Measuring European Stock Market Integration Via a Stochastic Discount Factor Approach

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Abstract

We test for European stock market integration by comparing the expectations of stochastic discount factors (SDF) across markets. As opposed to other market integration methods, the SDF approach allows for lesser and milder assumptions. We allow stocks to have general risk characteristics, which we only constrain through (i) the CAPM, (ii) the Fama and French, and the (iii) Carhart model of covariances. Our findings suggest that equity markets are not integrated on a pan-European level. We find, however, that the stock markets of Germany, France, and the United Kingdom are interrelated. We also document that the better part of European equity markets is linked to Germany's stock market. Our results also provide empirical support for an interdependence of the stock markets of the BeNeLux states.

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1. Introduction

Past research has shown that the inception of the European Economic and Monetary Union (EMU) in 1990 and the accompanied advent of the euro in

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1999 have had a considerable impact on the integration of European stock markets, especially those of the Eurozone. Yet, albeit gaining transparency on the extent to which European equity markets are integrated is of considerable interest under portfolio diversification considerations, there is still no clear consensus among existing studies on the actual degree of integration.[2] In fact, opinions vary, not seldom because findings are entirely conditioned on the specific approach chosen to measure integration.

In this study, we follow up on the idea of Roll and Ross (1980) that the measurement of integration is conditioned on the identification of risk. This entails that in integrated markets, assets are subject to the same market forces and should thence be priced by common risk factors. In the modern asset pricing literature, it has become a conventional habit to incorporate all these risk corrections by defining one *single* stochastic discount factor (SDF) (see Cochrane, 2005).[3] We embrace this concept and adopt the view that European equity markets are integrated, if there is no significant difference among country and industry specific sets of SDF across European stock markets. Specifically, in line with Flood and Rose (2004, 2005a,b) we define European equity markets to be integrated, if all assets priced in these markets satisfy the pricing condition

$$P_t^j = E_t(M_{t+1}X_{t+1}^j) \tag{1}$$

where P_t^j is the price of an asset j at time t, $E_t(\cdot)$ is the expectations operator, which is conditional on information at time t; X_{t+1}^j is the payoff to be received at time *t+1* by owners of asset j;[4] M_{t+1} is the SDF for a payoff accruing at time *t+1* and constitutes therefore the focal point of our interest.[5] Equality among different sets of SDF implies that there are no frictions among European equity markets and that European investors face the same opportunity set, irrespective of their physical presence within Europe.

[2]If markets are integrated, investors need to decide on whether to invest outside Europe to minimize risk in line with modern portfolio theory (see Markowitz, 1952), or, alternatively, to find means to diversify European-wide if they are reluctant to invest abroad.

[3]The SDF is also known, among others, as marginal rate of substitution (MRS), pricing kernel, or marginal utility growth.

[4]The payoff of an asset j equals the future price of this asset (P_{t+1}^j) plus any dividends or coupons (D_{t+1}^j). In a nutshell, $X_{t+1} = P_{t+1} + D_{t+1}$.

[5]The term stochastic discount factor refers to the way M generalizes standard discount factor ideas. It is stochastic (or random) in nature because it is not known with certainty at time t.

As opposed to any other market integration technique, the SDF method allows for lesser and milder assumptions in regard to market completeness or the homogeneity of investors. It also allows assets to have general risk characteristics, which we only constrain through (i) the CAPM (Lintner, 1965, Sharpe, 1964, Treynor, 1965), (ii) the Fama and French (1993) three factor model (3FM), and (iii) the Carhart (1997) four factor model (4FM) of covariances. However, we allow parameters to vary over time. This relieves a major constrain of many unconditional asset pricing models. Additionally, the comparison of SDF across countries (industries) provides us with the opportunity to study stock market integration not only on a pan-European level but also on a *bilateral*, i.e., country-by-country (industry-by-industry) basis. Finally, in spite of its ease to implement and despite of its intuitive strength vis-à-vis other integration methods, the SDF mode has not yet been applied to test for the integration among European equity markets. This study aims at filling this void using a sample of 16 European countries and 10 pan-European industries over three different time periods between January 1990 and April 2008.

We focus our analysis merely on the *expectation* of the SDF, even if agents may use the entire perceived distribution of the pricing kernel. This is in line with Flood and Rose (2004, 2005a,b). The reasons are twofold. First, the expectation of the SDF is easy to measure and it is unique. This is in contrast to Hansen and Jagannathan (1991), who show that there may exist more than one SDF consistent with any set of market prices and payoffs. Second, cross-market differences in estimated expectation of the SDF appear to be highly revealing in practice, because standard risk models can be used to easily discriminate between the integration and segmentation of markets.

Nevertheless, despite the advantages, it is worthy to note that a sheer comparison of first moments entails merely a necessary but not sufficient condition for market integration. Specifically, if markets are integrated, then assets in these markets are priced by the same expectation of SDF. Yet, passing this SDF test alone does not necessarily imply that markets are integrated. On the other hand, if the priced assets do not exhibit the same SDF expectation, then it may be reasonably argued that markets are not integrated. This ease to distinguish between integration and segmentation depicts a highly revealing means under practical consideration.

The remainder of this paper is structured as follows. Section 2 presents a brief review of related literature. Section 3 depicts the methodology employed. Section 4 discusses the sample data. Section 5 provides the findings and the discussion. Section 6 concludes the paper.

2. Background

The following section depicts (i) a quick recap of the EMU and its presumed impact on European stock market integration, and (ii) a brief overview of related integration literature.

2.1. The Impact of the EMU on Europe's Financial Markets

Ever since the launch of its first official stage on January 1990, the EMU has strived for a sedulous harmonization of monetary, fiscal, and legal policies across its member states. So far, this alignment process has found its culmination in the advent of a single currency, the euro, on January 1999. Albeit the 16 European countries that have entered the third stage of the EMU by January 2009 still possess sovereignty on their fiscal policies, monetary decisions have been centralized with the foundation of the European Central Bank (ECB).[6]

This institutional development has triggered an extensive line of research on both an economic integration and the interdependence of financial, and especially stock, markets. For instance, a variety of studies reports strong convergence of different sets of economic variables across Eurozone countries and suggests that this serves as empirical support for the existence of an *economic* integration among EMU states.[7] Another strand of literature, in turn, takes the economic integration among EMU members as given and studies the effects of the economic interdependence on long-run *stock market* integration throughout Europe. Most of the documented findings entail a positive impact on the integration process of European equity markets.[8] For

[6]As of January 2009, the 16 members of the Eurozone are: Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, and Spain.

[7]Among these variables are, for example, money supplies, inflation rates, short-term and long-term interest rates, gross domestic products (GDP) and indices of industrial productions, and national budget deficits as a ratio of GDP (see Bernard and Durlauf, 1995, Bredin and Fountas, 1998, Caporale and Pittis, 1993, Fountas and Wu, 1998, Hafer and Kutan, 1997, Haug, MacKinnon, and Michelis, 2000, Holmes, 2000, 2002).

[8]see Atteberry and Swanson (1997), Chen, Firth, and Meng Rui (2002), Abbot and Chow (1993), Hardouvelis, Malliaropulos, and Priestley (2006), Prati and Schinasi (1997), Serletis and King (1997), Baele, Ferrando, Hördahl, Krylova, and Monnet (2004), Worthington, Katsuura, and Higgs (2003).

example, Hardouvelis et al. (2006) and Prati and Schinasi (1997) remark that the introduction of the euro has worked as a catalyst for a further harmonization among European equity markets in terms of legislation, regulation, and settlement procedures and systems. Other studies suggest that the integration of European capital markets may allow for better risk sharing and diversification due to a smoothing of economic shocks (Baele et al., 2004, Melitz and Zumer, 1999), and an improved capital allocation thanks to lower transaction cost and vanishing information asymmetries (Baele et al., 2004, Levine, 1997).

In spite of that, Yang, Min, and Li (2003) show that the inception of the EMU has actually had an uneven effect on EMU member states. Their findings reveal that the financial markets of bigger EMU economies have become more integrated after the establishment of the EMU, while smaller markets have in fact become more isolated. Nonetheless, any present frictions among the financial markets of the EMU might further diminish due to the impact of the Markets in Financial Instruments Directive (MiFID), which came into effect on November 1, 2007.[9]

2.2. Related Integration Literature

Past studies have suggested different means to test the integration of financial markets. Among the most popular approaches are those based on purchasing power parity (PPP), correlation patterns, asset pricing, and consumption growth interdependence.[10] These methods, however, rest on a strong set of assumptions and restrictions regarding both model specifications and conceptual fit. For instance, testing integration via PPP has been

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[9] For more details on the Markets in Financial Instruments Directive (MiFID), please refer to: http://ec.europa.eu/interna_market/securities/isd/index_en.htm, last visited January 2009.

[10] For (i) PPP see Alesina and Perotti (1998), Froot and Rogoff (1991), Koedijk, Tims, and Van Dijk (2004), Lopez and Papell (2007), Nessen (1996), for (ii) correlation patterns see Bertero and Mayer (1990), Eun and Shim (1989), Grubel and Fadner (1971), Heston and Rouwenhorst (1994, 1995), King and Wadhwani (1990), King, Sentana, and Wadhwani (1994), Levy and Sarnat (1970), Park and Fatemi (1993), Ratner (1992), for (iii) asset pricing see Agmon (1972, 1973), Bodnar, Dumas, and Marston (2003), Chan, Karolyi, and Stulz (1992), Cho, Eun, and Senbet (1986), De Santis and Gerard (1997), Grinold, Rudd, and Stefek (1989), Koedijk and Van Dijk (2004), Lessard (1974), Solnik (1974), Stulz (1995), for (iv) consumption growth interdependence see Benartzi and Thales (1995), Kocherlakota (1996), Mehra (2003), Mehra and Prescott (1985).

criticized for being entirely conditioned on the indices employed. This approach also imposes the homogeneity of both indices and agents' preferences across countries. The correlation approach, on the other hand, may be suitable for testing short run integration rather than long run integration. Yet, it neglects that asset prices may move together while violating the law of one price (see Adler and Dumas, 1983). Finally, past studies have shown that basic consumption capital asset pricing models (CCAPM) do not seem to be able to explain fully financial market data, despite the models' strong economic rationale.[11] Besides, the theoretical convention of treating the stock market as a valid proxy for total consumption or the aggregate wealth of an economy appears more plausible in highly capitalized countries.[12]

A more recent strand of literature has focused on using an SDF approach to study financial market integration. In this framework, two different means to market integration have evolved. The first method focuses on the law of one price based on expected future cash flows. For instance, Chen and Knez (1995, 1996) suggest that markets cannot be perfectly integrated if there are cross-market opportunities and if there are two portfolios, both from different markets, that have identical payoffs but differ in prices. In this context, testing for market integration involves devising unconditional and conditional mean-variance spanning tests that exploit the Hansen and Jagannathan (1991) bounds and mean-standard deviation frontiers.[13]

Bekaert and Urias (1996) were among the first to employ this SDF method to examine the diversification benefits from emerging equity markets using data sets on US and UK traded closed-end funds. They find significant diversification benefits for the UK country funds, but not for the US funds. They suggest that the difference appears to relate to differences in portfolio holdings rather than to the behavior of premiums in the United States versus

[11]see Campbell (1996), Grauer and Hakansson (1987), Zimmermann, Drobetz, and Oertmann (2003).

[12]For instance, Campbell (1999) documents that in highly capitalized countries, such as the United Kingdom and Switzerland, the Morgan Stanley Capital International (MSCI) index accounted for about 80% of GDP in 1993, whereas in Germany and Italy it accounted for less than 20% of GDP in the same year. Additionally, stock ownership tends to be much more concentrated in countries with low capitalization, making it harder to employ the CCAPM across different countries.

[13]In particular, one needs to (i) identify acceptable sets of SDF from different markets, (ii) measure the distance between these sets of SDF, and (iii) finally examine if and to what extent they overlap.

the United Kingdom. Hentschel, Kang, and Long Jr. (2002) also employ this SDF approach and document financial integration for both bond and equity markets between US and non-US markets.

The second branch of literature within the SDF framework is based on parametric asset pricing models and goes beyond mere cash flow considerations. For example, Flood and Rose (2004, 2005a,b) remark that two different assets usually do not have identical cash flows. Hence, the definition of market integration must be expended above mere cash flow considerations. In fact, in line with Roll and Ross (1980), Flood and Rose (2004, 2005a,b) remark that two financial markets are integrated when risk in these markets is entirely shared and identically priced. In this context, a parametric discount-rate model is used to (i) price asset portfolios and to (ii) compare thereafter the determined pricing errors. If the pricing errors are not systematically identifiable with the portfolios in which they originate, then the portfolios, and, hence, the markets for which they serve as proxies, can be considered integrated. Admittedly, Flood and Rose (2004, 2005b) find very little evidence of integration between, amongst others, the apparently deep frictionless markets of the S&P 500, the NASDAQ, and the Toronto Stock Exchange.

3. Methodology

The basic pricing condition stated in equation 1 implies that one may incorporate all risk corrections by defining one *single* SDF, i.e., the same pricing kernel for each asset. In case of a risk-free environment and, thus, total payoff certainty, prices can be expressed in form of the present value formula

$$P_t = \frac{1}{R^f} X_{t+1} \tag{2}$$

where R^f is the gross risk-free rate, which is known ahead of time. $1/R^f$ is the corresponding discount factor, i.e., $M = 1/R^f$. If the risk-free rate is not traded, then R^f can be defined as the shadow gross risk-free rate (Flood and Rose, 2004). As riskier assets have usually lower prices than equivalent risk-free assets, they are often valued using asset-specific risk-adjusted discount factors, i.e., $1/R^j$. This can generally be expressed as follows:

$$P_t^j = \frac{1}{R^j} E_t(X_{t+1}^j). \tag{3}$$

In this context, asset specific risk corrections are captured by the correlation between the random components of the common discount factor M (note that here $M = 1/R^j$) and the asset-specific payoff X^j. Using the definition of covariance, equation 1 can also be expressed as

$$\begin{aligned} P_t^j &= E_t(M_{t+1}X_{t+1}^j) \\ &= E_t(M_{t+1})E_t(X_{t+1}^j) + COV_t(M_{t+1}, X_{t+1}^j) \end{aligned} \tag{4}$$

where $COV(\cdot)$ represents the conditional covariance operator, which captures the risk adjustment for non-risk-free assets.[14]

3.1. The Expectation of the SDF

Instead of comparing all aspects of a fully parameterized SDF approach (see Bekaert and Harvey, 1995, Chen and Knez, 1995, 1996), we merely focus on the *first moment* of the SDF. As mentioned earlier, this only constitutes a necessary but not sufficient condition for market integration. Notwithstanding, it allows for simple discrimination as regards the integration versus the segmentation of markets.

Flood and Rose (2004, 2005a,b) suggest that if one could extract $E(M_{t+1})$ independently from a number of different asset markets, then all these expectations of M_{t+1} are to be the same if these markets are integrated. They further remark that the discount rate does not have to be determined uniquely, as long as the expectations of the discount rate are unique. This implies that there should be at least one solution for the SDF in order for integration to hold.

To ensure stationary of all variables, and based on the argument that $COV_t(M_{t+1}, R_{t+1}^j)$ can be modeled by a simple factor model with time-invariant coefficients more plausibly than $COV_t(M_{t+1}, X_{t+1}^j)$, we normalize our data by dividing equation 4 by lagged prices, i.e., P_t^j, and solving for the expected return, i.e.,

$$E_t(R_{t+1}^j) = \frac{1 - COV_t(M_{t+1}, R_{t+1}^j)}{E_t(M_{t+1})} \tag{5}$$

[14] An asset whose payoff covaries positively (negatively) with the discount factor has its price raised (lowered). Obviously, in case of a risk free asset, $COV_t(M_{t+1}, X_{t+1}^j) = 0$.

or as a stochastic process as

$$R^j_{t+1} = \frac{1 - COV_t(M_{t+1}, R^j_{t+1})}{E_t(M_{t+1})} + \epsilon^j_{t+1} \tag{6}$$

where R^j is the return to asset j at time t and $\epsilon^j_{t+1} = R^j_{t+1} - E_t(R^j_{t+1})$, i.e., the prediction error of the equation.[15] Dividing the future payoff of asset j by its lagged price also allows us to interpret equation 6 as an asset pricing equation. Fractioning out $1/E_t(M_{t+1})$, results in the following simplification

$$R^j_{t+1} = \delta_t[1 - COV_t(M_{t+1}, R^j_{t+1})] + \epsilon^j_{t+1} \tag{7}$$

where $\delta_t \equiv 1/E_t(M_{t+1})$, i.e., the vector of discount factors. Under the null hypothesis of market integration, δ is supposed to be equal across all assets, yet it may vary over time.

In line with Flood and Rose (2004, 2005a,b) and in accordance with standard practice (see Campbell, Lo, and MacKinlay, 1997, Cochrane, 2005), we introduce two assumptions to provide economic content to equation 7. We first assume rational expectations, i.e., we impose ϵ^j_{t+1} to be white noise. Second, we define the covariance as

$$COV_t(M_{t+1}, R^j_{t+1}) = \sum_{i=1}^{n} \beta^j_i f_{i,t+1}$$

where β^j_i is a set of n asset-specific factor loadings and $f_{i,t}$ denotes a vector of factors that vary over time.[16] Taking these two assumptions and combining them with equation 7 results in

$$R^j_{t+1} = \delta_t \left(1 + \sum_{i=1}^{n} \beta^j_i f_{i,t+1}\right) + \epsilon^j_{t+1}. \tag{8}$$

Equation 8 represents a panel data estimating equation.[17] We use *time-series* analysis to determine the country-specific (industry-specific) factor

[15] Note that $E_t(X_{t+1})/P^j_t = E_t(R^j_{t+1})$. This assumes, however, that $D_{t+1} = 0$.

[16] Using this covariance model makes sense under the following two underlying presumptions: (i) The SDF is spanning, i.e., an admissible M_{t+1} can be chosen as an affine function of some factors; (ii) the coefficients are time-invariant, i.e., in a conditional affine regression of returns on factors, the conditional coefficients are time-invariant.

[17] Please refer to the Appendix for a more detailed description on how to transform the basic pricing equation 1 into an expected return beta representation.

loadings β, which represent the country-specific (industry-specific) systematic risk. The β parameters are considered constant over time. On the other hand, we employ *cross-sectional* variation in order to estimate the δs. The estimation of δ in equation 8 for a specific set of equity portfolios $j = 1, \ldots, J_0$ of one country (industry) along with subsequent analyses for the same time period with different sets of equity portfolios $j = 1, \ldots, J_n$ of another country (industry) provides us with various sets of estimates for the coefficient δ, along with a time-series sequence of estimated discount rates. These may then be compared directly, using conventional statistical techniques, such as the analysis of variances (ANOVA), or likelihood-ratio tests.[18] Under the null hypothesis of market integration, the δ coefficients are equal.

It is worth mentioning that we neither presume that equation 8 holds for the bond market nor that bond markets are integrated with other security markets. For instance, equation 1 implies for a basic zero-coupon bond, which pays one monetary unit independently of the state of nature at the end of time *t+1*, i.e., a bond without nominal risk, that

$$1 = E_t(M_{t+1} R^f_{t+1}) \tag{9}$$

where R^f_{t+1} is the one period nominal gross risk-free rate known today, and M_{t+1} is again the nominal SDF. Traditionally, inside domestic finance it is assumed that the SDF that prices bonds is the same for all bonds and identical to that pricing all other securities. If we were to make this assumption across European countries, then it would be trivial to determine the risk-less SDF simply because $\delta_t \equiv 1/E_t(M_{t+1}) = R^f_{t+1}$. As such, we closely follow Flood and Rose (2004, 2005a,b) and do not impose this assumption. Yet, we

[18] Other than using ANOVA, one may employ multiple two sample T-tests and compare δ_1 with δ_2, δ_1 with δ_3 and so forth (i.e., comparing all the individual pairs). Yet, for any given significance level α, the probability of making a Type 1 error (i.e., the error of rejecting a null hypothesis when it is actually true) when running more than one test would increase. ANOVA, on the other hand, allows for simultaneous comparison of sample means. ANOVA thereby compares two types of variances, i.e., the variance within each sample and the variance between different samples. The underlying assumption of this method is that if means are different, then the variance within the samples must be small compared to the variance between the sample. Thus, if the *variance between* divided by the *variance within* is large, then the means are said to be different. This in turn would lead to the rejection of the null hypothesis that means are equal. Note also that when there are only two means to compare, the T-test and the F-test are equivalent; the relation between ANOVA and T is given by $F = T^2$.

rather test and eventually aim at rejecting it.

3.2. Empirical Models and Sensitivity Considerations

In order to implement the SDF technique, we start by estimating a model with asset specific intercepts and a time varying market factor. This scenario represents the classical CAPM and can be expressed in our context for countries (industries) $j = 1, \ldots, J$ and periods $t = 1, \ldots, T$ more formally as follows

$$R^j_{t+1} = \delta_t \left(1 + \beta^j_1 f_{1,t+1}\right) + \epsilon^j_{t+1}. \tag{10}$$

While we allow δ_t to vary period by period, we allow the factor loadings β^j to vary asset by asset.

To test whether key results are insensitive to the factors used to model δ, we employ sensitivity analysis. We also examine a covariance model based on the three Fama and French (1992, 1993) (FF) factors, i.e., (i) the market risk factor (MRF), (ii) the performance of small stocks relative to big stocks (small minus big, SMB), and (iii) the performance of *value* stocks relative to *growth* stocks (high book-to-market minus low book-to-market, HML). In this scenario, equation 10 is extended by two additional factors, i.e.,

$$R^j_{t+1} = \delta_t(1 + \beta^j_1 f_{1,t+1} + \beta^j_2 f_{2,t+1} + \beta^j_3 f_{3,t+1}) + \epsilon^j_{t+1}. \tag{11}$$

We finally conduct the same analysis, considering the Carhart (1997) 4FM, which extends FF's 3FM by momentum (winners minus losers, WML). More formally,

$$\begin{aligned} R^j_{t+1} &= \delta_t(1 + \beta^j_1 f_{1,t+1} + \beta^j_2 f_{2,t+1} + \ldots \\ &+ \beta^j_3 f_{3,t+1} + \beta^j_4 f_{4,t+1}) + \epsilon^j_{t+1}. \end{aligned} \tag{12}$$

Equations 10 to 12 can be directly estimated by using least square regressions. The degree of non-linearity is not particularly high;[19] conditional on δ_t, the problem is linear in β^i and vice versa. We correct for autocorrelation and heteroscedasticity using the Newey and West (1987) estimator.

We employ multiple measures to eventually test whether the expectations of delta are equal across countries (industries). We use ANOVA analyses to compare the first moments of the individual delta vectors across countries (industries). To measure the degree of integration, we also rely on the mean

[19]Please refer to Section 4 for a more detailed data description.

absolute difference (MAD) between expected discount rates. In particular, for any two countries (industries) i and j, we compute

$$MAD \equiv \frac{1}{T}\sum_{t=1}^{T} |\delta_t^i - \delta_t^j|. \tag{13}$$

In addition, we employ a closely related measure based on the Grubel and Lloyd (1975) (GL) measure of intra-industry trade, i.e.,

$$GL \equiv \frac{1}{T}\sum_{t=1}^{T} 2\frac{|\delta_t^i - \delta_t^j|}{(\delta_t^i + \delta_t^j)}, \tag{14}$$

which measures the proportion of idiosyncratic risk in one market, i.e., the proportion of risk inherent in that market, which is net of any external risk induced by foreign markets.[20] For both measures, smaller values indicate closer integration, i.e., a value of zero implies perfect integration.

3.2.1. Robustness Considerations

Using ANOVA as a means to test the null hypothesis that our expectations of δ are equal usually rests on two main assumptions: (i) the variables are normally distributed and (ii) the variances in the different groups are identical.[21] Yet, Box and Andersen (1955) and Lindman (1974) show that the F-distribution is remarkably robust to deviations from normality. Besides, as regards the homogeneity of variances, Box (1954a,b), Lindman (1974), and Hsu (1938) argue that the F-statistic is also quite robust against this assumption, i.e., in case variances are heteroscedastic.

4. Data & Descriptive Statistics

4.1. Sample Period and Data Sources

Our total sample includes monthly data ranging from January 1990 to April 2008. These data, such as firms' equity prices, indices, interest rates,

[20]The original Grubel and Lloyd (1975) index (I) of intra-industry trade (IIT) describes the fraction of total trade in an industry i that is accounted for by IIT, i.e.,

$$I \equiv 1 - \frac{|EX_i - IM_i|}{(EX_i + IM_i)}$$

where EX equals exports to other industries and IM equals imports from other industries.

[21]In the context of this study, *group* shall refer to either country or industry.

and firm ratios are collected through Datastream. Specifically, beginning of month equity prices and indices are taken from Datastream's TOTMK indices. We also include the DJ EuroStoxx index in our analyses whenever we refer to pan-European indices. The return to a one-month ecu-market deposit serves as our risk-free return. Equity prices are adjusted for stock splits and dividends.

We choose a monthly frequency since it accounts for speed in arbitrage adjustments but mitigates any potential problems that are associated with microstructure issues such as bid-ask spreads. Besides, the use of monthly data allows us to neglect that there might be no simultaneous trading for a given day, as trading days may differ per country, e.g., due to local bank holidays.

Each firm considered is classified by country and industry. We draw our sample for nine Eurozone member states, i.e., Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain.[22] These countries comprise our *Eurozone*. In addition, we extend our sample for robustness analyses by three further members of the European Union (EU), i.e., Denmark, Sweden, and the United Kingdom (UK), plus two other European countries, i.e., Norway and Switzerland. The Eurozone countries plus Denmark, Sweden, and the UK comprise our *European Union* sample. Eventually, these EU countries plus Norway and Switzerland make up our common *European* market. Smaller countries are usually ignored for these kinds of studies due to a lack of available data. For firms in the Eurozone, prices are given in euros. Prior to January 1999, prices are given in ecu, which is in accordance with Datastream computations. For non-members of the EMU, we compute prices and returns based on the countries' respective exchange rate with either (i) the ecu prior to 1999 or (ii) the euro as of 1999.

We also classify the firms in our sample along ten different industries as defined by the *Financial Times Actuaries*. These industries include: *basic industries (BAS), cyclical consumer goods (CGD), cyclical services (CSER), financials (TOLF), general industries (GN), information technol-*

[22] We do not include the EMU member states Austria, Luxembourg (both joined 1999), Greece (joined 2001), Slovenia (joined January 2007), Cyprus, Malta (both joined January 2008), and Slovakia (joined January 2009) in our country analyses, simply due to limitations of data availability and a potential lack of market integration. However, data for Austria, Greece, and Luxembourg are considered for the construction of industry portfolios.

ogy (ITECH), non-cyclical consumer goods (NCGD), non-cyclical services (NCSR), resources (RES), and*utilities (UTL)*.[23] Besides, for further analytical purposes, we group the sectors *cyclical services*, *non-cyclical services*, and *financials* under the common umbrella *services*. The remaining sectors are clustered under *industries*.

As we face different sample periods for the individual countries and industries, we subdivide our sample period into three phases. This is crucial, since if we want to compare our set of estimated δs, which represents a time-series sequence of estimated discount rates across different countries (industries), the time period has to be the same for each country (industry). Next to considering the entire sample period from January 1990 to April 2008, we subdivide this timeframe into two subsample groups per country and industry. The first subsample runs from January 1990 to April 1998, while the second time frame covers January 2000 to April 2008. Our choice for these two sub-periods is twofold. First, we face constraints on data availability. Going back to January 1990 allows us to include at least a considerable number of countries and industries. Second, the third and last stage of the EMU just took place in January 1999 with the introduction of the euro. Thence, taking into account a time period way prior to this may actually conflict with real market integration considerations. In other words, there exists a trade-off between the availability of data and the compliance with the null hypothesis of integrated markets.

Overall, the two subsamples may also allow us to test for the degree of integration not only across markets, but also across time. Our hypothesis is that the degree of integration is higher for the sample period as of 2000 than for the one before. This is simply motivated by an increasing harmonization of monetary and fiscal policies among the euro area member states throughout the last decades. Table 1 depicts the countries considered per period. Table 2 does the same per industry.

[Insert Table 1 here]

[Insert Table 2 here]

Finally, Table 3 provides a joint overview of the distribution of the average

[23] For a more detailed description of this classification, please refer to Table A.1 in the Appendix and to http://www.ftse.com, last accessed January 2009.

number of stocks per country and industry.[24] As Germany, France, and the UK have the highest proportion of stocks in our data sample, one might argue that some industries, such as *non-cyclical consumer goods* and *basic industries*, are, to some extent, country specific, since they comprise only a few stocks of smaller economies, such as Greece or Ireland. Yet, given an increasing importance of industry factors versus country factors for the explanation of equity returns in Europe, we consider it appropriate to cluster our firms along the two dimensions, i.e., country and industry.[25]

[Insert Table 3 here]

4.2. Construction of Risk Factors

To conduct our sensitivity analysis demands ex ante the construction of the FF factors along with a factor which mimics momentum. We follow closely the construction procedure of Liew and Vassalou (2000), who use a three sequential sort to compile portfolios that proxy for a size, book-to-market, and momentum effect.[26] The returns to these portfolios shall thereby serve as the returns to the FF factors (*SMB* and *HML*) and to our momentum factor (*WML*). We derive the returns for annually rebalanced and equally weighted portfolios per country and industry. For the latter, we compile the risk factors per industry across our Eurozone countries, per industry across our EU countries, and per industry across all our European countries.

[24] A more detailed overview of the number of stocks per country and industry can be found in Tables A.2 to A.3 in the Appendix.

[25] For the increasing importance of industry vis-à-vis country effects see: Urias, Sharaiha, and Hendricks (1998), Baca, Garbe, and Weiss (2000), Cavaglia, Brightman, and Aked (2000), Diermeier and Solnik (2001), Cavaglia and Moroz (2002), Brooks and Catao (2000), L'Her, Sy, and Tnani (2002), Ferreira and Gama (2005), Flavin (2004), Isakov and Sonney (2004), Campa and Fernandes (2006), Moerman (2008), Taing and Worthington (2005), Wang, Lee, and Huang (2003).

[26] Fama and French (1993) use a two-tier independent classification mode to define *HML* and *SMB*. However, given our small sample size at hand, we choose to follow a three sequential portfolio construction procedure. Our results may, therefore, be said to be specific to the sorting order used. Yet, robustness tests of Liew and Vassalou (2000) imply that this sorting methodology is stable and that results are, in fact, not conditioned on the sorting sequence employed. Hence, we are comfortable in following our three sequential sort.

Specifically, to build the risk factors, we start with ranking all stocks by their book-to-market ratio for each month in year t-1.[27] We then classify the ranked stocks into three different portfolios: portfolio 1 contains the stocks with the highest book-to-market ratios; portfolio 2 comprises the stocks with the medium book-to-market ratios; and portfolio 3 consists of the stocks with the lowest book-to-market ratios. Thereafter, we take each of these three portfolios, one at a time, and re-sort all stocks according to their market capitalization (i.e., small, medium, and big market capitalization). Thereby, three portfolios within each book-to-market portfolio are created. This leads to nine portfolios.

In a next step, each of those nine portfolios is again divided into three sub-portfolios, based on the momenta of the inherent stocks (i.e., winner stocks, midfield stocks, and loser stocks). The momentum of a stock is computed by deriving the mean of a stock's past year's returns. We exclude, however, the most recent month.[28] We eventually classify as winners the top third of the stocks per country (industry) with the highest last year's average return. Correspondingly, losers comprise the bottom third per country (industry). The midfield stocks are the remaining (middle) third of the sample. At last, we obtain 27 portfolios, which we number from *P1* to *P27*.[29] Table 4 provides an overview of the three sequential portfolio construction procedure. Note also that our sorting method assures that each stock can only be in one of the 27 portfolios at a time.

[27] For the book-to-market ratio we use the inverse of the Datastream price-to-book value datatype (BP). Book value refers thereby to the latest book value shown on the balance sheet.

[28] Liew and Vassalou (2000) suggest to exclude the most recent month in order to eliminate problems that are associated with microstructure issues such as the bid-ask spread.

[29] Since we create 27 portfolios, the number of securities has to be at least 27. If one country/industry has more than 27 stocks, then we first divide the total number of stocks in this country/industry by 3. The greatest feasible devisor is then included in the extreme portfolios, i.e., high/low (for book-to-market), small/big (for size), and winner/loser (for momentum). The remaining stocks are sorted in the respective middle portfolio. For instance, in our sample, the total number of stocks for Spain is 119. After having ranked these stocks by their book-to-market ratio, we divide 119 by 3 and obtain 39.6666. We thus put the 39 stocks with the highest book-to-market ratio into the first portfolio that will thus include all *value* stocks. The lowest ranked 39 assets are put into the portfolio with the assets comprising the lowest book-to-market ratio. The remaining 41 [= 119 - 39 - 39] stocks are then put in the middle portfolio. We follow the same logic for the remaining rebalancing steps.

[Insert Table 4 here]

The return to our 27 portfolios represent the ingredients for the return to our three risk factors, i.e., *HML*, *SMB*, and *WML*. This is in line with the existing literature. In particular, we compute the factor returns by adding and subtracting the returns to the individual portfolios as follows:

$$HML = 1/9 * \begin{bmatrix} (P1 - P19) + (P2 - P20) + (P3 - P21) + (P4 - P22) + (P5 - P23) \\ + (P6 - P24) + (P7 - P25) + (P8 - P26) + (P9 - P27) \end{bmatrix}$$

$$SMB = 1/9 * \begin{bmatrix} (P1 - P7) + (P2 - P8) + (P3 - P9) + (P10 - P16) + (P11 - P17) \\ + (P12 - P18) + (P19 - P25) + (P20 - P26) + (P21 - P27) \end{bmatrix}$$

$$WML = 1/9 * \begin{bmatrix} (P3 - P1) + (P6 - P4) + (P9 - P7) + (P12 - P10) + (P15 - P13) \\ + (P18 - P16) + (P21 - P19) + (P24 - P22) + (P27 - P25) \end{bmatrix}$$

In summary, *HML* describes the return to a portfolio that is long on high book-to-market firms and short on low book-to-market firms. By simultaneously controlling for *SMB* and *WML*, *HML* becomes size and momentum neutral. Similar interpretations can be given for *SMB*, mimicking a size-effect, and *WML*, proxying for a momentum effect. Accordingly, *SMB* and *WML* are corrected for a book-to-market and momentum, or size effect, respectively. These corrections allow for eliminating any potential problems of multicollenarity.[30]

4.3. Descriptive Characteristics of Risk Factors

Before we employ the constructed risk factors as means to test for the integration of European equity markets, we briefly study the performance and characteristics of the factors per country and industry.

First of all, we are interested in whether our risk factors show a Gaussian-normal behavior. The findings of past studies suggest that financial data usually exhibit non-normal behavior (see Cochrane, 2005). Thus, we expect

[30]To test for multicollinearity, we derive variance inflation factors (VIF) (see Wooldridge, 2000) for each risk factor per country and industry. Our results suggest that there is no severity in multicollinearity among the risk factors, when following the common rule of thumb, i.e., a $VIF(\hat{\beta}_i) > 10$ is said to imply high multicollinearity (see Kutner, Nachtsheim, and Neter, 2003). The results are depicted in Table A.4 in the Appendix.

to find the same for our data sample at hand.[31] We test for normality by taking a look at the third and fourth central moments (i.e., skewness and kurtosis) of the variables and by employing also the Jarque-Bera test statistic (Jarque and Bera, 1980, 1981) as a goodness-of-fit measure.

Next to normality, we are interested in whether our variables exhibit unit roots. Specifically, in order to obtain meaningful results from our regression analyses, we want our variables to be level stationary. We test for the presence of unit roots using the Augmented Dickey-Fuller (ADF) test statistic (see Said and Dickey, 1984, Dickey and Fuller, 1979), given a constant and setting the lag p equal to 1.

Finally, we are interested in the mean and median returns of the individual variables along with the corresponding standard deviations. Positive mean/median returns for *HML*, *SMB*, and *WML* indicate that these trading strategies result in abnormal return patterns and may thus contain information, which makes them attractive as risk factors in pricing models (see Fama and French, 1992, 1993, Carhart, 1997).

Tables 5 to 7 report the summary statistics for the risk factors per country and per industry aggregated across the Eurozone.[32] The statistics imply that most of the variables are not normally distributed. This is in line with past empirical findings. In about 50% of the cases, we reject the null hypothesis of normally distributed data at a 1% significance level when considering the Jarque-Bera test statistic. A tendency of non-normal behavior is also underpinned by simply looking at the documented third and fourth central moments of the respective variables. *SMB* and *HML* exhibit chiefly a positive skewness, while *MRF* and *WML* appear mainly negatively skewed for the majority of countries and industries.

[Insert Table 5 here]

[Insert Table 6 here]

[31] Albeit we may conduct our regression analyses with our variables being non-normally distributed, we need to be aware that the explanation of non-normal data requires further effort to be interpreted correctly.

[32] Due to space constraints, we do not report the summary statistics for industries aggregated across the EU and Europe as a whole. The results are, however, to a large extent in line with those for industries aggregated across the Eurozone. The statistics are available upon request.

[Insert Table 7 here]

Intuitively, it appears that the variables for smaller European economies, such as Portugal, Ireland, Finland, and Sweden, possess higher fourth moments. This might imply that stock returns in these countries are more sensitive to extreme events (for instance, the 'dot-com' bubble) and infrequent deviations than the equity returns observed in bigger economies such as Germany and the UK.[33] This is supported by high kurtoses for the *information technology* sector and coinciding positive return fluctuations during the late 1990s and early 2000.[34] Nonetheless, a high kurtosis cannot necessarily be generalized across small countries as we find rather low kurtosis values for Belgium, Greece, and Denmark. This indicates that the returns to the risk factors in these countries show rather modestly-sized deviations.

Moreover, most of our variables show level stationarity when considering the Augmented Dickey-Fuller (ADF) test statistic. Thence, we are confident in obtaining meaningful regression estimates. The most noteworthy exceptions are Austria, Greece, Spain and the *resources* and *utilities* sectors.[35]

Overall, our findings support the existence of a value, size, and momentum effect, not only for different countries but also for different industries. First, we find that a *HML* portfolio, which is long on high book-to-market stocks and short on low book-to-market stocks, yields above average market returns in all countries and industries. Our results are thus in line with those of FF and Liew and Vassalou (2000), who remark that a value premium is pervasive. Second, we document that mean and median returns are consistently higher to small firm portfolios than to big firm portfolios, except for Portugal and *basic industries*, where we find small negative median, though positive mean, returns for *SMB*. This is contrary to the findings of Otten and Bams (2002), who document the existence of a growth effect (i.e., big stocks outperform small stocks) in major European markets.[36] Yet, our findings for a size

[33]Alternatively, the smaller number of stocks available for small countries relatively to bigger countries may serve as an explanation.

[34]Return time plots and histograms allowed us to detect the events associated with the highest fluctuations in returns. Again, due to space considerations, the figures are not presented here. They can, however, be requested from the authors.

[35]There is also some weaker statistical support for the presence of unit roots for some factors in case of Belgium, Finland, Germany, Ireland, Portugal, Denmark, Sweden, Switzerland, and the *noncyclical consumer goods* sector.

[36]One explanation for the discrepancy in the findings might be due to varying sample

premium are in line with FF, Banz (1981), and Liew and Vassalou (2000).

Finally, regarding *WML*, and thus the profitability of a momentum strategy, our results for median and mean returns imply that past winner stocks usually outperform past loser stocks in the short run for (i) nearly all countries, except Portugal, Denmark, and Sweden, and (ii) all industries, except the *information technologies* sector. This is in line with the findings of Jegadeesh and Titman (1993), Liew and Vassalou (2000), and Rouwenhorst (1998). Our results also suggest that momentum is very sensitive to the turnover frequency of the portfolios.[37] The more often the portfolios are rebalanced, the higher become (on average) their mean and median returns. In other words, returns to *WML* decrease significantly as the turnover interval increases. Yet, in practice, any potential financial gains associated with a higher turnover may eventually be offset by occuring transaction costs.

5. Empirical Tests

The following paragraphs describe the empirical findings for testing equations 10, 11, and 12 across countries and industries. In a first step, we focus on our two sub-periods spanning (i) from January 1990 to April 1998 and (ii) from January 2000 to April 2008. This allows us to test for integration across both countries (industries) and time. In a second step, we test for integration across the entire sample period, i.e., from January 1990 to April 2008, to see whether integration among European equity markets is sensitive to the time period chosen.

Next to testing for an overall stock market integration, and an integration across industries, we focus our discussion on the interdependence of the stock markets of Europe's biggest economies, namely, Germany, France, and the UK. This is motivated by the findings of Yang et al. (2003), who suggest that the financial markets of Europe's bigger countries have become more integrated with the processing of the EMU. We also pay particular attention to a potential integration of the BeNeLux states, simply given the economic and geographical proximity of these countries in the Eurozone. Moreover, given that Belgium, the Netherlands, and France posses a common stock

periods, i.e., Otten and Bams (2002) focus exclusively on the period 1991 to 1998, and, thus, ex-ante the 'dot-com' bubble.

[37]Note that the results are not reported here. They may, however, be requested from the authors.

exchange, namely Euronext, we are also interested in studying whether this common institution has had any considerable impact on the integration of the equity markets of the affiliated countries.[38] Furthermore, next to the BeNeLux states, the Nordic countries, i.e., Denmark, Finland, Norway, and Sweden, represent as well a sort of loose intra-European entity based on political and cultural similarities. This triggers the question of whether the stock markets of Scandinavia are also integrated.[39] Finally, given Germany's central geographic and economic role in Europe, and especially the Eurozone, we test to what extent all European equity markets are integrated with the German stock market.

5.1. Sub-Period I vs. Sub-Period II

5.1.1. Results per Country

Tables 8 and 9 comprise, respectively, our estimates of delta (δ) expectations per European country for sub-period I and sub-period II.[40] We also present in the Appendix estimates for the mean absolute difference (MAD) between expected discount rates and our adopted Grubel and Lloyd (1975) intra-industry trade measures (cf. Tables A.5 and A.6). Altogether, the figures presented provide us with four main insights:

[Insert Table 8 here]

[Insert Table 9 here]

First, our results convey that equity markets are as a whole not integrated across Europe, the EU, or even the Eurozone. This is irrespective of the asset pricing model and sub-period considered. The F-statistics presented in the bottom part of Tables 8 and 9 let us reject the null hypothesis of equal $E(\delta)$s at the 1% significance level for all three regions. Put differently, the expectations of delta are not equal for all European countries, and neither for all EU, or even Eurozone countries.

[38] We neglect Luxembourg simply due to data limitations.

[39] Strictly speaking, *Scandinavia* only refers to the monarchies of Denmark, Sweden, and Norway, and not Finland. Here, however, we shall use the terms *Nordic countries* and *Scandinavia* synonymously, i.e., including all four countries.

[40] Corresponding time-series graphs and box-plots for the delta expectations can be requested from the authors.

Second, our findings provide statistical support for an integration of the equity markets of Germany and France, given that the expectations of the SDF are nearly similar, i.e., we fail to reject the null hypothesis of equal E(δ)s when comparing the first moments of the pricing kernels for Germany and France. This is underpinned by relatively small values for (i) the mean absolute difference (MAD) between expected discount rates (MAD=0.08 for 3FM) and for (ii) our adopted Grubel and Lloyd (1975) intra-industry trade measure (GL=0.07 for 3FM). Our results are, therefore, in line with the findings of Yang et al. (2003). In addition, a statistically non-significant F-value for the comparison of the E(δ)s for Germany, France, and the UK implies also that the stock markets of Europe's three biggest economies are integrated. This integration seems yet to be of a somewhat lesser strength than the bilateral integration of the stock markets of Germany and France. This again holds irrespective of the sub-period considered.

Third, the statistics presented in Tables 8 and 9 illustrate the existence of an intra-regional integration, i.e., an integration between the equity markets of Belgium and the Netherlands. Although we lack data for Luxembourg, the statistically supported similarity of the expected discount factors might be explained by the proximity and interdependence of the economic union of the BeNeLux states. However, it appears that the creation of Euronext, i.e., the common stock exchange of Belgium, the Netherlands, and France, has not had any impact on the integration among the equity markets of the affiliated countries. Regardless of whether we focus on the sub-period January 1990 to April 1998 or January 2000 to April 2008, we always reject the null hypothesis of similar E(δ)s at the 1% significance level. This is again true for all three asset pricing models under consideration.

Finally, although our results provide empirical support for an integration among the BeNeLux states, we fail to find the same tendency for the Scandinavian markets, i.e., Denmark, Finland, Norway, and Sweden. The δ expectations especially differ between Denmark [E(δ)=1.1775 for 3FM] and Norway [E(δ)=1.1040 for 3FM] (cf. Table 9).[41] The thought that this difference is due to the fact that Norway does not belong to the EU does not seem to be very robust, given that our findings do not suggest any integration among the equity markets of the member states of the EU either.

[41] Note that we test for an integration among the Scandinavian equity markets only for sub-period II, since we lack sufficient data for sub-period I.

Yet, it seems worth mentioning that Germany, as Europe's biggest economy, takes on a particular role. If we consider the equity market of Germany as a benchmark, then the relatively low MAD values and adopted Grubel and Lloyd (1975) intra-industry trade measures of other countries with Germany (cf. Tables A.5 and A.6 in the Appendix) suggest that most of Europe's equity markets are on average more integrated with Germany's stock market than with any other European stock market. This holds in particular under the consideration of the 3FM.

5.1.2. Results per Industry

Moving from the summary statistics for the integration across countries to the corresponding statistics for an integration among industries leads us to Tables 10 and 11, which depict the δ expectations for industries aggregated across the Eurozone.[42] Accompanying MAD values and adjusted Grubel and Lloyd (1975) intra-industry measures can be found in Tables A.7 and A.8 in the Appendix.

[Insert Table 10 here]

[Insert Table 11 here]

The statistics presented let us reject the null hypothesis of similar $E(\delta)$s across industries in most of the cases at either the 1% or 5% significance level. We do not find any empirical support for an integration among industries across the Eurozone, neither if we focus on the time period January 1990 to April 1998 nor the same time frame a decade later. Yet, a closer look at the F-statistics imply that the statistical support for non-integration is slightly weaker when just testing for an integration between *aggregated industries* and *aggregated services*. However, we still reject the null hypothesis that $E(\delta)$s are equal at the 10% significance level. The same holds for industries aggregated across the EU.

Besides, although our findings are not necessarily significant at a high level, there appears to be a tendency for a diminishing level of integration

[42]Due to space constraints, we do not report the statistics for industries aggregated across the EU and Europe as a whole. They can, however, be requested from the authors. Corresponding time-series graphs and box-plots for the delta expectations are also available upon request.

among the industries over the years. This is represented by on average considerably lower F-statistics for sub-period I relative to sub-period II. As suggested earlier, a diminishing level of integration across European industries may indicate that industry characteristics have become more important in pricing equity across Europe. This is in line with a variety of past studies.[43]

Nevertheless, as a whole there appears to be only very little, if any, support for an integration of industries. In fact, most of the statistics derived provide a claim for a segmentation of industries throughout the Eurozone, at least from an equity pricing perspective.[44]

5.2. Total Sample Period

The following paragraphs present our empirical results for comparing delta expectations across countries and industries for the entire sample period, i.e., from January 1990 to April 2008. Contrasting these findings with the one for sub-period I and sub-period II allows us to infer to what extent our results are sensitive to the time period chosen. We start again with the findings per country, which we complement thereafter with our findings per industry.

5.2.1. Results per Country

Our results for an integration across countries are to a large extent in line with our previous findings. First, the statistics presented in Table 12 let us reject the null hypothesis that the expectations of δ are equal when comparing countries across the Eurozone, the EU, and Europe as a whole.[45]

[Insert Table 12 here]

Second, the F-statistics depicted in Table 12 show that there is again empirical support for an integration among Europe's biggest economies and capital markets. In other words, we fail to reject the null hypothesis that

[43] Urias et al. (1998), Baca et al. (2000), Cavaglia et al. (2000), Diermeier and Solnik (2001), Cavaglia and Moroz (2002), Brooks and Catao (2000), L'Her et al. (2002), Wang et al. (2003), Ferreira and Gama (2005), Flavin (2004), Isakov and Sonney (2004), Campa and Fernandes (2006), Moerman (2008), Taing and Worthington (2005).

[44] The same holds for industries across the EU and Europe as a whole.

[45] Table A.9 in the Appendix depicts MAD values and adjusted Grubel and Lloyd (1975) intra-industry measures. Corresponding time series plots of δ expectations per country and pricing model, as well as, box-plots can be requested from the authors.

the expectations of δ are equal in case of Germany, France, and the UK. Albeit the expectations of the discount factors are marginally closer when just comparing the two Eurozone countries France and Germany, the inclusion of the UK does not alter the picture very much.

Third, we find once again empirical support for an integration between the equity markets of Belgium and the Netherlands. This may again be explained by the proximity and interdependence of these economies.[46] Moreover, we once more fail to find integration among Belgium, the Netherlands, and France, at least at the same significance level as for sub-periods I and II. This implies that despite the existence of a common stock exchange, i.e., Euronext, the discount factors that price equity in these three countries differ significantly.

Finally, the relatively low MAD values and the adjusted Grubel and Lloyd (1975) intra-industry trade measures between most European countries and Germany (cf. Table A.9 in the Appendix) strengthen further the particular role that the German stock market plays in the conjunction of European equity markets. Considering especially the findings for the 3FM, it appears that the majority of Europe's equity markets are on average more integrated with Germany's stock market than with any other European equity marketplace.

5.2.2. Results per Industry

If we now shift the view to our industries, we find, however, a somewhat surprising result, given our findings discussed above. Table 13 depicts the summary statistics for industries aggregated across the Eurozone.[47] The F-statistics suggest that we fail to reject the null hypothesis of similar expectations of δ in all cases considered, i.e., regardless of whether we concentrate on *all industries/services*, only *non-aggregated industries*, or just *industry vs. service*. This holds irrespective of whether we focus on an aggregation across the Eurozone, the EU, or Europe as a whole. In other words, in the long run, equity returns across European industries are determined by common

[46] Again, unfortunately, the lack of data for Luxembourg does not allow us to test for an integration among the economic union of the BeNeLux states.

[47] Again, the corresponding statistics for the EU and Europe as a whole can be requested from the author. Time series graphs and box-plots of $E(\delta)$ per industry and pricing model are also available upon request. Besides, for industries aggregated across the Eurozone, the Appendix comprises MAD values and adjusted Grubel and Lloyd (1975) intra-industry measures in Table A.10.

SDF, which, at first glance, implies that equity markets are integrated across industries.

[Insert Table 13 here]

However, this finding should be treated with caution as this pan-European industry integration might actually represent an integration across countries. Table 3 reveals that a large proportion of *cyclical consumer goods*, *cyclical services*, *financials*, and *general industries* is comprised of stocks from Germany, France, and the UK. As shown earlier, the equity markets of these three countries seem to be integrated. Hence, the cross-country integration may be the underlying driver for the cross-industry integration. This is even further underpinned by the time period for which data are available per country, i.e., our sample constitutes only little data from January 1990 onwards from countries other than Germany, France, and the UK.[48]

6. Conclusion

The aim of this apper has been to test whether there exists a common SDF expectation that prices equity collectively across Europe. We take the premise that equity markets are integrated whenever stocks are priced by the same pricing kernel, i.e., we consider equity markets integrated if there is no market specific SDF for either one particular country or industry. This suggests that the measurement of integration is conditioned on the identication of risk (see Roll and Ross, 1980).

We have allowed stocks to have general risk characteristics, which we have only constrained through the CAPM, the 3FM, and the 4FM. Yet, unlike the unconditional versions of these models, we have allowed parameters to vary over time. Albeit our mere focus on the first central moment solely constitutes a necessary but not sufficient condition for equity market integration, our proposed SDF mode allows for a simple discrimination between the integration and segmentation of markets. This is highly revealing under practical considerations.

Covering three different time periods between January 1990 and April 2008, our findings suggest that equity markets are not integrated on a pan-European level. This is irrespective of whether the focus is on Europe as

[48] These countries include: Belgium, Italy, the Netherlands, Spain, and Norway.

a whole, the EU, or even the Eurozone. Apparently, the increasing harmonization of monetary and fiscal policies across the EMU seems to have had a deficient impact on the overall integration of European equity markets. This entails that country effects still play a reasonable role for the pricing of equity in Europe.[49]

Yet, on a less aggregate level, we have found that the equity markets of Germany, France, and the UK are integrated. This is in line with the findings of Yang et al. (2003). Additionally, our findings suggest that the bulk of European equity markets is more integrated with Germany's stock market than with any other European stock market. This holds especially when considering the 3FM. Furthermore, our findings reveal that there exists a sort of intra-regional integration, as represented by an integration between the equity markets of Belgium and the Netherlands. This may be explained by the proximity and interdependence of the economic union of the BeNeLux states. Nonetheless, the foundation of a common stock exchange between Belgium, the Netherlands, and France, namely Euronext, does not seem to have had any impact on the integration among the equity markets of the former two BeNeLux states with that of France.

Our results for an integration across industries prevailingly suggest that equity across European industries is not priced by a common SDF expectation. This implies that equity returns of different industries are not necessarily subject to the same market forces, which, in turn, entails that industry characteristics are not negligible for the pricing of equity across Europe. This is in line with a variety of past studies.[50]

Altogether, our findings reveal that European equity investors may enhance their mean-variance frontiers in line with modern portfolio theory (see Markowitz, 1952) by investing across pan-European industries rather than across European countries. Notwithstanding, given that equity markets do not appear to be entirely integrated on a pan-European level, European investors may still benefit in the long-rum from diversifying their portfolios

[49] This is in line with Grinold et al. (1989), Drummen and Zimmermann (1992), Heston and Rouwenhorst (1994, 1995), Beckers, Connor, and Ross (1996), Griffin and Karolyi (1998), Rouwenhorst (1999), and Serra (2000).

[50] see Urias et al. (1998), Baca et al. (2000), Cavaglia et al. (2000), Diermeier and Solnik (2001), Cavaglia and Moroz (2002), Brooks and Catao (2000), L'Her et al. (2002), Ferreira and Gama (2005), Flavin (2004), Isakov and Sonney (2004), Campa and Fernandes (2006), Moerman (2008), Taing and Worthington (2005), and Wang et al. (2003).

across specific country borders. Albeit they should refrain from holding a big proportion of German stocks and desist from trying to disperse their risk exposure solely across Europe's biggest economies or the BeNeLux states. In sum, despite any institutional harmonization among European countries, there is overall still considerable potential for an intra-European wide dispersion of risk on a stock market level: either by diversifying equity portfolios across industries or, to a lesser extent, across a selective set of European countries.

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7. Appendix

7.1. Derivation of Expected Return-Beta Representation

The following lines highlight the necessary steps to arrive to the expected return-beta representation when starting from the general pricing equation.

Consider the general pricing equation

$$P_t^j = E_t(M_{t+1}X_{t+1}^j) = E_t(M_{t+1})E_t(X_{t+1}^j) + COV_t(M_{t+1}, X_{t+1}^j) \tag{A.1}$$

which, when divided by lagged prices, i.e., P_t^j, results in the following equation:

$$1 = E_t\left(M_{t+1}\frac{X_{t+1}^j}{P_t^j}\right) = E_t(M_{t+1})E_t\left(\frac{X_{t+1}^j}{P_t^j}\right) + COV_t\left(M_{t+1}, \frac{X_{t+1}^j}{P_t^j}\right). \tag{A.2}$$

Now, let $R_{t+1}^j = X_{t+1}^j/P_t^j$ (note, that this assumes that there are no dividends at time $t+1$, i.e., $D_{t+1} = 0$). This results in the following simplification of equation A.2:

$$1 = E_t(M_{t+1}R_{t+1}^j) = E_t(M_{t+1})E_t(R_{t+1}^j) + COV_t(M_{t+1}, R_{t+1}^j). \tag{A.3}$$

Subtracting $COV(\cdot)$ from each side and dividing by the expectation of the discount factor, i.e., $E_t(M_{t+1})$, we obtain

$$E_t(R_{t+1}^j) = \frac{1 - COV_t(M_{t+1}, R_{t+1}^j)}{E_t(M_{t+1})} \tag{A.4}$$

or in a slightly different manner

$$E_t(R_{t+1}^j) = \frac{1}{E_t(M_{t+1})} - \frac{COV_t(M_{t+1}, R_{t+1}^j)}{E_t(M_{t+1})}. \tag{A.5}$$

Simultaneously multiplying and dividing each side by the variance of the discount factor, i.e., $VAR(M_{t+1})$, leads to the following expression:

$$E_t(R_{t+1}^j) = \underbrace{\frac{1}{E_t(M_{t+1})}}_{\delta_t} + \left[\underbrace{\left(\frac{COV_t(M_{t+1}, R_{t+1}^j)}{VAR(M_{t+1})}\right)}_{\beta^j} \times \underbrace{\left(-\frac{VAR(M_{t+1})}{E_t(M_{t+1})}\right)}_{\lambda^M}\right]. \tag{A.6}$$

This can be simplified to

$$E_t(R_{t+1}^j) = \delta_t + \beta^j\lambda^M. \tag{A.7}$$

where δ_t is the discount factor, λ^M can be interpreted as the *price* of risk, and β^j as the *quantity* of risk in each asset. The coefficient λ^M is the same for all assets j, while the β^j varies from asset to asset. Equation A.7 shows that the price of risk λ^M depends on the volatility of the discount factor.
Recalling that $\delta_t = 1/E_t(M_{t+1}) = R^f_{t+1}$, equation A.7 may also be expressed in form of excess returns, i.e.,

$$E_t(R^j_{t+1}) - R^f_{t+1} = \beta^j \lambda^M. \tag{A.8}$$

7.2. Descriptive Statistics

[Insert Table A.1 here]

[Insert Table A.2 here]

[Insert Table A.3 here]

7.3. Variance Inflation Factors (VIF)

[Insert Table A.4 here]

7.4. Degree of Market Integration

[Insert Table A.5 here]

[Insert Table A.6 here]

[Insert Table A.7 here]

[Insert Table A.8 here]

[Insert Table A.9 here]

[Insert Table A.10 here]

Table 1: Countries Considered per Sample Period

Sub-Period I	Sub-Period II	Total Period
Jan. 1990 - Apr. 1998	Jan. 2000 - Apr. 2008	Jan. 1990 - Apr. 2008
Belgium	Belgium	Belgium
	Finland	
France	France	France
Germany	Germany	Germany
	Ireland	
Italy	Italy	Italy
Netherlands	Netherlands	Netherlands
	Portugal	
Spain	Spain	Spain
	Denmark	
	Sweden	
United Kingdom	United Kingdom	United Kingdom
Norway	Norway	Norway
	Switzerland	

This table presents an overview of the three sample periods considered. The first sub-periods spans from January 1990 to April 1998. The second sub-period covers the time frame January 2000 to April 2008. The last period covers the entire time frame from January 1990 to April 2008. The countries are clustered along three dimensions. The first group comprises those countries that belong to the Eurozone. The second cluster represents countries of the EU that do not belong to the Eurozone. The last cluster contains European countries that neither belong to the Eurozone nor the EU.

Table 2: Industries Considered per Sample Period

Sub-Period I	Sub-Period II	Total Period
Jan. 1990 - Apr. 1998	Jan. 2000 - Apr. 2008	Jan. 1990 - Apr. 2008
	BAS	
CGD	CGD	CGD
CSER	CSER	CSER
TOLF	TOLF	TOLF
GN	GN	GN
	ITECH	
	NCGD	
	UTL	
Industry§	Industry§	Industry§
Service†	Service†	Service†

§ Industry includes stocks of BAS, CGD, GN, ITECH, NCGD, RES, and UTL
† Service includes stocks of CSER, TOLF, and NCSR

This table presents an overview of the three sample periods considered. The first sub-periods spans from January 1990 to April 1998. The second sub-period covers the time frame January 2000 to April 2008. The last period covers the entire time frame from January 1990 to April 2008.

BAS = *basic industries*; CGD = *cyclical consumer goods*; CSER = *cyclical services*; TOLF = *financials*; GN = *general industries*; ITECH = *information technology*; NCGD = *non-cycical consumer goods*; NCSR = *non-cycical services*; RES = *resources*; UTL = *utilities.*

Table 3: Average Number of Stocks per Country, Region & Industry - Jan. 1990 to Apr. 2008

	BAS	CGD	CSER	TOLF	GN	ITECH	NCGD	NCSR	RES	UTL	Total	Industry	Service	Total
Austria§	3	2	1	11	8	0	0	0	1	2	30	17	13	30
Belgium	5	8	4	18	9	2	6	1	1	2	55	32	23	55
Finland	7	3	6	3	13	2	2	0	0	1	37	27	10	37
France	4	27	27	40	36	13	14	3	6	8	178	108	70	178
Germany	13	28	14	41	41	7	11	1	3	9	169	113	57	169
Greece§	2	5	2	12	7	0	1	1	1	1	32	17	15	32
Ireland	2	8	4	6	7	2	2	0	3	0	32	22	10	32
Italy	3	13	8	36	24	3	2	2	2	5	98	53	45	98
Luxembourg§	2	6	3	13	1	0	0	0	1	3	27	11	16	27
Netherlands	5	9	13	21	31	10	3	0	2	0	93	59	34	93
Portugal	5	3	6	5	10	1	1	1	0	2	34	21	13	34
Spain	7	12	4	22	18	3	3	1	2	7	79	52	28	79
Denmark	0	7	0	13	11	0	7	0	1	1	39	26	13	39
Sweden	4	4	5	16	17	2	2	1	0	0	53	30	22	53
United Kingdom	14	30	64	140	92	14	10	5	12	6	388	180	208	388
Norway	2	2	1	3	10	1	0	0	7	2	29	24	4	29
Switzerland	7	9	6	30	22	4	11	1	1	6	97	60	37	97
Eurozone	58	124	93	228	205	42	44	11	22	37	865	532	332	865
European Union	76	164	162	397	326	59	63	17	36	45	1344	769	575	1344
Europe	85	177	172	436	363	66	74	17	43	54	1486	860	625	1486

§ Stocks of Austria, Greece, and Luxembourg are only considered for industry portfolios.

This table reports the average number of stocks available per country/industry for the period from January 1990 to April 2008. The countries are clustered along three dimensions. The first group comprises those countries that belong to the Eurozone. The second cluster represents countries of the European Union that do not belong to the Eurozone. The last cluster contains European countries that neither belong to the Eurozone nor the European Union. Note that the total averages stated per country and industry might differ from the ones stated in Tables A.2 to A.3 in the Appendix. This is due to the varying sample periods per country/industry that we consider for the individual country/industry analysis.

BAS = *basic industries*; CGD = *cyclical consumer goods*; CSER = *cyclical services*; TOLF = *financials*; GN = *general industries*; ITECH = *information technology*; NCGD = *non-cycical consumer goods*; NCSR = *non-cycical services*; RES = *resources*; UTL = *utilities*.

Table 4: Portfolio Construction Procedure

Book-to-Market	**Market Capitalization**	**Momentum**	**Portfolio**
High	Small	Losers	P1
		Medium	P2
		Winners	P3
	Medium	Losers	P4
		Medium	P5
		Winners	P6
	Big	Losers	P7
		Medium	P8
		Winners	P9
Medium	Small	Losers	P10
		Medium	P11
		Winners	P12
	Medium	Losers	P13
		Medium	P14
		Winners	P15
	Big	Losers	P16
		Medium	P17
		Winners	P18
Low	Small	Losers	P19
		Medium	P20
		Winners	P21
	Medium	Losers	P22
		Medium	P23
		Winners	P24
	Big	Losers	P25
		Medium	P26
		Winners	P27

This table shows the portfolio construction procedure in line with Liew and Vassalou (2000).

Table 5: Summary Statistics for Eurozone Countries

	Mean (%)	Median (%)	Std. (%)	Skweness	Kurtosis	Jarque-Bera	ADF
Austria[§]							
MRF	18.89	14.35	19.83	0.295	1.642	2.715	-1.254
HML	8.26	4.09	20.41	1.291	4.780	8.600**	-1.555
SMB	11.73	9.96	20.77	0.481	2.047	2.218	-2.566
WML	4.86	5.21	10.93	-0.478	3.729	1.098	-2.413
Belgium							
MRF	9.94	12.79	21.37	-0.396	2.169	2.820	-1.997
HML	5.12	7.26	12.82	-0.636	2.843	3.120	-2.920*
SMB	10.34	9.42	12.90	0.248	2.248	1.855	-2.999**
WML	7.73	6.25	14.44	0.318	2.053	2.835	-2.832*
Finland							
MRF	23.01	21.50	48.13	0.724	3.691	4.090	-2.491
HML	23.58	11.33	53.07	3.499	16.341	375.146***	-3.674***
SMB	28.65	13.73	55.46	3.100	14.393	277.488***	-4.021***
WML	1.18	0.79	10.72	-0.004	3.476	0.187	-2.678*
France							
MRF	8.41	10.24	25.33	0.161	2.660	1.127	-4.737***
HML	10.97	5.36	24.81	2.398	11.153	381.172***	-3.847***
SMB	9.56	9.75	19.95	-0.266	3.083	1.226	-4.015***
WML	4.51	2.65	13.66	1.232	5.270	47.337***	-5.486***
Germany							
MRF	6.10	11.83	21.98	-0.317	2.551	1.768	-3.178**
HML	10.44	7.05	17.75	1.814	7.635	85.077***	-4.694***
SMB	13.53	4.56	24.75	1.689	5.958	49.524***	-2.438
WML	6.58	5.45	8.67	0.511	3.228	2.697	-3.816***
Greece[§]							
MRF	5.10	13.82	25.57	-0.254	1.699	2.381	-1.649
HML	12.41	9.25	23.92	0.257	2.218	1.196	-2.275
SMB	15.61	1.43	33.52	0.846	2.591	3.026	-1.116
WML	0.47	2.59	21.62	0.411	3.995	1.106	-3.481**
Ireland							
MRF	4.52	7.93	16.81	-0.454	2.390	1.814	-1.407
HML	25.42	16.29	32.25	1.927	6.973	36.024***	-2.670*
SMB	10.15	1.46	31.93	1.086	4.170	7.077**	-2.929*
WML	-3.95	3.02	28.93	-1.325	6.498	22.107***	-3.608**
Italy							
MRF	3.63	4.62	24.47	0.429	3.317	2.472	-2.954**
HML	5.14	3.77	13.37	-0.121	2.916	0.265	-4.591***
SMB	6.41	6.34	15.94	-0.062	3.488	0.565	-3.399**
WML	3.84	3.73	10.92	-0.318	3.447	1.682	-5.468***
Netherlands							
MRF	5.73	8.05	20.69	0.134	3.718	1.537	-3.030**
HML	4.58	1.00	16.30	0.875	3.978	12.401***	-3.806***
SMB	6.74	4.59	17.45	0.558	3.087	3.994	-3.081**
WML	3.83	2.50	13.06	-0.126	3.104	0.206	-4.147***
Portugal							
MRF	1.13	3.58	21.68	-0.139	1.564	3.491	-1.856
HML	18.07	7.58	31.11	1.995	7.989	51.329***	-3.627**
SMB	4.41	-1.80	37.10	2.320	9.621	82.661***	-3.087**
WML	-0.85	-2.28	17.19	0.131	4.210	1.470	-2.876*
Spain							
MRF	13.57	14.68	23.13	0.058	2.570	0.601	-1.734
HML	10.91	13.40	17.72	-0.238	3.904	1.530	-2.941*
SMB	16.12	4.51	26.97	1.273	4.206	14.298***	-2.501
WML	-0.69	0.72	18.77	-1.022	7.142	37.455***	-3.896***

[§] Stocks of Austria, Greece, and Luxembourg are only considered for industry portfolios. Descriptives for Luxembourg are not presented because of the small number of stocks available.

This table reports the annualized summary statistics for all risk factors considered for each Eurozone country. The results are based on annually rebalanced HML, SMB, and WML portfolios using monthly observations. MRF denotes the return to the market risk factor. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market securities, holding size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization securities, holding book-to-market and momentum characteristics of the portfolio constant. WML is the return on a portfolio that is long on the best performing stocks of the past year ('winners') and short on the worst performing securities of the previous year ('losers') holding book-to-market and size characteristics of the portfolio constant. *, **, *** used for the Jarque-Bera (JB) test and for the Augmented Dickey Fuller (ADF) test denote, respectively, significance at the 10%, 5%, and 1% significance level.

Table 6: Summary Statistics for Non-Eurozone Countries

	Mean (%)	Median (%)	Std. (%)	Skweness	Kurtosis	Jarque-Bera	ADF
Denmark							
MRF	12.79	14.85	23.74	-0.192	2.222	1.604	-2.941*
HML	14.63	16.06	18.17	0.158	3.175	0.164	-4.354***
SMB	21.21	9.95	27.32	0.910	3.134	5.392*	-2.094
WML	-2.24	-1.04	16.84	-0.178	3.457	0.359	-3.176***
Sweden							
MRF	16.91	19.42	33.22	0.441	3.907	3.101	-3.207**
HML	14.08	7.22	37.98	3.913	19.230	699.514***	-5.403***
SMB	12.57	12.37	22.88	-0.214	3.300	0.481	-2.544
WML	-4.01	-3.03	21.40	-2.296	9.740	142.028***	-5.512***
United Kingdom							
MRF	5.86	6.55	14.84	-0.402	3.278	3.006	-3.871***
HML	5.35	5.26	9.73	0.345	4.269	8.370**	-4.824***
SMB	10.13	7.64	14.24	1.769	8.762	194.023***	-4.964***
WML	2.26	2.56	9.54	-0.892	4.667	24.931***	-5.938***
Norway							
MRF	12.17	9.97	28.66	0.335	2.336	3.176	-3.738***
HML	5.29	3.21	18.06	1.021	5.238	28.196***	-5.191***
SMB	2.80	3.70	18.40	0.071	5.079	12.771***	-3.806***
WML	3.73	2.27	18.05	0.065	3.370	0.326	-4.756***
Switzerland							
MRF	10.04	10.82	20.94	-0.103	2.697	0.484	-3.004**
HML	12.22	12.61	31.25	-0.037	3.309	0.113	-2.573
SMB	15.05	8.68	27.53	1.104	4.531	16.348***	-3.432**
WML	-2.75	2.19	21.66	-2.064	9.056	123.345***	-3.988***

This table reports the annualized summary statistics for all risk factors considered per country for the EU and Europe (total). The countries are clustered along two dimensions. The first group comprises those countries that are part of the European Union but that do not belong to the Eurozone. The second cluster contains European countries that neither belong to the Eurozone nor the European Union. The results are based on annually rebalanced HML, SMB, and WML portfolios using monthly observations. MRF denotes the return to the market risk factor. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market securities, holding size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization securities, holding book-to-market and momentum characteristics of the portfolio constant. WML is the return on a portfolio that is long on the best performing stocks of the past year ('winners') and short on the worst performing securities of the previous year ('losers') holding book-to-market and size characteristics of the portfolio constant. *, **, *** used for the Jarque-Bera (JB) test and for the Augmented Dickey Fuller (ADF) test denote, respectively, significance at the 10%, 5%, and 1% significance level.

Table 7: Summary Statistics per Industry (Eurozone)

	Mean (%)	Median (%)	Std. (%)	Skweness	Kurtosis	Jarque-Bera	ADF
BAS							
MRF	5.97	6.27	21.77	-0.221	2.680	1.028	-2.900*
HML	12.13	5.64	22.33	1.108	3.888	15.945***	-3.280**
SMB	4.33	-1.31	25.71	1.048	4.427	17.746***	-3.255**
WML	1.62	2.12	17.31	-0.879	7.610	66.970***	-5.928***
CGD							
MRF	5.67	7.23	21.70	-0.242	2.580	1.549	-3.478*
HML	6.81	4.57	14.04	0.405	3.263	2.251	-4.578***
SMB	4.94	5.70	15.40	-0.431	3.322	2.606	-2.870*
WML	6.68	5.00	9.00	0.689	3.698	7.413**	-4.154***
CSER							
MRF	6.86	8.46	21.24	-0.316	2.799	1.487	-2.985**
HML	9.60	6.72	18.14	0.989	3.422	12.588***	-3.974***
SMB	10.27	9.27	14.67	0.485	4.135	6.390**	-4.167***
WML	3.72	3.57	13.17	-0.358	4.005	4.255	-4.478***
TOLF							
MRF	5.67	7.23	21.70	-0.242	2.580	1.549	-3.478*
HML	8.30	7.32	11.24	0.847	4.446	15.366***	-5.649***
SMB	10.23	8.61	16.95	0.651	3.932	7.874**	-4.135***
WML	5.44	4.59	15.56	-1.173	8.242	103.615***	-7.011***
GN							
MRF	5.67	7.23	21.70	-0.242	2.580	1.549	-3.478**
HML	10.43	9.56	12.55	1.655	10.270	201.848***	-5.365***
SMB	16.03	13.43	23.69	3.950	25.540	1823.498***	-5.314***
WML	1.24	4.66	22.09	-5.012	33.356	3271.297***	-5.426***
ITECH							
MRF	1.68	5.77	23.11	-0.456	2.055	2.682	-2.186
HML	28.74	5.49	64.62	3.572	17.314	317.094***	-7.393***
SMB	16.56	14.29	42.89	2.529	12.258	136.635***	-7.430***
WML	-7.59	-2.52	28.68	-2.568	11.418	119.402***	-6.205***
NCGD							
MRF	0.86	5.41	22.95	-0.423	2.045	2.492	-2.249
HML	9.26	6.72	26.40	-0.542	3.841	1.986	-3.158**
SMB	18.89	19.16	30.59	-0.008	2.564	0.477	-2.505
WML	4.06	7.43	26.86	0.147	2.791	0.302	-3.742***
RES							
MRF	10.02	10.20	8.95	-0.774	3.999	5.896*	-0.941
HML	27.02	13.12	42.60	1.152	3.446	10.151***	-3.354**
SMB	64.46	55.23	42.80	1.003	3.974	8.865**	-3.023**
WML	11.72	8.36	44.53	-0.167	3.419	0.365	-1.877
UTL							
MRF	1.72	5.41	22.76	-0.467	2.118	2.631	-1.976
HML	3.16	1.68	13.03	0.198	2.228	1.384	-2.014
SMB	9.88	9.66	15.77	0.039	1.973	1.896	-1.773
WML	-1.09	-1.24	8.48	0.015	1.993	1.829	-5.609***
Industry							
MRF	5.67	7.23	21.70	-0.242	2.580	1.549	-3.478**
HML	6.52	5.42	9.84	0.401	3.040	2.093	-4.552***
SMB	12.15	12.48	15.01	0.950	6.780	55.814***	-3.013**
WML	3.67	5.14	12.15	-2.401	13.347	413.811***	-4.966***
Service							
MRF	5.67	7.23	21.70	-0.242	2.580	1.549	-3.478**
HML	7.25	7.75	10.66	1.081	5.629	36.147***	-5.018***
SMB	10.45	10.74	13.55	0.613	4.626	12.609***	-3.981***
WML	4.78	5.29	11.53	-0.814	5.105	21.850***	-6.693***

Note that descriptives for NCSR are not presented because of the small number of stocks available.

This table reports the annualized summary statistics for all risk factors considered per industry. The results are based on annually rebalanced HML, SMB, and WML portfolios using monthly observations. MRF denotes the return to the market risk factor. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market securities, holding size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization securities, holding book-to-market and momentum characteristics of the portfolio constant. WML is the return on a portfolio that is long on the best performing stocks of the past year ('winners') and short on the worst performing securities of the previous year ('losers') holding book-to-market and size characteristics of the portfolio constant. *, **, *** used for the Jarque-Bera (JB) test and for the Augmented Dickey Fuller (ADF) test denote, respectively, significance at the at the 10%, 5%, and 1% significance level.

BAS = *basic industries*; CGD = *cyclical consumer goods*; CSER = *cyclical services*; TOLF = *financials*; GN = *general industries*; ITECH = *information technology*; NCGD = *non-cycical consumer goods*; NCSR = *non-cycical services*; RES = *resources*; UTL = *utilities.*

Table 8: Delta Expectations per Country - Sub-Period I (01/1990 - 04/1998)

	CAPM		3FM		4FM	
	E(δ)		E(δ)		E(δ)	
Belgium	1.0576		1.0570		1.0570	
France	1.1335		1.1313		1.1313	
Germany	1.1307		1.1238		1.1234	
Italy	1.0764		1.0757		1.0757	
Netherlands	1.0470		1.0427		1.0425	
Spain	1.0304		1.0250		1.0250	
United Kingdom	1.0952		1.0939		1.0933	
Norway	1.1114		1.1063		1.1062	
	F-Statistic	P-Value	F-Statistic	P-Value	F-Statistic	P-Value
Eurozone	4.868***	0.000	4.604***	0.000	4.576***	0.000
European Union	4.405***	0.000	4.203***	0.000	4.158***	0.000
Europe	4.038***	0.000	3.765***	0.001	3.728***	0.001
Germany/France	0.017	0.896	0.111	0.740	0.122	0.727
Germany/France/UK	1.973	0.141	1.566	0.211	1.579	0.208
Belgium/NL	0.144	0.705	0.260	0.611	0.266	0.607
Belgium/NL/France	7.047***	0.001	6.900***	0.001	6.896***	0.001

This table presents an overview on the delta expectations, i.e., E(δ), per country, considering the time period January 1990 to April 1998. We use the CAPM (Sharpe, 1964, Lintner, 1965, Treynor, 1965), the Fama and French (1993) 3FM, and the Carhart (1997) 4FM to extract E(δ). The countries are clustered along three dimensions. The first group comprises those countries that belong to the Eurozone. The second cluster represents countries of the European Union that do not belong to the Eurozone. The last cluster contains European countries that neither belong to the Eurozone nor the European Union. F-statistics and p-values are computed for the null hypothesis that there is no difference in the delta expectations. *, **, and *** are used as indicators of statistical significance at, respectively, the 10%, 5%, and 1% signicance level.

Table 9: Delta Expectations per Country - Sub-Period II (01/2000 - 04/2008)

	CAPM		3FM		4FM	
	E(δ)		E(δ)		E(δ)	
Belgium	1.0586		1.0580		1.0580	
Finland	1.1573		1.1665		1.1657	
France	1.1322		1.1301		1.1301	
Germany	1.1307		1.1244		1.1239	
Ireland	1.1463		1.1360		1.1358	
Italy	1.0758		1.0751		1.0752	
Netherlands	1.0456		1.0415		1.0413	
Portugal	1.0869		1.0741		1.0733	
Spain	1.1155		1.1133		1.1133	
Denmark	1.1818		1.1775		1.1772	
Sweden	1.1430		1.1340		1.1340	
United Kingdom	1.0929		1.0916		1.0909	
Norway	1.1097		1.1040		1.1039	
Switzerland	1.1021		1.0977		1.0986	
	F-Statistic	P-Value	F-Statistic	P-Value	F-Statistic	P-Value
Eurozone	5.037***	0.000	5.317***	0.000	5.254***	0.000
European Union	6.022***	0.000	5.885***	0.000	5.819***	0.000
Europe	4.644***	0.000	4.516***	0.000	4.482***	0.000
Germany/France	0.004	0.948	0.062	0.804	0.071	0.790
Germany/France/UK	2.088	0.126	1.698	0.185	1.712	0.182
Belgium/NL	0.212	0.646	0.336	0.563	0.345	0.558
Belgium/NL/France	6.699***	0.001	6.611***	0.002	6.605***	0.002
Scandinavia[a]	2.913**	0.034	3.595**	0.014	3.502**	0.016
Eurozone (Period I)[b]	4.671***	0.000	4.336***	0.001	4.333***	0.001
European Union (Period I)[c]	4.038***	0.001	3.753***	0.001	3.732***	0.001
Europe (Period I)[d]	3.425***	0.001	3.086***	0.003	3.068***	0.003

[a] Scandinavia refers to Denmark, Finland, Norway, and Sweden
[b] Eurozone (Period I) includes only those countries considered for sub-peirod I, i.e., Belgium, France, Germany, Italy, the Netherlands, and Spain.
[c] European Union (Period I) comprises Eurozone (Period I) plus United Kingdom.
[d] Europe (Period I) comprises European Union (Period I) plus Norway.

This table presents an overview on the delta expectations, i.e., E(δ), per country, considering the time period January 2000 to April 2008. We use the CAPM (Sharpe, 1964, Lintner, 1965, Treynor, 1965), the Fama and French (1993) 3FM, and the Carhart (1997) 4FM to extract E(δ). The countries are clustered along three dimensions. The first group comprises those countries that belong to the Eurozone. The second cluster represents countries of the European Union that do not belong to the Eurozone. The last cluster contains European countries that neither belong to the Eurozone nor the European Union. F-statistics and p-values are computed for the null hypothesis that there is no difference in the delta expectations. *, **, and *** are used as indicators of statistical significance at, respectively, the 10%, 5%, and 1% signicance level.

Table 10: Delta Expectations per Industry - Sub-Period I (01/1990 - 04/1998)

	CAPM		3FM		4FM	
	E(δ)		E(δ)		E(δ)	
Cyclical Consumer Goods	1.1084		1.1084		1.1078	
Cyclical Services	1.0545		1.0536		1.0530	
Financials	1.1080		1.1070		1.1068	
General Industries	1.1279		1.1272		1.1272	
Industry (aggregated)	1.1280		1.1280		1.1280	
Service (aggregated)	1.0917		1.0910		1.0905	
	F-Statistic	P-Value	F-Statistic	P-Value	F-Statistic	P-Value
All Industries/Services[a]	3.952***	0.002	4.015***	0.001	4.011***	0.001
All Non-Aggregated Industries[b]	5.384***	0.001	5.384***	0.001	5.339***	0.001
Industry vs. Service[c]	3.218*	0.074	3.399*	0.067	3.464*	0.064

[a] All Industries/Services include: *Cyclical Consumer Goods, Cyclical Services, Financials, General Industries, Industry (aggregated)*, and *Service (aggregated).*
[b] All Non-Aggregated Industries include: *Cyclical Consumer Goods, Cyclical Services, Financials, General Industries.*
[c] Industry vs. Service includes: *Industry (aggregated)* and *Service (aggregated).*

This table presents an overview on the delta expectations, i.e., E(δ), per industry aggregated across the Eurozone, considering the time period January 1990 to April 1998. We use the CAPM (Sharpe, 1964, Lintner, 1965, Treynor, 1965), the Fama and French (1993) 3FM, and the Carhart (1997) 4FM to extract E(δ). F-statistics and p-values are computed for the null hypothesis that there is no difference in the delta expectations. *, **, and *** are used as indicators of statistical significance at, respectively, the 10%, 5%, and 1% signicance level.

Table 11: Delta Expectations per Industry - Sub-Period II (01/2000-04/2008)

	CAPM		3FM		4FM	
	E(δ)		E(δ)		E(δ)	
Basic Industries	1.1237		1.1172		1.1154	
Cyclical Consumer Goods	1.1075		1.1074		1.1069	
Cyclical Services	1.0512		1.0517		1.0517	
Financials	1.1072		1.1063		1.1060	
General Industries	1.1253		1.1226		1.1227	
Information Technology	0.9015		0.9903		0.9904	
Non-Cyclical Consumer Goods	1.1685		1.1669		1.1666	
Utilities	1.1040		1.1017		1.1017	
Industry (aggregated)	1.1261		1.1258		1.1257	
Service (aggregated)	1.0904		1.0898		1.0893	
	F-Statistic	P-Value	F-Statistic	P-Value	F-Statistic	P-Value
All Industries/Services[a]	6.513***	0.000	5.803***	0.000	5.720***	0.000
All Non-Aggr. IN[b]	6.851***	0.000	6.385***	0.000	6.286***	0.000
All Non-Agg. IN ex. ITECH[c]	6.593***	0.000	5.883***	0.000	5.730***	0.000
Industry vs. Service[d]	3.053*	0.082	3.120*	0.079	3.167*	0.077
All Non-Aggr. IN (Period I)[e]	4.669***	0.003	4.309***	0.005	4.252***	0.006

[a] All Industries/Services include: *Basic Industries, Cyclical Consumer Goods, Cyclical Services, Financials, General Industries, Information Technology, Non-Cyclical Consumer Goods, Utilities, Industry (aggregated)*, and *Service (aggregated)*.
[b] All Non-Aggregated Industries (IN) include: *Basic Industries, Cyclical Consumer Goods, Cyclical Services, Financials, General Industries, Information Technology, Non-Cyclical Consumer Goods*, and *Utilities*.
[c] All Non-Aggregated Industries (IN) ex. ITECH include: All Non-Aggregated Industries minus *Information Technology*.
[d] Industry vs. Service includes: *Industry (aggregated)* and *Service (aggregated)*.
[e] All Non-Aggregrated Industries (IN) (Period I) include: *Cyclical Consumer Goods, Cyclical Services, Financials, General Industries*.

This table presents an overview of the delta expectations, i.e., E(δ), per industry aggregated across the Eurozone, considering the period January 2000 to April 2008. We use the CAPM, the Fama and French (1993) 3FM, and the Carhart (1997) 4FM to extract E(δ). F-statistics and p-values are computed for the null hypothesis that there is no difference in the delta expectations. *, **, and *** are used as indicators of statistical significance at, respectively, the 10%, 5%, and 1% signicance level.

Table 12: Delta Expectations per Country - Total Period (01/1990 - 04/2008)

	CAPM		3FM		4FM	
	E(δ)		E(δ)		E(δ)	
Belgium	1.0448		1.0433		1.0429	
France	1.0797		1.0751		1.0751	
Germany	1.0764		1.0707		1.0699	
Italy	1.0155		1.0119		1.0119	
Netherlands	1.0524		1.0665		1.0816	
Spain	1.0790		1.0729		1.0727	
United Kingdom	1.0652		1.0590		1.0589	
Norway	1.0791		1.0760		1.0760	
	F-Statistic	P-Value	F-Statistic	P-Value	F-Statistic	P-Value
Eurozone	4.170***	0.001	3.582***	0.003	3.967***	0.001
European Union	3.746***	0.001	3.151***	0.005	3.497***	0.002
Europe	3.464***	0.001	2.910***	0.005	3.157***	0.003
Germany/France	0.050	0.824	0.080	0.778	0.109	0.742
Germany/France/UK	0.557	0.573	0.580	0.560	0.562	0.570
Belgium/NL	0.231	0.631	2.013	0.157	4.951**	0.027
Belgium NL/France	2.583*	0.076	2.159	0.116	3.123**	0.045

This table presents an overview on the delta expectations, i.e., E(δ), per country, considering the time period January 1990 to April 2008. We use the CAPM (Sharpe, 1964, Lintner, 1965, Treynor, 1965), the Fama and French (1993) 3FM, and the Carhart (1997) 4FM to extract E(δ). The countries are clustered along three dimensions. The first group comprises those countries that belong to the Eurozone. The second cluster represents countries of the European Union that do not belong to the Eurozone. The last cluster contains European countries that neither belong to the Eurozone nor the European Union. F-statistics and p-values are computed for the null hypothesis that there is no difference in the delta expectations. *, **, and *** are used as indicators of statistical significance at, respectively, the 10%, 5%, and 1% signicance level.

Table 13: Delta Expectations per Industry - Total Period (01/1990 - 04/2008)

	CAPM		3FM		4FM	
	$E(\delta)$		$E(\delta)$		$E(\delta)$	
Cyclical Consumer Goods	1.0738		1.0707		1.0705	
Cyclical Services	1.0658		1.0848		1.0875	
Financials	1.0871		1.0848		1.0843	
General Industries	1.0951		1.0934		1.0926	
Industry (aggregated)	1.0901		1.0875		1.0866	
Service (aggregated)	1.0786		1.0765		1.0757	
	F-Statistic	P-Value	F-Statistic	P-Value	F-Statistic	P-Value
All Industries/Services[a]	1.114	0.351	0.601	0.699	0.590	0.708
All Non-Aggregated Industries[b]	1.601	0.188	0.828	0.479	0.795	0.497
Industry vs. Service[c]	0.603	0.438	0.530	0.467	0.504	0.478

[a] All Industries/Services include: *Cyclical Consumer Goods, Cyclical Services, Financials, General Industries, Industry (aggregated)*, and *Service (aggregated)*.
[b] All Non-Aggregated Industries include: *Cyclical Consumer Goods, Cyclical Services, Financials, General Industries.*
[c] Industry vs. Service includes: *Industry (aggregated)* and *Service (aggregated)*.

This table presents an overview on the delta expectations, i.e., $E(\delta)$, per industry aggregated across the Eurozone, considering the time period January 1990 to April 2008. We use the CAPM (Sharpe, 1964, Lintner, 1965, Treynor, 1965), the Fama and French (1993) 3FM, and the Carhart (1997) 4FM to extract $E(\delta)$. F-statistics and p-values are computed for the null hypothesis that there is no difference in the delta expectations. *, **, and *** are used as indicators of statistical significance at, respectively, the 10%, 5%, and 1% signicance level.

Table A.1: Industry Classification

Basic Industries (BAS)	**Information Technology (ITECH)**
Chemicals	Information tech hardware
Construction and building materials	Software and computer services
Forestry and paper	**Non-cyclical Consumer Goods (NCGD)**
Steel and other metals	Beverages
Cyclical Consumer Goods (CGD)	Food prodcuers and processors
Automobiles and parts	Health
Houshold goods and textiles	Personal care and household products
Cyclical Services (CSER)	Pharmaceuticals and biotechnology
General retailers	Tobacco
Leisure and hotels	**Non-cyclical Services (NCSR)**
Media and entertainment	Food and drug retailers
Support services	Telecommunication services
Transport	**Resources (RES)**
Financials (TOLF)	Mining
Banks	Oil and gas
Insurance	**Utilities (UTL)**
Life insurance / assurance	Electricity
Investment companies	Gas distribution
Real estate	Water
Speciality and other finance	
General Industries (GN)	
Aerospace and defense	
Diversified industrials	
Electronic and electrical equipment	
Engineering and machinery	

This table reports the classification of industries according to the Financial Times Actuaries.

Table A.2: Number of Stocks Included in Annually Rebalanced Portfolios - Country

	Austria§	Belgium	Finland	France	Germany	Greece§	Ireland	Italy	Luxembourg§	Netherlands	Portugal	Spain	Denmark	Sweden	United Kingdom	Norway	Switzerland	Eurozone	European Union†	Europe‡
1990	13	*35	19	*115	*116	15	24	*58		*64	17	*52	26	34	*269	*15	76	*528	*857	*948
1991	13	35	23	124	123	16	24	62		65	18	55	28	*35	280	16	84	558	901	1001
1992	16	35	25	127	126	18	25	63	4	68	18	58	32	36	290	16	86	583	941	1043
1993	19	35	26	128	128	18	25	63	25	71	22	62	33	37	296	19	*86	622	988	1093
1994	19	35	29	131	129	18	25	64	25	73	22	64	33	38	308	19	89	634	1013	1121
1995	21	37	32	145	131	23	27	65	26	76	24	65	33	41	326	20	92	672	1072	1184
1996	24	37	*33	149	136	25	27	72	26	79	28	65	34	44	340	20	97	701	1119	1236
1997	25	41	36	155	144	26	27	75	27	82	28	68	38	49	362	21	98	734	1183	1302
1998	28	45	38	162	149	28	29	79	30	90	32	76	*38	52	382	28	105	786	1258	1391
1999	28	53	41	180	160	31	31	86	32	97	38	79	40	54	389	29	112	856	1339	1480
2000	32	63	43	191	177	34	*34	97	32	105	*40	83	41	57	398	29	118	931	1427	1574
2001	*34	64	44	202	195	38	36	111	35	106	43	86	44	60	415	29	127	994	1513	1669
2002	35	66	44	207	198	*43	36	121	35	106	43	90	44	62	422	32	131	1024	1552	1715
2003	36	68	44	212	200	44	36	127	36	106	43	92	44	65	438	34	134	1044	1591	1759
2004	40	71	44	212	202	46	36	131	36	109	44	93	44	65	448	34	135	1064	1621	1790
2005	40	73	44	219	205	46	37	137	36	109	45	95	44	65	468	38	138	1086	1663	1839
2006	42	79	47	228	215	47	39	143	37	112	46	96	45	65	488	44	143	1131	1729	1916
2007	46	82	49	239	232	49	45	154	37	120	47	105	49	70	513	50	148	1205	1837	2035
2008	50	90	49	248	249	50	50	159	38	128	50	119	50	70	535	50	150	1280	1935	2135
Average	40	55	43	178	169	46	39	98	-	93	45	79	44	54	388	29	119	865	1344	1486

§ Stocks of Austria, Greece, and Luxembourg are only considered for pan-European portfolios
† Includes Eurozone countries plus Denmark, Sweden, and United Kingdom
‡ Includes European Union countries plus Norway and Switzerland

This table reports the number of stocks available per country in a given year. The average number of stocks reported is computed solely on the numbers highlighted in bold, starting with a marked *. These stocks represent those used for the country regressions. The limitation of the time period is due to the necessity to have a limited amount of stocks available for the construction of the HML, SMB, and WML risk factors. For instance, in case of Austria, we run country regressions merely for the time period July 2001 to April 2008. The remaining stocks of the period January 1990 to June 2001 are, however, not neglected, since they are used for pan-European (across the Eurozone, the European Union, and Europe as a whole) portfolios and are considered also for industry regressions.

Table A.3: Number of Stocks Included in Annually Rebalanced Portfolios - Industry

	BAS	CGD	CSER	TOLF	GN	ITECH	NCGD	NCSR	RES	UTL	Total	Industry	Service	Total
1990	41	***81**	***53**	***145**	***126**	22	22	4	12	22	***528**	***326**	***202**	***528**
1991	***42**	**83**	**58**	**155**	**135**	22	24	4	12	23	**558**	**341**	**217**	**558**
1992	**44**	**88**	**58**	**166**	**139**	22	26	4	12	24	**583**	**355**	**228**	**583**
1993	**45**	**95**	**62**	**177**	**147**	23	28	4	14	27	**622**	**379**	**243**	**622**
1994	**46**	**97**	**63**	**178**	**150**	24	31	4	14	27	**634**	**389**	**245**	**634**
1995	**49**	**101**	**67**	**188**	**163**	24	32	4	15	29	**672**	**413**	**259**	**672**
1996	**54**	**105**	**67**	**193**	**171**	26	34	5	17	29	**701**	**436**	**265**	**701**
1997	**55**	**109**	**74**	**200**	**178**	28	36	7	17	30	**734**	**453**	**281**	**734**
1998	**57**	**120**	**84**	**208**	**189**	31	38	8	19	32	**786**	**486**	**300**	**786**
1999	**61**	**133**	**92**	**223**	**202**	***36**	43	10	21	***35**	**856**	**531**	**325**	**856**
2000	**62**	**139**	**99**	**240**	**224**	**46**	***47**	12	23	**39**	**931**	**580**	**351**	**931**
2001	**62**	**143**	**110**	**254**	**237**	**54**	**53**	15	24	**42**	**994**	**615**	**379**	**994**
2002	**63**	**145**	**115**	**262**	**242**	**57**	**54**	15	26	**45**	**1024**	**632**	**392**	**1024**
2003	**64**	**146**	**116**	**268**	**245**	**59**	**56**	16	27	**47**	**1044**	**644**	**400**	**1044**
2004	**65**	**147**	**118**	**274**	**249**	**62**	**56**	17	***28**	**48**	**1064**	**655**	**409**	**1064**
2005	**66**	**149**	**123**	**279**	**252**	**64**	**57**	18	**28**	**50**	**1086**	**666**	**420**	**1086**
2006	**68**	**153**	**130**	**290**	**264**	**64**	**60**	19	**33**	**50**	**1131**	**692**	**439**	**1131**
2007	**74**	**156**	**138**	**309**	**282**	**69**	**63**	20	**41**	**53**	**1205**	**738**	**467**	**1205**
2008	**77**	**159**	**148**	**327**	**306**	**72**	**71**	20	**42**	**58**	**1280**	**785**	**495**	**1280**
Average	59	124	93	228	205	58	57	-	34	47	865	532	332	865

This table reports the number of stocks available per industry (Eurozone) in a given year. The average number of stocks reported is computed solely on the numbers highlighted in bold, starting with a marked *. These stocks represent those used for the industry regressions. The limitation of the time period is due to the necessity to have a limited amount of stocks available for the construction of the HML, SMB, and WML risk factors. For instance, in case of *information technology*, we run industry regressions merely for the time period August 1999 to April 2008. The remaining stocks of the period January 1990 to July 1999 are, however, not neglected, since they are used for pan-European (across the Eurozone, the European Union, and Europe as a whole) portfolios.

BAS = *basic industries*; CGD = *cyclical consumer goods*; CSER = *cyclical services*; TOLF = *financials*; GN = *general industries*; ITECH = *information technology*; NCGD = *non-cycical consumer goods*; NCSR = *non-cycical services*; RES = *resources*; UTL = *utilities*.

Table A.4: VIF per Country & Industry

Panel A: Countries / Region

	MRF	HML	SMB	WML
Austria	1.140	1.253	1.070	1.060
Belgium	1.381	1.216	1.288	1.615
Finland	1.456	4.264	4.877	1.010
France	1.244	1.152	1.192	1.268
Germany	1.368	1.646	1.379	1.128
Greece	1.304	2.322	2.074	1.073
Ireland	1.280	1.322	1.410	1.366
Italy	1.361	1.368	1.048	1.062
Luxembourg*	-	-	-	-
Netherlands	1.120	1.272	1.098	1.255
Portugal	1.276	3.665	4.201	1.783
Spain	1.780	1.057	1.740	1.368
Denmark	1.311	1.091	1.464	1.255
Sweden	1.220	3.456	1.087	3.089
United Kingdom	1.138	1.055	1.236	1.191
Norway	1.646	1.825	1.360	1.395
Switzerland	1.235	1.251	1.950	1.970

Panel B: Industries (Eurozone)

	MRF	HML	SMB	WML
Basic Industries	1.140	1.197	1.488	1.210
Cyclical Consumer Goods	1.290	1.175	1.089	1.130
Cyclical Services	1.108	1.135	1.064	1.063
Financials	1.111	1.197	1.130	1.133
General Industries	1.250	1.090	2.558	2.390
Information Technology	1.264	4.073	3.280	1.824
Non-Cyclical Consumer Goods	1.308	1.340	1.602	1.152
Non-Cyclical Services*	-	-	-	-
Resources	1.455	1.294	2.432	3.289
Utilities	1.024	1.727	1.748	1.011
Industry (aggregate)	1.328	1.025	1.775	1.428
Service (aggregate)	1.062	1.326	1.211	1.210

* Not sufficient data available

This table reports the variance inflation factor (VIF) for all risk factors per country and industry (Eurozone). The VIF is defined as: $VIF\left(\hat{\beta}_i\right) = 1/\left(1 - R_i^2\right)$. It is estimated by regressing each of the variables on the remaining three using all observations available per country. The countries are clustered along three dimensions. The first group comprises those countries that belong to the Eurozone. The second cluster represents countries of the European Union that do not belong to the Eurozone. The last cluster contains European countries that neither belong to the Eurozone nor the European Union. The results are based on annually rebalanced HML, SMB, and WML portfolios using monthly observations. MRF denotes the market risk factor. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market securities, holding size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization securities, holding book-to-market and momentum characteristics of the portfolio constant. WML is the return on a portfolio that is long on the best performing stocks of the past year ('winners') and short on the worst performing securities of the previous year ('losers') holding book-to-market and size characteristics of the portfolio constant.

Table A.5: Degree of Market Integration per Country - Sub-Period I (01/1990 - 04/1998)

Panel A: Capital Asset Pricing Model

	BEL	FRA	GER	ITA	NL	SPA	UK	NOR
BEL	-	0.09	0.11	0.10	0.12	0.19	0.07	0.11
FRA	0.09	-	0.07	0.07	0.12	0.22	0.06	0.08
GER	0.12	0.08	-	0.09	0.12	0.20	0.08	0.08
ITA	0.10	0.07	0.10	-	0.08	0.23	0.08	0.07
NL	0.11	0.11	0.11	0.07	-	0.23	0.10	0.08
SPA	0.19	0.22	0.19	0.22	0.22	-	0.20	0.23
UK	0.07	0.06	0.08	0.08	0.09	0.19	-	0.07
NOR	0.11	0.08	0.08	0.08	0.08	0.22	0.07	-

Panel B: Fama and French (1993) Model

	BEL	FRA	GER	ITA	NL	SPA	UK	NOR
BEL	-	0.09	0.10	0.09	0.14	0.22	0.07	0.09
FRA	0.10	-	0.04	0.07	0.11	0.23	0.05	0.08
GER	0.11	0.04	-	0.08	0.10	0.23	0.04	0.07
ITA	0.09	0.07	0.08	-	0.09	0.25	0.07	0.08
NL	0.12	0.10	0.09	0.08	-	0.26	0.10	0.11
SPA	0.21	0.23	0.22	0.24	0.24	-	0.22	0.25
UK	0.07	0.05	0.05	0.07	0.08	0.21	-	0.05
NOR	0.10	0.09	0.07	0.09	0.10	0.24	0.05	-

Panel C: Carhart (1997) Model

	BEL	FRA	GER	ITA	NL	SPA	UK	NOR
BEL	-	0.09	0.11	0.10	0.12	0.19	0.07	0.11
FRA	0.09	-	0.07	0.07	0.12	0.22	0.05	0.08
GER	0.11	0.08	-	0.09	0.12	0.20	0.06	0.08
ITA	0.10	0.07	0.10	-	0.08	0.23	0.07	0.07
NL	0.11	0.11	0.11	0.07	-	0.23	0.10	0.08
SPA	0.19	0.22	0.19	0.23	0.22	-	0.21	0.23
UK	0.07	0.05	0.07	0.07	0.09	0.20	-	0.06
NOR	0.11	0.08	0.08	0.08	0.08	0.22	0.07	-

This table presents two measures for the degree of integration. First, for each asset pricing model we report below the diagonal the mean absolute difference (MAD) between expected discount rates. For any two countries i and j, we compute $(1/T)\Sigma_t|\delta_t^i - \delta_t^j|$. The second, closely related measure, reported above the diagonal, is based on the Grubel and Lloyd (1975) measure of intra-industry trade and equals: $(1/T)\Sigma_t 2|\delta_t^i - \delta_t^j|/(\delta_t^i + \delta_t^j)$. For both measures, smaller values indicate closer integration, i.e., a value of zero implies perfect integration. A value of 0.01, for instance, would indicate a 1% monthly interest rate differential. Note: BEL = Belgium; FRA = France; GER = Germany; ITA = Italy; NL = The Netherlands; SPA = Spain; UK = United Kingdom; NOR = Norway

Table A.6: Degree of Market Integration per Country - Sub-Period II (01/2000 - 04/2008)

Panel A: Capital Asset Pricing Model

	BEL	FIN	FRA	GER	IRE	ITA	NL	POR	SPA	DEN	SWE	UK	NOR	CH
BEL	-	0.13	0.08	0.11	0.12	0.09	0.12	0.13	0.09	0.12	0.09	0.07	0.11	0.14
FIN	0.15	-	0.09	0.11	0.14	0.11	0.17	0.12	0.10	0.12	0.10	0.12	0.13	0.16
FRA	0.09	0.10	-	0.07	0.10	0.07	0.12	0.10	0.05	0.07	0.06	0.05	0.08	0.10
GER	0.12	0.13	0.08	-	0.11	0.09	0.12	0.10	0.07	0.07	0.09	0.08	0.08	0.11
IRE	0.13	0.16	0.10	0.11	-	0.13	0.17	0.17	0.10	0.10	0.10	0.11	0.14	0.13
ITA	0.09	0.12	0.07	0.10	0.13	-	0.08	0.08	0.09	0.10	0.10	0.08	0.07	0.09
NL	0.11	0.17	0.11	0.11	0.16	0.07	-	0.12	0.12	0.15	0.13	0.10	0.08	0.09
POR	0.14	0.12	0.10	0.11	0.17	0.08	0.12	-	0.12	0.13	0.14	0.11	0.10	0.12
SPA	0.09	0.12	0.06	0.08	0.11	0.09	0.10	0.12	-	0.09	0.07	0.07	0.09	0.13
DEN	0.14	0.14	0.08	0.08	0.11	0.11	0.14	0.14	0.10	-	0.09	0.09	0.09	0.10
SWE	0.10	0.11	0.07	0.10	0.10	0.10	0.12	0.14	0.08	0.10	-	0.08	0.10	0.14
UK	0.07	0.13	0.06	0.08	0.11	0.08	0.09	0.12	0.08	0.10	0.08	-	0.07	0.10
NOR	0.11	0.14	0.08	0.08	0.14	0.08	0.08	0.10	0.10	0.09	0.10	0.08	-	0.07
CH	0.14	0.17	0.10	0.10	0.13	0.09	0.09	0.13	0.13	0.10	0.13	0.10	0.07	-

Panel B: Fama and French (1993) Model

	BEL	FIN	FRA	GER	IRE	ITA	NL	POR	SPA	DEN	SWE	UK	NOR	CH
BEL	-	0.16	0.09	0.10	0.10	0.09	0.14	0.11	0.09	0.12	0.10	0.06	0.09	0.13
FIN	0.18	-	0.09	0.08	0.14	0.11	0.15	0.10	0.09	0.10	0.09	0.11	0.13	0.15
FRA	0.09	0.09	-	0.04	0.08	0.07	0.11	0.08	0.04	0.06	0.04	0.04	0.08	0.11
GER	0.11	0.09	0.04	-	0.09	0.08	0.10	0.07	0.05	0.06	0.06	0.05	0.07	0.09
IRE	0.10	0.16	0.09	0.10	-	0.11	0.16	0.11	0.07	0.09	0.10	0.08	0.09	0.12
ITA	0.09	0.12	0.07	0.08	0.11	-	0.10	0.07	0.08	0.10	0.09	0.07	0.08	0.09
NL	0.12	0.14	0.10	0.09	0.15	0.08	-	0.11	0.12	0.15	0.14	0.10	0.11	0.08
POR	0.11	0.11	0.08	0.07	0.12	0.08	0.10	-	0.06	0.10	0.10	0.07	0.08	0.10
SPA	0.09	0.11	0.05	0.06	0.08	0.08	0.10	0.06	-	0.08	0.06	0.04	0.07	0.10
DEN	0.14	0.11	0.07	0.07	0.10	0.11	0.14	0.11	0.09	-	0.09	0.08	0.08	0.11
SWE	0.10	0.10	0.04	0.07	0.11	0.09	0.12	0.10	0.06	0.10	-	0.07	0.11	0.14
UK	0.07	0.12	0.05	0.05	0.09	0.07	0.08	0.07	0.04	0.10	0.07	-	0.05	0.09
NOR	0.09	0.14	0.09	0.07	0.10	0.09	0.10	0.09	0.08	0.09	0.12	0.05	-	0.08
CH	0.13	0.15	0.10	0.08	0.11	0.09	0.08	0.10	0.10	0.11	0.13	0.09	0.08	-

Panel C: Carhart (1997) Model

	BEL	FIN	FRA	GER	IRE	ITA	NL	POR	SPA	DEN	SWE	UK	NOR	CH
BEL	-	0.13	0.08	0.11	0.12	0.10	0.12	0.13	0.09	0.12	0.09	0.07	0.11	0.14
FIN	0.15	-	0.09	0.11	0.14	0.11	0.17	0.12	0.09	0.12	0.09	0.11	0.13	0.17
FRA	0.09	0.10	-	0.07	0.10	0.07	0.12	0.09	0.05	0.06	0.06	0.05	0.08	0.11
GER	0.11	0.13	0.07	-	0.10	0.09	0.12	0.09	0.07	0.07	0.09	0.06	0.08	0.11
IRE	0.13	0.16	0.10	0.11	-	0.13	0.17	0.16	0.10	0.10	0.10	0.11	0.14	0.13
ITA	0.10	0.12	0.07	0.10	0.13	-	0.08	0.08	0.08	0.10	0.10	0.07	0.07	0.09
NL	0.11	0.17	0.11	0.11	0.16	0.07	-	0.12	0.11	0.14	0.13	0.10	0.08	0.09
POR	0.13	0.12	0.09	0.10	0.17	0.08	0.11	-	0.11	0.13	0.13	0.10	0.09	0.12
SPA	0.10	0.11	0.05	0.07	0.11	0.08	0.09	0.11	-	0.08	0.07	0.06	0.09	0.12
DEN	0.14	0.14	0.07	0.08	0.11	0.11	0.14	0.14	0.09	-	0.09	0.08	0.09	0.11
SWE	0.10	0.11	0.07	0.10	0.10	0.10	0.12	0.14	0.07	0.10	-	0.07	0.10	0.14
UK	0.07	0.12	0.05	0.07	0.11	0.07	0.09	0.10	0.06	0.09	0.08	-	0.07	0.10
NOR	0.11	0.14	0.08	0.08	0.14	0.08	0.08	0.10	0.09	0.09	0.10	0.07	-	0.08
CH	0.14	0.18	0.10	0.10	0.13	0.09	0.09	0.12	0.12	0.10	0.14	0.10	0.08	-

This table presents two measures for the degree of integration. First, for each asset pricing model we report below the diagonal the mean absolute difference (MAD) between expected discount rates. For any two countries i and j, we compute $(1/T)\Sigma_t|\delta_t^i - \delta_t^j|$. The second, closely related measure, reported above the diagonal, is based on the Grubel and Lloyd (1975) measure of intra-industry trade and equals: $(1/T)\Sigma_t 2|\delta_t^i - \delta_t^j|/(\delta_t^i + \delta_t^j)$. For both measures, smaller values indicate closer integration, i.e., a value of zero implies perfect integration. A value of 0.01, for instance, would indicate a 1% monthly interest rate differential.

BEL = Belgium; FIN = Finland; FRA = France; GER = Germany; IRE = Ireland; ITA = Italy; NL = The Netherlands; POR = Portugal; SPA = Spain; DEN = Denmark; SWE = Sweden; UK = United Kingdom; NOR = Norway; CH = Switzerland

Table A.7: Degree of Market Integration per Industry - Sub-Period I (01/1990 - 04/1998)

Panel A: Capital Asset Pricing Model

	CGD	CSER	TOLF	GN	Industry	Service
CGD	-	0.14	0.04	0.07	0.05	0.05
CSER	0.14	-	0.14	0.16	0.15	0.15
TOLF	0.04	0.15	-	0.04	0.03	0.03
GN	0.07	0.17	0.05	-	0.02	0.04
Industry	0.06	0.16	0.03	0.02	-	0.04
Service	0.06	0.15	0.03	0.05	0.04	-

Panel B: Fama and French (1993) Model

	CGD	CSER	TOLF	GN	Industry	Service
CGD	-	0.12	0.03	0.07	0.05	0.04
CSER	0.13	-	0.13	0.16	0.15	0.14
TOLF	0.03	0.14	-	0.04	0.03	0.02
GN	0.07	0.17	0.04	-	0.01	0.03
Industry	0.06	0.16	0.03	0.01	-	0.03
Service	0.04	0.15	0.02	0.04	0.04	-

Panel C: Carhart (1997) Model

	CGD	CSER	TOLF	GN	Industry	Service
CGD	-	0.13	0.03	0.07	0.05	0.05
CSER	0.14	-	0.14	0.15	0.15	0.14
TOLF	0.03	0.15	-	0.04	0.03	0.02
GN	0.07	0.16	0.05	-	0.02	0.04
Industry	0.06	0.16	0.03	0.02	-	0.04
Service	0.05	0.15	0.03	0.04	0.04	-

This table presents two measures for the degree of integration. First, for each asset pricing model we report below the diagonal the mean absolute difference (MAD) between expected discount rates. For any two countries i and j, we compute $(1/T)\Sigma_t|\delta_t^i - \delta_t^j|$. The second, closely related measure, reported above the diagonal, is based on the Grubel and Lloyd (1975) measure of intra-industry trade and equals: $(1/T)\Sigma_t 2|\delta_t^i - \delta_t^j|/(\delta_t^i + \delta_t^j)$. For both measures, smaller values indicate closer integration, i.e., a value of zero implies perfect integration. A value of 0.01, for instance, would indicate a 1% monthly interest rate differential. Note: CGD = *cyclical consumer goods*; CSER = *cyclical services*; TOLF = *financials*; GN = *general industries*

Table A.8: Degree of Market Integration per Industry - Sub-Period II (01/2000 - 04/2008)

Panel A: Capital Asset Pricing Model

	BAS	CGD	CSER	TOLF	GN	ITECH	NCGD	UTL	Industry	Service
BAS	-	0.06	0.10	0.06	0.07	0.40	0.07	0.06	0.05	0.06
CGD	0.07	-	0.09	0.04	0.07	0.41	0.06	0.04	0.05	0.05
CSER	0.10	0.09	-	0.08	0.08	0.44	0.12	0.10	0.08	0.06
TOLF	0.07	0.04	0.07	-	0.05	0.39	0.06	0.05	0.03	0.03
GN	0.07	0.08	0.08	0.05	-	0.39	0.05	0.07	0.03	0.05
ITECH	0.26	0.27	0.19	0.24	0.23	-	0.41	0.40	0.39	0.39
NCGD	0.08	0.08	0.12	0.07	0.05	0.25	-	0.08	0.04	0.07
UTL	0.07	0.04	0.09	0.05	0.08	0.27	0.09	-	0.06	0.06
Industry	0.06	0.06	0.08	0.04	0.03	0.23	0.05	0.07	-	0.04
Service	0.07	0.06	0.06	0.03	0.05	0.22	0.08	0.06	0.04	-

Panel B: Fama and French (1993) Model

	BAS	CGD	CSER	TOLF	GN	ITECH	NCGD	UTL	Industry	Service
BAS	-	0.03	0.08	0.02	0.03	-1.63	0.04	0.03	0.02	0.03
CGD	0.03	-	0.10	0.03	0.06	0.98	0.06	0.00	0.05	0.04
CSER	0.08	0.09	-	0.07	0.08	-0.36	0.12	0.10	0.08	0.05
TOLF	0.02	0.03	0.06	-	0.04	-0.74	0.05	0.03	0.03	0.02
GN	0.03	0.07	0.07	0.04	-	0.01	0.04	0.07	0.01	0.03
ITECH	0.38	0.41	0.33	0.38	0.35	-	-1.33	0.86	-0.21	-0.01
NCGD	0.05	0.07	0.12	0.06	0.04	0.35	-	0.07	0.04	0.07
UTL	0.04	0.00	0.09	0.03	0.07	0.42	0.08	-	0.06	0.05
Industry	0.02	0.06	0.07	0.03	0.01	0.36	0.04	0.06	-	0.03
Service	0.03	0.04	0.05	0.02	0.04	0.37	0.08	0.05	0.04	-

Panel C: Carhart (1997) Model

	BAS	CGD	CSER	TOLF	GN	ITECH	NCGD	UTL	Industry	Service
BAS	-	0.05	0.10	0.05	0.07	0.40	0.06	0.06	0.05	0.06
CGD	0.05	-	0.09	0.03	0.07	0.40	0.06	0.04	0.05	0.05
CSER	0.10	0.09	-	0.08	0.08	0.43	0.12	0.10	0.08	0.06
TOLF	0.06	0.04	0.07	-	0.05	0.40	0.05	0.05	0.03	0.02
GN	0.07	0.08	0.08	0.05	-	0.39	0.05	0.07	0.03	0.04
ITECH	0.26	0.26	0.19	0.24	0.23	-	0.40	0.40	0.39	0.39
NCGD	0.07	0.07	0.12	0.06	0.05	0.25	-	0.07	0.04	0.07
UTL	0.07	0.04	0.09	0.05	0.08	0.27	0.08	-	0.06	0.06
Industry	0.06	0.06	0.08	0.03	0.03	0.23	0.04	0.07	-	0.04
Service	0.06	0.05	0.05	0.02	0.05	0.22	0.08	0.07	0.04	-

This table presents two measures for the degree of integration. First, for each asset pricing model we report below the diagonal the mean absolute difference (MAD) between expected discount rates. For any two countries i and j, we compute $(1/T)\Sigma_t|\delta_t^i - \delta_t^j|$. The second, closely related measure, reported above the diagonal, is based on the Grubel and Lloyd (1975) measure of intra-industry trade and equals: $(1/T)\Sigma_t 2|\delta_t^i - \delta_t^j|/(\delta_t^i + \delta_t^j)$. For both measures, smaller values indicate closer integration, i.e., a value of zero implies perfect integration. A value of 0.01, for instance, would indicate a 1% monthly interest rate differential.

BAS = *basic industries*; CGD = *cyclical consumer goods*; CSER = *cyclical services*; TOLF = *financials*; GN = *general industries*; ITECH = *information technology*; NCGD = *non-cycical consumer goods*; UTL = *utilities.*

Table A.9: Degree of Market Integration per Country - Total Period (01/1990 - 04/2008)

Panel A: Capital Asset Pricing Model

	BEL	FRA	GER	ITA	NL	SPA	UK	NOR
BEL	-	0.08	0.10	0.14	0.10	0.12	0.10	0.13
FRA	0.08	-	0.07	0.12	0.09	0.10	0.08	0.10
GER	0.10	0.07	-	0.13	0.10	0.12	0.10	0.10
ITA	0.14	0.12	0.13	-	0.13	0.13	0.15	0.14
NL	0.10	0.09	0.10	0.13	-	0.12	0.09	0.09
SPA	0.12	0.10	0.12	0.13	0.12	-	0.12	0.12
UK	0.10	0.08	0.10	0.15	0.09	0.12	-	0.10
NOR	0.13	0.10	0.10	0.14	0.09	0.12	0.10	-

Panel B: Fama and French (1993) Model

	BEL	FRA	GER	ITA	NL	SPA	UK	NOR
BEL	-	0.07	0.09	0.12	0.09	0.10	0.08	0.12
FRA	0.07	-	0.05	0.12	0.07	0.09	0.05	0.11
GER	0.09	0.05	-	0.12	0.06	0.09	0.07	0.09
IITA	0.12	0.12	0.12	-	0.12	0.11	0.13	0.15
NL	0.09	0.07	0.06	0.12	-	0.09	0.06	0.12
SPA	0.10	0.09	0.09	0.11	0.09	-	0.10	0.11
UK	0.08	0.05	0.07	0.13	0.06	0.10	-	0.12
NOR	0.12	0.11	0.09	0.15	0.12	0.11	0.12	-

Panel C: Carhart (1997) Model

	BEL	FRA	GER	ITA	NL	SPA	UK	NOR
BEL	-	0.08	0.09	0.14	0.10	0.12	0.09	0.13
FRA	0.08	-	0.07	0.12	0.09	0.10	0.07	0.10
GER	0.09	0.07	-	0.12	0.10	0.12	0.10	0.10
ITA	0.14	0.12	0.12	-	0.13	0.13	0.14	0.14
NL	0.10	0.09	0.10	0.13	-	0.11	0.09	0.09
SPA	0.12	0.10	0.12	0.13	0.11	-	0.12	0.12
UK	0.09	0.07	0.10	0.14	0.09	0.12	-	0.10
NOR	0.13	0.10	0.10	0.14	0.09	0.12	0.10	-

This table presents two measures for the degree of integration. First, for each asset pricing model we report below the diagonal the mean absolute difference (MAD) between expected discount rates. For any two countries i and j, we compute $(1/T)\Sigma_t|\delta_t^i - \delta_t^j|$. The second, closely related measure, reported above the diagonal, is based on the Grubel and Lloyd (1975) measure of intra-industry trade and equals: $(1/T)\Sigma_t 2|\delta_t^i - \delta_t^j|/(\delta_t^i + \delta_t^j)$. For both measures, smaller values indicate closer integration, i.e., a value of zero implies perfect integration. A value of 0.01, for instance, would indicate a 1% monthly interest rate differential. Note: BEL = Belgium; FRA = France; GER = Germany; ITA = Italy; NL = The Netherlands; SPA = Spain; UK = United Kingdom; NOR = Norway

Table A.10: Degree of Market Integration per Industry - Total Period (01/1990 - 04/2008)

Panel A: Capital Asset Pricing Model

	CGD	CSER	TOLF	GN	Industry	Service
CGD	-	0.05	0.05	0.07	0.05	0.05
CSER	0.06	-	0.03	0.05	0.05	0.03
TOLF	0.06	0.06	-	0.04	0.05	0.02
GN	0.08	0.06	0.06	-	0.05	0.05
Industry	0.06	0.05	0.05	0.05	-	0.05
Service	0.06	0.05	0.03	0.06	0.05	-

Panel B: Fama and French (1993) Model

	CGD	CSER	TOLF	GN	Industry	Service
CGD	-	0.04	0.04	0.04	0.04	0.04
CSER	0.05	-	0.01	0.01	0.01	0.00
TOLF	0.02	0.04	-	0.01	0.01	0.00
GN	0.05	0.03	0.03	-	0.01	0.01
Industry	0.04	0.02	0.02	0.01	-	0.02
Service	0.03	0.02	0.02	0.02	0.01	-

Panel C: Carhart (1997) Model

	CGD	CSER	TOLF	GN	Industry	Service
CGD	-	0.05	0.05	0.06	0.05	0.05
CSER	0.06	-	0.03	0.05	0.04	0.03
TOLF	0.06	0.05	-	0.04	0.05	0.01
GN	0.07	0.05	0.05	-	0.04	0.04
Industry	0.05	0.04	0.04	0.05	-	0.05
Service	0.06	0.04	0.02	0.04	0.04	-

This table presents two measures for the degree of integration. First, for each asset pricing model we report below the diagonal the mean absolute difference (MAD) between expected discount rates. For any two countries i and j, we compute $(1/T)\Sigma_t|\delta_t^i - \delta_t^j|$. The second, closely related measure, reported above the diagonal, is based on the Grubel and Lloyd (1975) measure of intra-industry trade and equals: $(1/T)\Sigma_t 2|\delta_t^i - \delta_t^j|/(\delta_t^i + \delta_t^j)$. For both measures, smaller values indicate closer integration, i.e., a value of zero implies perfect integration. A value of 0.01, for instance, would indicate a 1% monthly interest rate differential. Note: CGD = *cyclical consumer goods*; CSER = *cyclical services*; TOLF = *financials*; GN = *general industries*