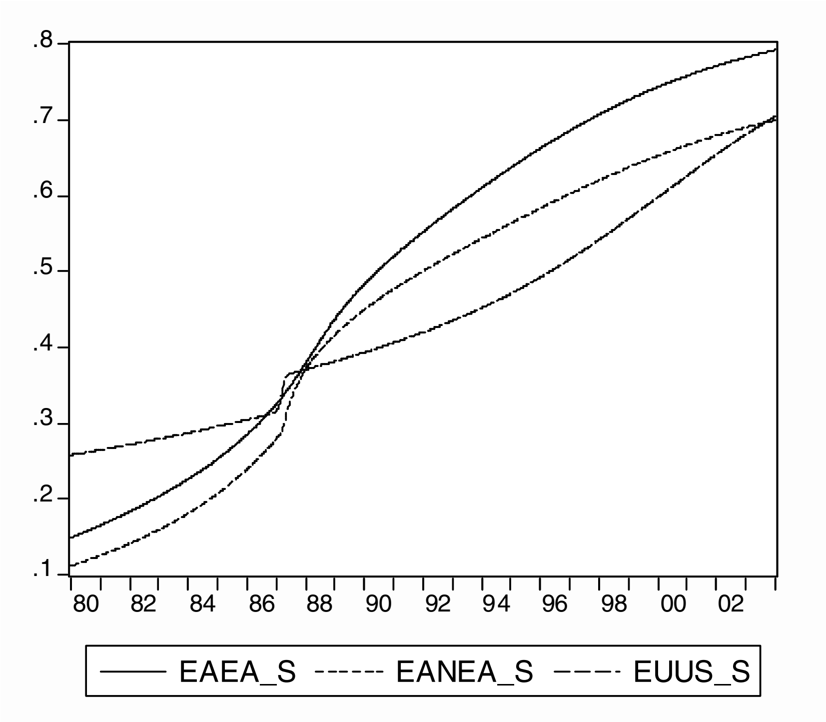
Skintzi, V.D., and A.P.N. Refenes (2004), Volatility spillovers and dynamic correlation in European bond markets, Working Paper, Athens University of Economics and Business.

Figure 1. Unweighted average of bond return correlations among groups of countries, 1988-2003



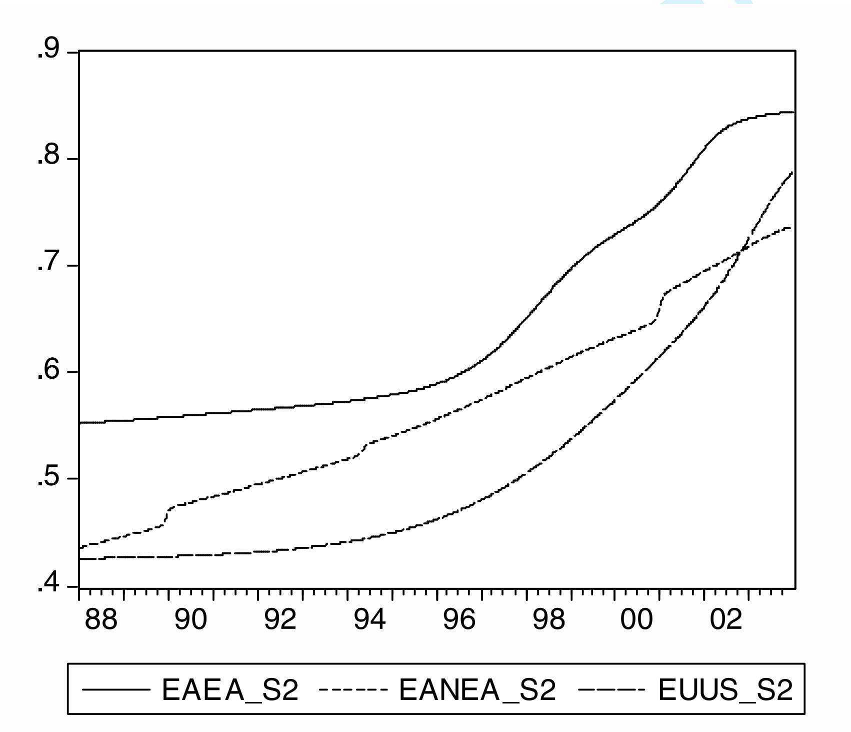
Note: EAEA = correlations among euro area countries (Belgium, France, Germany, Italy, the Netherlands); EANEA = correlations between the euro area countries and Denmark, Sweden, and the UK; EUUS = correlations between the EU countries and the US.

Figure 2. Unweighted average of stock return correlations among groups of countries, 1980-2003



Note: EAEA = correlations among euro area countries (Belgium, France, Germany, Italy, the Netherlands); EANEA = correlations between the euro area countries and Denmark, Sweden, and the UK; EUUS = correlations between the EU countries and the US.

Figure 3. Unweighted average of stock return correlations among groups of countries, 1988-2003



Note: EAEA = correlations among euro area countries (Belgium, France, Germany, Italy, the Netherlands); EANEA = correlations between the euro area countries and Denmark, Sweden, and the UK; EUUS = correlations between the EU countries and the US.

Table 1. Data availability and summary statistics weekly returns

Bonds

	period	#obs	mean	standard deviation	test AR(1)	p-value	test ARCH(5)	p-value
Germany	1980:01-2003:12	1252	0.138	0.577	20.35	0.000	91.8	0.000
France	1980:01-2003:12	1252	0.171	0.628	0.04	0.851	201.0	0.000
Italy	1980:01-2003:12	1252	0.208	0.626	0.27	0.603	90.4	0.000
Netherlands	1980:01-2003:12	1252	0.155	0.593	14.39	0.000	169.6	0.000
Belgium	1980:01-2003:12	1252	0.160	0.499	1.46	0.227	159.9	0.000
Denmark	1980:01-2003:12	1252	0.191	0.610	3.77	0.052	67.9	0.000
Sweden	1982:01-2003:12	1147	0.185	0.678	0.08	0.777	36.0	0.000
UK	1980:01-2003:12	1252	0.216	1.066	6.01	0.014	20.1	0.001
Switzerland	1980:01-2003:12	1252	0.102	0.502	19.84	0.000	41.9	0.000
US	1980:01-2003:12	1252	0.176	0.951	3.57	0.059	157.5	0.000

Stocks

	period		mean	standard deviation	AR(1)	p-value	ARCH(5)	p-value
Germany	1980:01-2003:12	1252	0.139	2.450	1.95	0.163	151.0	0.000
France	1985:01-2003:12	990	0.191	2.663	1.21	0.271	79.7	0.000
Italy	1988:01-2003:12	834	0.236	3.334	0.84	0.361	185.9	0.000
Netherlands	1980:01-2003:12	1252	0.186	2.284	0.42	0.516	97.5	0.000
Belgium	1986:01-2003:12	938	0.164	2.193	2.41	0.120	37.6	0.000
Denmark	1985:01-2003:12	990	0.250	2.385	1.18	0.278	22.6	0.000
Sweden	1987:02-2003:12	881	0.242	3.317	0.04	0.841	96.5	0.000
UK	1980:01-2003:12	1252	0.192	2.196	0.50	0.480	36.5	0.000
Switzerland	1980:12-2003:12	1203	0.176	2.142	2.04	0.153	162.1	0.000
US	1980:01-2003:12	1252	0.199	2.198	0.02	0.897	28.5	0.000

Note: AR(1) is the robust test for first order autocorrelation from Richardson and Smith (1994).
ARCH(5) is the test for autoregressive conditional heteroskedasticity (up to 5 lags) from Engle (1982).

Table 2. Characteristics of time profile of government bond return correlations

		start of sample	estimated correlation at start of sample	estimated correlation at the end of 2003	change in correlation	break date	correlation change in year around break date	percent of total change in year around break date
Germany	France	1985.01	0.519	0.965	0.446	1995.03	0.123	28
Germany	Italy	1988.01	0.309	0.940	0.630	1997.10	0.442	70
Germany	Netherlands	1980.01	0.616	0.994	0.377	1990.07	0.040	11
Germany	Belgium	1986.01	0.459	0.958	0.499	1994.06	0.146	29
France	Italy	1988.01	0.496	0.979	0.483	1997.12	0.304	63
France	Netherlands	1985.01	0.526	0.968	0.441	1995.07	0.137	31
France	Belgium	1986.01	0.476	0.994	0.519	1995.03	0.138	27
Italy	Netherlands	1988.01	0.344	0.941	0.596	1997.09	0.394	66
Italy	Belgium	1988.01	0.372	0.983	0.611	1997.11	0.338	55
Netherlands	Belgium	1986.01	0.537	0.963	0.426	1994.10	0.137	32
Germany	Denmark	1985.01	0.171	0.953	0.782	1992.01	0.062	8
France	Denmark	1985.01	0.082	0.958	0.876	1985.12	0.087	10
Italy	Denmark	1988.01	0.305	0.958	0.653	1996.05	0.069	11
Netherlands	Denmark	1985.01	0.230	0.961	0.731	1994.01	0.064	9
Belgium	Denmark	1986.01	0.306	0.954	0.648	1993.01	0.053	8
Germany	Sweden	1987.02	0.284	0.945	0.661	1997.09	0.076	11
France	Sweden	1987.02	0.333	0.945	0.612	1996.10	0.060	10
Italy	Sweden	1988.01	0.189	0.917	0.728	1995.06	0.063	9
Netherlands	Sweden	1987.02	0.216	0.947	0.731	1997.04	0.081	11
Belgium	Sweden	1987.02	0.166	0.932	0.766	1996.02	0.070	9
Germany	UK	1980.01	0.195	0.904	0.709	1994.02	0.045	6
France	UK	1985.01	0.145	0.903	0.758	1991.06	0.052	7
Italy	UK	1988.01	-0.020	0.900	0.921	1994.10	0.078	9
Netherlands	UK	1980.01	0.068	0.900	0.831	1990.09	0.047	6
Belgium	UK	1986.01	0.188	0.838	0.650	1993.09	0.069	11
Denmark	Sweden	1987.02	0.167	0.920	0.753	1994.07	0.157	21
Denmark	UK	1985.01	-0.003	0.904	0.907	1993.03	0.065	7
Sweden	UK	1987.02	0.256	0.915	0.659	1998.09	0.074	11
Germany	Switzerland	1980.12	0.265	0.797	0.532	1998.01	0.034	6
France	Switzerland	1985.01	0.047	0.754	0.707	1993.12	0.061	9
Italy	Switzerland	1988.01	0.046	0.758	0.712	1997.12	0.059	8
Netherlands	Switzerland	1980.12	0.327	0.798	0.471	1999.09	0.036	8
Belgium	Switzerland	1986.01	0.301	0.783	0.482	2000.03	0.042	9
Denmark	Switzerland	1985.01	-0.032	0.784	0.815	1993.08	0.056	7
Sweden	Switzerland	1987.02	0.094	0.782	0.688	1997.07	0.051	7
UK	Switzerland	1980.12	-0.031	0.690	0.721	1995.10	0.038	5
Germany	US	1980.01	0.361	0.758	0.398	1997.01	0.059	15
France	US	1985.01	0.334	0.782	0.448	1997.09	0.068	15
Italy	US	1988.01	0.023	0.770	0.748	1996.12	0.082	11
Netherlands	US	1980.01	0.383	0.750	0.367	1996.12	0.058	16
Belgium	US	1986.01	0.247	0.732	0.485	1996.06	0.087	18
Denmark	US	1985.01	0.099	0.828	0.729	1998.08	0.064	9
Sweden	US	1987.02	0.155	0.753	0.598	1999.02	0.078	13
UK	US	1980.01	0.217	0.726	0.509	1994.02	0.044	9
Switzerland	US	1980.12	0.159	0.560	0.401	1997.07	0.400	100

Table 3. Characteristics of time profile of stock return correlations, 1980-2003

		estimated correlation at start of sample *	estimated correlation at the end of 2003	change in correlation	break date	correlation change in year around break date	percent of total change in year around break date
Germany	France	0.128	0.903	0.775	1989.05	0.048	6
Germany	Italy	0.022	0.846	0.824	1992.02	0.047	6
Germany	Netherlands	0.178	0.878	0.700	1981.03	0.046	7
Germany	Belgium	0.165	0.665	0.500	1988.04	0.103	21
France	Italy	0.081	0.889	0.809	1993.12	0.058	7
France	Netherlands	0.282	0.889	0.607	1989.04	0.034	6
France	Belgium	0.245	0.662	0.417	1988.03	0.147	35
Italy	Netherlands	0.168	0.838	0.670	1994.06	0.046	7
Italy	Belgium	-0.051	0.639	0.690	1981.03	0.039	6
Netherlands	Belgium	0.267	0.719	0.452	1987.02	0.067	15
Germany	Denmark	0.076	0.589	0.513	1987.12	0.109	21
France	Denmark	0.035	0.489	0.454	1987.08	0.224	49
Italy	Denmark	0.116	0.475	0.359	1987.05	0.179	50
Netherlands	Denmark	0.055	0.583	0.528	1987.09	0.067	13
Belgium	Denmark	0.060	0.505	0.444	1987.09	0.117	26
Germany	Sweden	0.220	0.846	0.626	1992.03	0.036	6
France	Sweden	0.073	0.832	0.759	1991.09	0.044	6
Italy	Sweden	0.182	0.769	0.587	1997.01	0.046	8
Netherlands	Sweden	0.092	0.741	0.649	1983.01	0.059	9
Belgium	Sweden	-0.114	0.541	0.655	1985.07	0.110	17
Germany	UK	0.187	0.843	0.656	1992.12	0.038	6
France	UK	0.097	0.874	0.778	1988.11	0.044	6
Italy	UK	0.235	0.834	0.600	1997.08	0.053	9
Netherlands	UK	0.402	0.845	0.442	1981.03	0.025	6
Belgium	UK	0.183	0.739	0.556	1981.03	0.029	5
Denmark	Sweden	0.049	0.609	0.560	1983.01	0.047	8
Denmark	UK	0.084	0.559	0.474	1989.10	0.060	13
Sweden	UK	0.011	0.760	0.748	1983.01	0.051	7
Germany	Switzerland	0.632	0.910	0.278	2002.10	0.104	37
France	Switzerland	0.272	0.801	0.530	1993.04	0.027	5
Italy	Switzerland	0.127	0.745	0.618	1996.10	0.036	6
Netherlands	Switzerland	0.438	0.787	0.349	1981.03	0.017	5
Belgium	Switzerland	0.249	0.734	0.485	1989.02	0.022	5
Denmark	Switzerland	0.162	0.470	0.308	1987.09	0.154	50
Sweden	Switzerland	0.380	0.669	0.289	1983.01	0.014	5
UK	Switzerland	0.258	0.786	0.528	1993.02	0.026	5
Germany	US	0.313	0.803	0.490	1999.09	0.045	9
France	US	0.270	0.790	0.520	1996.12	0.031	6
Italy	US	0.166	0.768	0.602	1998.09	0.073	12
Netherlands	US	0.527	0.821	0.294	2002.09	0.062	21
Belgium	US	0.127	0.504	0.377	1987.02	0.189	50
Denmark	US	0.183	0.485	0.302	1981.03	0.014	5
Sweden	US	0.169	0.731	0.561	1992.01	0.029	5
UK	US	0.341	0.741	0.400	1992.02	0.018	5
Switzerland	US	0.467	0.820	0.353	2002.09	0.088	25

Note: Entries involving Sweden refer to the period 1982-2003.

Table 4. Characteristics of time profile of stock return correlations, 1988-2003
(based on estimates for 1988-2003)

		estimated correlation at start of 1988	estimated correlation at the end of 2003	correlation change over 1988-2003	break date	change in correlation in year around break date	percent of total change in year around break date
Germany	France	0.681	0.942	0.261	1999.08	0.053	20
Germany	Italy	0.454	0.845	0.391	1998.04	0.160	41
Germany	Netherlands	0.586	0.887	0.301	1994.04	0.023	8
Germany	Belgium	0.546	0.724	0.177	1988.10	0.012	7
France	Italy	0.431	0.882	0.451	1998.03	0.114	25
France	Netherlands	0.678	0.933	0.255	2000.05	0.050	20
France	Belgium	0.602	0.821	0.219	2001.12	0.156	71
Italy	Netherlands	0.446	0.813	0.367	1997.10	0.111	30
Italy	Belgium	0.439	0.707	0.268	2001.03	0.171	64
Netherlands	Belgium	0.659	0.886	0.227	2001.11	0.142	62
Germany	Denmark	0.363	0.590	0.227	1989.12	0.227	100
France	Denmark	0.430	0.611	0.181	2001.00	0.181	100
Italy	Denmark	0.372	0.496	0.124	1994.04	0.124	100
Netherlands	Denmark	0.252	0.580	0.328	1988.10	0.070	21
Belgium	Denmark	0.476	0.496	0.020	1988.10	0.001	6
Germany	Sweden	0.399	0.853	0.455	1994.12	0.034	8
France	Sweden	0.424	0.867	0.443	1999.02	0.047	11
Italy	Sweden	0.314	0.740	0.427	1997.09	0.068	16
Netherlands	Sweden	0.539	0.786	0.248	2000.08	0.020	8
Belgium	Sweden	0.500	0.840	0.339	2003.01	0.199	59
Germany	UK	0.393	0.836	0.443	1992.10	0.033	7
France	UK	0.455	0.874	0.420	1994.12	0.033	8
Italy	UK	0.352	0.796	0.444	1998.03	0.082	18
Netherlands	UK	0.717	0.878	0.161	2000.12	0.161	100
Belgium	UK	0.557	0.814	0.257	2001.08	0.144	56
Denmark	Sweden	0.365	0.643	0.278	1994.01	0.021	7
Denmark	UK	0.099	0.553	0.455	1988.10	0.089	20
Sweden	UK	0.449	0.788	0.339	2000.04	0.029	9
Germany	Switzerland	0.674	0.942	0.269	2003.03	0.218	81
France	Switzerland	0.621	0.911	0.291	2002.04	0.093	32
Italy	Switzerland	0.405	0.824	0.419	2001.05	0.062	15
Netherlands	Switzerland	0.681	0.851	0.170	2000.12	0.170	100
Belgium	Switzerland	0.592	0.752	0.159	2000.06	0.127	79
Denmark	Switzerland	0.365	0.480	0.115	1989.11	0.115	100
Sweden	Switzerland	0.573	0.888	0.315	2003.03	0.303	96
UK	Switzerland	0.532	0.832	0.300	2001.04	0.036	12
Germany	US	0.384	0.811	0.427	2000.07	0.047	11
France	US	0.480	0.845	0.365	2001.05	0.055	15
Italy	US	0.227	0.767	0.540	1999.04	0.080	15
Netherlands	US	0.561	0.876	0.316	2002.11	0.113	36
Belgium	US	0.469	0.868	0.399	2003.02	0.229	58
Denmark	US	0.299	0.546	0.247	1999.06	0.047	19
Sweden	US	0.440	0.811	0.371	2001.09	0.054	15
UK	US	0.547	0.800	0.253	2002.10	0.042	17
Switzerland	US	0.531	0.864	0.332	2003.01	0.137	41

APPENDIX with *Bond Market en Stock Market Integration in Europe*

This appendix is not to be published, but will be available from the authors upon request. It reports (detailed) results that are not essential to a good understanding of the paper, but may still be interesting for some researchers.

Contents

Table A1. Correlations of weekly bond returns

1988-1995

	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.716	0.371	0.876	0.676	0.609	0.393	0.473	0.484	0.328
France		0.511	0.710	0.642	0.712	0.455	0.483	0.347	0.367
Italy			0.439	0.418	0.523	0.436	0.348	0.240	0.164
Netherlands				0.741	0.611	0.365	0.547	0.489	0.331
Belgium					0.631	0.392	0.467	0.399	0.261
Denmark						0.416	0.415	0.298	0.231
Sweden							0.316	0.266	0.177
UK								0.269	0.368
Switzerland									0.093

1999-2003

	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.977	0.963	0.994	0.975	0.931	0.868	0.837	0.738	0.727
France		0.980	0.979	0.994	0.920	0.855	0.819	0.734	0.714
Italy			0.963	0.982	0.916	0.843	0.826	0.719	0.718
Netherlands				0.977	0.930	0.865	0.836	0.734	0.719
Belgium					0.921	0.854	0.816	0.736	0.723
Denmark						0.898	0.781	0.718	0.684
Sweden							0.738	0.696	0.610
UK								0.608	0.701
Switzerland									0.585

Table A2. Correlations of weekly stock market returns

1980-1987*	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.250	0.162	0.446	0.337	0.182	0.375	0.344	0.653	0.318
France		0.097	0.375	0.323	0.091	0.241	0.264	0.356	0.298
Italy			0.246	0.148	0.171	0.253	0.248	0.214	0.155
Netherlands				0.415	0.214	0.339	0.603	0.569	0.563
Belgium					0.173	0.294	0.364	0.442	0.246
Denmark						0.244	0.201	0.276	0.280
Sweden							0.283	0.511	0.305
UK								0.484	0.515
Switzerland									0.443

1988-1995	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.679	0.459	0.631	0.611	0.495	0.517	0.505	0.676	0.425
France		0.420	0.628	0.584	0.386	0.454	0.547	0.595	0.453
Italy			0.430	0.384	0.366	0.314	0.342	0.392	0.230
Netherlands				0.630	0.418	0.536	0.686	0.655	0.510
Belgium					0.453	0.512	0.494	0.608	0.430
Denmark						0.387	0.324	0.459	0.287
Sweden							0.459	0.542	0.439
UK								0.537	0.511
Switzerland									0.537

1999-2003	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.910	0.850	0.878	0.708	0.633	0.793	0.825	0.786	0.744
France		0.870	0.884	0.712	0.577	0.794	0.862	0.800	0.744
Italy			0.815	0.611	0.497	0.715	0.772	0.719	0.669
Netherlands				0.772	0.621	0.709	0.850	0.822	0.706
Belgium					0.514	0.534	0.735	0.756	0.589
Denmark						0.604	0.575	0.539	0.530
Sweden							0.710	0.642	0.713
UK								0.812	0.715
Switzerland									0.676

* Note: 1982-1987 for pairs involving Sweden.

Table A3. LM test statistic for constant correlation hypothesis
(p-values above diagonal, statistics below diagonal)

bond market returns (full sample)

	BEL	FRA	GER	ITA	NET	DEN	SWE	UK	SWI	US
Belgium		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
France	259.7		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Germany	170.0	204.6		0.000	0.000	0.000	0.000	0.000	0.000	0.000
Italy	189.6	188.1	169.9		0.000	0.000	0.000	0.000	0.000	0.000
Netherlands	144.0	174.7	372.7	148.5		0.000	0.000	0.000	0.000	0.000
Denmark	97.1	159.6	135.8	97.6	106.2		0.000	0.000	0.000	0.000
Sweden	84.9	87.9	84.4	91.1	86.6	180.3		0.000	0.000	0.000
UK	140.6	178.7	157.9	140.6	213.2	128.6	70.2		0.000	0.000
Switzerland	38.6	102.9	61.3	64.0	44.6	73.8	53.4	78.5		0.000
US	81.1	69.1	40.6	98.2	43.8	74.2	42.1	78.0	31.2	

stock market returns (full sample)

	BEL	FRA	GER	ITA	NET	DEN	SWE	UK	SWI	US
Belgium		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
France	68.9		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Germany	58.7	226.4		0.000	0.000	0.000	0.000	0.000	0.025	0.000
Italy	64.4	181.4	145.0		0.000	0.000	0.000	0.000	0.000	0.000
Netherlands	60.7	176.2	172.1	145.8		0.000	0.000	0.000	0.000	0.001
Denmark	29.6	47.4	56.4	30.4	62.8		0.000	0.000	0.000	0.001
Sweden	29.2	138.8	108.5	57.3	85.5	38.0		0.000	0.000	0.000
UK	67.4	190.3	126.3	86.9	92.4	52.9	94.3		0.000	0.000
Switzerland	39.4	73.1	5.0	75.6	39.9	16.0	17.1	55.9		0.002
US	31.4	75.2	48.4	50.7	10.4	11.0	54.1	47.4	9.2	

stock market returns (1988-2003)

	BEL	FRA	GER	ITA	NET	DEN	SWE	UK	SWI	US
Belgium		0.021	0.015	0.007	0.005	0.956	0.364	0.000	0.009	0.049
France	5.3		0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000
Germany	5.9	51.7		0.000	0.000	0.090	0.000	0.000	0.056	0.000
Italy	7.4	80.5	52.0		0.000	0.101	0.000	0.000	0.000	0.000
Netherlands	8.0	48.6	48.1	53.1		0.003	0.000	0.000	0.003	0.009
Denmark	0.0	3.5	2.9	2.7	9.0		0.002	0.000	0.828	0.010
Sweden	0.8	61.0	56.8	44.5	21.3	9.6		0.000	0.030	0.000
UK	15.5	59.1	54.7	52.2	18.3	14.4	29.8		0.000	0.000
Switzerland	6.8	15.0	3.6	24.5	8.7	0.0	4.7	21.1		0.068
US	3.9	23.8	30.1	38.8	6.8	6.6	21.6	12.2	3.3	

Table A4. STC-GARCH model estimates for bond market returns (full sample)

		start of sample	gamma	c	standard error	break date	rho_0	standard error	rho_1	standard error
Germany	France	1985.01	21.56	0.641	0.066	1995.03	0.519	0.068	0.965	0.009
Germany	Italy	1988.01	55.57	0.741	0.010	1997.10	0.309	0.040	0.940	0.014
Germany	Netherlands	1980.01	10.09	0.443	0.074	1990.07	0.612	0.070	0.995	.
Germany	Belgium	1986.01	21.73	0.604	0.028	1994.06	0.459	0.054	0.958	0.009
France	Italy	1988.01	47.40	0.749	0.023	1997.12	0.496	0.042	0.979	0.005
France	Netherlands	1985.01	24.33	0.650	0.064	1995.07	0.526	0.070	0.968	0.009
France	Belgium	1986.01	19.63	0.634	0.024	1995.03	0.475	0.049	0.995	0.002
Italy	Netherlands	1988.01	50.80	0.739	0.011	1997.09	0.344	0.041	0.941	0.014
Italy	Belgium	1988.01	39.96	0.744	0.023	1997.11	0.372	0.056	0.983	0.003
Netherlands	Belgium	1986.01	24.10	0.617	0.021	1994.10	0.537	0.046	0.963	0.009
Germany	Denmark	1985.01	4.92	0.503	0.165	1992.01	0.039	0.287	0.995	.
France	Denmark	1985.01	3.99	0.248	.	1985.12	-0.668	0.127	0.995	.
Italy	Denmark	1988.01	6.14	0.685	0.114	1996.05	0.278	0.173	0.995	.
Netherlands	Denmark	1985.01	6.00	0.588	0.139	1994.01	0.187	0.208	0.995	.
Belgium	Denmark	1986.01	4.82	0.546	0.208	1993.01	0.203	0.292	0.995	.
Germany	Sweden	1987.02	7.25	0.739	0.056	1997.09	0.277	0.065	0.991	0.056
France	Sweden	1987.02	6.01	0.703	0.080	1996.10	0.313	0.092	0.995	.
Italy	Sweden	1988.01	4.44	0.645	0.162	1995.06	0.088	0.269	0.995	.
Netherlands	Sweden	1987.02	6.99	0.724	0.059	1997.04	0.204	0.083	0.995	.
Belgium	Sweden	1987.02	5.50	0.673	0.096	1996.02	0.122	0.143	0.995	.
Germany	UK	1980.01	5.13	0.589	0.060	1994.02	0.156	0.078	0.995	.
France	UK	1985.01	3.63	0.479	0.147	1991.06	-0.102	0.248	0.995	.
Italy	UK	1988.01	4.26	0.617	0.121	1994.10	-0.186	0.264	0.995	.
Netherlands	UK	1980.01	4.19	0.446	0.103	1990.09	-0.076	0.175	0.995	.
Belgium	UK	1986.01	7.27	0.574	0.073	1993.09	0.159	0.313	0.849	0.215
Denmark	Sweden	1987.02	14.36	0.606	0.040	1994.07	0.165	0.083	0.920	0.015
Denmark	UK	1985.01	4.32	0.551	0.095	1993.03	-0.158	0.169	0.995	.
Sweden	UK	1987.02	6.81	0.781	0.056	1998.09	0.249	0.071	0.995	.
Germany	Switzerland	1980.12	4.09	0.753	0.076	1998.01	0.230	0.088	0.995	.
France	Switzerland	1985.01	5.86	0.581	0.064	1993.12	0.000	0.223	0.788	0.204
Italy	Switzerland	1988.01	3.85	0.746	0.245	1997.12	-0.037	0.292	0.941	0.552
Netherlands	Switzerland	1980.12	4.82	0.822	0.059	1999.09	0.314	0.068	0.995	.
Belgium	Switzerland	1986.01	4.16	0.843	0.099	2000.03	0.275	0.117	0.995	.
Denmark	Switzerland	1985.01	3.86	0.570	0.126	1993.08	-0.193	0.489	0.903	0.409
Sweden	Switzerland	1987.02	3.46	0.732	0.200	1997.07	-0.011	0.286	0.995	.
UK	Switzerland	1980.12	2.96	0.659	0.246	1995.10	-0.184	0.353	0.995	.
Germany	US	1980.01	14.16	0.712	0.061	1997.01	0.361	0.034	0.765	0.067
France	US	1985.01	11.45	0.738	0.050	1997.09	0.334	0.039	0.792	0.064
Italy	US	1988.01	6.46	0.707	0.087	1996.12	0.001	0.239	0.816	0.136
Netherlands	US	1980.01	15.21	0.706	0.074	1996.12	0.383	0.033	0.754	0.075
Belgium	US	1986.01	12.99	0.688	0.066	1996.06	0.246	0.046	0.734	0.068
Denmark	US	1985.01	5.35	0.778	0.062	1998.08	0.080	0.078	0.995	.
Sweden	US	1987.02	8.12	0.798	0.107	1999.02	0.153	0.054	0.811	0.145
UK	US	1980.01	7.86	0.591	0.065	1994.02	0.212	0.161	0.747	0.201
Switzerland	US	1980.12	400.00	0.733	0.003	1997.07	0.159	0.035	0.560	0.034

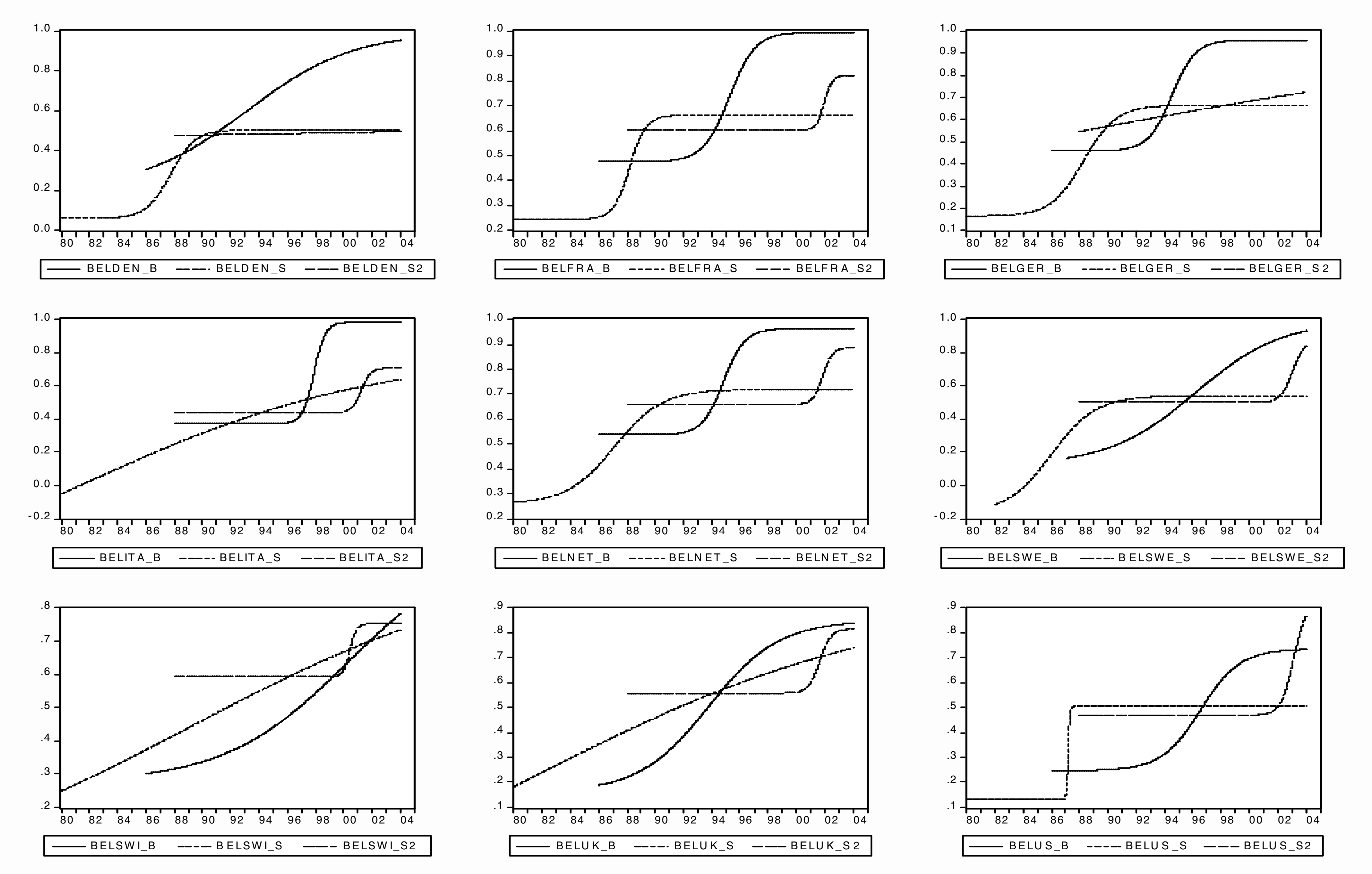
Table A5. STC-GARCH model estimates for stock market returns (full sample)

		start of sample	gamma	c	standard error	break date	rho_0	standard error	rho_1	standard error
Germany	France	1980.01	4.85	0.390	0.065	1989.05	0.003	0.105	0.950	.
Germany	Italy	1980.01	4.40	0.505	0.153	1992.02	-0.079	0.246	0.950	.
Germany	Netherlands	1980.01	3.10	0.050	.	1981.03	-0.485	0.132	0.950	.
Germany	Belgium	1980.01	20.90	0.345	0.032	1988.04	0.165	0.083	0.665	0.024
France	Italy	1980.01	6.26	0.582	0.085	1993.12	0.058	0.123	0.950	.
France	Netherlands	1980.01	4.09	0.387	0.142	1989.04	0.144	0.199	0.950	.
France	Belgium	1980.01	42.04	0.341	0.021	1988.03	0.245	0.068	0.662	0.023
Italy	Netherlands	1980.01	5.71	0.602	0.075	1994.06	0.144	0.119	0.910	0.088
Italy	Belgium	1980.01	2.29	0.050	.	1981.03	-0.814	0.407	0.803	0.500
Netherlands	Belgium	1980.01	14.41	0.297	0.064	1987.02	0.260	0.132	0.719	0.021
Germany	Denmark	1980.01	21.70	0.333	0.050	1987.12	0.076	0.054	0.589	0.039
France	Denmark	1980.01	121.21	0.319	0.013	1987.08	0.035	0.055	0.489	0.030
Italy	Denmark	1980.01	400.00	0.306	0.003	1987.05	0.117	0.043	0.474	0.032
Netherlands	Denmark	1980.01	12.17	0.323	0.102	1987.09	0.045	0.165	0.583	0.029
Belgium	Denmark	1980.01	27.88	0.322	0.035	1987.09	0.060	0.048	0.505	0.032
Germany	Sweden	1982.01	3.71	0.509	0.218	1992.03	0.089	0.280	0.950	.
France	Sweden	1982.01	3.71	0.491	0.203	1991.09	-0.096	0.318	0.950	.
Italy	Sweden	1982.01	5.77	0.708	0.128	1997.01	0.169	0.263	0.865	0.477
Netherlands	Sweden	1982.01	4.32	0.130	.	1983.01	-0.449	0.143	0.761	0.055
Belgium	Sweden	1982.01	14.10	0.250	0.192	1985.07	-0.165	0.683	0.541	0.040
Germany	UK	1980.01	4.52	0.540	0.097	1992.12	0.122	0.143	0.933	0.112
France	UK	1980.01	4.04	0.368	0.127	1988.11	-0.097	0.220	0.950	.
Italy	UK	1980.01	7.42	0.733	0.086	1997.08	0.232	0.109	0.918	0.302
Netherlands	UK	1980.01	2.29	0.050	.	1981.03	-0.087	0.084	0.950	.
Belgium	UK	1980.01	1.87	0.050	.	1981.03	-0.517	0.108	0.950	.
Denmark	Sweden	1982.01	3.85	0.130	.	1983.01	-0.437	0.175	0.636	0.086
Denmark	UK	1980.01	12.30	0.409	0.061	1989.10	0.081	0.060	0.559	0.040
Sweden	UK	1982.01	2.76	0.130	.	1983.01	-0.737	0.173	0.868	0.188
Germany	Switzerland	1980.01	37.26	0.948	0.024	2002.10	0.632	0.028	0.950	.
France	Switzerland	1980.01	3.28	0.555	0.215	1993.04	0.161	0.232	0.950	.
Italy	Switzerland	1980.01	3.93	0.699	0.166	1996.10	0.074	0.214	0.950	.
Netherlands	Switzerland	1980.01	1.70	0.050	.	1981.03	-0.033	0.107	0.950	.
Belgium	Switzerland	1980.01	2.11	0.381	0.901	1989.02	-0.065	0.945	0.950	.
Denmark	Switzerland	1980.01	400.00	0.318	0.002	1987.09	0.167	0.056	0.469	0.029
Sweden	Switzerland	1982.01	1.14	0.130	.	1983.01	-0.159	0.123	0.950	.
UK	Switzerland	1980.01	3.05	0.545	0.326	1993.02	0.127	0.342	0.950	.
Germany	US	1980.01	6.75	0.820	0.039	1999.09	0.311	0.053	0.950	.
France	US	1980.01	4.22	0.705	0.136	1996.12	0.235	0.145	0.950	.
Italy	US	1980.01	10.93	0.777	0.080	1998.09	0.166	0.047	0.820	0.208
Netherlands	US	1980.01	14.50	0.943	0.027	2002.09	0.527	0.053	0.950	.
Belgium	US	1980.01	400.00	0.300	0.004	1987.02	0.130	0.062	0.505	0.025
Denmark	US	1980.01	1.32	0.050	.	1981.03	-0.314	1.820	0.714	1.888
Sweden	US	1982.01	2.56	0.549	0.501	1992.01	-0.044	0.552	0.950	.
UK	US	1980.01	2.15	0.505	0.849	1992.02	0.135	0.671	0.950	.
Switzerland	US	1980.01	18.32	0.946	0.021	2002.09	0.467	0.038	0.950	.

Table A6. STC-GARCH model estimates for stock market returns (1988-2003)

		start of sample	gamma	c	standard error	break date	rho_0	standard error	rho_1	standard error
Germany	France	1988.01	12.64	0.816	0.034	1999.08	0.681	0.032	0.950	.
Germany	Italy	1988.01	27.81	0.762	0.023	1998.04	0.454	0.050	0.845	0.024
Germany	Netherlands	1988.01	3.07	0.593	0.468	1994.04	0.476	0.309	0.950	.
Germany	Belgium	1988.01	0.96	0.366	.	1988.10	0.161	0.095	0.950	.
France	Italy	1988.01	16.48	0.757	0.033	1998.03	0.431	0.056	0.884	0.019
France	Netherlands	1988.01	11.88	0.848	0.056	2000.05	0.678	0.036	0.950	.
France	Belgium	1988.01	56.98	0.913	0.028	2001.12	0.602	0.031	0.821	0.031
Italy	Netherlands	1988.01	19.90	0.740	0.051	1997.10	0.446	0.067	0.813	0.037
Italy	Belgium	1988.01	48.21	0.883	0.038	2001.03	0.439	0.039	0.707	0.076
Netherlands	Belgium	1988.01	46.76	0.909	0.021	2001.11	0.659	0.026	0.886	0.029
Germany	Denmark	1988.01	400.00	0.414	0.009	1989.12	0.363	0.092	0.590	0.026
France	Denmark	1988.01	400.00	0.874	0.003	2001.00	0.430	0.034	0.611	0.047
Italy	Denmark	1988.01	400.00	0.597	0.003	1994.04	0.372	0.052	0.496	0.035
Netherlands	Denmark	1988.01	8.22	0.366	.	1988.10	0.032	0.203	0.581	0.037
Belgium	Denmark	1988.01	0.08	0.366	.	1988.10	0.004	0.096	0.950	.
Germany	Sweden	1988.01	3.20	0.621	0.557	1994.12	0.261	0.539	0.950	.
France	Sweden	1988.01	5.61	0.797	0.094	1999.02	0.413	0.095	0.950	.
Italy	Sweden	1988.01	10.00	0.735	0.077	1997.09	0.313	0.062	0.749	0.075
Netherlands	Sweden	1988.01	2.76	0.858	0.336	2000.08	0.492	0.196	0.950	.
Belgium	Sweden	1988.01	38.34	0.959	0.031	2003.01	0.500	0.033	0.871	0.126
Germany	UK	1988.01	2.59	0.532	0.771	1992.10	0.136	0.773	0.950	.
France	UK	1988.01	3.45	0.623	0.623	1994.12	0.344	0.542	0.950	.
Italy	UK	1988.01	11.71	0.759	0.061	1998.03	0.352	0.052	0.803	0.079
Netherlands	UK	1988.01	400.00	0.873	0.003	2000.12	0.717	0.019	0.878	0.016
Belgium	UK	1988.01	40.39	0.900	0.034	2001.08	0.557	0.031	0.815	0.036
Denmark	Sweden	1988.01	2.80	0.585	0.653	1994.01	0.244	0.659	0.713	0.533
Denmark	UK	1988.01	7.41	0.366	.	1988.10	-0.219	0.207	0.554	0.049
Sweden	UK	1988.01	3.53	0.843	0.154	2000.04	0.415	0.121	0.950	.
Germany	Switzerland	1988.01	68.25	0.965	0.021	2003.03	0.674	0.025	0.950	.
France	Switzerland	1988.01	18.51	0.928	0.031	2002.04	0.621	0.030	0.950	.
Italy	Switzerland	1988.01	7.31	0.890	0.046	2001.05	0.404	0.055	0.950	.
Netherlands	Switzerland	1988.01	400.00	0.873	0.005	2000.12	0.681	0.024	0.851	0.021
Belgium	Switzerland	1988.01	69.16	0.850	0.028	2000.06	0.592	0.032	0.752	0.038
Denmark	Switzerland	1988.01	400.00	0.413	0.004	1989.11	0.365	0.083	0.480	0.030
Sweden	Switzerland	1988.01	124.34	0.963	0.013	2003.03	0.573	0.027	0.889	0.032
UK	Switzerland	1988.01	5.47	0.885	0.081	2001.04	0.527	0.068	0.950	.
Germany	US	1988.01	5.22	0.854	0.065	2000.07	0.374	0.068	0.950	.
France	US	1988.01	7.55	0.889	0.055	2001.05	0.479	0.053	0.950	.
Italy	US	1988.01	8.87	0.801	0.104	1999.04	0.226	0.068	0.806	0.131
Netherlands	US	1988.01	19.09	0.949	0.042	2002.11	0.561	0.045	0.950	.
Belgium	US	1988.01	36.05	0.962	0.030	2003.02	0.469	0.031	0.919	0.108
Denmark	US	1988.01	11.88	0.811	0.130	1999.06	0.299	0.063	0.555	0.077
Sweden	US	1988.01	6.77	0.903	0.048	2001.09	0.438	0.053	0.950	.
UK	US	1988.01	6.72	0.948	0.058	2002.10	0.546	0.048	0.950	.
Switzerland	US	1988.01	21.80	0.959	0.027	2003.01	0.531	0.035	0.950	.

Figure A1. Estimated correlations



Note: BEL=Belgium, DEN=Denmark, FRA=France, GER=Germany, ITA=Italy, NET=the Netherlands, SWE=Sweden, SWI=Switzerland, UK=United Kingdom, US=United States, _B=Bond returns, _S=Stock returns (full sample), _S2=Stock returns (1988-2003).

Figure A1. continued

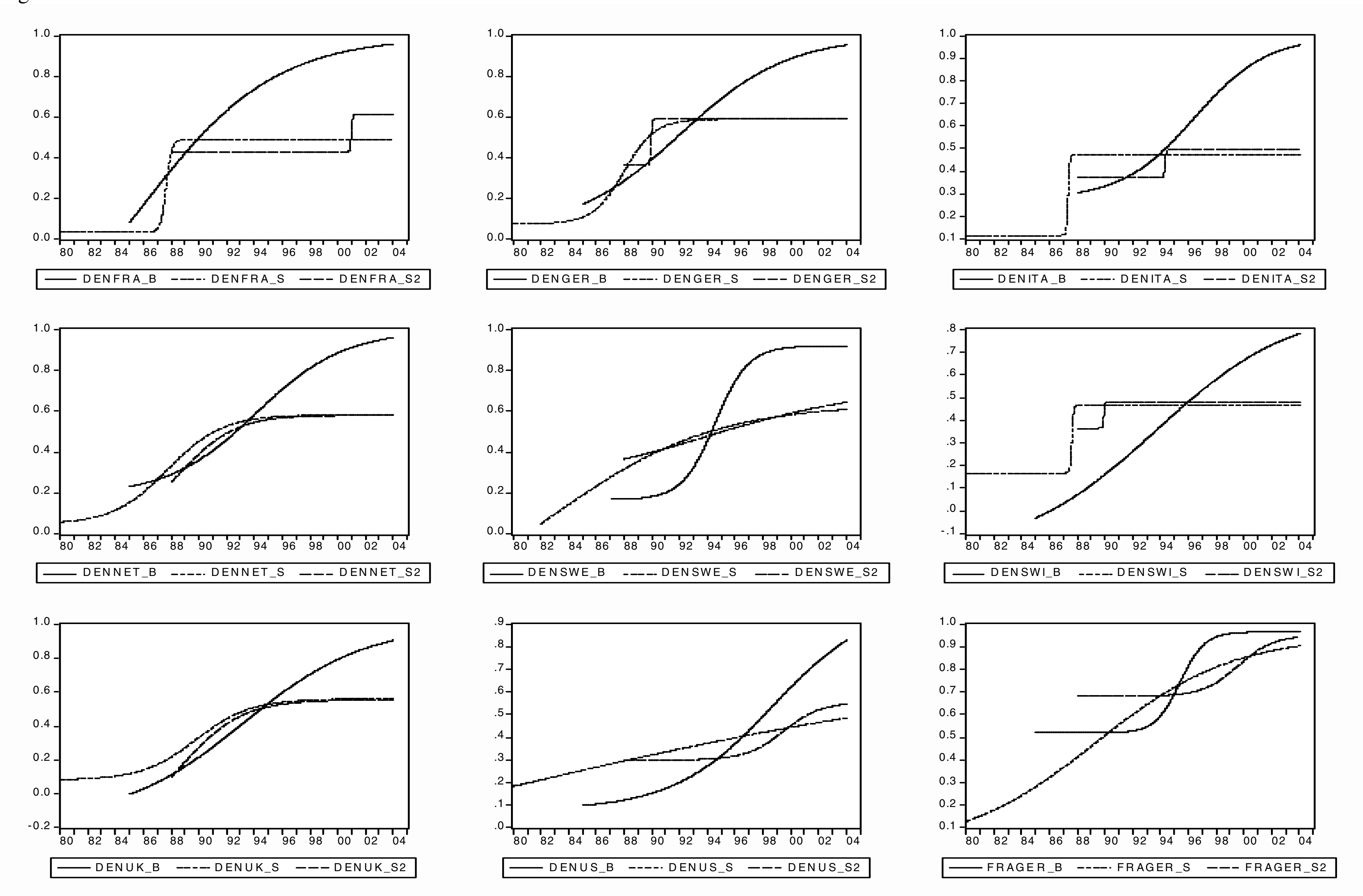


Figure A1. continued

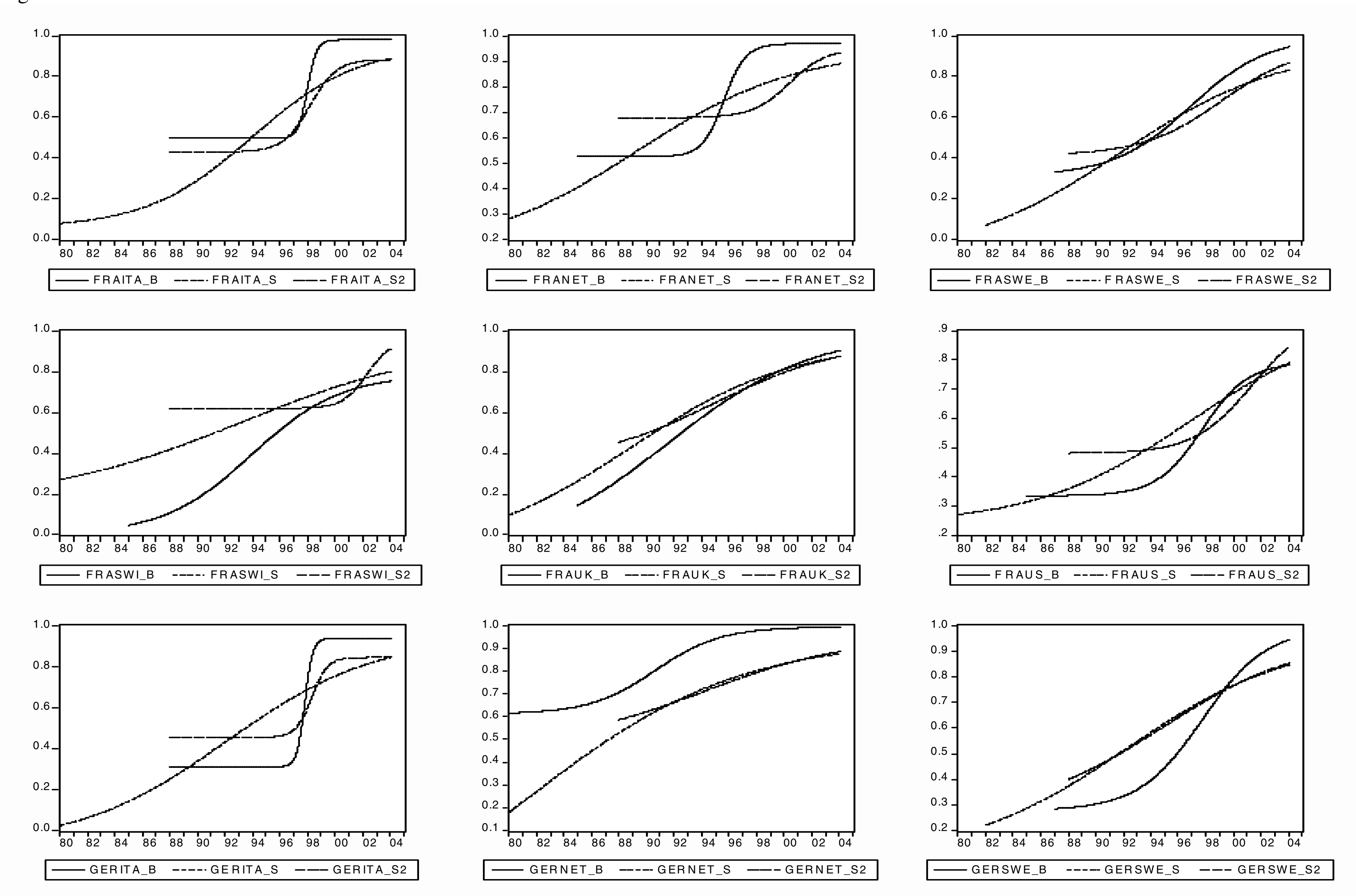


Figure A1. continued

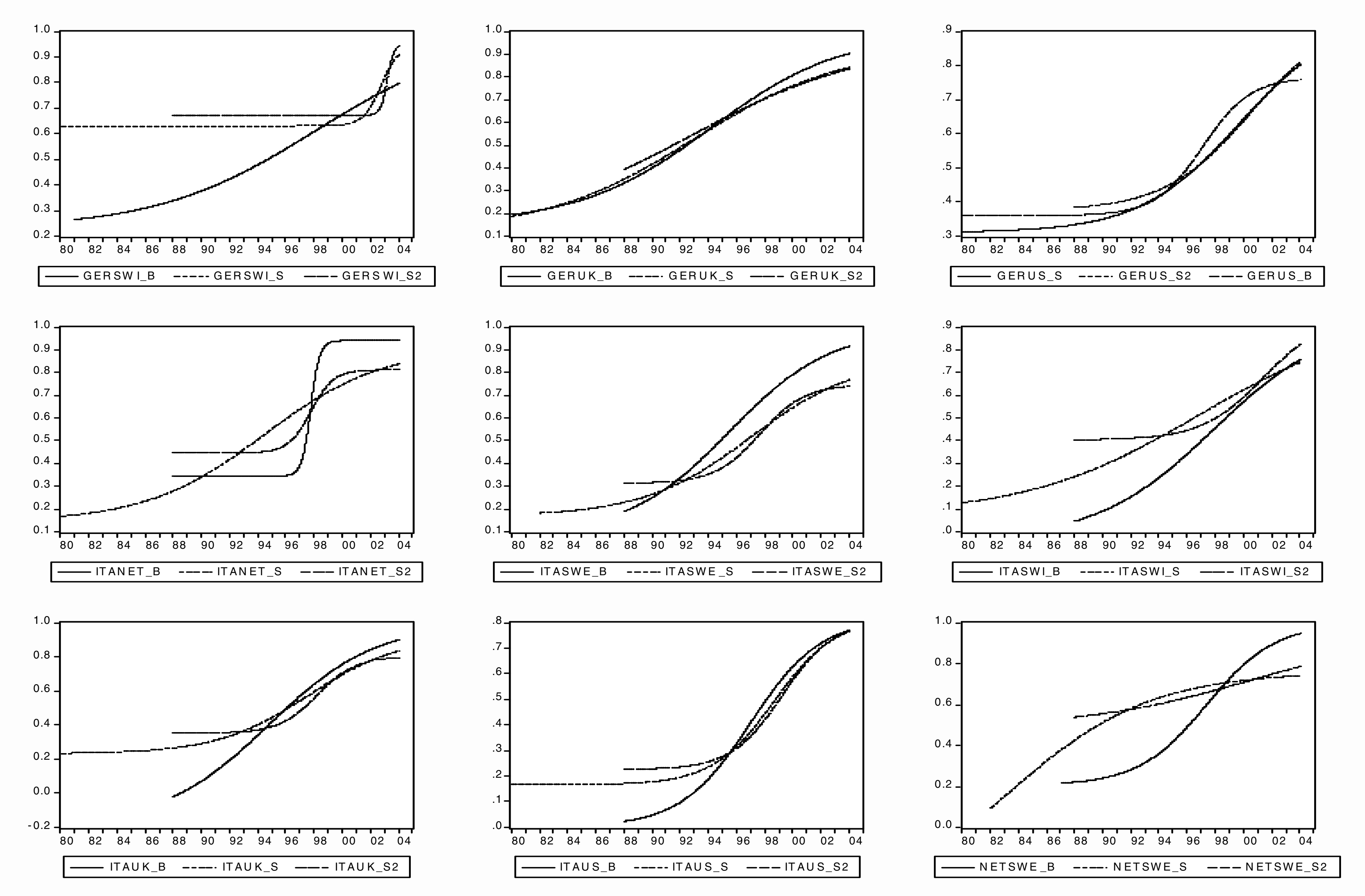
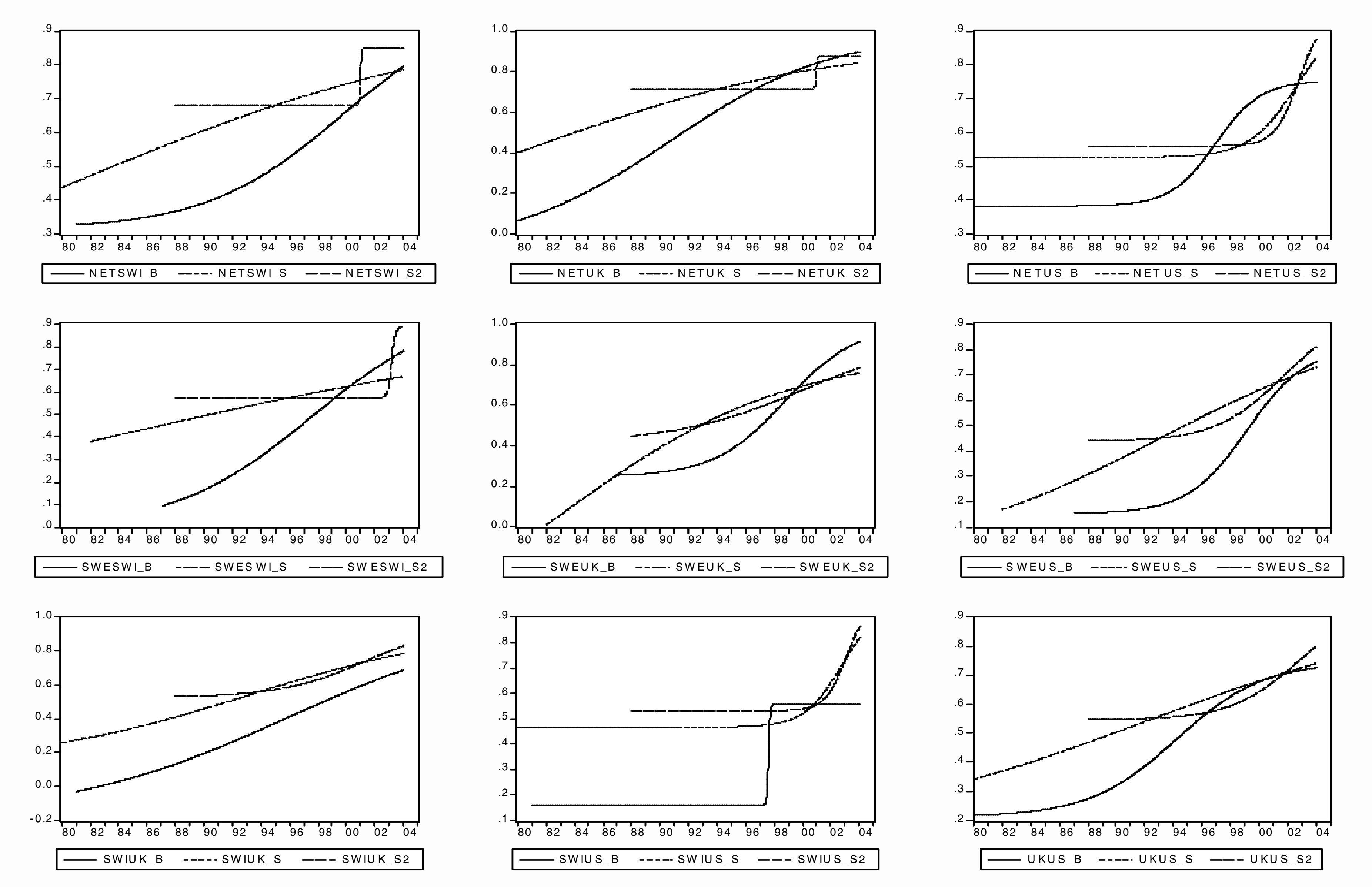


Figure A1. continued



Bond Market and Stock Market Integration in Europe:
A Smooth Transition Approach

Robert-Paul Berben*

Economics and Research Division, De Nederlandsche Bank, Amsterdam, The Netherlands

W. Jos Jansen

Economic Policy Department, Ministry of Social Affairs and Employment, The Hague, The Netherlands

This paper investigates whether there has been a structural increase in financial market integration in nine European countries and the US in the period 1980-2003. We employ a GARCH model with a smoothly time-varying correlation to estimate the date of change and the speed of the transition between the low and high correlation regimes. Our test produces strong evidence of greater comovement across the board for both stock markets and government bond markets. Dates of change and speeds of adjustment vary widely across country linkages. Stock market integration is a more gradual process than bond market integration. The impact of European monetary union (EMU) is rather limited, as it has mainly affected the timing of bond market correlation gains (but hardly their size) and has had little discernible effect on stock market integration.

JEL Code: C22, G10, G15

Keywords: financial integration, comovement, smooth transition, European integration

June 2006

*Corresponding author: Robert-Paul Berben, Economics and Research Division, De Nederlandsche Bank, P.O. Box 98, 1000 AB Amsterdam, The Netherlands; email: r.p.berben@dnb.nl; phone: 00-31-20-5243036; fax 00-31-20-5242506.

Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank or the Dutch Ministry of Social Affairs and Employment.

Bond Market and Stock Market Integration in Europe:
A Smooth Transition Approach

Bond Market and Stock Market Integration in Europe

This paper investigates whether there has been a structural increase in financial market integration in nine European countries and the US in the period 1980-2003. We employ a GARCH model with a smoothly time-varying correlation to estimate the date of change and the speed of the transition between the low and high correlation regimes. Our test produces strong evidence of greater comovement across the board for both stock markets and government bond markets. Dates of change and speeds of adjustment vary widely across country linkages. Stock market integration is a more gradual process than bond market integration. The impact of European monetary union (EMU) is rather limited, as it has mainly affected the timing of bond market correlation gains (but hardly their size) and has had little discernible effect on stock market integration.

1. Introduction

The process towards European Economic and Monetary Union (EMU) has given a tremendous impetus to financial market integration in Europe. Capital controls were completely eliminated in the course of the 1980s and 1990s. The introduction of the euro on 1 January 1999 removed all remaining exchange rate risk among the EMU participants, and marked the beginning of a single monetary policy for the euro area. As a consequence, the money market became fully integrated. It is widely believed that EMU will also greatly affect European capital markets (Danthine, Giavazzi and von Thadden 2000). Cross-country differences in long-term interest rates fell sharply as long-run inflation expectations declined in countries with historical records of high inflation, and fiscal discipline improved. The degree of comovement among European equity markets seems to have increased as well. However, a substantial degree of segmentation continues to exist in European capital markets. To address this problem, the European Union has drawn up the Financial Services Action Plan (FSAP).

Although EMU has clearly been an important driver for change, financial market developments in Europe are part of a global phenomenon. Financial integration has been spurred on a global scale by advances in information technology, the world-wide liberalization of cross-border financial flows, financial innovation as well as growing economic integration due to intensifying international trade relations and the internationalization of production through foreign direct investment. Over the past twenty years, the importance of financial markets in many industrialized economies has grown sharply, while at the same time asset returns tend to display a more synchronized behavior. This observation holds for both stock markets and bond markets.

An accurate assessment of the degree of comovement among international financial markets is important for investors, supervisory authorities, and central bankers alike. An important empirical issue is whether the apparent rise in the degree of comovement among national financial markets is a structural phenomenon. It is conceivable that this idea is colored by a biased reading of the data. Empirical tests for changes in correlation usually involve some sort of two-step approach, where in the first step correlations are calculated over either fixed or moving subsamples, and in the second step the presence of level shifts or trends is assessed. These tests may suffer from two statistical deficiencies. First, Boyer, Gibson and Loretan (1999) show that changes in correlations over time or across regimes cannot be detected reliably by splitting a sample according to the realized values of the data. Tests of changes in correlations are therefore often severely biased. Put differently, it is not possible to assess the presence of an upward trend in correlations by looking at the (trending) behavior of subsample estimates of correlations. A second weakness, which particularly applies to the sample-splitting approach, is that such tests will lack power if the selected subsamples do not closely match the true correlation regimes. For these reasons, Berben and Jansen (2005) introduce a multivariate GARCH model with smoothly time-varying correlations, and derive a novel test for the constant correlation hypothesis that avoids the statistical weaknesses discussed above. Their set-up allows not only to endogenously determine the date of change, but also whether the transition to the new regime was abrupt or gradual.

In this paper, we attempt to find out whether there has been a structural increase in financial market integration in Europe, and if so, in which years the bulk of the gain was achieved. One of our aims is to investigate what influence the emergence of the monetary union has had on the process of financial market integration in Europe. Has it led to substantial gains in stock market integration, or has its impact been rather limited, as Baele (2005) claims? Our focus is on the dominant trends in the evolution of financial integration, which we measure by the conditional correlation between weekly returns. We employ a data set covering almost a quarter of a century (1980-2003). Our sample comprises ten countries: five countries from the euro area (Germany, France, Italy, the Netherlands and Belgium), the three EU-members that have not adopted the euro (Denmark, Sweden and the United Kingdom), Switzerland and the United States. Unlike most studies, which focus on either equity market or bond market integration, we contrast the different experiences of the stock market and the government bond market.[1] Differences in integration trends across markets or (groups of) countries may provide valuable clues about the forces that appear to drive financial market integration.

The remainder of this paper is organized as follows. Section 2 offers a brief survey of the literature. Section 3 discusses our time-varying correlation GARCH model and the Lagrange Multiplier test for the null-hypothesis of a constant correlation over time. Section 4 describes the data and Section 5 presents the empirical results. Section 6 contains a summary and some concluding remarks.

2. Overview of the literature

Although there is general agreement that correlations between equity markets are not constant over time, it is less clear whether correlations are actually trending upward.[2] For instance, Roll (1989), surveying a number of papers published in the 1980s, concludes that the increase in international stock return correlations in the 1980s compared to the 1970s is only of a small magnitude. Similarly, King, Sentana and Wadhwani (1994) find little support for a trend increase in correlations among stock markets for the 1970-90 period. They conclude that authors who argue that markets have become increasingly integrated on the basis of data immediately around the crash in 1987 might confuse a transitory (ie. around the crash) with a permanent increase in correlations. By contrast, Longin and Solnik (1995), who explicitly model the conditional

[1] Exceptions are Cappiello, Engle and Sheppard (2003), Christiansen (2004) and Kim, Moshirian and Wu (2006).
[2] Karolyi and Stulz (2003) offer a comprehensive survey of the literature on comovement among international equity markets.

multivariate distribution of international equity returns, are able to show that, for the period 1960-90, correlations between stock returns in the US and in France, Switzerland, Japan, and the UK, respectively, have increased significantly. Similarly, Berben and Jansen (2005) find a statistically significant, broad-based increase in stock market comovement among Germany, the UK and the US in the period 1980-2000, whereas the trend towards stock market integration seems to have bypassed Japan. Taking a long-term perspective, Goetzmann, Li and Rouwenhorst (2005) document that international equity correlations have changed dramatically through time, with peaks in the late 19th Century, the Great Depression, and the late 20th Century. Yang, Tapon and Sun (2006) show that correlations among stock markets have risen, and that correlations tend to be higher when conditional volatility is high.

The arrival of EMU has stimulated interest into the issue whether (the process leading up to) EMU has led to increased integration of the national equity markets within the euro area. Having similar inflation rates and interest rates, a common monetary policy and constraints on fiscal policy (Stability and Growth Pact) can be expected to translate into greater similarity of the discount rates used to value future cash flows, and hence, a higher degree of stock market comovement. Hardouvellis, Malliaropulos and Priestley (1999) analyze the pre-EMU experience with an asset pricing model with a time-varying degree of integration. They conclude that the degree of a country's stock market integration (with the global European index) is positively related to the markets' perception of the probability that the country will join EMU. According to their estimates, stock market integration made large leaps after 1995. Similarly, Fratzscher (2002), investigating stock market integration among European equity markets in the years 1986-2000, concludes that stock markets in the euro area appear to be highly integrated since 1996 only. Theses results are generally seen as supporting the view that the European unification process is promoting greater integration of European stock markets. By contrast, Baele (2005) takes a different view on the link between stock market integration and the emergence of EMU. Employing longer time series than the papers cited above (1980-2000), his analysis based on a regime-switching GARCH model shows that the rise in European integration took mainly place in the second half of the 1980s and the first half of the 1990s. This finding suggests that further economic integration (boosted by the 1986 Single European Act) as well as efforts to further liberalize European capital markets were more important in bringing markets closer together than the process towards monetary integration and the introduction of the single currency.

Empirical work on international bond market integration is relatively scarce. Using data from the period of the EMS (1989-1994) for several European countries, Bodart and Reding (1999) find that a decrease in exchange rate volatility is accompanied by a rise in the correlation among bond markets. Christiansen (2006) estimates volatility spillover models in which volatility depends on global, regional and local effects. Her results for nine European bond markets show that bond market volatility in Europe is mainly affected by common European factors and own market effects before EMU. After the introduction of the euro, however, the influence of idiosyncratic factors appears to have decreased dramatically, while the importance of the

European factor has sharply risen. Skintzi and Refenes (2004) study the time-varying correlation structure between twelve individual European bond market indices, the aggregate Euro area bond market index and the US bond market index in the years 1991-2002. Their findings suggest significant volatility spillovers from the US bond market to all individual European bond markets. Moreover, spillovers from the Euro area index have significantly increased for individual EMU-participants after the start of the monetary union. Estimates by Cappiello, Engle and Sheppard (2003) of a dynamic conditional correlation GARCH model show a rapid change to a near-perfect correlation among EMU bond markets in the second half of the 1990s. They also found an increase in correlation between the European and US bond markets. Yang, Shin and Khan (2007) present evidence on increased interest rate linkages based on recursive cointegration analysis.

3. The model

The empirical analysis focuses on the (bilateral) correlations between returns for all possible country pairs among the 10 countries (45 cases in all) for both stock returns and bond returns. The asset returns are modeled as a Smooth-Transition Correlation GARCH (STC-GARCH) process, which we developed in an earlier paper (Berben and Jansen 2005)[3]. The bivariate observed time series of asset returns y_t ($t = 1, \dots, n$), with elements $y_{1,t}$ and $y_{2,t}$, is described by the following model

$$y_t = \mu_{t-1} + \varepsilon_t \tag{1}$$

$$\mu_{t-1} = E[y_t | \Psi_{t-1}] \tag{2}$$

$$\varepsilon_t | \Psi_{t-1} \sim N(0, H_t) \tag{3}$$

where Ψ_{t-1} is the information set consisting of all relevant information up to and including time $t-1$, $E[.]$ is the expectation operator, ε_t is the unexpected part of the returns, and $N(.)$ denotes the bivariate normal distribution. H_t, the conditional covariance matrix of ε_t, is assumed to follow a time-varying structure given by

$$H_t = E[\varepsilon_t \varepsilon_t' | \Psi_{t-1}] \tag{4}$$

$$h_{11,t} = \omega_1 + \alpha_1 \varepsilon_{1,t-1}^2 + \beta_1 h_{11,t-1} \tag{5}$$

$$h_{22,t} = \omega_2 + \alpha_2 \varepsilon_{2,t-1}^2 + \beta_2 h_{22,t-1} \tag{6}$$

$$h_{12,t} = \rho_t (h_{11,t} h_{22,t})^{1/2} \tag{7}$$

[3] The main advantage of this model over other models that allow for time-varying conditional correlations, such as the dynamic conditional correlations model of Engle (2002), is that it allows the timing of the change in correlation to be determined endogenously from the data.

$$\rho_t = \rho_0(1 - G(s_t;\gamma,c)) + \rho_1 G(s_t;\gamma,c) \quad (8)$$

The conditional variances $h_{11,t}$ and $h_{22,t}$ both follow a GARCH(1,1) specification. The model allows for a smooth transition between two correlation regimes, which are characterized by ρ_0 and ρ_1. $G(s_t;\gamma,c)$ is the logistic function

$$G(s_t;\gamma,c) = \frac{1}{1+\exp(-\gamma(s_t - c))} \quad (9)$$

where s_t is the transition variable, and γ and c determine the smoothness and location, respectively, of the transition between the two correlation regimes. As our focus is on dominant, long-run trends in correlations among stock returns, there is one change in correlation regime and the transition variable is specified as a function of time: $s_t = t/n$.

The Smooth-Transition Correlation GARCH (STC-GARCH) model is able to capture a wide variety of patterns of change. The model allows for both structural increases and decreases. The pace of change between correlation regimes is abrupt for large values of γ, while the transition can be made arbitrarily gradual for small values of γ.[4] Bollerslev's (1990) constant correlation model is a special case of the STC-GARCH model. It obtains if either $\rho_0 = \rho_1$ or $\gamma = 0$.

Assuming normality, the log-likelihood of the observation at time *t* is given by (ignoring constants)

$$l_t(\theta) = -\frac{1}{2}\ln|H_t| - \frac{1}{2}\varepsilon_t' H_t^{-1}\varepsilon_t \quad (10)$$

where θ is the vector of all the parameters to be estimated. The log-likelihood for the whole sample from time 1 to *n*, $L(\theta)$, is given by

$$L(\theta) = \sum_{t=1}^{n} l_t(\theta) \quad (11)$$

This log-likelihood is maximized with respect to all parameters simultaneously, employing numerical derivatives of the log-likelihood. Robust standard errors of the parameter estimates are computed using the procedure proposed by Bollerslev and Wooldridge (1992).

Before we estimate the STC-GARCH model, we first formally test whether it outperforms the constant correlation GARCH model. As discussed above, the constant correlation GARCH model can be obtained from the STC-GARCH model by either setting $\gamma = 0$ or $\rho_0 = \rho_1$. This illustrates that any test of the constant correlation hypothesis in the STC-GARCH model will suffer from unidentified nuisance parameters under the null hypothesis, which is typical for tests of structural change.[5] Berben and Jansen (2005) derive a Lagrange Multiplier test that deals with this problem.

4. Data

We use weekly holding period returns on stocks and government bonds for 10 countries: Belgium, Denmark, France, Germany, Italy, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States.[6] Stock returns refer to the Datastream broad stock market index; bond returns refer to the J.P. Morgan government bond index. All data are from Datastream. Weekly returns are calculated from daily price indices (closing values), as weekly log first differences from Thursday to Thursday, multiplied by one hundred. We use weekly data to avoid spurious spillover effects due to non-synchronous trading hours.[7] Furthermore, from the perspective of a policy maker concerned with financial stability, correlations at a high frequency are more relevant than correlations over long horizons.[8] Our exact concept of return is chosen such that it matches, as closely as possible, price developments as they are perceived by policy makers and in the financial press. That means first of all that we focus on returns denominated in local currency. This amounts to analyzing returns on portfolios that are fully hedged against exchange rate risk. Furthermore, stock price indices are not corrected for dividend payments. Our definition of the bond return does include coupon payments, however, as the J.P. Morgan government bond indices are constructed by assuming that coupon payments and redemptions are reinvested in new government bond issues.

Subject to data availability, we collected weekly data spanning 24 years (3 January 1980 through 24 December 2003). In a number of cases data were available for shorter time-spans. Table 1 presents information on the sample, the number of observations and some descriptive statistics of the time series of the weekly returns. According to Richardson and Smith's (1994) robust test for first order autocorrelation, the stock return series do not show evidence of serial correlation. The bond return series displays statistically significant autocorrelation (at the 10% level) for Denmark, Germany, the Netherlands, Switzerland, the United Kingdom and the United States. The statistical model therefore includes autoregressive terms in the

---

[4] Note that if $\gamma \to \infty$, the transition between ρ_0 and ρ_1 becomes a step at $t = cn$.
[5] Hansen (1996) presents a general treatment of the issue of unidentified nuisance parameters in econometric tests.
[6] We did not include Japan, because Berben and Jansen (2005) found that the LM test indicated that stock market correlations between Japan and the UK, the US and Germany respectively did not change in the years 1980-2000.
[7] Burns, Engle and Mezrich (1998) show that aggregation to weekly returns largely solves the problems caused by non-synchronous trading hours.

mean equation (1) in these cases. Results on Engle's ARCH test (allowing for five lags), suggest that second moments are heavily autocorrelated with long lags for all returns, pointing towards an ARCH parameterization for the second moments. We model the conditional variances in our multivariate GARCH model as GARCH(1,1) processes, as the empirical literature has found that this specification adequately captures the persistence in second moments of high frequency asset returns.

5. When and how quickly did correlations change?

In this section, we investigate whether a structural change has occurred in the correlations among the financial markets of our 10 countries. We first formally test the hypothesis of an unchanged correlation for each country pair and financial market (90 tests in all), applying the LM test of Berben and Jansen (2005). The null hypothesis of no change is rejected at the 1% significance level in 89 out of 90 cases.[9] In fact, the marginal significance level of the test statistic is essentially zero for the large majority of country pairs. As the LM test produces overwhelming evidence in favor of change, we subsequently estimate the STC-GARCH model to determine the date and speed of these changes, obtaining a profile of the correlation's evolution over time. We also contrast the experiences with stock market integration and these with government bond market integration in the past twenty years or so. This may shed light on the interesting issue of which fundamental forces seem to shape the integration process in financial markets, and to what extent these forces may differ between stock markets and government bond markets.

Bond return correlations

We first estimate the STC-GARCH model for bond returns, using all available observations for each country pair. Table 2 presents the main characteristics of the time profile of the bond market correlations that can be derived from the estimates.[10] We first show the estimated values of the correlation at the start of the sample and in December 2003. Next we present the change in the correlation over this time-span. Under the heading 'break date' we report the month that corresponds to the parameter *c*, which determines the location of the inflection point of the transition curve. This is the point in time at which the correlation changed at the fastest pace. The next column reports by how much the correlation changed during the year surrounding the break date (six months before through six months after the break date). The final column expresses the change during this twelve months period as a percentage of the total change over the complete sample. The larger this percentage, the more abrupt the transition has been. Plots of all estimated time profiles are available from the authors upon request. The rows of the table refer to the 45 possible country pairs, which are grouped together in the following way. The first ten rows present the results for all possible pairs within

---

[8] Monthly correlations display the same trending behavior as weekly correlations.
[9] The one exception is the stock return correlation between Germany and Switzerland (*p*-value 0.025). The results of the LM test are available from the authors upon request.
[10] As the parameters of the model are difficult to interpret, we report the estimates of the model in an appendix that is available from the authors upon request.

the euro zone. The next 15 rows involve the pairs between our five euro area countries and the three EU-members that did not adopt the euro. We then present the results for the three pairs among the latter three countries. Links between Switzerland and EU-countries are next, and the table closes with all the country pairs involving the US.

A glance through Table 2 immediately makes clear that dates of change and speeds of adjustment vary widely across country linkages. Among the shapes of the transition curve are abrupt steps, steep S-shapes, elongated curves and (virtually) straight lines. Moreover, all changes involve increases. The main message of Table 2 is that bond market integration among the ten industrialized countries of our sample underwent a sea change in the past 20 years. To an important extent this is a global phenomenon. However, significant differences in the size, and pace and timing of correlation changes can be observed between different groups of countries.

As expected, the five countries from the euro area display the most dramatic changes in bond market integration. The average estimated correlation among the EMU members is around 0.97 at the end of 2003. The most extreme transitions involve Italy. In a very short time, Italy's bond return correlations with the other EMU participants increased by 0.50 to 0.60 points to a level of about 0.95. In fact, 55% to 70% of this tremendous gain was accomplished within the span of a year (mid-1997 through mid-1998). The correlations among the other EMU members also show large gains, and much of these can be dated to the second half of the 1990s. In these cases the transition appears to have been fairly swift as well, with the twelve months of fastest change typically accounting for around 30% of the total increase. The one exception is the Dutch-German link, for which the break is pinpointed in the middle of 1990 and much of the gain was accomplished by 1995 already. The correlation was comparatively large in 1980 (over 0.60) and only rose gradually over time. The Dutch and German bond markets were the best integrated pair within the euro area in the pre-EMU years.

Correlations between euro area countries and Denmark, Sweden and the UK have also greatly increased between 1988 and 2003. In fact, many correlations display a larger gain than the correlations within the euro area, pointing to a catch-up of the three countries with the rest of the EU. The average value of these 15 correlations was about 0.93 at the end of 2003, indicating a very high degree of integration, albeit not so close as within the euro area. Interestingly, the increase in bond market integration between EMU members and non-EMU members within the European Union seems to have been a much more gradual process than that among the euro area countries. Break dates are more scattered through time, and the differences between the average pace of change and that around the break date are mostly rather small.

Turning to the correlations between EU countries and non-EU countries, we also see large gains in bond market comovement. Linkages with the Swiss government bond market have intensified in a very gradual fashion for all EU countries. The introduction of the euro does not appear to have had any visible impact on the integration process. Despite large gains since 1980, correlation values hover in the range 0.75-0.80 at the end of 2003 for all EU countries except the UK (0.69), which is substantially lower than the correlations prevailing within the European Union. In contrast to linkages between EU countries and Switzerland, linkages between EU and US bond markets show a remarkable intensification in the second half of the 1990s. Breakdates mostly fall in the pre-EMU years 1996-1998, with fairly steep transitions for several linkages. The average value of the eight EU-US correlations is around 0.75 in 2003, pointing to a significantly lower degree of integration of the US and European bond markets compared to that within the European Union.

As a summary, Figure 1 depicts the evolution of the average bond return correlation for three country groupings: (1) that among EMU-members Germany, France, Italy, the Netherlands and Belgium (10 correlations); (2) that between the euro area countries and Denmark, Sweden and the UK (15 correlations); and (3) that between the EU countries and the United States (8 correlations). Figure 1 clearly demonstrates that the bond market integration process has a large global component. This component may partly be determined by the ever-intensifying relationships among countries in the areas of international trade, foreign direct investment and cross-border portfolio investment. As a result, business cycles display an increasing degree of comovement over time.[11] In 2001, the dispersion of economic growth rates across the industrialized economies even fell to its lowest level in over 30 years. Moreover, the emergence of low and stable inflation around the globe has played a crucial part, as has the consensus that central banks should strive for low and stable inflation. Finally, government finances are in better shape today than in the late 1980s and early 1990s.

Figure 1 also conveys the impression that there is a European component, as correlations among EU bond markets are greater than those between EU bond markets and non-EU bond markets (Switzerland and the US). This can be explained by the fact that the forces that underlie the global trend towards greater interdependence are even more pronounced within Europe due to the Single Market program. Although the introduction of the euro triggered a tremendous acceleration of the integration trend in the years 1996-1998 among the countries that adopted the single currency, it has had no discernible effects on integration after 1999 (see also Baele et al. 2004). By contrast, bond market integration outside the euro area has continued to make advances after 1999. The rather small differences at the end of 2003 between linkages among euro countries themselves on the one hand, and those between euro countries and non-euro countries on the other hand, in combination with the finding that the latter group of linkages has evolved more smoothly over time, suggest that the arrival of EMU has mainly affected the timing of the rise in integration.

[11] Recent empirical evidence on increasing business cycle comovement is provided by Lumsdaine and Prasad (2003) and Helbling and Bayoumi (2003), among others.

The patterns of change within the European Union suggest that exchange rate stability (credibility of pegs) may be an important driving factor of bond market integration. This is consistent with research by Bodart and Reding (1999), who found that a decrease in exchange rate volatility is associated with a rise in bond market correlation. The integration process started off with Germany and the Netherlands, which maintained the most credible peg in the EMS, in the late 1980s. After the turbulence of the EMS crises in 1992-93 had died down and the move towards the monetary union was envisaged, integration with Belgium and France, which belonged to the core of the EMS, began to make great strides forward. By contrast, bond market linkages with Italy, with its history of exchange rate crises, remained tenuous until 1997, when financial markets apparently became convinced that Italy would join EMU from the start in 1999, thereby definitely making devaluations a thing of the past. Looking at the linkages between EMU-members and the non-euro EU-members the same pattern emerges. Denmark, which maintains a fixed exchange rate versus the euro, has the closest bond market links with the euro area in 2003 (correlations exceeding 0.95). Bond market correlations are significantly lower for the UK (still 0.90 though), which lets its currency freely float against the euro.

Stock market return correlations

Turning now to the stock market experience, Table 3 presents the main characteristics of the time profile of the stock market correlations in the period 1980-2003. Like for bond market integration, we find that dates of change and speeds of adjustment vary widely across country pairs, and that all changes are increases. Among the shapes of the transition curve are abrupt steps, steep S-shapes, elongated curves and (virtually) straight lines. The degree of stock market comovement in the industrialized world has greatly increased since 1980. As a global measure of the shift: the simple average of the 45 stock return correlations went up from 0.19 in 1980 to 0.71 in 2003. Many break dates are located in the second half of the 1980s, implying that much of the total change happened in the 1980s. Hence, with the benefit of hindsight, we may conclude that the conjecture by King, Sentana and Wadhwani (1994) that much of the observed gain in stock market integration in the late 1980s involved a transitory shift, has turned out to be wrong.

Comparing the profiles in Tables 2 and 3, it appears that stock market integration evolves in a more gradual fashion than bond market integration. Bond market correlations typically show larger gains than stock market correlations in the year around the break date, when the speed of change is at its maximum. Linkages involving Denmark are the main exception to this pattern. In the year of fastest change, the average bond market correlation increases by 0.106 (averaged over the 45 bilateral linkages), against 0.065 for the average stock market correlation.

In the euro area, stock market integration has progressed at a fairly constant pace. Relatively swift transitions only occur for Belgium, but these transitions are still rather modest by bond market standards. Episodes with the most rapid change are generally located in the late 1980s or early 1990s, preceding the convergence phase prior to EMU by a wide margin. Our results corroborate those of Baele (2005), who finds that the largest increase in stock market integration took place in the period 1985-1995. In 2003, the average stock market correlation within the euro area equaled 0.79 (compared to 0.97 for the government bond markets). Euro area bond markets thus exhibit a much larger tendency to move together than euro area stock markets. Moreover, stock markets display larger differences in integration than bond markets. Belgium is the least integrated stock market in the euro area.

Looking at the linkages between the five euro area countries and Denmark, Sweden and the United Kingdom, we also find that break dates are often located in the 1980s. Within this country grouping, Denmark went through very abrupt changes in integration at the time of the 1987 stock market crash. At the end of 2003, stock market correlations between euro area countries on the one hand, and Denmark, Sweden and the United Kingdom on the other were on average 0.70, somewhat lower that its counterpart among the EMU members (0.79). However, this number hides a sizable difference between Denmark and the other two non-euro EU countries. The Danish stock market shows a much lower degree of integration with the euro area stock markets than Sweden and the UK.

Stock market linkages between EU countries and Switzerland typically intensified in a very gradual fashion. Only the German-Swiss link, which is historically a strong one, displays a sudden transition in the aftermath of the stock market downturn after 2000. Finally, coming to the links between Europe and the US, we find break dates mostly fall in the second half of the sample. Transitions are generally smooth, with the exception of Belgium (jump in 1987), Switzerland and the Netherlands (steep increase after 2000). Compared to the dating of structural change within Europe, changes in linkages between Europe and the US have taken place a couple of years later. By the end of 2003, linkages between most European stock markets and the US stock market have become quite similar in strength. In terms of correlations, countries such as France and Italy have caught up with the Netherlands and Switzerland, which always have had relatively close stock market links with the US. US stock market linkages with Belgium and Denmark are still quite weak, however.

As the counterpart to Figure 1, Figure 2 summarizes the evolution of stock return correlations between 1980 and 2003. Once again, the global factor jumps to the fore. There is also a euro area factor. At the end of 2003, correlations within the euro area are the largest, and they also display the largest gains between 1980 and 2003. Since the late 1980s, comovement among euro area markets has developed at a faster pace than in the rest of the European Union. However, the introduction of the common currency as such does not appear to have had a significant impact on the pace and timing of stock market integration. This is a notable difference with the recent experience with bond market integration. The invisibility of the EMU-event in the time profiles suggests that stock market integration is less driven by factors such as monetary policy convergence, better fiscal policy coordination and greater exchange rate stability, and more by slow-moving underlying trends such as ever closer trade linkages, continuous capital market liberalization and intensifying foreign direct investment relations (see also Baele 2005). Correlation patterns at the end of 2003 also suggest that exchange rate stability has a minor influence on stock market integration, which is in accordance with the empirical findings of Bodart and Reding (1999). For example, stock market linkages between the euro area and UK are much tighter than those between the euro area and Denmark, despite the peg between the Danish krone and the euro, whereas for government bond market linkages the reverse pattern is observed.

Stock market return correlations, 1988-2003

As explained in section 3, our STC-GARCH model estimates the dominant trend of the correlation over the period 1980-2003. Our finding that stock market integration in the euro area did not accelerate in the run-up to EMU should be interpreted in the context of this relatively long sample. It is conceivable that European stock market integration did get a boost from monetary union, but that our model fails to pick this up because the change is not big enough compared to what happened in the 1980s. To further investigate this issue, we have rerun the LM-test for structural change and re-estimated the STC-GARCH models, using data from 1988-2003. Table 4 presents the main characteristics of the time profiles of the stock market correlations in this period, while Figure 3 plots the evolution of stock return correlations among country groups. In a large number cases Table 4 indeed offers evidence of structural change at a relatively late point of time in the shorter sample. Within the euro area, this holds for eight out of the ten linkages (exceptions are the pairs Germany-Netherlands and Germany-Belgium). Figure 3 shows that the average correlation within the euro area increased at a faster pace in the years 1996-2001, which at first sight appears to be supportive evidence for the notion that the introduction of the euro has directly affected the stock market integration process within Europe. However, taking a closer look, it is mainly the Italian linkages that are consistent with this hypothesis. The Belgian correlations only go up quickly from 2001 onward, well after the start of the monetary union. Moreover, Figure 3 makes clear that correlations between US (and Swiss) markets and European markets went up as well in the second half of the 1990s, and posted gains of comparable magnitude. This suggests that the recently observed rise in stock market integration in the euro area probably reflects a global factor, for example the global stock market bubble and its aftermath.

6. Conclusion

This paper investigates whether there has been a structural increase in financial market integration in nine European countries and the US. We focus on the dominant trend of conditional cross-country correlations in both stock and bond markets in the period 1980-2003. Employing a series of bivariate GARCH models with a smoothly time-varying correlation, we first formally test the constant-correlation hypothesis directly by way of a Lagrange Multiplier (LM) test. Our procedure treats both the date of change and the speed of the transition as being endogenous, and thus avoids the statistical deficiencies which often afflict other approaches in the literature.

Our main findings can be summarized as follows. The LM-test produces very strong evidence of greater comovement across the board for both stock markets and bond markets. Dates of change and the speeds of the transition between low and high correlation regimes vary widely across country linkages. This finding suggests that the observed structural shift towards a greater degree of comovement among international financial markets is not solely governed by global factors – such as advances in information technology, financial innovation, greater trade interdependence and convergence of inflation rates to a low level – but that country-specific factors also have a substantial impact. Relevant country-specific factors may be exchange rate risk, market size, differences in economic policies and financial market regulation, and differences in transaction costs and information costs. Apart from the large global component, the integration process in Europe contains a substantial common factor. For euro area countries, the highest correlations are found among themselves, and the lowest with the US and Switzerland.

Comparing the correlation time profiles across type of market, we find that stock market integration is a more gradual process than bond market integration. Moreover, exchange rate stability and monetary (and fiscal) policy convergence appear to be more important drivers for bond market integration than stock market integration. Regarding the emergence of the European monetary union on 1 January 1999, our results suggest that its impact has been rather limited. For government bond markets, EMU has affected the timing of the integration advances rather than the size of them. The run-up to EMU in the years 1996-1998 coincides with a sudden and large increase in bond market correlations among euro area countries to near-perfect levels, translating into a large gap between correlations among euro adopters on the one hand and correlations between euro adopters and non-adopters on the other hand at the beginning of 1999. However, this gap has not persisted, as over the next five years bond market linkages between EMU members and non-EMU members have continued to strengthen. As for stock markets, EMU appears to have hardly influenced the pace of stock market integration within Europe. Much of the gains were realized in the late 1980s and early 1990s. Although an acceleration of the integration trend in the euro area was detected in the late 1990s when we focused on a shorter sample, this appears to reflect a global factor.

Our finding of widely varying dates and speeds of structural change is a strong reminder that a flexible approach to modeling structural change really pays dividends. However, our methodology still contains some important restrictive elements, in particular the strict monotonicity of correlation change and the limitation to two correlation regimes. As our research provides some preliminary evidence that stock market integration may have advanced in two stages (late 1980s and late 1990s), relaxing these restrictions is an interesting topic for future research. An alternative set-up would be not to use time as the transition variable, but a measure of interdependence, for instance international trade patterns. As such variables may not be necessarily monotonic, this also introduces the possibility of non-monotonic change. An additional advantage of this approach is that it may shed some light on the underlying causes of long-run changes in the degree of financial market comovement.

References

Baele, L. (2005), Volatility spillover effects in European equity markets, *Journal of Financial and Quantitative Analysis* **40**, 509-530.

Baele, L., A. Ferrando, P. Hördahl, E. Krylova and C. Monnet (2004), Measuring European financial integration, *Oxford Review of Economic Policy* **20**, 509-530.

Berben, R.P. and W.J. Jansen (2005), Comovement in international equity markets: A sectoral view, *Journal of International Money and Finance* **24**, 832-857.

Bodart, V. and P. Reding (1999), Exchange regime, volatility and international correlations on bond and stock markets, *Journal of International Money and Finance* **18**, 133-151.

Bollerslev, T. (1990), Modeling the coherence in short-run nominal exchange rates: a multivariate generalized ARCH approach, *Review of Economics and Statistics* **72**, 498-505.

Bollerslev, T. and J.M. Wooldridge (1992), Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances, *Econometric Reviews* **11**, 143-172.

Boyer, B.H., M.S. Gibson and M. Loretan (1999), Pitfalls in tests for changes in correlations, International Finance Discussion Paper 597, Federal Reserve Board, Washington, DC.

Burns, P., R.F. Engle and J. Mezrich (1998), Correlation and volatilities of asynchronous data, *Journal of Derivatives* **4**, 1-12.

Cappiello, L., R.F. Engle and K. Sheppard (2003), Asymmetric dynamics in the correlations of global equity and bond markets, ECB Working Paper 204 (January).

Christiansen, C. (2004), Decomposing European bond and equity volatility, Finance Research Group Working Paper F-2004-01, University of Aarhus.

Christiansen, C. (2006), Volatility-spillover effects in European bond markets, forthcoming in *European Financial Management.*

Danthine, J.-P., F. Giavazzi and I.-L. von Thadden (2000), European financial markets after EMU: A first assessment, NBER Working Paper no. 8044 (December).

Engle, R. (2002), Dynamic Conditional Correlation – A simple class of multivariate GARCH models, *Journal of Business and Economic Statistics* **20,** 339-350.

Fratzscher, M. (2002), Financial market integration in Europe: On the effects of EMU on stock markets, *International Journal of Finance and Economics* **7**, 165-193.

Goetzmann, W.N., L. Li and K.G. Rouwenhorst (2005), Long-term global market correlations, *Journal of Business* **78**, 1-38.

Hansen, B.E. (1996), Inference when a nuisance parameter is not identified under the null hypothesis, *Econometrica* **64**, 413-430.

Helbling, T. and T. Bayoumi (2003), Are they all in the same boat? The 2002-2001 growth slowdown and the G-7 business cycle linkages, IMF Working Paper 03/46 (March), International Monetary Fund.

Karolyi, G.A. and R.M. Stulz (2003), Are financial assets priced locally or globally?, in *Handbook of the Economics of Finance* (eds.) G.M. Constantinidis, M. Harris and R.M. Stulz, Elsevier.

Kim, S. J., F. Moshirian and E. Wu (2006), Evolution of international stock and bond market integration: influence of the European Monetary Union, *Journal of Banking & Finance* **30**, 1507-1534.

King, M., E. Sentana and S. Wadhwani (1994), Volatility and links between national stock markets, *Econometrica* **62**, 901-933.

Longin, F. and B. Solnik (1995), Is the correlation in international equity returns constant: 1960-1990?, *Journal of International Money and Finance* **14**, 3-26.

Lumsdaine, R.L. and E.S. Prasad (2003), Identifying the common component of international economic fluctuations: A new approach, *Economic Journal* **113**, 101-127.

Richardson, M. and T. Smith (1994), A unified approach to testing for serial correlation in stock returns, *Journal of Business* **67**, 371-399.

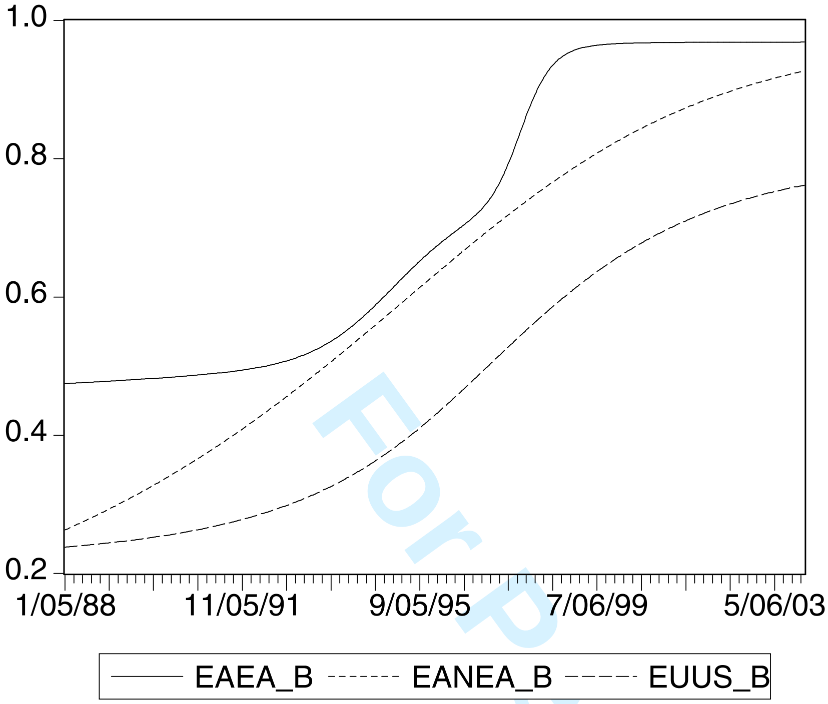
Roll, R. (1989), Price volatility, international market links, and their implications for regulatory policies, *Journal of Financial Services Research* **3**, 211-246.

Skintzi, V.D., and A.P.N. Refenes (2004), Volatility spillovers and dynamic correlation in European bond markets, Working Paper, Athens University of Economics and Business.

Yang, J., J. Shin and M. Khan (2007), Causal linkages between US and Eurodollar interest rates: further evidence, *Applied Economics* **39**, 135-144.

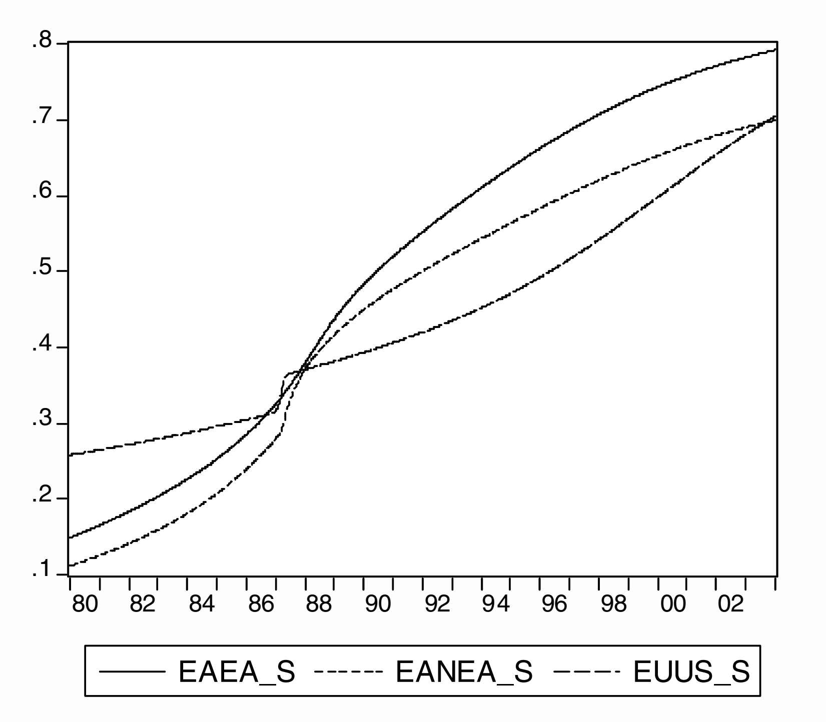
Yang, L., F. Tapon and Y. Sun (2006), International correlations across stock markets and industries: trends and patterns 1988-2002, *Applied Financial Economics* **16**, 1171-1183.

Figure 1. Unweighted average of bond return correlations among groups of countries, 1988-2003



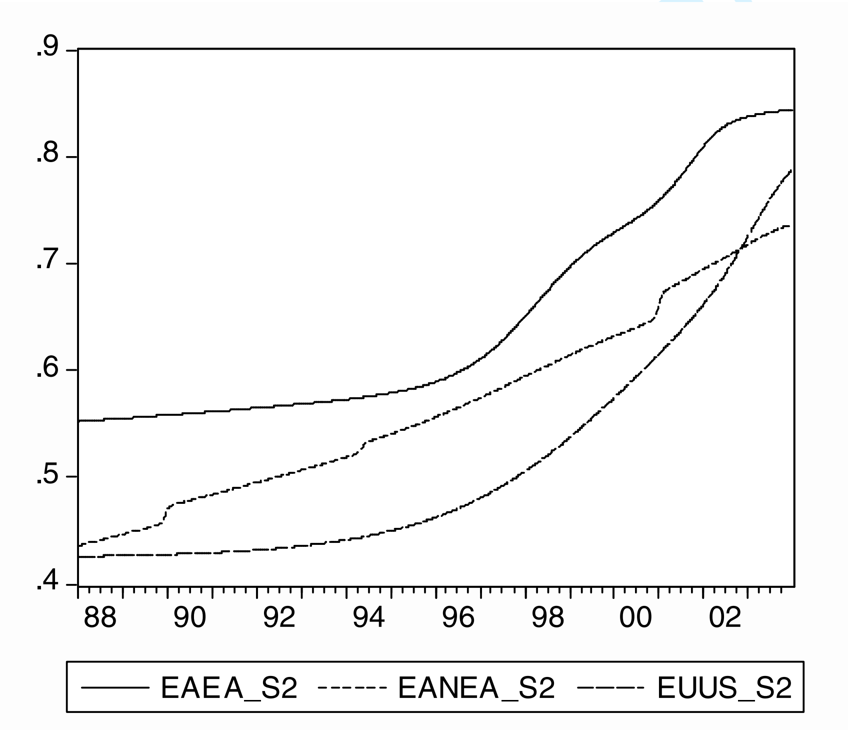
Note: EAEA = correlations among euro area countries (Belgium, France, Germany, Italy, the Netherlands); EANEA = correlations between the euro area countries and Denmark, Sweden, and the UK; EUUS = correlations between the EU countries and the US.

Figure 2. Unweighted average of stock return correlations among groups of countries, 1980-2003



Note: EAEA = correlations among euro area countries (Belgium, France, Germany, Italy, the Netherlands); EANEA = correlations between the euro area countries and Denmark, Sweden, and the UK; EUUS = correlations between the EU countries and the US.

Figure 3. Unweighted average of stock return correlations among groups of countries, 1988-2003



Note: EAEA = correlations among euro area countries (Belgium, France, Germany, Italy, the Netherlands); EANEA = correlations between the euro area countries and Denmark, Sweden, and the UK; EUUS = correlations between the EU countries and the US.

Table 1. Data availability and summary statistics weekly returns

Bonds

	period	#obs	mean	standard deviation	test AR(1)	p-value	test ARCH(5)	p-value
Germany	1980:01-2003:12	1252	0.138	0.577	20.35	0.000	91.8	0.000
France	1980:01-2003:12	1252	0.171	0.628	0.04	0.851	201.0	0.000
Italy	1980:01-2003:12	1252	0.208	0.626	0.27	0.603	90.4	0.000
Netherlands	1980:01-2003:12	1252	0.155	0.593	14.39	0.000	169.6	0.000
Belgium	1980:01-2003:12	1252	0.160	0.499	1.46	0.227	159.9	0.000
Denmark	1980:01-2003:12	1252	0.191	0.610	3.77	0.052	67.9	0.000
Sweden	1982:01-2003:12	1147	0.185	0.678	0.08	0.777	36.0	0.000
UK	1980:01-2003:12	1252	0.216	1.066	6.01	0.014	20.1	0.001
Switzerland	1980:01-2003:12	1252	0.102	0.502	19.84	0.000	41.9	0.000
US	1980:01-2003:12	1252	0.176	0.951	3.57	0.059	157.5	0.000

Stocks

	period		mean	standard deviation	AR(1)	p-value	ARCH(5)	p-value
Germany	1980:01-2003:12	1252	0.139	2.450	1.95	0.163	151.0	0.000
France	1985:01-2003:12	990	0.191	2.663	1.21	0.271	79.7	0.000
Italy	1988:01-2003:12	834	0.236	3.334	0.84	0.361	185.9	0.000
Netherlands	1980:01-2003:12	1252	0.186	2.284	0.42	0.516	97.5	0.000
Belgium	1986:01-2003:12	938	0.164	2.193	2.41	0.120	37.6	0.000
Denmark	1985:01-2003:12	990	0.250	2.385	1.18	0.278	22.6	0.000
Sweden	1987:02-2003:12	881	0.242	3.317	0.04	0.841	96.5	0.000
UK	1980:01-2003:12	1252	0.192	2.196	0.50	0.480	36.5	0.000
Switzerland	1980:12-2003:12	1203	0.176	2.142	2.04	0.153	162.1	0.000
US	1980:01-2003:12	1252	0.199	2.198	0.02	0.897	28.5	0.000

Note: AR(1) is the robust test for first order autocorrelation from Richardson and Smith (1994).
ARCH(5) is the test for autoregressive conditional heteroskedasticity (up to 5 lags) from Engle (1982).

Table 2. Characteristics of time profile of government bond return correlations

		start of sample	estimated correlation at start of sample	estimated correlation at the end of 2003	change in correlation	break date	correlation change in year around break date	percent of total change in year around break date
Germany	France	1985.01	0.519	0.965	0.446	1995.03	0.123	28
Germany	Italy	1988.01	0.309	0.940	0.630	1997.10	0.442	70
Germany	Netherlands	1980.01	0.616	0.994	0.377	1990.07	0.040	11
Germany	Belgium	1986.01	0.459	0.958	0.499	1994.06	0.146	29
France	Italy	1988.01	0.496	0.979	0.483	1997.12	0.304	63
France	Netherlands	1985.01	0.526	0.968	0.441	1995.07	0.137	31
France	Belgium	1986.01	0.476	0.994	0.519	1995.03	0.138	27
Italy	Netherlands	1988.01	0.344	0.941	0.596	1997.09	0.394	66
Italy	Belgium	1988.01	0.372	0.983	0.611	1997.11	0.338	55
Netherlands	Belgium	1986.01	0.537	0.963	0.426	1994.10	0.137	32
Germany	Denmark	1985.01	0.171	0.953	0.782	1992.01	0.062	8
France	Denmark	1985.01	0.082	0.958	0.876	1985.12	0.087	10
Italy	Denmark	1988.01	0.305	0.958	0.653	1996.05	0.069	11
Netherlands	Denmark	1985.01	0.230	0.961	0.731	1994.01	0.064	9
Belgium	Denmark	1986.01	0.306	0.954	0.648	1993.01	0.053	8
Germany	Sweden	1987.02	0.284	0.945	0.661	1997.09	0.076	11
France	Sweden	1987.02	0.333	0.945	0.612	1996.10	0.060	10
Italy	Sweden	1988.01	0.189	0.917	0.728	1995.06	0.063	9
Netherlands	Sweden	1987.02	0.216	0.947	0.731	1997.04	0.081	11
Belgium	Sweden	1987.02	0.166	0.932	0.766	1996.02	0.070	9
Germany	UK	1980.01	0.195	0.904	0.709	1994.02	0.045	6
France	UK	1985.01	0.145	0.903	0.758	1991.06	0.052	7
Italy	UK	1988.01	-0.020	0.900	0.921	1994.10	0.078	9
Netherlands	UK	1980.01	0.068	0.900	0.831	1990.09	0.047	6
Belgium	UK	1986.01	0.188	0.838	0.650	1993.09	0.069	11
Denmark	Sweden	1987.02	0.167	0.920	0.753	1994.07	0.157	21
Denmark	UK	1985.01	-0.003	0.904	0.907	1993.03	0.065	7
Sweden	UK	1987.02	0.256	0.915	0.659	1998.09	0.074	11
Germany	Switzerland	1980.12	0.265	0.797	0.532	1998.01	0.034	6
France	Switzerland	1985.01	0.047	0.754	0.707	1993.12	0.061	9
Italy	Switzerland	1988.01	0.046	0.758	0.712	1997.12	0.059	8
Netherlands	Switzerland	1980.12	0.327	0.798	0.471	1999.09	0.036	8
Belgium	Switzerland	1986.01	0.301	0.783	0.482	2000.03	0.042	9
Denmark	Switzerland	1985.01	-0.032	0.784	0.815	1993.08	0.056	7
Sweden	Switzerland	1987.02	0.094	0.782	0.688	1997.07	0.051	7
UK	Switzerland	1980.12	-0.031	0.690	0.721	1995.10	0.038	5
Germany	US	1980.01	0.361	0.758	0.398	1997.01	0.059	15
France	US	1985.01	0.334	0.782	0.448	1997.09	0.068	15
Italy	US	1988.01	0.023	0.770	0.748	1996.12	0.082	11
Netherlands	US	1980.01	0.383	0.750	0.367	1996.12	0.058	16
Belgium	US	1986.01	0.247	0.732	0.485	1996.06	0.087	18
Denmark	US	1985.01	0.099	0.828	0.729	1998.08	0.064	9
Sweden	US	1987.02	0.155	0.753	0.598	1999.02	0.078	13
UK	US	1980.01	0.217	0.726	0.509	1994.02	0.044	9
Switzerland	US	1980.12	0.159	0.560	0.401	1997.07	0.400	100

Table 3. Characteristics of time profile of stock return correlations, 1980-2003

		estimated correlation at start of sample *	estimated correlation at the end of 2003	change in correlation	break date	correlation change in year around break date	percent of total change in year around break date
Germany	France	0.128	0.903	0.775	1989.05	0.048	6
Germany	Italy	0.022	0.846	0.824	1992.02	0.047	6
Germany	Netherlands	0.178	0.878	0.700	1981.03	0.046	7
Germany	Belgium	0.165	0.665	0.500	1988.04	0.103	21
France	Italy	0.081	0.889	0.809	1993.12	0.058	7
France	Netherlands	0.282	0.889	0.607	1989.04	0.034	6
France	Belgium	0.245	0.662	0.417	1988.03	0.147	35
Italy	Netherlands	0.168	0.838	0.670	1994.06	0.046	7
Italy	Belgium	-0.051	0.639	0.690	1981.03	0.039	6
Netherlands	Belgium	0.267	0.719	0.452	1987.02	0.067	15
Germany	Denmark	0.076	0.589	0.513	1987.12	0.109	21
France	Denmark	0.035	0.489	0.454	1987.08	0.224	49
Italy	Denmark	0.116	0.475	0.359	1987.05	0.179	50
Netherlands	Denmark	0.055	0.583	0.528	1987.09	0.067	13
Belgium	Denmark	0.060	0.505	0.444	1987.09	0.117	26
Germany	Sweden	0.220	0.846	0.626	1992.03	0.036	6
France	Sweden	0.073	0.832	0.759	1991.09	0.044	6
Italy	Sweden	0.182	0.769	0.587	1997.01	0.046	8
Netherlands	Sweden	0.092	0.741	0.649	1983.01	0.059	9
Belgium	Sweden	-0.114	0.541	0.655	1985.07	0.110	17
Germany	UK	0.187	0.843	0.656	1992.12	0.038	6
France	UK	0.097	0.874	0.778	1988.11	0.044	6
Italy	UK	0.235	0.834	0.600	1997.08	0.053	9
Netherlands	UK	0.402	0.845	0.442	1981.03	0.025	6
Belgium	UK	0.183	0.739	0.556	1981.03	0.029	5
Denmark	Sweden	0.049	0.609	0.560	1983.01	0.047	8
Denmark	UK	0.084	0.559	0.474	1989.10	0.060	13
Sweden	UK	0.011	0.760	0.748	1983.01	0.051	7
Germany	Switzerland	0.632	0.910	0.278	2002.10	0.104	37
France	Switzerland	0.272	0.801	0.530	1993.04	0.027	5
Italy	Switzerland	0.127	0.745	0.618	1996.10	0.036	6
Netherlands	Switzerland	0.438	0.787	0.349	1981.03	0.017	5
Belgium	Switzerland	0.249	0.734	0.485	1989.02	0.022	5
Denmark	Switzerland	0.162	0.470	0.308	1987.09	0.154	50
Sweden	Switzerland	0.380	0.669	0.289	1983.01	0.014	5
UK	Switzerland	0.258	0.786	0.528	1993.02	0.026	5
Germany	US	0.313	0.803	0.490	1999.09	0.045	9
France	US	0.270	0.790	0.520	1996.12	0.031	6
Italy	US	0.166	0.768	0.602	1998.09	0.073	12
Netherlands	US	0.527	0.821	0.294	2002.09	0.062	21
Belgium	US	0.127	0.504	0.377	1987.02	0.189	50
Denmark	US	0.183	0.485	0.302	1981.03	0.014	5
Sweden	US	0.169	0.731	0.561	1992.01	0.029	5
UK	US	0.341	0.741	0.400	1992.02	0.018	5
Switzerland	US	0.467	0.820	0.353	2002.09	0.088	25

Note: Entries involving Sweden refer to the period 1982-2003.

Table 4. Characteristics of time profile of stock return correlations, 1988-2003
(based on estimates for 1988-2003)

		estimated correlation at start of 1988	estimated correlation at the end of 2003	correlation change over 1988-2003	break date	change in correlation in year around break date	percent of total change in year around break date
Germany	France	0.681	0.942	0.261	1999.08	0.053	20
Germany	Italy	0.454	0.845	0.391	1998.04	0.160	41
Germany	Netherlands	0.586	0.887	0.301	1994.04	0.023	8
Germany	Belgium	0.546	0.724	0.177	1988.10	0.012	7
France	Italy	0.431	0.882	0.451	1998.03	0.114	25
France	Netherlands	0.678	0.933	0.255	2000.05	0.050	20
France	Belgium	0.602	0.821	0.219	2001.12	0.156	71
Italy	Netherlands	0.446	0.813	0.367	1997.10	0.111	30
Italy	Belgium	0.439	0.707	0.268	2001.03	0.171	64
Netherlands	Belgium	0.659	0.886	0.227	2001.11	0.142	62
Germany	Denmark	0.363	0.590	0.227	1989.12	0.227	100
France	Denmark	0.430	0.611	0.181	2001.00	0.181	100
Italy	Denmark	0.372	0.496	0.124	1994.04	0.124	100
Netherlands	Denmark	0.252	0.580	0.328	1988.10	0.070	21
Belgium	Denmark	0.476	0.496	0.020	1988.10	0.001	6
Germany	Sweden	0.399	0.853	0.455	1994.12	0.034	8
France	Sweden	0.424	0.867	0.443	1999.02	0.047	11
Italy	Sweden	0.314	0.740	0.427	1997.09	0.068	16
Netherlands	Sweden	0.539	0.786	0.248	2000.08	0.020	8
Belgium	Sweden	0.500	0.840	0.339	2003.01	0.199	59
Germany	UK	0.393	0.836	0.443	1992.10	0.033	7
France	UK	0.455	0.874	0.420	1994.12	0.033	8
Italy	UK	0.352	0.796	0.444	1998.03	0.082	18
Netherlands	UK	0.717	0.878	0.161	2000.12	0.161	100
Belgium	UK	0.557	0.814	0.257	2001.08	0.144	56
Denmark	Sweden	0.365	0.643	0.278	1994.01	0.021	7
Denmark	UK	0.099	0.553	0.455	1988.10	0.089	20
Sweden	UK	0.449	0.788	0.339	2000.04	0.029	9
Germany	Switzerland	0.674	0.942	0.269	2003.03	0.218	81
France	Switzerland	0.621	0.911	0.291	2002.04	0.093	32
Italy	Switzerland	0.405	0.824	0.419	2001.05	0.062	15
Netherlands	Switzerland	0.681	0.851	0.170	2000.12	0.170	100
Belgium	Switzerland	0.592	0.752	0.159	2000.06	0.127	79
Denmark	Switzerland	0.365	0.480	0.115	1989.11	0.115	100
Sweden	Switzerland	0.573	0.888	0.315	2003.03	0.303	96
UK	Switzerland	0.532	0.832	0.300	2001.04	0.036	12
Germany	US	0.384	0.811	0.427	2000.07	0.047	11
France	US	0.480	0.845	0.365	2001.05	0.055	15
Italy	US	0.227	0.767	0.540	1999.04	0.080	15
Netherlands	US	0.561	0.876	0.316	2002.11	0.113	36
Belgium	US	0.469	0.868	0.399	2003.02	0.229	58
Denmark	US	0.299	0.546	0.247	1999.06	0.047	19
Sweden	US	0.440	0.811	0.371	2001.09	0.054	15
UK	US	0.547	0.800	0.253	2002.10	0.042	17
Switzerland	US	0.531	0.864	0.332	2003.01	0.137	41

APPENDIX with *Bond Market en Stock Market Integration in Europe*

This appendix is not to be published, but will be available from the authors upon request. It reports (detailed) results that are not essential to a good understanding of the paper, but may still be interesting for some researchers.

Contents

Table A1. Correlations of weekly bond returns

1988-1995

	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.716	0.371	0.876	0.676	0.609	0.393	0.473	0.484	0.328
France		0.511	0.710	0.642	0.712	0.455	0.483	0.347	0.367
Italy			0.439	0.418	0.523	0.436	0.348	0.240	0.164
Netherlands				0.741	0.611	0.365	0.547	0.489	0.331
Belgium					0.631	0.392	0.467	0.399	0.261
Denmark						0.416	0.415	0.298	0.231
Sweden							0.316	0.266	0.177
UK								0.269	0.368
Switzerland									0.093

1999-2003

	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.977	0.963	0.994	0.975	0.931	0.868	0.837	0.738	0.727
France		0.980	0.979	0.994	0.920	0.855	0.819	0.734	0.714
Italy			0.963	0.982	0.916	0.843	0.826	0.719	0.718
Netherlands				0.977	0.930	0.865	0.836	0.734	0.719
Belgium					0.921	0.854	0.816	0.736	0.723
Denmark						0.898	0.781	0.718	0.684
Sweden							0.738	0.696	0.610
UK								0.608	0.701
Switzerland									0.585

Table A2. Correlations of weekly stock market returns

1980-1987*	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.250	0.162	0.446	0.337	0.182	0.375	0.344	0.653	0.318
France		0.097	0.375	0.323	0.091	0.241	0.264	0.356	0.298
Italy			0.246	0.148	0.171	0.253	0.248	0.214	0.155
Netherlands				0.415	0.214	0.339	0.603	0.569	0.563
Belgium					0.173	0.294	0.364	0.442	0.246
Denmark						0.244	0.201	0.276	0.280
Sweden							0.283	0.511	0.305
UK								0.484	0.515
Switzerland									0.443

1988-1995	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.679	0.459	0.631	0.611	0.495	0.517	0.505	0.676	0.425
France		0.420	0.628	0.584	0.386	0.454	0.547	0.595	0.453
Italy			0.430	0.384	0.366	0.314	0.342	0.392	0.230
Netherlands				0.630	0.418	0.536	0.686	0.655	0.510
Belgium					0.453	0.512	0.494	0.608	0.430
Denmark						0.387	0.324	0.459	0.287
Sweden							0.459	0.542	0.439
UK								0.537	0.511
Switzerland									0.537

1999-2003	France	Italy	N'lands	Belgium	Denmark	Sweden	UK	Switzerl.	US
Germany	0.910	0.850	0.878	0.708	0.633	0.793	0.825	0.786	0.744
France		0.870	0.884	0.712	0.577	0.794	0.862	0.800	0.744
Italy			0.815	0.611	0.497	0.715	0.772	0.719	0.669
Netherlands				0.772	0.621	0.709	0.850	0.822	0.706
Belgium					0.514	0.534	0.735	0.756	0.589
Denmark						0.604	0.575	0.539	0.530
Sweden							0.710	0.642	0.713
UK								0.812	0.715
Switzerland									0.676

* Note: 1982-1987 for pairs involving Sweden.

Table A3. LM test statistic for constant correlation hypothesis
(p-values above diagonal, statistics below diagonal)

bond market returns (full sample)

	BEL	FRA	GER	ITA	NET	DEN	SWE	UK	SWI	US
Belgium		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
France	259.7		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Germany	170.0	204.6		0.000	0.000	0.000	0.000	0.000	0.000	0.000
Italy	189.6	188.1	169.9		0.000	0.000	0.000	0.000	0.000	0.000
Netherlands	144.0	174.7	372.7	148.5		0.000	0.000	0.000	0.000	0.000
Denmark	97.1	159.6	135.8	97.6	106.2		0.000	0.000	0.000	0.000
Sweden	84.9	87.9	84.4	91.1	86.6	180.3		0.000	0.000	0.000
UK	140.6	178.7	157.9	140.6	213.2	128.6	70.2		0.000	0.000
Switzerland	38.6	102.9	61.3	64.0	44.6	73.8	53.4	78.5		0.000
US	81.1	69.1	40.6	98.2	43.8	74.2	42.1	78.0	31.2	

stock market returns (full sample)

	BEL	FRA	GER	ITA	NET	DEN	SWE	UK	SWI	US
Belgium		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
France	68.9		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Germany	58.7	226.4		0.000	0.000	0.000	0.000	0.000	0.025	0.000
Italy	64.4	181.4	145.0		0.000	0.000	0.000	0.000	0.000	0.000
Netherlands	60.7	176.2	172.1	145.8		0.000	0.000	0.000	0.000	0.001
Denmark	29.6	47.4	56.4	30.4	62.8		0.000	0.000	0.000	0.001
Sweden	29.2	138.8	108.5	57.3	85.5	38.0		0.000	0.000	0.000
UK	67.4	190.3	126.3	86.9	92.4	52.9	94.3		0.000	0.000
Switzerland	39.4	73.1	5.0	75.6	39.9	16.0	17.1	55.9		0.002
US	31.4	75.2	48.4	50.7	10.4	11.0	54.1	47.4	9.2	

stock market returns (1988-2003)

	BEL	FRA	GER	ITA	NET	DEN	SWE	UK	SWI	US
Belgium		0.021	0.015	0.007	0.005	0.956	0.364	0.000	0.009	0.049
France	5.3		0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000
Germany	5.9	51.7		0.000	0.000	0.090	0.000	0.000	0.056	0.000
Italy	7.4	80.5	52.0		0.000	0.101	0.000	0.000	0.000	0.000
Netherlands	8.0	48.6	48.1	53.1		0.003	0.000	0.000	0.003	0.009
Denmark	0.0	3.5	2.9	2.7	9.0		0.002	0.000	0.828	0.010
Sweden	0.8	61.0	56.8	44.5	21.3	9.6		0.000	0.030	0.000
UK	15.5	59.1	54.7	52.2	18.3	14.4	29.8		0.000	0.000
Switzerland	6.8	15.0	3.6	24.5	8.7	0.0	4.7	21.1		0.068
US	3.9	23.8	30.1	38.8	6.8	6.6	21.6	12.2	3.3	

Table A4. STC-GARCH model estimates for bond market returns (full sample)

		start of sample	gamma	c	standard error	break date	rho_0	standard error	rho_1	standard error
Germany	France	1985.01	21.56	0.641	0.066	1995.03	0.519	0.068	0.965	0.009
Germany	Italy	1988.01	55.57	0.741	0.010	1997.10	0.309	0.040	0.940	0.014
Germany	Netherlands	1980.01	10.09	0.443	0.074	1990.07	0.612	0.070	0.995	.
Germany	Belgium	1986.01	21.73	0.604	0.028	1994.06	0.459	0.054	0.958	0.009
France	Italy	1988.01	47.40	0.749	0.023	1997.12	0.496	0.042	0.979	0.005
France	Netherlands	1985.01	24.33	0.650	0.064	1995.07	0.526	0.070	0.968	0.009
France	Belgium	1986.01	19.63	0.634	0.024	1995.03	0.475	0.049	0.995	0.002
Italy	Netherlands	1988.01	50.80	0.739	0.011	1997.09	0.344	0.041	0.941	0.014
Italy	Belgium	1988.01	39.96	0.744	0.023	1997.11	0.372	0.056	0.983	0.003
Netherlands	Belgium	1986.01	24.10	0.617	0.021	1994.10	0.537	0.046	0.963	0.009
Germany	Denmark	1985.01	4.92	0.503	0.165	1992.01	0.039	0.287	0.995	.
France	Denmark	1985.01	3.99	0.248	.	1985.12	-0.668	0.127	0.995	.
Italy	Denmark	1988.01	6.14	0.685	0.114	1996.05	0.278	0.173	0.995	.
Netherlands	Denmark	1985.01	6.00	0.588	0.139	1994.01	0.187	0.208	0.995	.
Belgium	Denmark	1986.01	4.82	0.546	0.208	1993.01	0.203	0.292	0.995	.
Germany	Sweden	1987.02	7.25	0.739	0.056	1997.09	0.277	0.065	0.991	0.056
France	Sweden	1987.02	6.01	0.703	0.080	1996.10	0.313	0.092	0.995	.
Italy	Sweden	1988.01	4.44	0.645	0.162	1995.06	0.088	0.269	0.995	.
Netherlands	Sweden	1987.02	6.99	0.724	0.059	1997.04	0.204	0.083	0.995	.
Belgium	Sweden	1987.02	5.50	0.673	0.096	1996.02	0.122	0.143	0.995	.
Germany	UK	1980.01	5.13	0.589	0.060	1994.02	0.156	0.078	0.995	.
France	UK	1985.01	3.63	0.479	0.147	1991.06	-0.102	0.248	0.995	.
Italy	UK	1988.01	4.26	0.617	0.121	1994.10	-0.186	0.264	0.995	.
Netherlands	UK	1980.01	4.19	0.446	0.103	1990.09	-0.076	0.175	0.995	.
Belgium	UK	1986.01	7.27	0.574	0.073	1993.09	0.159	0.313	0.849	0.215
Denmark	Sweden	1987.02	14.36	0.606	0.040	1994.07	0.165	0.083	0.920	0.015
Denmark	UK	1985.01	4.32	0.551	0.095	1993.03	-0.158	0.169	0.995	.
Sweden	UK	1987.02	6.81	0.781	0.056	1998.09	0.249	0.071	0.995	.
Germany	Switzerland	1980.12	4.09	0.753	0.076	1998.01	0.230	0.088	0.995	.
France	Switzerland	1985.01	5.86	0.581	0.064	1993.12	0.000	0.223	0.788	0.204
Italy	Switzerland	1988.01	3.85	0.746	0.245	1997.12	-0.037	0.292	0.941	0.552
Netherlands	Switzerland	1980.12	4.82	0.822	0.059	1999.09	0.314	0.068	0.995	.
Belgium	Switzerland	1986.01	4.16	0.843	0.099	2000.03	0.275	0.117	0.995	.
Denmark	Switzerland	1985.01	3.86	0.570	0.126	1993.08	-0.193	0.489	0.903	0.409
Sweden	Switzerland	1987.02	3.46	0.732	0.200	1997.07	-0.011	0.286	0.995	.
UK	Switzerland	1980.12	2.96	0.659	0.246	1995.10	-0.184	0.353	0.995	.
Germany	US	1980.01	14.16	0.712	0.061	1997.01	0.361	0.034	0.765	0.067
France	US	1985.01	11.45	0.738	0.050	1997.09	0.334	0.039	0.792	0.064
Italy	US	1988.01	6.46	0.707	0.087	1996.12	0.001	0.239	0.816	0.136
Netherlands	US	1980.01	15.21	0.706	0.074	1996.12	0.383	0.033	0.754	0.075
Belgium	US	1986.01	12.99	0.688	0.066	1996.06	0.246	0.046	0.734	0.068
Denmark	US	1985.01	5.35	0.778	0.062	1998.08	0.080	0.078	0.995	.
Sweden	US	1987.02	8.12	0.798	0.107	1999.02	0.153	0.054	0.811	0.145
UK	US	1980.01	7.86	0.591	0.065	1994.02	0.212	0.161	0.747	0.201
Switzerland	US	1980.12	400.00	0.733	0.003	1997.07	0.159	0.035	0.560	0.034

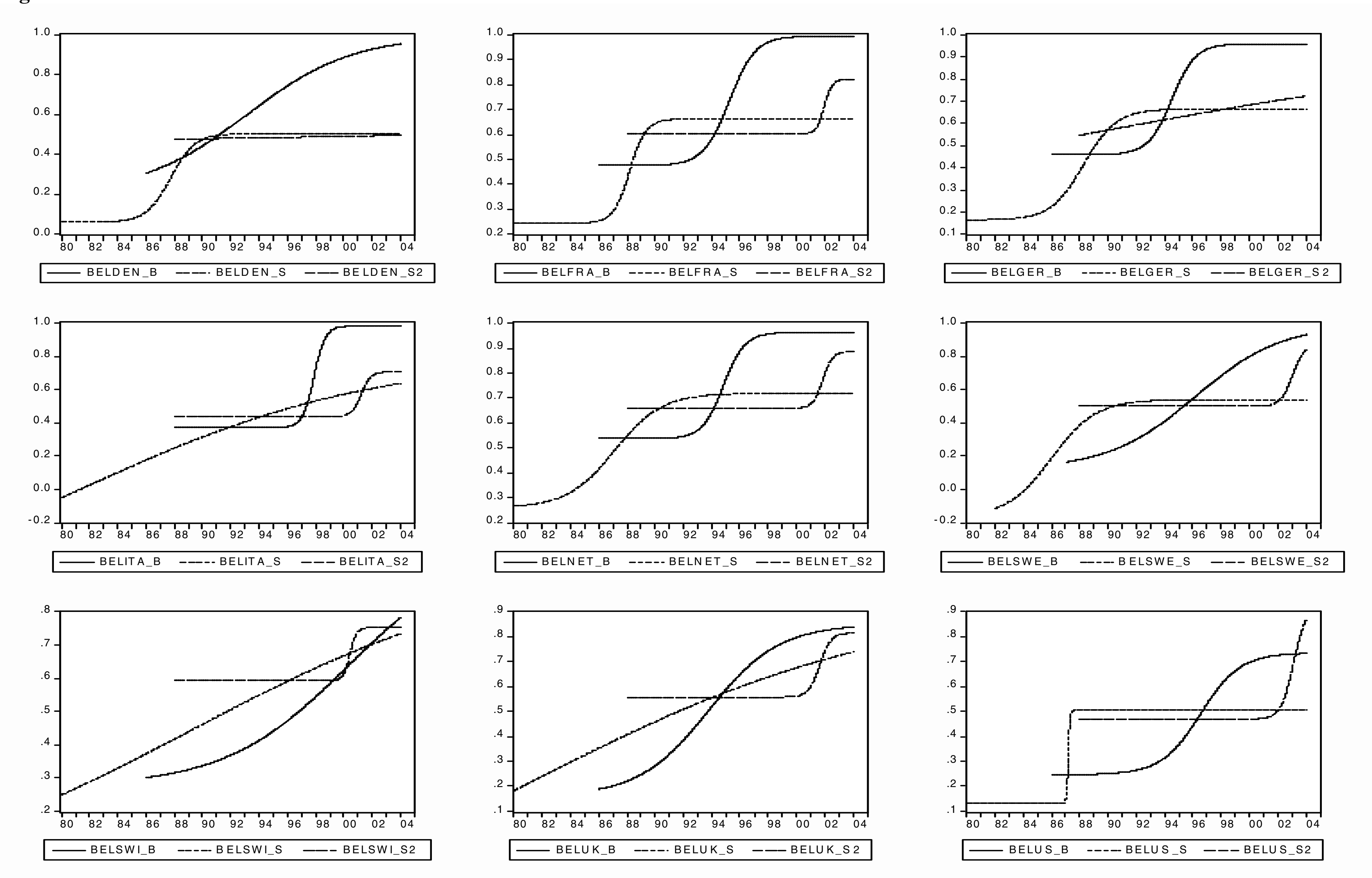
Table A5. STC-GARCH model estimates for stock market returns (full sample)

		start of sample	gamma	c	standard error	break date	rho_0	standard error	rho_1	standard error
Germany	France	1980.01	4.85	0.390	0.065	1989.05	0.003	0.105	0.950	.
Germany	Italy	1980.01	4.40	0.505	0.153	1992.02	-0.079	0.246	0.950	.
Germany	Netherlands	1980.01	3.10	0.050	.	1981.03	-0.485	0.132	0.950	.
Germany	Belgium	1980.01	20.90	0.345	0.032	1988.04	0.165	0.083	0.665	0.024
France	Italy	1980.01	6.26	0.582	0.085	1993.12	0.058	0.123	0.950	.
France	Netherlands	1980.01	4.09	0.387	0.142	1989.04	0.144	0.199	0.950	.
France	Belgium	1980.01	42.04	0.341	0.021	1988.03	0.245	0.068	0.662	0.023
Italy	Netherlands	1980.01	5.71	0.602	0.075	1994.06	0.144	0.119	0.910	0.088
Italy	Belgium	1980.01	2.29	0.050	.	1981.03	-0.814	0.407	0.803	0.500
Netherlands	Belgium	1980.01	14.41	0.297	0.064	1987.02	0.260	0.132	0.719	0.021
Germany	Denmark	1980.01	21.70	0.333	0.050	1987.12	0.076	0.054	0.589	0.039
France	Denmark	1980.01	121.21	0.319	0.013	1987.08	0.035	0.055	0.489	0.030
Italy	Denmark	1980.01	400.00	0.306	0.003	1987.05	0.117	0.043	0.474	0.032
Netherlands	Denmark	1980.01	12.17	0.323	0.102	1987.09	0.045	0.165	0.583	0.029
Belgium	Denmark	1980.01	27.88	0.322	0.035	1987.09	0.060	0.048	0.505	0.032
Germany	Sweden	1982.01	3.71	0.509	0.218	1992.03	0.089	0.280	0.950	.
France	Sweden	1982.01	3.71	0.491	0.203	1991.09	-0.096	0.318	0.950	.
Italy	Sweden	1982.01	5.77	0.708	0.128	1997.01	0.169	0.263	0.865	0.477
Netherlands	Sweden	1982.01	4.32	0.130	.	1983.01	-0.449	0.143	0.761	0.055
Belgium	Sweden	1982.01	14.10	0.250	0.192	1985.07	-0.165	0.683	0.541	0.040
Germany	UK	1980.01	4.52	0.540	0.097	1992.12	0.122	0.143	0.933	0.112
France	UK	1980.01	4.04	0.368	0.127	1988.11	-0.097	0.220	0.950	.
Italy	UK	1980.01	7.42	0.733	0.086	1997.08	0.232	0.109	0.918	0.302
Netherlands	UK	1980.01	2.29	0.050	.	1981.03	-0.087	0.084	0.950	.
Belgium	UK	1980.01	1.87	0.050	.	1981.03	-0.517	0.108	0.950	.
Denmark	Sweden	1982.01	3.85	0.130	.	1983.01	-0.437	0.175	0.636	0.086
Denmark	UK	1980.01	12.30	0.409	0.061	1989.10	0.081	0.060	0.559	0.040
Sweden	UK	1982.01	2.76	0.130	.	1983.01	-0.737	0.173	0.868	0.188
Germany	Switzerland	1980.01	37.26	0.948	0.024	2002.10	0.632	0.028	0.950	.
France	Switzerland	1980.01	3.28	0.555	0.215	1993.04	0.161	0.232	0.950	.
Italy	Switzerland	1980.01	3.93	0.699	0.166	1996.10	0.074	0.214	0.950	.
Netherlands	Switzerland	1980.01	1.70	0.050	.	1981.03	-0.033	0.107	0.950	.
Belgium	Switzerland	1980.01	2.11	0.381	0.901	1989.02	-0.065	0.945	0.950	.
Denmark	Switzerland	1980.01	400.00	0.318	0.002	1987.09	0.167	0.056	0.469	0.029
Sweden	Switzerland	1982.01	1.14	0.130	.	1983.01	-0.159	0.123	0.950	.
UK	Switzerland	1980.01	3.05	0.545	0.326	1993.02	0.127	0.342	0.950	.
Germany	US	1980.01	6.75	0.820	0.039	1999.09	0.311	0.053	0.950	.
France	US	1980.01	4.22	0.705	0.136	1996.12	0.235	0.145	0.950	.
Italy	US	1980.01	10.93	0.777	0.080	1998.09	0.166	0.047	0.820	0.208
Netherlands	US	1980.01	14.50	0.943	0.027	2002.09	0.527	0.053	0.950	.
Belgium	US	1980.01	400.00	0.300	0.004	1987.02	0.130	0.062	0.505	0.025
Denmark	US	1980.01	1.32	0.050	.	1981.03	-0.314	1.820	0.714	1.888
Sweden	US	1982.01	2.56	0.549	0.501	1992.01	-0.044	0.552	0.950	.
UK	US	1980.01	2.15	0.505	0.849	1992.02	0.135	0.671	0.950	.
Switzerland	US	1980.01	18.32	0.946	0.021	2002.09	0.467	0.038	0.950	.

Table A6. STC-GARCH model estimates for stock market returns (1988-2003)

		start of sample	gamma	c	standard error	break date	rho_0	standard error	rho_1	standard error
Germany	France	1988.01	12.64	0.816	0.034	1999.08	0.681	0.032	0.950	.
Germany	Italy	1988.01	27.81	0.762	0.023	1998.04	0.454	0.050	0.845	0.024
Germany	Netherlands	1988.01	3.07	0.593	0.468	1994.04	0.476	0.309	0.950	.
Germany	Belgium	1988.01	0.96	0.366	.	1988.10	0.161	0.095	0.950	.
France	Italy	1988.01	16.48	0.757	0.033	1998.03	0.431	0.056	0.884	0.019
France	Netherlands	1988.01	11.88	0.848	0.056	2000.05	0.678	0.036	0.950	.
France	Belgium	1988.01	56.98	0.913	0.028	2001.12	0.602	0.031	0.821	0.031
Italy	Netherlands	1988.01	19.90	0.740	0.051	1997.10	0.446	0.067	0.813	0.037
Italy	Belgium	1988.01	48.21	0.883	0.038	2001.03	0.439	0.039	0.707	0.076
Netherlands	Belgium	1988.01	46.76	0.909	0.021	2001.11	0.659	0.026	0.886	0.029
Germany	Denmark	1988.01	400.00	0.414	0.009	1989.12	0.363	0.092	0.590	0.026
France	Denmark	1988.01	400.00	0.874	0.003	2001.00	0.430	0.034	0.611	0.047
Italy	Denmark	1988.01	400.00	0.597	0.003	1994.04	0.372	0.052	0.496	0.035
Netherlands	Denmark	1988.01	8.22	0.366	.	1988.10	0.032	0.203	0.581	0.037
Belgium	Denmark	1988.01	0.08	0.366	.	1988.10	0.004	0.096	0.950	.
Germany	Sweden	1988.01	3.20	0.621	0.557	1994.12	0.261	0.539	0.950	.
France	Sweden	1988.01	5.61	0.797	0.094	1999.02	0.413	0.095	0.950	.
Italy	Sweden	1988.01	10.00	0.735	0.077	1997.09	0.313	0.062	0.749	0.075
Netherlands	Sweden	1988.01	2.76	0.858	0.336	2000.08	0.492	0.196	0.950	.
Belgium	Sweden	1988.01	38.34	0.959	0.031	2003.01	0.500	0.033	0.871	0.126
Germany	UK	1988.01	2.59	0.532	0.771	1992.10	0.136	0.773	0.950	.
France	UK	1988.01	3.45	0.623	0.623	1994.12	0.344	0.542	0.950	.
Italy	UK	1988.01	11.71	0.759	0.061	1998.03	0.352	0.052	0.803	0.079
Netherlands	UK	1988.01	400.00	0.873	0.003	2000.12	0.717	0.019	0.878	0.016
Belgium	UK	1988.01	40.39	0.900	0.034	2001.08	0.557	0.031	0.815	0.036
Denmark	Sweden	1988.01	2.80	0.585	0.653	1994.01	0.244	0.659	0.713	0.533
Denmark	UK	1988.01	7.41	0.366	.	1988.10	-0.219	0.207	0.554	0.049
Sweden	UK	1988.01	3.53	0.843	0.154	2000.04	0.415	0.121	0.950	.
Germany	Switzerland	1988.01	68.25	0.965	0.021	2003.03	0.674	0.025	0.950	.
France	Switzerland	1988.01	18.51	0.928	0.031	2002.04	0.621	0.030	0.950	.
Italy	Switzerland	1988.01	7.31	0.890	0.046	2001.05	0.404	0.055	0.950	.
Netherlands	Switzerland	1988.01	400.00	0.873	0.005	2000.12	0.681	0.024	0.851	0.021
Belgium	Switzerland	1988.01	69.16	0.850	0.028	2000.06	0.592	0.032	0.752	0.038
Denmark	Switzerland	1988.01	400.00	0.413	0.004	1989.11	0.365	0.083	0.480	0.030
Sweden	Switzerland	1988.01	124.34	0.963	0.013	2003.03	0.573	0.027	0.889	0.032
UK	Switzerland	1988.01	5.47	0.885	0.081	2001.04	0.527	0.068	0.950	.
Germany	US	1988.01	5.22	0.854	0.065	2000.07	0.374	0.068	0.950	.
France	US	1988.01	7.55	0.889	0.055	2001.05	0.479	0.053	0.950	.
Italy	US	1988.01	8.87	0.801	0.104	1999.04	0.226	0.068	0.806	0.131
Netherlands	US	1988.01	19.09	0.949	0.042	2002.11	0.561	0.045	0.950	.
Belgium	US	1988.01	36.05	0.962	0.030	2003.02	0.469	0.031	0.919	0.108
Denmark	US	1988.01	11.88	0.811	0.130	1999.06	0.299	0.063	0.555	0.077
Sweden	US	1988.01	6.77	0.903	0.048	2001.09	0.438	0.053	0.950	.
UK	US	1988.01	6.72	0.948	0.058	2002.10	0.546	0.048	0.950	.
Switzerland	US	1988.01	21.80	0.959	0.027	2003.01	0.531	0.035	0.950	.

Figure A1. Estimated correlations



Note: BEL=Belgium, DEN=Denmark, FRA=France, GER=Germany, ITA=Italy, NET=the Netherlands, SWE=Sweden, SWI=Switzerland, UK=United Kingdom, US=United States, _B=Bond returns, _S=Stock returns (full sample), _S2=Stock returns (1988-2003).

Figure A1. continued

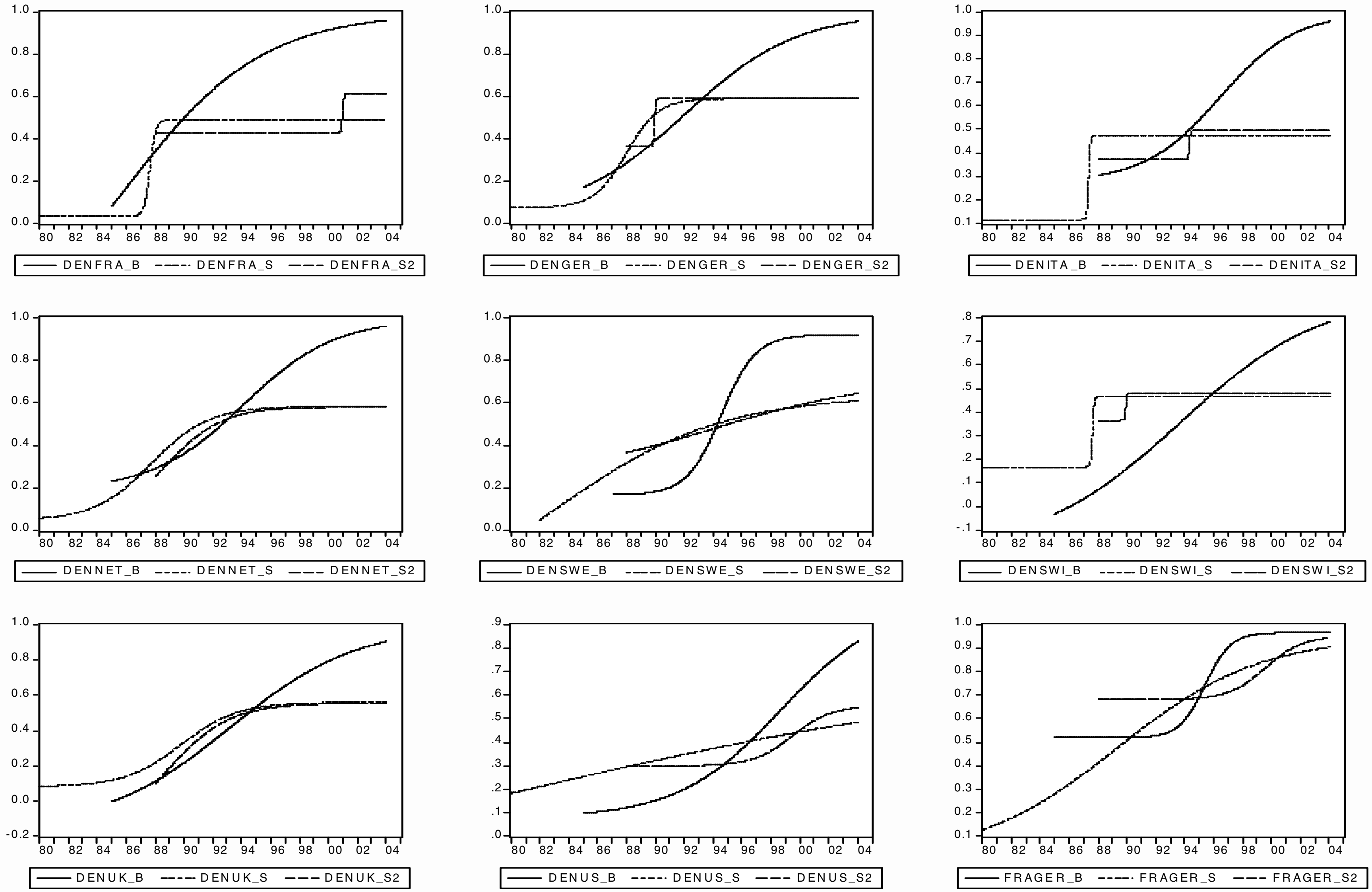


Figure A1. continued

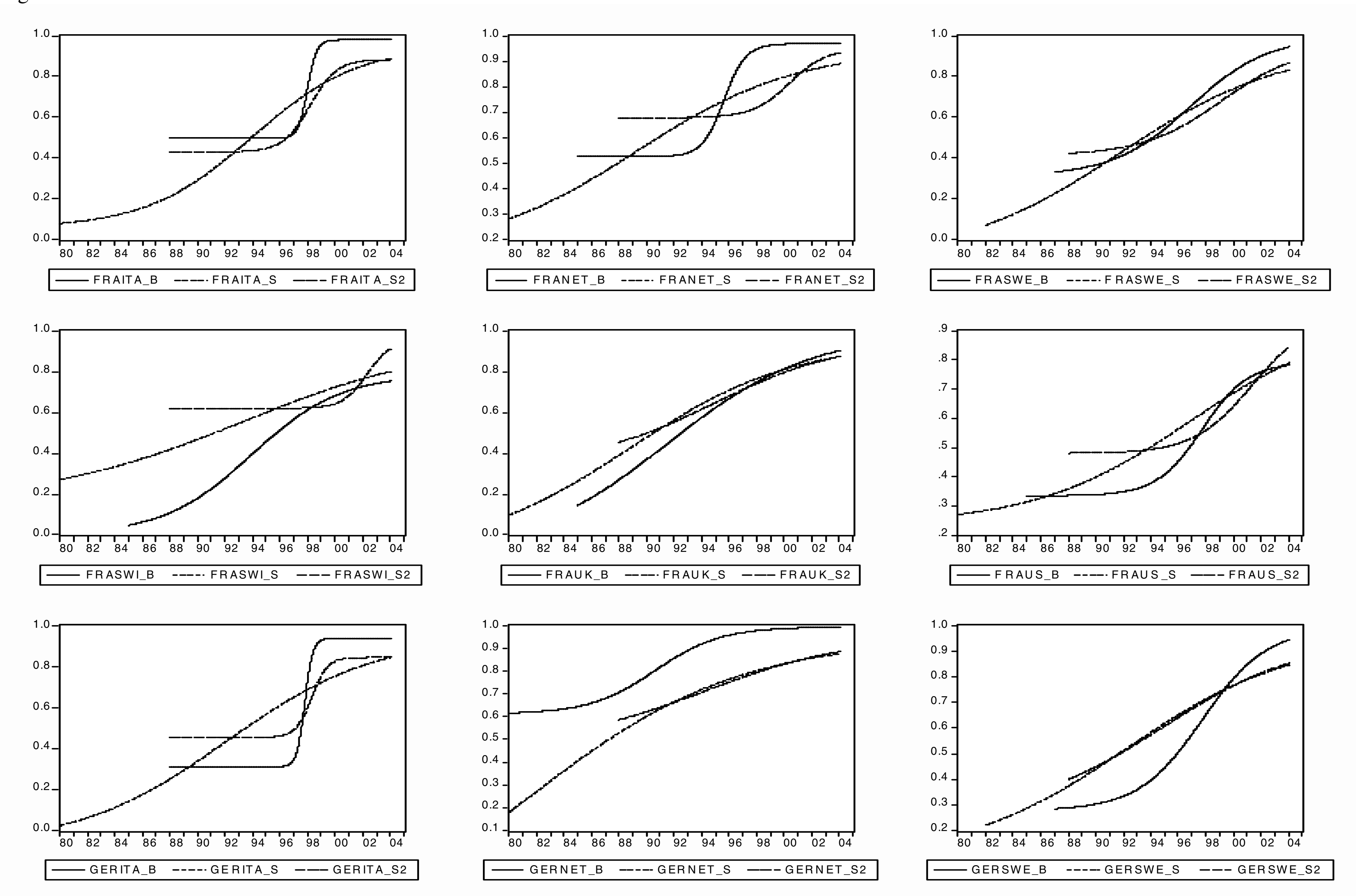


Figure A1. continued

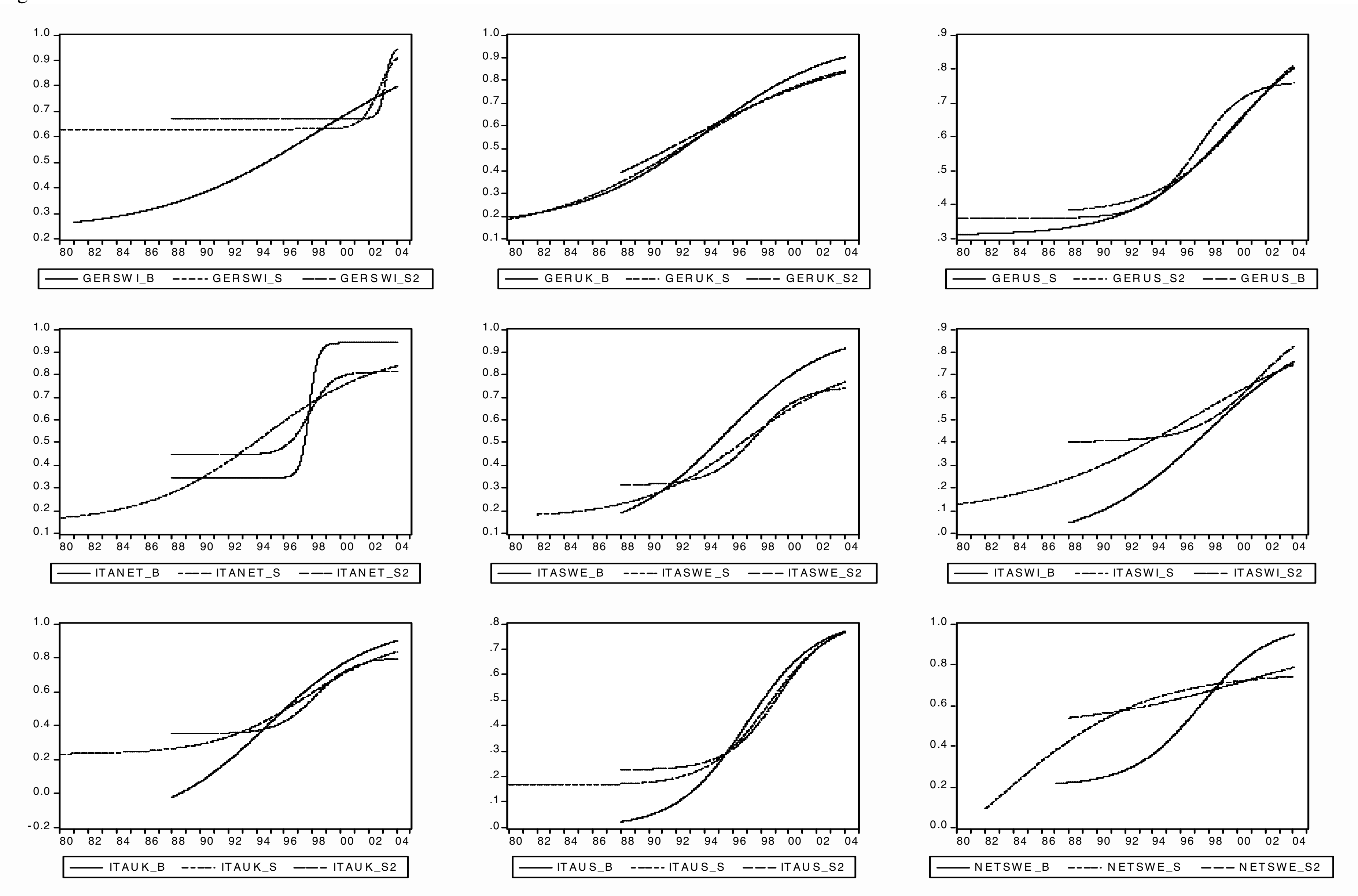
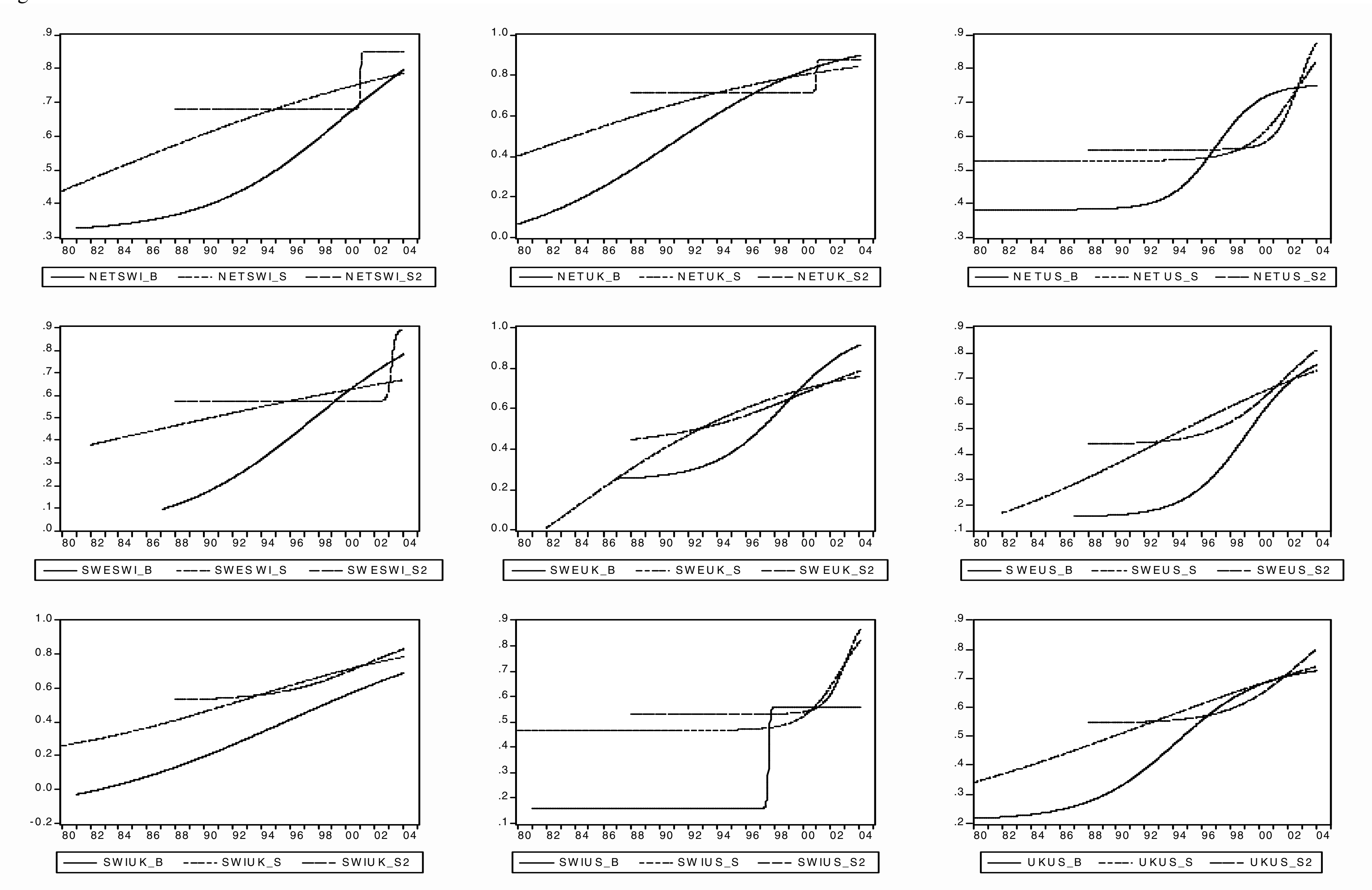


Figure A1. continued



Bond Market and Stock Market Integration in Europe:
A Smooth Transition Approach

Robert-Paul Berben*

Economics and Research Division, De Nederlandsche Bank, Amsterdam, The Netherlands

W. Jos Jansen

Economic Policy Department, Ministry of Social Affairs and Employment, The Hague, The Netherlands

This paper investigates whether there has been a structural increase in financial market integration in nine European countries and the US in the period 1980-2003. We employ a GARCH model with a smoothly time-varying correlation to estimate the date of change and the speed of the transition between the low and high correlation regimes. Our test produces strong evidence of greater comovement across the board for both stock markets and government bond markets. Dates of change and speeds of adjustment vary widely across country linkages. Stock market integration is a more gradual process than bond market integration. The impact of European monetary union (EMU) is rather limited, as it has mainly affected the timing of bond market correlation gains (but hardly their size) and has had little discernible effect on stock market integration.

JEL Code: C22, G10, G15

Keywords: financial integration, comovement, smooth transition, European integration

January 2007

*Corresponding author: Robert-Paul Berben, Economics and Research Division, De Nederlandsche Bank, P.O. Box 98, 1000 AB Amsterdam, The Netherlands; email: r.p.berben@dnb.nl; phone: 00-31-20-5243036; fax 00-31-20-5242506.

Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank or the Dutch Ministry of Social Affairs and Employment.