Regional and Global Stock Market Integration in the EU

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Abstract

Stock markets in the European Union have experienced large changes in regulatory, institutional, and economic prerequisites during the last decade, not least due to the introduction of the common currency. Has this had any effect on the level of integration among EU stock markets? In contrast to previous research, we suggest to evaluate the presence or absence of integration by separating between three levels on integration: segmentation, regional (EU-wide) integration, and global integration. Do local, regional, or global factors best explain intertemporal variations in returns of EU stocks? Are local, regional, or global risk factors priced or not? We can reject all forms of segmentation and integration and must conclude that markets seem to be partially regionally and globally integrated. We also find that local (global) market risk is relatively more (less) important than regional and global (local). The relative importance of local market risk has fallen, however.

Keywords: stock market integration, euro, beta, expected return, conditional asset pricing model.

JEL classification: G12

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1 Introduction

The institution of the euro on January 1, 1999 meant that bilateral exchange rates within the euro area were irrevocably fixed, and two years later completely replaced by a common currency in circulation. The participating countries began sharing a common monetary policy with the explicit goal of protecting price stability in the euro area, carried out by a common monetary authority, the European Central Bank (ECB). They now share exchange rates vis-à-vis the rest of the world, overnight lending and deposit rates, and, except for differences in countries' credit risks, interest rates at longer maturities. The euro area has experienced converging inflation rates, fiscal policies are increasingly coordinated, and the EU continues to harmonize legal and regulatory frameworks surrounding financial services and trading in stocks. All of these changes could be assumed to increase the degree of integration among stock markets in the EU in general and in the euro area in particular.

In an international-asset-pricing framework, integration means that the risk-free rate should be the same for all investors everywhere and the same risks should be priced and carry the same prices across markets. Complete segmentation, on the other hand, would mean that only local risks would be priced in the respective markets. Adjouté and Danthine (2003) show that the introduction of the euro has resulted in the same risk-free rate being available across the euro area. But what about the pricing of risk?

Baele and Van der Vennet (2001) examine differences in the pricing of risk in the euro area during the 1990s, including the impact of the introduction of the euro. They find that both local and regional EU risk factors are priced with regional factors increasing in importance over time. Hardouvelis, Malliaropulos, and Priestley (1999) find similar results; euro-area stock markets are partially integrated, and integration grew stronger during the 1990s as EU countries' probabilities of joining the euro are increased. Sentana (2002) finds indications of segmentation rather than integration; prices of common market risk are not the same across the investigated EU countries, and residual local market risks are priced.

All referred studies focus on regional integration within the euro area. They do not take into consideration that markets might be globally integrated, which would affect the testing of regional integration. Also, they expose their studies to aggregation bias from using exchange-rate indexes to measure exchange-rate risk. Stocks could have offsetting exposures to individual exchange rates, which would be masked in an exchange-rate index (Bartov and Bodnar, 1994).

De Santis, Gérard, and Hillion (2003) focus specifically on the pricing of exchange-rate risk over the 1974-1997 period. They find euro-area stocks to be exposed to both intra-euro area and extra-euro area exchange-rate risk, but find that the price of the euro-area countries' exchange-rate risk was small and decreasing during the 1990s. However, they focus on a small number of countries and do not specifically test for integration vs segmentation.

This article provides a comprehensive examination of whether stock markets in the EU are segmented or integrated, and to what extent the introduction of the euro has affected the degree of segmentation or integration. We investigate if intertemporal variations in stock returns are best explained by local, regional (EU-wide), or global risk factors. We also investigate differences in risk-adjusted expected returns across national markets, as well as test for the pricing of local and foreign inflation risk. Our aim is to compare segmentation versus integration in all 15 EU member countries and to evaluate how this has changed due to the introduction of the euro. By including the non-euro countries Greece (parts of the period), Denmark, Sweden, and the UK, we can explicitly evaluate the importance of the euro. Recent work by Conrad, Cooper & Kaul (2003) suggests that data grouping methods can significantly affect results. To avoid this problem, individual security data are examined. Using individual security data has the added advantage of making possible testing of the importance of various risk factors to the within-country cross-sectional differences in returns.

In the next section, we outline the international-asset-pricing framework we follow in our testing, followed by a review of arguments in favor why we would expect market integration in the EU. In Section 4, we present our methodology and data, whereas Section 5 contains our empirical results on determinants of variations in stock returns. In Section 6, we present results on the pricing of risk within the EU. Finally, Section 7 contains our conclusions.

2 The international-asset-pricing framework

Just as in the domestic asset-pricing literature, there are competing asset-pricing frameworks explaining stock returns under international financial integration. For example, Stulz (1981) derives a consumption-based international asset-pricing model, whereas Solnik (1983) extends the arbitrage-pricing theory to an international setting. The Fama and French (1993) three-factor model has also been tested internationally (Fama and French, 1998; Griffin, 2002). We instead follow the thread of the CAPM, where consumers are assumed to be concerned about their real wealth at the end of the holding period.

Under segmentation, the local CAPM governs equilibrium expected returns. If inflation is stochastic and investors care about their real purchasing power, CAPM gives the following nominal risk-return relationship:

$$E(R_i) = E\left(R_0\right) + \beta_{im}^L E\left(R_m^L\right) + \beta_{i\pi}^L E\left(R_\pi^L\right) \tag{1}$$

where R_i is the nominal log return on asset i in excess of the local risk-free interest rate ($R_i = r_i - r_f$), $E(\cdot)$ is the expectations operator, ${R_m}^L$ is the excess return on the local (L) market (m) portfolio, ${\beta_{im}}^L$ is asset i's systematic risk relative to the local market portfolio, ${\beta_{i\pi}}^L$ is asset i's exposure to the local inflation (π) rate, and ${R_\pi}^L$ is the excess return on a portfolio that is as highly correlated as possible with local inflation (the local-inflation hedge portfolio). All returns and inflation are measured in local currency. R_0 is the excess return on a local zero-beta portfolio. The Sharpe-Lintner version of the CAPM corresponds to the case where $E(R_0) = 0$; $E(R_0) > 0$ implies that the Black (1972) model is a better description of asset returns.

CAPM cannot easily be extended to an international context. It is transferable only by assuming that (*i*) all investors have logarithmic utility (unit relative risk aversion), (*ii*) asset returns are independent of, or perfectly hedged against exchange-rate and/or inflation changes, or (*iii*) investors in different countries have identical consumption baskets and purchasing power parity (PPP) holds exactly (Stulz, 1995; Solnik, 1997). All assumptions are highly unreasonable. If, however, PPP were to hold exactly, then under integration (1) would describe equilibrium expected returns, with the local market replaced by the world market (Grauer, Litzenberger, and Stehle, 1976). The difference between national and international portfolio theory is that international portfolio theory considers investors in different countries who choose portfolios differently due to deviations from PPP.

In an integrated capital market the same asset-pricing model should describe expected returns in all countries and irrespective of numeraïre currency. Adler and Dumas (1983; also see Dumas, 1993 and 1994) derive an international CAPM under the assumptions that PPP does not hold, inflation is stochastic, and investors are risk averse and are concerned about their real purchasing power in local currency. They show that investors in equilibrium hold a combination of the world (*W*) market portfolio and inflation (domestic and foreign) hedge portfolios. Adler and Dumas derive the following nominal pricing relationship:

$$E(R_i) = \theta_m^W \sigma_{im_W} + \sum_{l=1}^{N} \theta_\pi^l \sigma_{i\pi_l} \qquad (2)$$

where R_i is the return on asset *i* measured in a numeraïre currency in excess of the numeraïre-currency risk-free interest rate, σ_{im_W} is the covariance between r_i and $r_m{}^W$ (the return on the world market portfolio), $\sigma_{i\pi_l}$ is the covariance between r_i and the inflation rate of country *l*, $\theta_m{}^W$ is the market price of world-market risk, which is a wealth-weighted aggregate of investors' degrees of relative risk aversion, and $\theta_\pi{}^l$ is the market price of country *l* inflation risk; all returns and inflation rates are expressed in the numeraïre currency. The coefficients of the $N + 1$ covariance terms ($\theta_m{}^W + \Sigma_l \theta_\pi{}^l$) should sum to one. In this model, there are as many inflation rates as there are integrated countries (= *N*).[1]

Following O'Brien and Dolde (2000), (2) applied to the risk premia on the $N + 1$ risk factors must satisfy

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[1] In Grauer, Litzenberger, and Stehle's (1976) international asset pricing model only the numeraïre-currency inflation risk will be priced, since under PPP all expected inflation rates are equal when expressed in the same currency.

$$
\begin{aligned}
&E\left(R_m^W\right)=\theta_m^W \sigma_{m_W}^2 + \sum_l \theta_\pi^l \sigma_{m_W \pi_l} \\
&E\left(R_\pi^1\right)=\theta_m^W \sigma_{m_W \pi_1} + \theta_\pi^1 \sigma_{\pi_1}^2 + \sum_{l=1}^{N-1} \theta_\pi^l \sigma_{\pi_1 \pi_l} \\
&\vdots \\
&E\left(R_\pi^N\right)=\theta_m^W \sigma_{m_W \pi_N} + \theta_\pi^N \sigma_{\pi_N}^2 + \sum_{l=1}^{N-1} \theta_\pi^l \sigma_{\pi_N \pi_l}
\end{aligned} \tag{3}
$$

where $R_m{}^W$ is the excess return on the world-market portfolio, the $R_\pi{}^l$s are excess returns on the N portfolios that hedge against inflation risks, $\sigma_{m_W}{}^2$ ($\sigma_{\pi_1}{}^2$ and $\sigma_{\pi_N}{}^2$) is the variance of r_{iw} (π_1 and π_N, respectively), $\sigma_{m_w\pi_1}$ ($\sigma_{m_w\pi_N}$) is the covariance between r_{im} and π_1 (π_N), $\sigma_{\pi_1\pi_l}$ ($\sigma_{\pi_N\pi_l}$) is the covariance between π_1 (π_N) and π_l. Simultaneously solving (3) for the prices of risk and inserting in (2) yields Adler and Dumas' international asset pricing model (IAPM):

$$
E(R_i)=E\left(R_0\right)+\beta_{im}^W E\left(R_m^W\right)+\sum_{l=1}^{N} \beta_{i\pi}^l E\left(R_\pi^l\right) \tag{4}
$$

Solnik (1974) and Sercu (1980) derive a related IAPM by assuming that inflation rates are non-stochastic. This means that the local inflation rate disappears from (4) and the N-1 foreign inflation rates entirely reflect the random fluctuations in each foreign currency against the numeraïre currency. As noted by Adler and Dumas (1983), the two IAPMs will normally coincide, due to the relative stability of inflation compared to exchange rates.[2]

Several studies document that the world market factor is an important determinant of stock returns (see, for example, Solnik, 1974a; Stehle, 1977; Korajczyk and Viallet, 1989; Choi and

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[2] Vassalou (2000) nests the two IAPMs in a model containing both exchange and inflation rates and find both exchange-rate and inflation risk to be priced. This nesting should be impossible due to multicollinearity. However, by using different methods to construct her exchange-rate and inflation indexes, she erroneously avoids multicollinearity.

Rajan, 1997). What is perhaps more striking is the importance of the local market factor (see, for example, Jorion and Schwartz, 1986; Korajczyk and Viallet, 1989; Choi and Rajan, 1997). There is also evidence that exchange rate and inflation risks contribute to explaining intertemporal variations in stock returns (for inflation risk see Fama, 1981; Geske and Roll, 1983; Boudoukh, Richardson, and Whitelaw, 1994; Andrén, 2001; for exchange-rate risk see Choi and Prasad, 1995; He and Ng, 1998; Miller and Reuer, 1998; Andrén, 2001) and that they contribute to explaining cross-sectional differences in stock returns (Gruber and Rentzler, 1983; Chen, Roll, and Ross, 1986; Ferson and Harvey, 1994; Dumas and Solnik, 1995; Choi, Hiraki, and Takezawa, 1998; De Santis and Gérard, 1998; Vassalou, 2000).

3 Why expect market integration in the EU?

EU stock markets are, by and large, formally integrated; the regulatory structures in the EU have been harmonized throughout the 1990s (Licht, 1997). But are the markets actually integrated? Adjouté and Danthine (2003) report a number of obstacles that could influence investors' behaviors. Compared to the US, the EU has more settlement and payment systems and stock, bond, and derivatives markets; cross-border transactions and securities settlement are substantially more expensive and time-consuming; there are country differences in taxation of cross-border transactions and accounting and reporting standards. Other potential obstacles to integration are information asymmetries arise from language barriers, corporate takeover defenses, and home bias.

On the other hand, the 1990s saw the birth of the euro. There are several reasons to believe that this could have been supportive of increased stock-market integration. Among the direct effects, the euro reduced information and transaction costs and opened up investment possibilities for insurance and pension funds that are required to match foreign-currency assets and liabilities. The introduction has been accompanied by a wave of mergers and alliances within the financial-services sector in general and among stock markets in particular; new euro- and EU-wide stock-market indexes have been introduced and adopted among funds for portfolio indexation (Adjouté and Danthine, 2003); many portfolio managers seem to have adopted a sector-based rather than country-based approach to asset allocation (ibid); holdings of foreign equity have increased among pension funds and life insurance companies (Hardouvelis et al, 1999).

An obvious consequence of the introduction of the euro is that it removed exchange-rate risk within the euro area and, accordingly, reduced costs for currency hedging. This is not necessarily of any importance from an integration point of view; the reduction of exchange-rate risk could be countered by increased risk relative to outside currencies. Also, elimination of exchange-rate risk eliminates the associated risk-diversification opportunities. Furthermore, reduction of exchange-rate risk would only be beneficial if the eliminated risk was important to asset returns and systematically priced. As noted initially, De Santis, Gérard, and Hillion (2003) find support on both accounts, but find the price of intra-EMU exchange-rate risk to be small. Perhaps more important from an integration viewpoint, the euro has been accompanied by converging economic developments, harmonized monetary and fiscal policies, and equilibration of risk-free interest rates across the euro area (Adjouté and Danthine, 2003).

Empirically, there is also reason to expect EU stock markets to be integrated. Rouwenhorst (1999) and Adjouté and Danthine (2003) investigate the relative importance of home country and industry affiliation as determinants of stock returns in the EU and come to complementary conclusions. Rouwenhorst finds that country effects have dominated throughout the period 1982 to 1998. Adjouté and Danthine come to the same conclusion, but find a reversal in early 1999; after this industry effects seem to dominate.

Freimann (1998) find that correlations among EU stock markets have been fairly stable throughout the 1990s, whereas Beckers (1999) find statistically significant upward trends. Westermann (2004) shows that Germany leads other markets in Europe prior to the introduction of the euro, whereas all lead-lag relationships have disappeared since. Yang, Min, and Li (2003) argue that the major European stock markets are increasingly cointegrated after the introduction of the euro.

4 Methodology

We test Adler and Dumas' IAPM. This means that we assume that PPP does not hold and that inflation is stochastic. A multitude of research shows that PPP does not hold (see Rogoff, 1996, for a review), not even within the euro area after the introduction of the euro (Engel & Roger 2004; Andrén and Oxelheim, 2005). The introduction of the euro by definition eliminated exchange-rate risk within the euro area. If the Solnik-Sercu IAPM were a true description of expected returns, then the euro has reduced the level of systematic risk. However, the introduction of the euro did not necessarily eliminate inflation risk. We test this possibility by assuming that inflation is non-stochastic.

We consider three competing models of asset pricing in the EU:

- Segmentation, where the only priced factors would be the systematic risks vis-à-vis the local market index and the local inflation rate,
- Regional integration, where only the systematic risks vis-à-vis the EU market index and the inflation rates of the EU countries are priced, and
- Global integration, where only the systematic risks vis-à-vis the world market index and the inflation rates of all the countries that are globally integrated are priced.

We test integration in two ways. Firstly, we investigate the importance of different risk factors as determinants of intertemporal variations in stock returns. Secondly, we investigate the pricing of risk.

Testing intertemporal variations in stock returns

Under segmentation, asset returns would follow a two-factor model, as follows, where international risk factors would have no explanatory power,

$$R_{it} = \alpha_i + \beta_{im}^L R_{mt}^L + \beta_{i\pi}^L \pi_t^L + e_{it} \qquad i = 1,...,n \;\; t = 1,...,T \tag{5}$$

Following Jorion and Schwartz (1986), regional (global) integration vs segmentation can be evaluated by adding to (5) EU (global) risk factors that are independent of the local risk factors. The pure EU component of market risk in excess of local market risk can be extracted by orthogonalization:

$$R_{mt}^E = a_0 + a_1 R_{mt}^L + V_{mt}^{E.L} \tag{6}$$

The residuals $V_m^{E.L}$ measure that part of the EU market return that is independent of the local market return. The pure global component market risk ($V_m^{W.L}$) can be extracted accordingly. In a similar manner, the pure non-local inflation rates can be extracted by orthogonalizing each of the $l = 1,\ldots,N$-1 foreign EU inflation rates on the local inflation rate:

$$\pi_t^l = b_0 + b_1 \pi_t^L + Z_{\pi t}^{l.L} \tag{7}$$

$Z_\pi^{l.L}$ measures the pure inflation rate of country l (and similarly $Z_\pi^{k.L}$ for the $k = 1,\ldots,K$ non-local (global) inflation rates, $K \geq N$, in the case of global integration). All inflation rates are denominated in local currency, which means we are capturing local and foreign currency risk. The following model can then be used to test local segmentation:

$$R_{it} = \alpha_i + \beta_{im}^{L} R_{mt}^{L} + \beta_{im}^{E.L} V_{mt}^{E.L} + \beta_{i\pi}^{L} \pi_t^{L} + \sum_{l=1}^{N-1} \beta_{i\pi}^{l.L} Z_{\pi t}^{l.L} + e_{it} \tag{8}$$

A comparison of (5) and (8) tests local segmentation; if adding pure EU risks to (5) yields significant betas $\beta_{im}{}^{E.L}$ and $\beta_{i\pi}{}^{l.L}$ and higher adjusted R^2s, then local segmentation can be rejected.[3] Segmentation can be tested relative to global integration by replacing the pure EU risks in (8) with pure global risks. We test for integration in a similar fashion, by adding pure local market risk ($V_m{}^{L.E}$ or $V_m{}^{L.W}$) to a base version of (5) containing only EU or global risk factors.[4] If the pure local factors are significant and have explanatory power, it means that either perfect regional or global integration can be discarded.

Adding pure local risk factors to regional or global base models tests integration but does not give more than indirect indications of if integration is regional or global. We test regional integration by adding pure global market ($V_m{}^{W.E}$) and inflation ($Z_\pi{}^{k.E}$) risks to a base version of (1) containing only EU risk factors. Similarly, we test global integration by adding pure EU market ($V_m{}^{E.W}$) risk to (5) only containing global factors.

We estimate all models over two test periods, prior to (January 1994 to December 1998) and after (January 1999 to December 2003) the introduction of the euro.[5] We investigate all EU countries except Luxembourg. Luxembourg has for a very long time been in a monetary

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[3] As noted by Griffin (2002), asset-pricing models do not really say anything about the adjusted R^2. However, a better specified model would automatically have a higher adjusted R^2.

[4] Pure local inflation risk cannot be added, since the local inflation rate already is included in the regional and global base models.

[5] In all, we work with nine model specifications: local base model (5) and adding pure regional or global risks (8); regional base model (5) and adding pure local or global risks (8), and global base model (5) and adding pure local or regional risks (8).

union with Belgium and we consider the two countries as one. We let Australia, Canada, Japan, New Zealand, Norway, Switzerland, and the US proxy for the non-EU part of the global market.

Under regional (global) integration, inflation rates of all EU (all integrated) countries should be systematic. Since inflation and exchange rates in the EU (and globally) are closely related, including 14 (21) inflation rates expressed in local currency in the same regression would result in multicollinearity. It would also increase the risk of reduced efficiency in the testing due to over-parameterization of the models. To counter these problems, we reduce the number of inflation rates with factor analysis. We run factor analyses separately for each model, each local currency, and each of the two test periods. The factor-analysis method consists of calculating the correlation matrix of the concerned inflation rates. Then the number of factors (eigenvalues ≥ 1) and their matrices of factor loadings are estimated using principal-components extraction with orthogonal varimax rotation. Finally, we choose as representative inflation rates those inflation rates that are most highly correlated with each of the extracted factors. These representative rates are then used instead of the full set of inflation rates in our testing. We describe the factor analyses and their results more in detail in Appendix A.

Testing pricing of risk

The time-series tests outlined above are equivalent to the first step in a traditional two-step test of asset-pricing models. Integration makes two predictions: the same risks should be priced and the prices should be the same across integrated stock markets. To examine this, we utilize the market and inflation betas from the time-series tests in cross-sectional regressions (CRSs). More specifically, we estimate CSRs for each of our nine model specifications in both periods, individually for each country. The CSRs have the following general form (this is the specification for the local base model, but the other models are specified similarly):

$$R_{it} = \lambda_{mt}^{L}\beta_{im}^{L} + \lambda_{\pi t}^{L}\beta_{i\pi}^{L} + \varepsilon_{it} \qquad i = 1,...,n+1 \tag{9}$$

where $\lambda_m{}^L$ ($\lambda_\pi{}^L$) is the local market risk premium (local inflation risk premium). This model is estimated for each of the t = 1…T time periods in each sample period. Following Cochrane (2001), we exclude constants and include the riskfree assets in the CSRs. Since we are studying individual asset returns, we invariably run into an errors-in-variables problem from using estimated betas in the CSRs. We utilize a correction due to Shanken (1992). Following Fama and MacBeth (1973), the time-series means of the monthly regression coefficients, $\bar{\hat{\lambda}}_{m}^{L}$ and $\bar{\hat{\lambda}}_{\pi}^{L}$, then provide tests of whether the risk factors are priced or not. In particular, we focus on differences in pricing across countries.

If markets are not locally segmented, then adding international factors should reduce estimate pricing errors (αs). The pricing errors from (9) are

$$\hat{\alpha}_t = E_t(R) - \hat{\lambda}_{mt}^{L}\beta_{im}^{L} - \hat{\lambda}_{\pi t}^{L}\beta_{i\pi}^{L} \tag{10}$$

Cochrane (2001) shows that the statistic $\hat{\alpha}'\operatorname{cov}(\hat{\alpha})^{-1}\hat{\alpha} \sim \chi^2_{n\text{-}1}$ can be used to test for mispricing. If adding international factors to the local base model yields smaller absolute αs and reduces, or even eliminates, mispricing that would reject local segmentation. The argumentation is similar for the other model specifications.

We apply full-sample period estimates of betas in the CSRs. As argued by Chen and Chan (1988), Shanken (1992), and Fama and French (1993), this will not bias the results, even though ex-post data are used. Pragmatically, we do not have much choice but to use full-period estimates in the post-euro period, due to the shortage of observations. For consistency, we apply the same methodology in the pre-euro period.

Data and descriptive statistics

All variables are specified in local currencies and all excess returns are in excess of the local risk-free rate. Many empirical studies instead express all variables in a common currency (see, for example, Vassalou, 2000; Griffin, 2002). Under integration, the results should be independent of the choice of numeraïre currency. It is then irrelevant if we specify our test models in local currencies or use a common numeraïre currency for all EU countries. However, under segmentation the choice of numeraïre is no longer irrelevant; local investors price assets based on local market conditions, so to test segmentation correctly we specify all variables in local currencies.

We gather end-of-month stock-price data from the databases of the Reuter Securities system for the period December 1993 to December 2003. All stocks included in one of 30 EU stock-market indexes[6], covering all EU stock exchanges, at the end of February 2004 and with at least 36 months of observations in one of our two test periods (1994-1998 and 1999-2003) are included in the sample. This leaves us with a sample of 2,983 stocks in the post-euro period and 1,694 stocks in the pre-euro period, distributed as in Table 1, from all lines of business.

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[6] Wiener Boerse Index, ATX-index Vienna, Luxembourg SE LuxX Index, Copenhagen SE All Share index, HSE General, CAC 40 index, SBF French Second Market Index, Mid CAC Index, SBF 250 Index, DAX Composite Index, Classic All PF Index, XETRA New Market Top 50 Auction Mid Index, ASE (Athens), ASE mid (Athens), ASE small 50 (Athens), ISEQ General Index, ISEQ Overall Index, Milan SE MIBSTAR Index, MIBTEL General Index, Midex Index, AEX All Share Index, Lisabon SE BVL General Index, Oporto SE PSI 20 Index, Barcelona SE BCN Mid-50 Index, IBEX Nuevo Mercado, IBEX 35 Index, NUMTEL Index, Madrid SE General Index, SX All share PI Market Index, and FTSE All Share index. The stock lists had to be cleaned to delete preference shares. For firms with more than one type of share, we chose the most traded type.

Stock prices are not adjusted for dividends, however Sharpe and Cooper (1972) and Vassalou (2000) show that beta estimates are insensitive to if total returns or capital gains are used.

Our sample covers all 15 EU member countries, but Luxembourg and Belgium are treated as one country. As local market proxies we use Morgan Stanley Capital International (MSCI) indexes for each country. Our EU market proxy is the MSCI EU index, while our global market proxy is the MSCI world index. The MSCI indexes are constructed to broadly represent the stock composition in the different countries, but are weighted towards larger capitalization stocks. As risk-free rates we use end-of-period one-month interbank time-deposit rates from Reuter Securities.[7] [8] End-of-period exchange rates are from Reuter Securities. Inflation is measured with harmonized indexes of consumer prices from the OECD Statistical Compendium (series 248J).[9] To test global integration we add Australia, Canada, Japan, New Zealand, Norway, Switzerland, and the US.[10]

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[7] Often, T-bill rates are used as proxies for the risk-free rate. Interbank deposit rates could be assumed to be a better proxy for the risk-free rate available to market participants. Furthermore, this is the primary money-market indicator used by the ECB, and so should be relevant as a measure of the risk-free rate within the euro area. There are furthermore no systematic differences between these interbank rates and 3-month T-bill rates from EcoWin. The interbank rates are end-of-month rates, whereas T-bill rates reported by EcoWin, IMF, and OECD are monthly averages. Furthermore, they are monthly deposit rates, whereas reported T-bill rates are 3-month or 1-year rates.

[8] In the post-euro period, we use the one-month EURIBOR rate as the risk-free rate for all euro countries. We thereby assume perfect integration in terms of risk-free rates.

[9] We use HICP All items. For Germany, Greece, and Ireland, we use CPI all items during 1994. Up to December 1996, Ireland only reported quarterly CPI figures. We calculate monthly CPI by using linear interpolation.

[10] We use CPI All items from OECD Statistical Compendium (series 241K) for Australia, Canada, New Zealand, Switzerland, and the US, while Norwegian inflation is calculated from CPI All items to 1995:1 and thereafter

Unconditional means, standard deviations, and the number of stocks in each country sample and test period are reported in Table 1.

5 Determinants of variations in stock returns

In this section, we present results of time-series estimations to test for the importance of local, regional, and global risk factors. Table 2 contains a summary of our major results. More detailed results on individual countries are presented in Table 3 on adjusted R^2s in the different model specifications and Tables 4-6 on shares of significant coefficients.

Beginning with comparing the local, regional, and global base models (Table 2), we see that average explanatory values are similar, but that the share of significant market betas is markedly smaller in the global model. These averages hide notable country differences. For Ireland, Italy, Portugal, Spain, and Sweden, and prior to the introduction of the euro, the local market explains four to ten percentage points more of return variations than regional and global markets. On the other hand, the EU market explains three to six percentage points more in Finland, the Netherlands, and the UK than local and global risk. These differences disappear in the post-euro period, where differences in explanatory value are much smaller. Looking at shares of significant coefficients (Tables 3-6), we see a similar pattern of larger shares of significant local market betas for many countries in the pre-euro period. Again, these discrepancies are reduced in the latter period. Though not formal tests of integration vs segmentation, these stylized facts point towards a relative decrease in importance of the local market after the introduction of the euro.

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based on HICP All items (OECD Statistical Compendium series 248J). Monthly CPI figures for Australia and New Zealand are linearly interpolated from quarterly data.

A test of segmentation implies that coefficients on pure regional and global factors are zero when added to a model only containing local factors and that adding international factors do not improve on the local model. From Table 3, we see that adding international factors increases the explanatory value, more so in the pre-euro period, and that 17-22% of pure international market betas are significant. This is well beyond what could be expected by coincidence and the segmentation hypothesis can thus be rejected. In the pre-euro period, adding international factors increase the explanatory value by more than a quarter. In the post-euro period, the increase is reduced to about one-seventh. The share of significant market betas remains stable across periods. A (two-sided) 95% confidence interval for type-I error is given by $p \pm 1.96\sqrt{p(1-p)/n}$, where p is the significance level (5%) and n is the number of firms (Nydahl, 1999). In the pre-euro period the shares of significant international market betas for both Portugal and Spain fall in the respective confidence intervals, whereas we see the same result for Austria, Denmark, Germany, the Netherlands, Portugal, and Spain when adding either regional or global factors. To summarize, we can reject local segmentation on average in both periods, but not for Portugal and Spain in the first period.

Adding global factors to the regional base model provides a test of regional segmentation. Looking at Table 3, we see slight increases in adjusted R^2s, whereas shares of significant global market betas are significantly higher than 5%. The inclusion of global factors adds more in the pre- than the post-euro period. Results are similar for the individual countries, but the shares of significant global market betas are below 5% in the post-euro period for both Austria and Greece, and within the 95% confidence interval for Greece and Spain (period I) and Finland (period II). We can thus safely reject regional segmentation on average in both periods, but not for Greece in either period.

Instead adding pure local market risk to the regional base model provides a test of regional integration. The adjusted R^2 is increased by almost 20% (13%) on average in period I (II) and the shares of significant local market betas are high (35% and 24%, respectively). Explanatory values increase for all countries in the pre-euro period, particularly in Ireland, Italy, Portugal, Spain, and Sweden in the pre-euro period (between five and 15 percentage points). Changes are more modest in period II. Shares of significant coefficients are significantly higher than 5% for all countries except Greece in period I and for all countries except Greece and Ireland in period II. To conclude, we can reject regional integration on average, particularly in period I, except for Greece (in both periods) and Ireland (period II).

Our final testing consists of adding local or regional factors to a global base model, which allows testing for global integration. In the pre-euro period adjusted R^2s increase by 25-40% on average. Increases are more modest in the post-euro period (12-21% increases). Shares of significant local and regional market betas are high in both periods, but particularly in period I when 51% of the pure-local-market betas are significant. Looking at individual countries supports these observations. Explanatory values increase for almost all countries in both periods and both when adding local and regional factors. Adding local market risk adds more than adding regional market risk. Shares of significant coefficients for the individual countries further stress these patterns; Greece is the only country where the pure-local-market beta is not significant for at least 30% in the pre- and 18% in the post-euro periods of all stocks; instead the Greek shares are 4% and 2% in the pre- and post-euro periods. Shares are also not significantly larger than 5% for Austrian and Danish stocks in period II when adding regional market risk. To conclude, global integration is strongly rejected on average and for all individual countries.

Table 2 also reports average shares of significant inflation rates. More detailed results on inflation exposures are provided in Tables 4-6. When adding pure regional or global inflation to the local base model, 18% (11%) of all inflation coefficients turn out significant in the pre-euro (post-euro) period. The shares of significant inflation exposures have thus fallen, which is what would be expected from the introduction of the euro. Exchange rates are notoriously more volatile than inflation rates and introducing the euro would then reduce the level of foreign inflation risk. This would influence results when adding both regional and global inflation rates, since the regional rates make up a large subsection of the global ones. We see a similar pattern when looking at the shares of significant inflation rates in the regional base models, where the share fall from 16% to 12%. When looking at the global base model we also see a decrease in the share of significant inflation rates, but as expected not as marked.

To sum up our testing of intertemporal determinants of stock returns, we can reject local and regional segmentation and regional and global integration. This is in line with prior testing of stock-market integration, where results also point towards stock markets being partially segmented. What surprises is the relative importance of local market risk and the relative unimportance of global market risk, in particular in the pre-euro period. The local base model generates a larger share of significant coefficients than the regional and global base models and adding local market risk adds more to the regional (global) base model than adding global (regional) market risk. Results are similar, but not as notable in the post-euro period. The relative reduction in the importance of local market risk suggests that markets have become more integrated over time. The relative unimportance of global market risk shows itself in the form of the smallest share of significant market betas in the base models and in the lowest shares of pure global market betas when added to the local or regional base models.

Looking at individual countries, we can conclude that the local market is important to stocks in Ireland, Italy, Portugal, Spain, and Sweden. We cannot even reject local segmentation for Portugal and Spain in the first period. International factors are particularly important for Greek stocks. We cannot reject either regional segmentation or regional integration in the case of Greece. On the other hand, we can reject local segmentation and global integration. These results suggest that the Greek stock market is the only truly regionally integrated stock market in our sample.

6 Pricing of risk

To be continued…

7 Conclusions

Stock markets in the European Union have undergone large changes during the last decade, in the form of harmonization of regulatory frameworks, increasing monetary and (implicitly) fiscal policy coordination through the stability pact, and – not least – the introduction of the euro. But what has all this meant to European stock-market integration? Prior testing have focused on the importance or EU-wide vs local market factors, whereas the more general international asset-pricing literature has focused on global vs local market factors. We instead suggest explicitly considering all three levels – local, regional, and global – simultaneously. A test of regional integration will be mis-specified if markets actually are globally integrated, just as will tests of local segmentation vs global integration if markets actually are regionally integrated.

We can reject all forms of segmentation and integration and can instead conclude that European stock markets are partially integrated. Only one country, Greece, stands out as being fully regionally integrated. Local market risk is relatively more important to stock returns than regional and global risk, particularly prior to the introduction of the euro. Global market risk turns out to be of less importance than local and regional market risk to asset returns.

The introduction of the euro eliminated exchange-rate risk within the euro area, but since inflation can still fluctuate, local and foreign currency risk remains. Including local and foreign currency risk in the testing allows evaluating this. We find that European currency risk has indeed fallen in terms of fewer assets being significantly exposed to foreign currency risk.

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Appendix A

We use factor analysis to reduce the number of inflation rates included in eight of our nine model specifications. In the local base model (only containing local factors) no reduction is required, since only local inflation is included. In the regional (global) base model, we reduce the 14 EU (21 global) inflation rates using principal-components extraction with orthogonal varimax rotation. Factors with eigenvalues ≥ 1 are selected and we then identify representative inflation rates, which are those inflation rates that are most highly correlated with each of the factors (one representative per factor). When adding EU factors to a local base model, we similarly reduce the 13 added EU inflation rates, individually for each numeraïre currency and separately for the two test periods. Since we want to add pure inflation risk, we first orthogonalize each of the inflation rates to local inflation and then run factor analyses. When adding global factors to a local model, we reduce the 20 orthogonalized (to local inflation) foreign inflation rates. Similarly, when adding global factors to an EU model, we reduce the six orthogonalized (to the representative EU inflation rates) non-EU inflation rates.[11]

In Tables A1 and A2, those inflation rates that are used as representatives in the different models in the two periods are listed. Between one and seven inflation rates are extracted.

[11] Adding EU or local factors to a global base model does not require any reduction, since the EU or local inflation rates already are included in the global model. The same logic applies to addition of local factors to an EU base model.

Table A1 Extracted inflation rates in local currency, 1994-1998

Local base model	EU factors added to local base model	Global factors added to local base model	EU base model	Global factors added to EU base model	Global base model
AT	DE, ES, NL, UK	DE, ES, JP, NL, UK, US	AT, NL, ES, UK	CH, US	AT, DE, ES, JP, NO, US
BE	DE, ES, NL, UK	AU, CH, DE, ES, GR, NO	BE, DK, DE, ES, UK	CH, US	AT, BE, ES, GR, JP, NL, US
DK	BE, GR, NL, SE, UK	BE, GR, JP, NL, SE, UK, US	FI, DE, IT, NL, UK	CH, US	DE, DK, FI, IT, JP, NZ, UK
FI	DE, IT	DE, JP, SE, UK	FI, DE, IT	JP. NO, US	DE, FI, JP, SE, UK
FR	DE, SE, UK	DE, ES, JP, NO, US	BE, FR, ES, UK	CH, US	DE, ES, FR, JP, UK, US
DE	AT, ES, NL, UK	AT, CH, DK, ES, UK, US	BE, DK, FI, IE	CH, US	AT, DE, DK, ES, JP, US
GR	IT, NL	AU, DE, JP	DE, IT	JP, NO, US	DE, GR, JP, US
IE	DE, IT	CA, DE, IT, JP	DE, IE, IT	JP, NO, US	DE, IE, SE, US
IT	DE, UK	BE, UK, US	DK, UK	CA, CH, NZ	DK, IT, US
NL	DE, FI, GR, UK	DE, FI, GR, JP, NZ, US	DK, FI, DE, UK	CH, US	DE, FI, GR, JP, NO, US
PT	FI, IT, NL, UK	AU, ES, FI, JP, NL, UK	DK, FI, IE, IT, PT	CH, US	ES, FI, JP, NL, NZ, PT, UK
ES	DE, SE, UK	BE, JP, SE, UK, US	DE, SE, UK	CH, US	DE, ES, GR, IE, US
SE	DE, IT	DE, IT, NZ	NL, UK	CH, US	NL, NZ, SE
UK	DK	AU, DK, JP	PT, UK	JP, NO, US	DK, JP, UK, US

All inflation rates are in local currency and in percent per month for the period January 1994-December 1998. Inflation is measured as log consumer-price changes. The table shows the inflation rates most highly correlated with the factors with eigenvalues ≥ 1 extracted with principal-components extraction and after varimax rotation. EU (global) base model is equation (5) containing EU (global) risk factors, EU (global) factors added to local base model refers to the addition of foreign EU (global) inflation rates to a local version of (5), and Global factors added to EU base model refers to the addition of non-EU inflation rates to an EU base model. Countries included: Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), the UK (UK), Australia (AU), Canada (CA), Japan (JP), New Zealand (NZ), Norway (NO), Switzerland (CH), and the US (US).

Table A2 Extracted inflation rates in local currency, 1999-2003

Local base model	EU factors added to local base model	Global factors added to local base model	EU base model	Global factors added to EU base model	Global base model
AT	BE, DE, IT, NL, SE	AU, CA, DE, FI, IT, SE	AT, NL, ES, UK	AU, NO, US	AU, CA, DE, FI, IT, SE
BE	DE, ES, NL, SE	AU, CA, DE, ES, FI, SE	BE, DK, DE, ES, UK	AU, NO, US	AU, CA, DE, FI, IT, SE
DK	IE, IT, NL, SE	AU, FR, IT, NL, US	FI, DE, IT, NL, UK	AU, CA	AU, CA, FI, IT, NO
FI	BE, FR, IT, NL, SE	AU, BE, CA, DK, FR, IT, NL	FI, DE, IT	AU, NO, US	AU, CA, DE, FI, IT, SE
FR	BE, IT, NL, UK	AU, BE, CA, DE, DK, IT	BE, FR, ES, UK	AU, NO, US	AU, CA, DE, FI, IT, SE
DE	BE, IT, NL, SE	AU, CA, FI, IT, SE	BE, DK, FI, IE	AU, NO, US	AU, CA, DE, FI, IT, SE
GR	FI, PT, UK	AU, BE, CA, FR, NO	DE, IT	AU, CA	AU, BE, CA, FR, SE
IE	BE, DE, FI, IT, UK	AU, CA, DE, FI, IT, SE	DE, IE, IT	AU, NO, US	AU, CA, DE, FI, IT, SE
IT	DE, ES, NL, SE, UK	CA, DE, IE, NL, NZ, PT	DK, UK	AU, NO, US	AU, CA, DE, FI, IT, SE
NL	IE, IT, SE, UK	BE, CA, DE, IT, NZ, SE	DK, FI, DE, UK	AU, NO, US	AU, CA, DE, FI, IT, SE
PT	BE, DE, IT, NL	AU, CA, DE, ES, FI, NO	DK, FI, IE, IT, PT	AU, NO, US	AU, CA, DE, FI, IT, SE
ES	FR, IT, NL, UK	AU, CA, DE, FR, IT, SE	DE, SE, UK	AU, NO, US	AU, CA, DE, FI, IT, SE
SE	FR	AT, AU, CA	NL, UK	AU, CA	AT, AU, CA, SE
UK	FR	DK, AU, US	PT, UK	NO, NZ, US	AT, CA, DK, UK

All inflation rates are in local currency and in percent per month for the period January 1999-December 2003. See comments on Table A1 for further specification.

Table 1 Summary statistics for stock returns in excess of local-currency risk-free rate

Country	*Number of firms*	*Mean*	*Std dev*
PANEL A. Pre-euro period, 1994:1 – 1998:12			
Austria	53	-.0023	.0731
Belgium	74	.0084	.0775
Denmark	138	.0030	.0848
Finland	56	.0060	.1031
France	195	.0029	.0937
Germany	141	-.0057	.0917
Greece	69	.0073	.1385
Ireland	34	.0079	.0904
Italy	116	.0018	.1144
Netherlands	106	.0076	.0837
Portugal	32	.0035	.0991
Spain	67	.0122	.1133
Sweden	110	.0057	.0967
UK	504	-.0023	.0905
PANEL B. Post-euro period, 1999:1 – 2003:12			
Austria	65	-.0095	.1104
Belgium	128	-.0121	.1077
Denmark	165	-.0030	.0997
Finland	101	-.0022	.1150
France	314	-.0030	.1278
Germany	615	-.0359	.2105
Greece	128	-.0091	.1786
Ireland	50	-.0027	.1313
Italy	220	-.0116	.1184
Netherlands	152	-.0129	.1289
Portugal	48	-.0114	.0981
Spain	97	-.0045	.0989
Sweden	252	-.0131	.1545
UK	648	-.0018	.1229

All rates are in local currency. The second column reports the number of stocks available in each country sample and each test period. Only stocks with at least 36 observations in a test period were included. The third (fourth) column gives the average monthly stock return in excess of the local-currency risk-free rate (standard deviation of excess returns) for each country and test period.

Table 2 Summary of results on tests of integration vs segmentation

	1994:1 – 1998:12			*1999:1 – 2003:12*		
Sample: All firms	*Local base model*	*Regional factors added to local base model*	*Global factors added to local base model*	*Local base model*	*Regional factors added to local base model*	*Global factors added to local base model*
R^2_{adj}	.1810	.2303	.2336	.1554	.1772	.1754
$\beta_m^{\,L}$ / $\beta_m^{\,E.L}$ / $\beta_m^{\,W.L}$	.7279	.2090	.1691	.6433	.2199	.1740
$\beta_\pi^{\,L}$ / $\Sigma\beta_\pi^{\,l.L}$ / $\Sigma\beta_\pi^{\,k.L}$	.1033	.1849	.1807	.1009	.1111	.1088
	Regional base model	*Local factors added to regional base model*	*Global factors added to regional base model*	*Regional base model*	*Local factors added to regional base model*	*Global factors added to regional base model*
R^2_{adj}	.1927	.2294	.2070	.1602	.1808	.1687
$\beta_m^{\,E}$ / $\beta_m^{\,L.E}$ / $\beta_m^{\,W.E}$	.7054	.3536	.1452	.6671	.2394	.1173
$\Sigma\beta_\pi^{\,l}$ / – / $\Sigma\beta_\pi^{\,k.L}$	.1639	–	.1305	.1236	–	.1120
	Global base model	*Local factors added to global base model*	*Regional factors added to global base model*	*Global base model*	*Local factors added to global base model*	*Regional factors added to global base model*
R^2_{adj}	.1652	.2333	.2070	.1453	.1758	.1630
$\beta_m^{\,W}$ / $\beta_m^{\,L.W}$ / $\beta_m^{\,E.W}$	.5750	.5130	.4221	.4941	.2960	.2196
$\Sigma\beta_\pi^{\,k}$ / – / –	.1305	–	–	.1142	–	–

Table 3 Adjusted R^2s

Country	*Local base model*	*Regional factors added to local base model*	*Global factors added to local base model*	*Regional base model*	*Local factors added to regional base model*	*Global factors added to regional base model*	*Global base model*	*Regional factors added to global base model*	*Local factors added to global base model*
PANEL A. Pre-euro period, 1994:1 – 1998:12									
Austria	.1527	.2072	.2128	.1704	.2043	.1787	.1562	.1728	.2033
Belgium	.1920	.2196	.2203	.1972	.2169	.2034	.1892	.2141	.2214
Denmark	.0969	.1472	.1547	.1129	.1345	.1156	.1163	.1204	.1478
Finland	.1350	.2072	.1907	.1819	.2072	.1762	.1469	.1773	.1907
France	.2177	.2316	.2402	.2035	.2318	.2234	.1592	.2228	.2409
Germany	.1649	.1830	.1848	.1498	.1750	.1565	.1330	.1561	.1778
Greece	.0020	.1600	.1612	.1491	.1616	.1726	.1531	.1660	.1587
Ireland	.2334	.2512	.2531	.1901	.2539	.1927	.1966	.2115	.2713
Italy	.2644	.3112	.3104	.1632	.3118	.1817	.0952	.1716	.3095
Netherlands	.2251	.2650	.2737	.2563	.2623	.2633	.2325	.2729	.2775
Portugal	.2852	.2982	.2993	.2195	.2947	.2467	.1314	.2558	.3034
Spain	.2751	.2875	.2998	.2106	.2852	.2252	.2102	.2293	.3037
Sweden	.1908	.2010	.2031	.1132	.2016	.1259	.0812	.1257	.2035
UK	.1721	.2492	.2513	.2383	.2530	.2592	.2053	.2561	.2524
All firms	.1810	.2303	.2336	.1927	.2294	.2070	.1652	.2070	.2333
Euro firms	.2123	.2418	.2454	.1925	.2397	.2043	.1613	.2059	.2454

Country	*Local base model*	*Regional factors added to local base model*	*Global factors added to local base model*	*Regional base model*	*Local factors added to regional base model*	*Global factors added to regional base model*	*Global base model*	*Regional factors added to global base model*	*Local factors added to global base model*
PANEL B. Post-euro period, 1999:1 – 2003:12									
Austria	.0715	.0691	.0805	.0163	.0653	.0349	.0352	.0365	.0800
Belgium	.1348	.1536	.1581	.1145	.1571	.1214	.1093	.1196	.1574
Denmark	.0636	.0611	.0819	.0515	.0721	.0631	.0572	.0580	.0740
Finland	.0859	.1472	.1347	.1261	.1379	.1399	.1144	.1266	.1343
France	.1781	.1900	.1822	.1900	.1968	.1964	.1606	.1905	.1914
Germany	.1314	.1397	.1420	.1397	.1453	.1481	.1254	.1370	.1420
Greece	.0147	.0818	.0413	.1072	.0994	.0871	.0599	.0739	.0543
Ireland	.0981	.1075	.1071	.0774	.1115	.0814	.0753	.0773	.1065
Italy	.2205	.2285	.2373	.1992	.2299	.2156	.1634	.2142	.2357
Netherlands	.1608	.1879	.1742	.1668	.1879	.1704	.1349	.1599	.1681
Portugal	.1620	.1767	.1849	.1123	.1817	.1324	.0836	.1254	.1864
Spain	.1778	.2065	.1906	.1838	.2173	.1889	.1413	.1634	.1970
Sweden	.1995	.2244	.2181	.1890	.2247	.1906	.1706	.1906	.2181
UK	.2020	.2379	.2385	.2127	.2378	.2267	.2161	.2274	.2365
All firms	.1554	.1772	.1754	.1602	.1808	.1687	.1453	.1630	.1758
Euro firms	.1509	.1661	.1648	.1510	.1698	.1602	.1303	.1518	.1660

The table presents average adjusted R^2. Panel A (B) presents results for the pre-euro (post-euro) period. The following time-series models are estimated:

Local base model: $R_{it} = \alpha_i + \beta_{im}^{L} R_{mt}^{L} + \beta_{i\pi}^{L} \pi_t^{L} + e_{it}$

Local base model + regional factors: $R_{it} = \alpha_i + \beta_{im}^{L} R_{mt}^{L} + \beta_{im}^{E.L} V_{mt}^{E.L} + \beta_{i\pi}^{L} \pi_t^{L} + \sum_{l=1}^{N-1} \beta_{i\pi}^{l.L} Z_{\pi t}^{l.L} + e_{it}$

Local base model + global factors: $R_{it} = \alpha_i + \beta_{im}^{L} R_{mt}^{L} + \beta_{im}^{W.L} V_{mt}^{W.L} + \beta_{i\pi}^{L} \pi_t^{L} + \sum_{k=1}^{K-1} \beta_{i\pi}^{k.L} Z_{\pi t}^{k.L} + e_{it}$

Regional base model: $R_{it} = \alpha_i + \beta_{im}^{E} R_{mt}^{E} + \sum_{l=1}^{N-1} \beta_{i\pi}^{l} \pi_t^{l} + e_{it}$

Regional base model + local factors: $R_{it} = \alpha_i + \beta_{im}^{E} R_{mt}^{E} + \sum_{l=1}^{N-1} \beta_{i\pi}^{l} \pi_t^{l} + \beta_{im}^{L.E} V_{mt}^{L.E} + e_{it}$

Regional base model + global factors: $R_{it} = \alpha_i + \beta_{im}^{E} R_{mt}^{E} + \sum_{l=1}^{N-1} \beta_{i\pi}^{l} \pi_t^{l} + \beta_{im}^{L.E} V_{mt}^{L.E} + \sum_{k=1}^{K-1} \beta_{i\pi}^{k.l} Z_{\pi t}^{k.l} + e_{it}$

Global base model: $R_{it} = \alpha_i + \beta_{im}^{W} R_{mt}^{W} + \sum_{k=1}^{K-1} \beta_{i\pi}^{k} \pi_t^{k} + e_{it}$

Global base model + local factors: $R_{it} = \alpha_i + \beta_{im}^{W} R_{mt}^{W} + \sum_{k=1}^{K-1} \beta_{i\pi}^{k} \pi_t^{k} + \beta_{im}^{L.W} V_{mt}^{L.W} + e_{it}$

Global base model + regional factors: $R_{it} = \alpha_i + \beta_{im}^{W} R_{mt}^{W} + \sum_{k=1}^{K-1} \beta_{i\pi}^{k} \pi_t^{k} + \beta_{im}^{E.W} V_{mt}^{E.W} + e_{it}$

All excess returns and inflation rates are in local currency.

Table 4 Shares of significant coefficients in regressions of excess returns on local plus regional or global factors

	Local base model		*Regional factors added to local base model*					*Global factors added to local base model*				
Country	β_m^{L}	β_π^{L}	β_m^{L}	β_π^{L}	$\beta_m^{E.L}$	$\beta_\pi^{l.L}$	$\Sigma\beta_\pi^{l.L}$	β_m^{L}	β_π^{L}	$\beta_m^{W.L}$	$\beta_\pi^{k.L}$	$\Sigma\beta_\pi^{k.L}$
PANEL A. Pre-euro period, 1994:1 – 1998:12												
Austria	.5283	.0755	.4340	.1509	.1887	.4717	.1462	.4528	.1698	.1321	.5472	.1415
Belgium	.6757	.1216	.6081	.1351	.2703	.2838	.0980	.5676	.1351	.1081	.5811	.1216
Denmark	.5580	.1304	.3188	.1159	.1014	.5580	.1754	.3043	.1232	.1014	.6884	.1667
Finland	.7143	.0714	.7321	.0714	.5000	.1786	.0893	.7679	.0714	.2143	.3571	.1205
France	.8763	.1907	.8557	.2113	.1031	.2835	.1134	.6907	.1907	.1598	.5206	.1433
Germany	.6809	.0922	.6099	.1206	.1135	.4043	.1401	.5319	.1560	.1489	.5390	.1418
Greece	.0435	.0290	.0290	.1304	.7826	.4638	.2681	.0580	.1304	.7681	.7826	.3768
Ireland	.7941	.0588	.7941	.0882	.1176	.2353	.1324	.8235	.0588	.1176	.4118	.1250
Italy	.8707	.0259	.9483	.1466	.0948	.4914	.2629	.9397	.1810	.1293	.5603	.2126
Netherlands	.8208	.0849	.7170	.1226	.2547	.5660	.2052	.6792	.1226	.1415	.6981	.1824
Portugal	.8125	.1875	.8125	.1875	.0625	.4063	.1016	.8125	.1875	.0313	.5625	.1406
Spain	.9104	.0299	.8955	.0299	.0896	.2985	.1194	.8358	.0597	.0896	.5075	.1343
Sweden	.8273	.1000	.8364	.0818	.0727	.1909	.1000	.7818	.1000	.0909	.2818	.1152
UK	.7460	.1091	.7540	.1627	.2659	.3948	.4345	.6806	.1409	.1607	.5714	.2698
All EU firms	.7279	.1033	.6954	.1399	.2090	.3867	.1849	.6399	.1393	.1641	.5561	.1807
Euro firms	.7858	.1019	.7560	.1386	.1649	.3734	.1451	.6976	.1466	.1375	.5430	.1492

	Local base model		Regional factors added to local base model					Global factors added to local base model				
Country	$\beta_m{}^L$	$\beta_\pi{}^L$	$\beta_m{}^L$	$\beta_\pi{}^L$	$\beta_m{}^{E.L}$	$\beta_\pi{}^{l.L}$	$\Sigma\beta_\pi{}^{l.L}$	$\beta_m{}^L$	$\beta_\pi{}^L$	$\beta_m{}^{W.L}$	$\beta_\pi{}^{k.L}$	$\Sigma\beta_\pi{}^{k.L}$
PANEL B. Post-euro period, 1999:1 – 2003:12												
Austria	.3231	.1077	.3538	.1231	.1231	.3538	.0985	.3385	.1231	.0769	.4923	.1026
Belgium	.6484	.0938	.6406	.1406	.2344	.2891	.0820	.5938	.1328	.1953	.4688	.1094
Denmark	.3333	.1030	.3030	.1394	.0848	.3636	.0982	.2788	.1394	.1152	.4970	.1406
Finland	.3762	.0693	.2871	.0693	.5248	.5347	.1663	.3564	.1188	.2376	.5644	.1245
France	.7102	.0764	.7325	.0892	.1720	.3057	.0916	.6051	.0987	.0987	.4618	.1030
Germany	.5691	.1285	.5431	.1724	.0699	.3870	.1264	.4829	.1415	.1285	.3870	.1021
Greece	.0391	.2188	.0469	.3281	.6328	.1172	.0391	.0859	.3125	.4297	.2188	.0516
Ireland	.5200	.1000	.5800	.1400	.2200	.4200	.1120	.5000	.1000	.1400	.4400	.0933
Italy	.8091	.0273	.7727	.0591	.1591	.3864	.0982	.7909	.0591	.1727	.4500	.1106
Netherlands	.7961	.0395	.7632	.0461	.2105	.3487	.1118	.7105	.0724	.0658	.4539	.1009
Portugal	.7917	.0625	.6875	.0625	.0833	.3958	.0990	.6875	.0625	.1458	.4375	.1042
Spain	.7629	.0515	.7835	.0619	.1546	.4124	.1263	.6907	.0928	.0825	.4845	.1117
Sweden	.7976	.0437	.7460	.0317	.2698	.0873	.0873	.6984	.0595	.2222	.2540	.0992
UK	.7809	.1404	.7747	.1296	.3210	.1605	.1605	.5756	.1080	.2392	.3426	.1343
EU firms	.6433	.1009	.6262	.1207	.2199	.2906	.1111	.5478	.1153	.1740	.3976	.1088
Euro firms	.6436	.0860	.6268	.1134	.1592	.3721	.1127	.5743	.1095	.1307	.4413	.1057

Panel A (B) presents shares of significant coefficients for the post-euro (pre-euro) period; $\beta_m{}^L$ is the exposure to local market risk; $\beta_\pi{}^L$ is exposure to local inflation risk; $\beta_m{}^{E.L}$ ($\beta_m{}^{W.L}$) is exposure to orthogonal regional (global) market risk; $\beta_\pi{}^{l.L}$ and $\beta_\pi{}^{k.L}$ are shares of stocks significantly exposed to at least one foreign (regional or global) inflation rate; $\Sigma\beta_\pi{}^{l.L}$ and $\Sigma\beta_\pi{}^{k.L}$ give the share of significant exposures to inflation risk (the total number of significant foreign-inflation betas ÷ the number of estimated foreign-inflation betas).

Table 5 Shares of significant coefficients in regressions of excess returns on regional plus local or global factors

	Regional base model			*Local factors added to regional base model*			*Global factors added to regional base model*				
Country	β_m^E	β_π^l	$\Sigma\beta_\pi^l$	β_m^E	$\Sigma\beta_\pi^l$	$\beta_m^{L.E}$	β_m^E	$\Sigma\beta_\pi^l$	$\beta_m^{W.E}$	$\beta_\pi^{k.l.}$	$\Sigma\beta_\pi^{k.l}$
PANEL A. Pre-euro period, 1994:1 – 1998:12											
Austria	.5094	.4528	.1604	.4717	.1651	.3396	.5283	.1840	.1321	.2264	.1226
Belgium	.5811	.4054	.1108	.5946	.1027	.2568	.4865	.1297	.1757	.2297	.1216
Denmark	.3406	.5797	.1681	.3551	.1551	.2391	.2609	.1841	.1014	.2029	.1087
Finland	.8929	.3571	.1250	.8750	.0833	.2500	.7857	.1310	.1429	.1964	.0714
France	.8454	.3814	.1108	.8454	.1430	.3918	.5773	.1211	.2010	.3247	.1830
Germany	.5957	.3262	.1028	.5957	.1152	.3688	.4326	.1365	.1064	.2057	.1099
Greece	.7391	.4203	.2536	.7391	.2609	.1014	.7971	.2754	.0725	.4638	.1739
Ireland	.7647	.1765	.0588	.7941	.1275	.6176	.7059	.0784	.2353	.2941	.1078
Italy	.8103	.1897	.0948	.7586	.2586	.7845	.8448	.1466	.0948	.2586	.1034
Netherlands	.7547	.5283	.1769	.7453	.1840	.1698	.6509	.2241	.1226	.2075	.1132
Portugal	.8750	.4688	.1375	.8125	.1250	.5000	.6250	.1375	.3125	.2813	.1563
Spain	.8507	.4030	.1443	.8657	.1045	.6119	.7761	.1393	.0746	.2388	.1418
Sweden	.6091	.1818	.0909	.6182	.1136	.6455	.5727	.1273	.1000	.2091	.1045
UK	.7480	.4960	.2956	.7401	.3274	.2421	.6647	.3214	.1726	.3472	.1389
All EU firms	.7054	.4126	.1639	.6995	.1810	.3536	.6098	.1869	.1452	.2816	.1305
Euro firms	.5094	.4528	.1604	.7377	.1418	.4192	.6231	.1455	.1478	.2509	.1478

	Regional base model			Local factors added to regional base model			Global factors added to regional base model				
Country	β_m^{E}	β_π^{l}	$\Sigma\beta_\pi^{l}$	β_m^{E}	$\Sigma\beta_\pi^{l}$	$\beta_m^{L.E}$	β_m^{E}	$\Sigma\beta_\pi^{l}$	$\beta_m^{W.E}$	$\beta_\pi^{k.l.}$	$\Sigma\beta_\pi^{k.l}$
PANEL B. Post-euro period, 1999:1 – 2003:12											
Austria	.2769	.2923	.0831	.2154	.0923	.3385	.2308	.1169	.0462	.3846	.1436
Belgium	.5313	.4297	.1094	.5234	.1094	.3516	.4688	.1500	.1328	.3047	.1146
Denmark	.2909	.2606	.1010	.3091	.1111	.2303	.2485	.1232	.1030	.2242	.1242
Finland	.6040	.4851	.1287	.5941	.1188	.1485	.3960	.1267	.0792	.3564	.1419
France	.7484	.4140	.0981	.7548	.1057	.1561	.6401	.1108	.0892	.3025	.1157
Germany	.5398	.4911	.1320	.5203	.1392	.1528	.4033	.1506	.1285	.2894	.1127
Greece	.7969	.4219	.1719	.7969	.1641	.0469	.6094	.1484	.0313	.0703	.0391
Ireland	.5400	.4200	.0960	.5600	.1280	.3000	.4800	.1040	.1000	.3200	.1067
Italy	.7864	.4182	.1109	.7864	.0927	.3318	.5045	.1236	.1773	.3591	.1364
Netherlands	.7237	.4539	.1158	.7368	.1039	.2895	.5855	.1342	.1053	.2895	.1096
Portugal	.5000	.5625	.1458	.4583	.1417	.5208	.2917	.1542	.1667	.1667	.0694
Spain	.7526	.5876	.1711	.7010	.1608	.3918	.5464	.1918	.1134	.2577	.0962
Sweden	.8214	.2421	.1290	.8294	.0575	.3333	.6905	.1151	.1270	.1548	.0853
UK	.7654	.2531	.1404	.7531	.1443	.2562	.6698	.1466	.1281	.3025	.1137
All EU firms	.6617	.3832	.1236	.6540	.1215	.2394	.5303	.1372	.1173	.2769	.1120
Euro firms	.6263	.4587	.1200	.6151	.1206	.2346	.4777	.1373	.1196	.3045	.1166

Table 6 Shares of significant coefficients in regressions of excess returns on global plus regional or local factors

	Global base model			*Regional factors added to global base model*			*Local factors added to global base model*		
Country	β_m^{W}	β_π^{k}	$\Sigma\beta_\pi^{k}$	β_m^{W}	$\Sigma\beta_\pi^{k}$	$\beta_m^{E.W}$	β_m^{W}	$\Sigma\beta_\pi^{k}$	$\beta_m^{L.W}$
PANEL A. Pre-euro period, 1994:1 – 1998:12									
Austria	.4528	.6038	.1541	.4528	.1384	.3019	.4340	.1667	.3962
Belgium	.5676	.5541	.1081	.5135	.1197	.3919	.5676	.1236	.3378
Denmark	.2609	.6522	.1708	.2391	.1729	.1377	.2319	.1770	.3623
Finland	.7143	.4643	.1107	.6964	.1143	.3036	.5714	.1107	.5179
France	.5619	.5515	.1246	.5464	.1667	.5979	.5722	.1512	.5876
Germany	.4752	.5532	.1300	.4113	.1229	.3050	.3759	.1170	.4539
Greece	.8116	.7971	.3188	.7971	.2681	.2029	.5942	.3007	.0435
Ireland	.5588	.3529	.0882	.5588	.1103	.3235	.6471	.1250	.6765
Italy	.5862	.3190	.1063	.6207	.1264	.6724	.5431	.2155	.8534
Netherlands	.5943	.7075	.1965	.5755	.1934	.4623	.5283	.2154	.4057
Portugal	.5313	.5000	.1071	.5000	.1518	.7813	.6250	.1518	.7188
Spain	.7910	.4776	.1134	.7612	.1224	.2537	.7313	.1313	.7015
Sweden	.4182	.2273	.0939	.3455	.1576	.4909	.4273	.1030	.7727
UK	.6171	.5813	.2019	.5933	.2063	.4504	.6052	.2277	.4821
All EU firms	.5614	.5425	.1570	.5366	.1670	.4221	.5289	.1760	.5130
Euro firms	.5750	.5223	.1305	.5544	.1442	.4593	.5395	.1519	.5590

Country	*Global base model*			*Regional factors added to global base model*			*Local factors added to global base model*		
	$\beta_m{}^W$	$\beta_\pi{}^k$	$\Sigma\beta_\pi{}^k$	$\beta_m{}^W$	$\Sigma\beta_\pi{}^k$	$\beta_m{}^{E.W}$	$\beta_m{}^W$	$\Sigma\beta_\pi{}^k$	$\beta_m{}^{L.W}$
PANEL B. Post-euro period, 1999:1 – 2003:12									
Austria	.2615	.5077	.1077	.1538	.1077	.0615	.1692	.0795	.2923
Belgium	.4453	.5625	.1367	.4297	.1146	.2344	.3828	.1120	.4063
Denmark	.2121	.3758	.1006	.2303	.1006	.0788	.1697	.0945	.2303
Finland	.3960	.5149	.1238	.2475	.1106	.1782	.4158	.1172	.1881
France	.6146	.5000	.1083	.4777	.0998	.3408	.5318	.1008	.3057
Germany	.4309	.4715	.1117	.3886	.1022	.1675	.3691	.1062	.2211
Greece	.5625	.5156	.1297	.3672	.1016	.2266	.6406	.1156	.0156
Ireland	.3800	.4200	.0933	.3200	.0767	.1200	.3600	.0967	.3200
Italy	.4727	.4864	.1053	.3545	.1265	.3591	.4818	.0985	.4864
Netherlands	.5921	.5132	.1217	.5132	.1064	.2961	.4276	.0976	.3947
Portugal	.2917	.5000	.1285	.2083	.0833	.3333	.1458	.0938	.6042
Spain	.5464	.5567	.1340	.4227	.1375	.2577	.4330	.1151	.4330
Sweden	.6667	.3730	.1121	.5754	.0873	.2381	.6627	.0873	.4048
UK	.5355	.3781	.1138	.4969	.1246	.1852	.4985	.1208	.2546
All EU firms	.4941	.4542	.1142	.4204	.1083	.2196	.4472	.1053	.2960
Euro firms	.4760	.4961	.1146	.3922	.1074	.2419	.4101	.1035	.3218