International Diversification in the Euro-zone: The Increasing Riskiness of Industry Portfolios

Esther Eiling, Bruno Gerard, and Frans de Roon*

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Abstract

We investigate, from a portfolio performance perspective, the relative importance of country and industry factors as determinants of international equity returns in the Euro-zone over the 1990 to 2003 period. Although industry- and country-based portfolios are indistinguishable in terms of mean-variance efficiency and Sharpe ratios, we document remarkable changes in the structure of Euro-zone equity returns. Whereas country returns were more volatile but less correlated than industry returns in the early nineties, the opposite is true for the late 90s and the beginning of the 21st century. After the launch of the Euro, the fraction of Euro-wide industry risk unrelated to country factors nearly doubles. This striking increase in industry idiosyncratic risk suggests that cross-border diversification within a single Euro-zone industry fails to deliver the full benefits of international diversification. Indeed, it has caused a near doubling of the average annual gains from Euro-wide cross-industry diversification, from 5.2% p.a. in the convergence period to 9.7% in the Euro period. We argue that the increasing importance of industry factors may be related to the enhanced economic integration of Euro-zone countries induced by the EMU convergence process.

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*Eiling is with the Department of Finance and CentER, Tilburg University, P.O.Box 90153, 5000 LE Tilburg, The Netherlands, tel: +31-134668760, email: E.Eiling@uvt.nl; Gerard is with Mellon Capital Management, 595 Market Street, Suite 3000, San Francisco Ca 94105, tel: +1-415-975 3569, email: brunog@mcm.com; De Roon is with the Department of Finance, CentER and Tias Business School, Tilburg University, P.O.Box 90153, 5000 LE Tilburg, The Netherlands, tel: +31-134668604, email: F.A.deroon@uvt.nl.

1 Introduction

Since the early 1970's, the international finance literature provides ample evidence of the substantial benefits that investors can derive from cross-border diversification (e.g., Levy and Sarnat 1970, Solnik 1974c, De Santis and Gerard 1997). However, a clear understanding of the factors driving international equity returns is required to take full advantage of the diversification opportunities afforded by international portfolios. This paper takes an investor's perspective to assess the relative importance of industry and country factors as determinants of equity returns in the Euro area over the 1990 to 2003 period.

Lessard (1974) was the first to study the influence of industry factors on national equity returns. Today, more than 30 years later, the country-industry debate carries on vividly. Traditionally, country factors have been considered to be the dominant driving forces for international equity returns (amongst others, Grinold, Rudd and Stefek 1989, Heston and Rouwenhorst 1994, Griffin and Karolyi 1998, Brooks and del Negro 2004, Bekaert, Hodrick and Zhang 2005). Nevertheless, a number of papers suggest the increasing importance of industry factors (Roll 1992, Baca, Garbe and Weiss 2000, Cavaglia, Brightman and Aked 2000, Isakov and Sonney 2004, Carrieri, Errunza and Sarkissian 2004b, Baele and Inghelbrecht 2005).

The introduction of the Euro in 1999 has sparked further re-examination of the relative importance of country and industry factors. Due to the strong regional impact of the monetary and economic convergence process that preceded and accompanied the transition to the single currency, the current evidence on the relative importance of industry and country factors extracted from global markets is difficult to extrapolate to the markets of the European Monetary Union (EMU). The Euro launch has effectively eliminated intra-Euro-zone currency risk. Moreover, the foreign exchange rate risk exposure of Euro-zone countries has decreased (Bartram and Karolyi 2006). De Santis and Gerard (1998) show that currency risk premiums are large and economically significant. Different exchange rate exposures across countries lead to varying currency risk premiums, and may result in lower cross-country correlations. Conversely, the elimination of currency risk in the EMU may induce higher correlations between Euro-countries, and potentially reduce the benefits of cross-country diversification. Indeed, Adjaouté and Danthine (2001) document a significant increase in cross-country correlations within the Euro-zone. Bartram and Karolyi (2006) also report a decrease in the exposure of Euro-zone equity returns to country-specific factors related to the decrease in currency risk exposure. A consequence of the introduction of the Euro and the EMU convergence process is that Euro-zone markets have become highly integrated (see, for instance, Fratzscher 2002, Hartmann, Maddaloni and Manganelli 2003, Baele et al. 2004, Hardouvelis, Malliaropulos and Priestley 2006). More integrated markets imply that country-specific factors become less important relative to common market factors. We postulate that the high level of integration of Euro-zone equity markets due to the economic convergence leading to the adoption of the single currency may have led to a decrease in the importance of country factors.

So far, the relative importance of country and industry factors in the Euro-zone is still an open question, as recent studies remain inconclusive. Some papers find an increasing importance of industry factors in the Euro-zone (Ferreira and Ferreira 2005, Adjaouté and Danthine 2003), while others find evidence in favour of the continuing dominance of country factors (Rouwenhorst 1999, Ehling and Ramos 2005). On the other hand, in practice the Euro has induced a radical revision of the asset allocation process of many EMU-area fund managers. A survey by Goldman Sachs/Watson Wyatt (1998)[1] suggests that over 60% of fund managers have switched their allocation strategy from country- to industry-based.

We re-examine this issue purely from an investor's perspective by comparing the performance of industry- and country-based portfolios. Our approach differs from the two methods commonly used to compare country and industry factors. First, many papers use the methodology first proposed by Heston and Rouwenhorst (1994) and subsequently modified by Griffin and Karolyi (1998). However, this approach assumes a unit exposure to the global market shock for all assets, while the literature provides evidence that market betas are time-varying (see, for instance, Bekaert and Harvey 1997 and Ng 2000). Assuming unit betas may bias the comparison of country and industry factors (Baele and Inghelbrecht 2005). Second, a number of papers compare country and industry factors by comparing the levels of correlations between country portfolios and industry portfolios. However, investment opportunities depend both on correlations and on risk-return characteristics and hence all of these features must be taken into account when comparing country and industry portfolio returns.

We conduct our investigation of the relative importance of country and industry factors by evaluating the performance of country- and industry-based portfolios using two complementary methodologies: mean-variance efficiency tests and style analysis. In a first stage, we use mean-variance spanning tests to investigate whether adding Euro-wide industry portfolios would significantly enhance the risk-return trade-off of country-based portfolios and conversely. Using a test developed by Gerard, Hillion, De Roon and Eiling (2006), we directly compare cross-country to cross-industry diversification by testing the difference in maximum Sharpe ratios. As mean-variance efficient portfolios for a particular sample may often yield extreme long or short positions, we focus on efficiency tests with short sales

[1] http://www.watsonwyatt.com/europe/pubs/investment/articles/1998_08_05.asp, visited on 16-02-04

constraints[2]. In a second stage, we run a style analysis to examine whether it is easier to replicate the variation of Euro-wide industry portfolio returns with country equity indices or country index returns with Euro-wide industry portfolios. In essence, we investigate whether the volatility of the countries' market returns is due solely to their industry composition and vice versa. In contrast to spanning and efficiency tests, which are a function of the estimates of both means and covariances of asset returns, style analysis focuses on the returns covariance structure, which can be estimated more accurately than mean returns. To assess pure country and industry effects, we repeat all our tests excluding overlapping components from the benchmark indices[3].

We conduct our investigation using monthly returns from March 1990 to August 2003 for all 11 country that have adopted the single currency and 10 Euro-wide industry indices. We find that country- and industry-based portfolios are indistinguishable in terms of mean-variance efficiency.[4] First, countries span Euro-wide industries and vice versa. Second, optimal portfolios constructed from either country indices or Euro-wide industry portfolios yield indistinguishable Sharpe ratios. This holds over the full sample period, for the sub-samples corresponding to the pre-convergence period, from 1990 to 1994, the convergence period, from 1995 to 1998 and the post-Euro period, from 1999 to 2003 as well as for all 60-month rolling windows. However, style analysis uncovers remarkable differences in relative country and industry performance. Prior to 2000, country composition accounts for a significantly larger fraction of industry volatility than vice versa. In contrast, after 2000 it is considerably more difficult to replicate the return volatility of Euro-wide industry portfolio with country benchmarks. This pattern is strengthened when the assets included in the portfolio being replicated are excluded from the benchmark indices.

Our results suggest a shift in the structure of Euro-zone equity returns that coincides with the introduction of the Euro. We find that whereas in the beginning of the 90s individual country returns were more volatile but less correlated than industry returns, the opposite holds following the adoption of the single currency. Furthermore, while Euro-zone wide country- and industry-based portfolios are equally mean-variance efficient throughout our sample period, after the Euro launch industry portfolios can better replicate country returns than vice

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[2] See Jagannathan and Ma (2003) for the importance of no-short sales constraints to reduce the risk in estimated optimal portfolios.

[3] Based on a similar argument Rouwenhorst (1999) computes the correlation of a country (industry) with the European market index excluding that country (industry).

[4] Ehling and Ramos (2005) also compare Euro-zone country and industry based portfolios in terms of mean variance efficiency and document an outperformance of country portfolios. However, they employ the Basak, Jagannathan and Sun (2002) approach by testing the mean variance efficiency of the optimal country (industry) portfolio with respect to a possibly suboptimal industry (country) portfolio that is restricted to have the same mean return. Often this restriction cannot be met. In contrast, we test the mean variance efficiency of the optimal country portfolio with respect to the optimal industry portfolio.

versa. The style analysis also shows that while the level of country return volatility unrelated to its industry composition (i.e. the country idiosyncratic risk) has remained relatively stable over time, while, in contrast, Euro-wide industry idiosyncratic risk has more than doubled from 1990 to 2003. This suggests an increasing relative importance of industry factors. We discuss how the increasing idiosyncratic risk and improving replicating abilities of the Euro-wide industry portfolios could be explained by the increased level of integration of the Euro-zone equity markets induced by the EMU convergence process.

The large increase in Euro-wide industry idiosyncratic risk has substantially enhanced the benefits from holding a portfolio optimally diversified across industries within the Euro-zone rather than a single Euro-zone industry portfolio. During the second half of the 1990s an optimally diversified industry portfolio with volatility equal to the average industry volatility returns 5.2% more per annum than the average industry. After the introduction of the single currency this increases to 9.7% per year. In contrast, the benefits in terms of risk-adjusted returns from optimally diversifying across EMU countries have decreased slightly from 5.8% to 5.1% per annum over the same periods. These results emphasize that the gains from international diversification remain highly significant, even within a group of closely linked economies like the Euro-zone. Furthermore, our results show that investing in a single Euro-wide industry has become considerably more risky over the last decade, and provides little of the benefits that international diversification has to offer: not only should investors get out of one country, they should also diversify out of a single Euro-wide industry portfolio.

Our findings are robust to many potential confounding events. First, we conduct ‘pseudo style regressions’ where the actual index weights of local industries are used as time-varying and observable regression coefficients. These pseudo replicating portfolios truly represent trading strategies and do not suffer from estimation error. The pseudo style regressions confirm our results. Furthermore, our results are unchanged when we control for the internet hype, for the intra Euro-zone currency risk prior to 1999 and when we use different lengths of rolling windows. In addition, we adjust the spanning tests and style analysis for changes in aggregate volatility and we find that our results are strengthened. Finally, we confirm our findings for a subset of the countries over an extended sample period starting in February 1975.

The remainder of the paper is organized as follows. Section 2 discusses the methodology. Section 3 describes the data. We report and discuss our main results in section 4. Section 5 discusses the implications of our results in terms of risk and benefits of cross-border or cross-industry diversification and the impact of the EMU convergence process. Section 6 reports the results of a battery of robustness checks. Section 7 concludes.

2 Methodology

We conduct our analysis of country and Euro-wide industry portfolio returns using two complimentary methodologies, efficiency tests and style analysis. Throughout, countries will be denoted by *x* and industries by *y*. We consider *K* countries, *N* industries and *T* observations. In total we have *K*N* country/industry indices (e.g. resources in France), which we refer to as sub-indices and which constitute our base assets. We construct value-weighted Euro-wide industry portfolios by aggregating industry sub-indices across countries. Similarly, country portfolios are constructed by aggregating the value-weighted sub-indices of the particular country across industries. Country and Euro-wide industry indices are all based on the same universe of sub-indices. Hence a portfolio of all country indices comprises the same base assets as all regional industry indices combined. This allows us to directly compare the benefits of using Euro-wide industries or countries as intermediate portfolio construction blocks. However, by construction, each country and Euro-wide industry portfolio pair includes one common sub-index. These common components could be the main source of the covariance between industry and country portfolios. To assess the extent to which co-movements between aggregate portfolios are due to these common components, we reconstruct for each Euro-wide industry portfolio its country benchmarks excluding that industry sub-index, and we do the same for the Euro-wide industry benchmarks used for each country portfolio.

2.1 Efficiency tests

One of the first issues an investor in equities of EMU-countries has to address is whether she should invest in Euro-wide industries, in countries or in both. Or should she select a Euro-zone portfolio manager that focuses on cross-industry diversification rather than cross-country diversification?

In a mean-variance setting, these questions can be reformulated using the Jensen measure (Jensen 1968, Huberman and Kandel 1987). The Jensen measure can be computed by the following regressions:

$$r_t^x = a_x + B_x r_t^y + \varepsilon_t^x \tag{1a}$$

$$r_t^y = a_y + B_y r_t^x + \varepsilon_t^y \tag{1b}$$

r_t^x is a K-dimensional vector of excess returns from time *t-1* to time *t* on the *K* country indices. Similarly, r_t^y is an N-dimensional vector of excess returns on the *N* industry indices and *a* is the vector of Jensen measures. The Jensen measures in (1a) and (1b) are *K*- and *N*-dimensional vectors respectively. Equation (1a) considers whether an original set of industry benchmark assets should be extended by a set of country test assets. If the Jensen measures of the test assets are significantly different from zero, the portfolio of benchmark assets alone is inefficient relative to portfolios combining benchmark and test assets. A zero Jensen measure supports mean-variance spanning: the mean-variance frontier remains unchanged when adding the test assets to the benchmark assets. Investing only in the benchmark assets is sufficient to yield the optimal risk return trade-off.

To test whether the Jensen measures for a set of test assets are jointly equal to zero (i.e. there is mean-variance spanning), we use a Wald test. The null hypothesis of mean-variance spanning (for equation (1a)) is the following:

$$H_0 : \mu_x - B_x \mu_y = 0$$

where μ_x (μ_y) is the expected excess return on the country (industry) index. Notice that since we use excess returns we do not have to impose constraints on the coefficients B_x. For the test statistic we consider the covariance matrix of the Jensen measures that takes the correlations between the error terms of the different regressions into account. We also allow for heteroskedasticity within regressions by using White standard errors. Under the null hypothesis of mean-variance spanning the test statistic for equation (1a) is χ_K^2 -distributed and for equation (1b) it is χ_N^2-distributed.

The Euro-wide industry portfolios and country indices are constructed from the same investment universe, implying that they have common components. A country index consists of all industries in that country and a Euro-wide industry portfolio includes stocks in that industry from all countries. Thus, a positive (negative) Jensen measure implies that the test assets are underweighted (over weighted) with respect to the benchmark portfolios, and that the out- (under-) performance of the test assets that can be exploited by increasing (decreasing) weight of the test assets.

To distinguish pure country and pure industry effects, we compute the Jensen measures after removing from each benchmark portfolio the components it has in common with the test asset. For example, if the French country index is the test asset, all French components are excluded from the Euro-wide industry benchmarks. The regressions for country *i* and for industry *j* are as follows:

$$r_{i,t}^{x} = \alpha_i + \sum_{j=1}^{N} \beta_{ij} r_{j,t}^{y \backslash i} + \varepsilon_{i,t}^{x} \qquad (2a)$$

$$r_{j,t}^{y} = \alpha_j + \sum_{i=1}^{K} \beta_{ji} r_{i,t}^{x \backslash j} + \varepsilon_{j,t}^{y} \qquad (2b)$$

where $r_{j,t}^{y\backslash i}$ ($r_{i,t}^{x\backslash j}$) is the excess return from time *t-1* to *t* on the j^{th} Euro-wide industry portfolio (country *i*) from which country *i* (industry *j*) components have been excluded. When α_i is significantly different from zero, a portfolio of industries that exclude the components of country *i* should be extended with the index of country *i* in order to obtain mean-variance efficiency. Since test and benchmark assets have no common components, a positive (negative) Jensen measure indicates that the benchmark asset risk return trade-off can be enhanced by taking a long (short) position in the test asset[5].

In practice, taking short positions may not be possible. Moreover, tangency portfolios computed on the basis of given samples historical mean returns and covariance matrix often yield extreme long and short positions (e.g. Jagannathan and Ma, 2003). To address this issue, we focus primarily on spanning tests with no short sales constraints on both the test assets and the benchmark assets. This implies that only those benchmark assets with positive weights in the tangency portfolio are considered. Additionally, under the null hypothesis of mean-variance spanning the vector of Jensen's alphas is smaller than or equal to zero. The test statistic follows a mixture of χ^2 –distributions (De Roon, Nijman and Werker 2001).[6]

The spanning tests described so far compare a portfolio consisting of countries (or industries) to a portfolio consisting of countries and industries. In order to directly compare the performance of countries versus industries, we adopt the approach of Gerard, Hillion, De Roon and Eiling (2006). We test whether the maximum Sharpe ratio of industry-based portfolios equals that of country-based portfolios. In that case country and industry portfolios are equally efficient. The maximum Sharpe ratios of the countries and the industries are denoted by θ_x and θ_y respectively. θ is the maximum Sharpe ratio of the joint set of countries and industries. Using the relationship between the maximum Sharpe ratios and the Jensen measures (Gibbons, Ross and Shanken 1989)

$$\theta^2 - \theta_x^2 = a_y'\Omega_{yy}^{-1}a_y \tag{3a}$$

$$\theta^2 - \theta_y^2 = a_x'\Omega_{xx}^{-1}a_x \tag{3b}$$

we can write the difference between the Sharpe ratios as follows:

$$\lambda = \theta_y^2 - \theta_x^2 = a_y'\Omega_{yy}^{-1}a_y - a_x'\Omega_{xx}^{-1}a_x \tag{4}$$

where Ω_{ii} is the covariance matrix of ε_i in (1a) and (1b). Hence the null hypothesis that industry and country portfolios are equally efficient comes down to H_0: λ=0. This equality can be tested using weighted least squares regressions.

$$\Omega_{xx}^{-1/2}r_t^x = c_x + D_x r_t^y + u_t^x \tag{5a}$$

$$\Omega_{yy}^{-1/2}r_t^y = c_y + D_y r_t^x + u_t^y \tag{5b}$$

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[5] When the benchmark assets exclude the overlapping components with each test asset, the test of whether all Jensen measures are jointly equal to zero is not a traditional spanning test (e.g. Huberman and Kandel 1987), as each test asset has a different set of benchmark assets.
[6] We can only impose short sales constraints when using indices excluding overlapping components. In that case a negative Jensen measure implies that a short position should be taken in the test asset. When the full indices are used it merely implies that the benchmark assets are overweighed with respect to the test asset.

The dependent variables from equations (1a) and (1b) are multiplied with $\Omega_{xx}^{-1/2}$ and $\Omega_{yy}^{-1/2}$ respectively. The constant terms are given by the same linear transformation:

$$c_x = \Omega_{xx}^{-1/2} a_x \qquad (6a)$$

$$c_y = \Omega_{yy}^{-1/2} a_y \qquad (6b)$$

Thus, the null hypothesis is equivalent to:

$$H_0 : \lambda = c_y' c_y - c_x' c_x = 0 \qquad (7)$$

The Wald test statistic of this nonlinear constraint will be asymptotically χ_1^2-distributed. Gerard, Hillion, De Roon and Eiling (2006) describe how to construct consistent estimates of the covariance matrices Ω_{ii} taking into account that both covariance matrices are estimated with error and that these errors are correlated. Thus, this test allows us to compare directly the mean-variance efficiency of the country optimal portfolio and that of the industry optimal portfolio. As in-sample maximum Sharpe ratios portfolios often include extreme long or short positions, in this case as well, we focus on maximum Sharpe ratios portfolios under the no short sales constraint (see De Roon, Nijman and Werker 2001).

2.2 Style analysis

The second approach that we use to compare country and industry portfolios is returns based style analysis (Sharpe 1992). In style analysis one identifies the passive portfolio long in the benchmark assets whose returns most closely track the returns of the tests asset, and computes the fraction of the test asset return volatility that can be accounted for by its mimicking style portfolio. Hence style analysis considers the following question: to what extend is the time series volatility of country returns accounted for by their industry mimicking portfolios or is there a large fraction of that volatility that is country-specific and unrelated to industry structure? And what is the fraction of Euro-wide industry returns that is industry specific and unrelated to their country composition? Whereas our first methodology compares mean-variance efficiency and depends on the estimation of both the mean and covariance of returns, style analysis focuses on covariance structures only. This is a clear advantage of style analysis as the estimates of covariances are more accurate than those of means. A typical style regression is specified as follows:

$$R_{test} = a_{test} + b_1 R_{benchmark_1} + b_2 R_{benchmark_2} + ... + b_n R_{benchmark_n} + e_{test}$$

The coefficients of the benchmark assets represent the style of the test asset (Sharpe 1992), and they are the weights of the benchmark assets in the portfolio whose returns characteristics most closely replicate those of the test asset. These coefficients are constrained to be nonnegative and to sum to one. Unlike the efficiency tests, we base our style analysis on total returns R_t rather than excess returns r_t. The weights of the benchmark assets are chosen such that the variance of the error term e_{test} (i.e., the tracking error) is minimized. In the style analysis, we define performance by considering the portion of the test asset's variance that can be explained by the replicating portfolio of benchmark assets. We will refer to this as the mimicking ability of the benchmarks. The mimicking ability of the countries as benchmark assets is measured by the weighted average R^2 of all style regressions for which Euro-wide industry portfolios are the test assets. The weights of the average R^2 are determined by the average index weights of the industries in the Euro-wide index. Similarly, industry performance is measured by the weighted average R^2 of the style regressions taking the countries as test assets and the industries as benchmarks.

The style regression for the country (test assets) styles in terms of industries (benchmark assets) is specified as follows:

$$R_{i,t}^{x} = \alpha_i + \sum_{j=1}^{N} \beta_{ij} R_{j,t}^{y} + \varepsilon_{i,t}^{x} \tag{8}$$

s.t. $\sum_{j=1}^{N} \beta_{ij} = 1$ and $\beta_{ij} \geq 0,\ j = 1,....,N$

where $R_{i,t}^{x}$ ($R_{j,t}^{y}$) is the return on country *i* (industry *j*) portfolio from time *t-1* to time *t*. The specification of the style regression for industries in terms of countries is similar.

The weight of the benchmarks in the replicating portfolio may be driven by the assets common to the test and benchmark portfolios. Therefore, for each test asset, we exclude the overlapping components from its benchmark assets and implement what we term the 'exclusive' style analysis. This allows us to examine the pure country and pure industry effects. It implies that the different test assets now have different benchmark indices. The 'exclusive' style regressions are given by the following equations:

$$R_{i,t}^{x} = \alpha_i + \sum_{j=1}^{N} \beta_{ij} R_{j,t}^{y\setminus i} + \varepsilon_{i,t}^{x} \tag{9a}$$

$$R_{j,t}^{y} = \alpha_j + \sum_{i=1}^{K} \beta_{ji} R_{i,t}^{x\setminus j} + \varepsilon_{j,t}^{y} \tag{9b}$$

Here, $R_{j.t}^{y\setminus i}$ ($R_{i,t}^{x\setminus j}$) is the return on the index of industry *j* (country *i*) excluding country *i* (industry *j*) from that index. The style regressions of equation (8) (based on full indices) are referred to as 'simple' style analysis.

We measure the relative performance of country and euro-wide industry portfolios in terms of mean-variance spanning, maximum Sharpe ratios and for the style analysis, in terms of the fraction of the test assets' volatility explained by a mimicking portfolio of benchmark assets. While formal tests of spanning or of differences in Sharpe ratios exist, the literature does not provide formal tests of whether average style regression R^2s differ across different sets of benchmark assets or over time. To evaluate the statistical significance of changes in R^2s we use a Monte Carlo approach to simulate the empirical distributions of the average R^2s of the style regressions. More specifically, we test the difference between the average R^2s of the style regressions taking countries as benchmarks and taking industries as benchmarks. This test is performed for the full sample as well as for the sub-samples. The details of these Monte Carlo simulations can be found in appendix A.

3 Data

We use monthly returns on ten EMU-zone industry indices and eleven country indices from March 1990 to August 2003, a total of 162 observations. The country/ industry sub-indices returns and market values are provided by Datastream. We use total return indices with dividends reinvested. From the twelve Euro-countries, we exclude Luxembourg because a large fraction of its equity flows (and hence its equity returns) is tax motivated.

We perform our analysis over the full sample period, which runs from March 1990 to August 2003. This sample covers a period preceding the decision to adopt a single currency as well as the convergence period and the period in which the Euro has been in use. To examine the effect of the Euro adoption process on our tests, we repeat the tests for three separate sub-samples that cover different phases of the EMU convergence process. The pre-convergence sub-sample covers the period from March 1990 to November 1994 and ends before January 1st, 1995, the date when the Maastricht Treaty entered in vigor. The convergence sub-sample runs from January 1995 to November 1998. It ends before the introduction of the Euro. The Euro sub-sample covers the period from January 1999 to August 2003. All three sub-samples have comparable sizes (57, 47 and 56 observations). To further investigate how our results change over time and how they are affected by the choice of sub-sample periods, we also perform a 60-month rolling window analysis.

Table 1 displays summary statistics over the full sample period for the monthly returns on the country portfolios (panel A) and on the industry indices (panel B) as well as the one month Euro-Mark deposit rate, which we use as the risk free rate (panel C). The average market value weights of the countries and industries in the Euro-wide market index are also reported. The country with the highest mean return is Finland. Its mean return is 18.7% per annum, while the average over all other countries is 10.4% per year. However, the Finnish index performance mostly reflects the performance of Nokia and the IT industry, as Nokia accounts for more than 50% of the index capitalization[7]. The null hypothesis that all mean country returns are zero cannot be rejected, while it is rejected at a 5% significance level for the industries that have on average a slightly higher annual mean return of 11.4%. The

[7] Note that in the exclusive analysis we will remove overlapping components between country and industry indices. We also exclude the IT sector as a whole as a robustness check.

industry with the highest mean return of 20.4% per year is IT. The null hypothesis that all mean returns are equal cannot be rejected for either countries or industries.

Among all industries, the financial sector has the largest capitalization and accounts for 29% of the Euro-wide market index. Not surprisingly since that they are the two main economies of the Euro-zone, Germany and France constitute more than half of the Euro-wide market index[8]. The industry weights in country indices[9] are similar to industry weights in the Euro-wide index. Similar results hold for country weights in Euro-wide industry indices.

Industry returns exhibit lower average volatility than country returns. However, cross-industry correlations on average exceed cross-country correlations (0.67 versus 0.57). This suggests more diversification benefits from cross-country diversification. However, the difference in correlations is small and the average is based on the full sample period. Therefore this correlation structure gives us limited insights into the relative importance of country and industry factors for international equity returns and their changes over time.

To analyze changes over time, we compute summary statistics for the three sub-samples as well as for 60-month rolling windows. These results are reported in panel D of table 1 and in figure 1 respectively. The summary statistics are computed for all individual countries and industries. For the three sub-samples we compute equally weighted averages over all countries and industries. For each rolling window a weighted average over all countries and over all industries is calculated, where the weights are the average weights of the countries and industries in the Euro-wide index during that particular window. For brevity we discuss the rolling window results in more detail.

Mean returns follow an inverted U-shaped pattern (these results are not reported in the paper). In the early windows the cross-section average mean monthly returns of industry and country indices are on average approximately 5%. They increase to a level of about 25% in windows that run from 1995 to 2000. In the later period, the mean returns decrease. In the last windows they are close to zero or even negative. The value-weighted averages of the mean country and industry returns are very close, which is due to index construction. Figure 1 shows weighted average volatilities and correlations for 60-month rolling windows. In all rolling windows the x-value is the ending date of the 60 month subsample under consideration In windows that end before February 2000, individual country returns are on average more volatile but also less correlated than industry returns. Then, both industry and country volatilities increase, although average industry volatility increases more steeply. Over the same period, cross-country correlations increase while cross-industry correlations

[8] While we use a value-weighted average of all style regression R^2s (which is influenced by the large weights of Germany and France), we also calculate equally weighted average R^2s as a robustness check.

[9] These results and all other auxiliary results that are discussed later in the paper but not included for the sake of brevity are available at http://papers.ssrn.com/sol3/cf_dev/AbsByAuth.cfm?per_id=350036.

decrease. As a result, in windows ending after February 2000 industry returns are more volatile than country returns but they are also less correlated.[10] Although the rolling window analysis of mean returns, volatilities and correlations suggests changes in the structure of equity returns in the Euro-zone, more formal tests are needed to assess the relative importance of country and industry factors.

4 Results

4.1 Efficiency tests

We first compare country- and regional industry-based portfolios in terms of mean-variance efficiency. We perform three kinds of efficiency tests. First, we consider the individual Jensen measures of country test assets relative to industry benchmarks and conversely. Subsequently we conduct multivariate spanning tests. These tests are performed for the full indices and the indices excluding overlapping components. For the latter, we also perform spanning tests with short sales constraints on both the benchmark and test assets. Additionally, country versus industry performance is compared by testing the difference in maximum Sharpe ratios, with and without short sales constraints. As in sample mean-variance efficient portfolios often yield extreme long or short positions, we focus primarily on the results when no short sales constraints are imposed.

4.1.1 Full sample efficiency tests

Table 2 shows the results of the efficiency tests. Panel A presents the individual Jensen measures based on the full sample period. All countries and industries have insignificant Jensen measures. This implies that adding individual industries to the investment set of country portfolios does not improve mean-variance efficiency. Similarly, the set of industry portfolios is already mean-variance efficient and individual country returns do not have to be added. When country or industry components have been removed from the benchmark assets, only the industry noncyclical consumer goods (NCGD) significantly outperforms the country indices at a 10% significance level. Next we perform multivariate spanning tests. The results are presented in panel B. We find that industries are not spanned by countries when short sales are allowed (both for full benchmark indices and for benchmark indices excluding overlapping components) suggesting that investing in country portfolios alone is inefficient and the investor should add industry portfolios to his investment set. However, when short sales are restricted the industry out-performance disappears and we cannot reject the spanning hypothesis. Industries span countries in all tests. Thus, with short sales constraints countries

[10] We also considered equally weighted averages. The results remain unchanged.

are spanned by industries and vice versa. In other words, it is sufficient to invest in country portfolios or in Euro-wide industry indices only. When short sales are allowed, the annualized industry Sharpe ratio of 1.07 exceeds the country Sharpe ratio of 0.83. They decrease to 0.58 and 0.44 respectively when short positions are restricted. So both with and without short sales constraints, industries have a higher maximum Sharpe ratio than countries. However, in both cases the difference is statistically insignificant. In summary, based on the full sample both the spanning tests and the Sharpe ratios suggest that country- and industry-based portfolios are equally efficient.

4.1.2 Sub-sample efficiency tests

So far, our analysis is based on the full sample period, from March 1990 to August 2003. However, EMU-zone financial markets went through several structural changes over that period, such as the adoption of the Maastricht treaty and the introduction of the Euro. Using data from the whole sample may obscure the impact of these changes on our tests. Therefore, we repeat the analysis for three different sub-samples: a pre-convergence period, a convergence period and a Euro period.

The results of the sub-period spanning and Sharpe ratios tests are presented in panel B of table 2. With short sales constraints, industries span countries and countries span industries in all three sub-samples. When short sales are not restricted, this is the case as well, except in the convergence period, when neither full industry or country indices span the others. The tests of the differences in maximum Sharpe ratios convey a similar message and the differences remain insignificant for all sub-periods, with or without short sales restrictions.

Hence, as over the full sample, the results show that countries and industries are equally efficient in each sub-period. It is sufficient to invest in either country-based or in industry-based portfolios.

4.1.3 Rolling window efficiency tests

The sub-period analysis may be affected by the dating of the sub-samples. Therefore we also perform a 60-month rolling window analysis to examine the changes over time of the relative mean-variance efficiency of industry- and country-based portfolios.

Figure 2 plots the *p*-values of the null hypothesis of mean-variance spanning. We use indices excluding overlapping components and we impose short sales constraints on both the test assets and the benchmark assets. If the *p*-values fall below the horizontal line at 0.05, mean-variance spanning is rejected at a 5% level. When we examine the time series of *p*-values we find that spanning is rejected for industries in only 5 windows out of the 103 windows, all ending in 2000. In all other windows spanning cannot be rejected. When short sales are unrestricted, spanning is rejected for industries and countries in a large number of windows ending before 2002. However, at the end of the sample period we cannot reject the null hypotheses that countries are spanned by industries and vice versa.

Figure 3 plots the annualized maximum Sharpe ratios with short sales constraints. The maximum Sharpe ratios of countries and industries are very close during most of the period. They start at about 0.25, increase to 2 halfway through the 1990s, and decrease to about 0.25 again by the end of the sample period. While the rolling window spanning tests reported industry out-performance in some windows ending in 2000, the difference in Sharpe ratios is insignificant for all windows. When short sales are unrestricted, the Sharpe ratios are indistinguishable in all but two windows.

Hence, direct comparison of the performance of country or industry based portfolios does not allow us to detect any significant differences: both approaches to portfolio construction seem equally efficient throughout the whole sample period.

4.2 Style analysis

We use style analysis as a complementary methodology to assess the relative importance of country and industry factors. In contrast to the efficiency tests, style analysis focuses mostly on the covariance structure of country and industry returns. The set of assets that can best replicate the style of the other set (i.e. that has the best mimicking abilities) is considered to show superior performance. The mimicking abilities of the benchmark assets are measured by the weighted average R^2 where the weights are determined by the average index weights of the countries and industries in the Euro-wide index. We test the significance of the differences in average R^2s by simulating the empirical distributions. The style regressions are performed for full benchmark indices ('simple' style analysis) and for benchmark indices that exclude overlapping components with test assets ('exclusive' style analysis).

4.2.1 Full sample style analysis

The estimated coefficients and the R^2s of the individual style regressions are displayed in table 3 and weighted average R^2s in table 4. In table 3, the columns 'Norm.' report the coefficients of the simple style regressions, while the columns 'Excl.' report the coefficients of the exclusive analysis. We first discuss the weights of the replicating portfolios and then examine the mimicking abilities of the benchmarks.

By comparing the coefficients of the simple and the exclusive style analyses, we can infer whether a certain benchmark has a large weight in the replicating portfolio because of large overlapping components with the test asset or because its ability to mimic it. Indeed, we find that in some cases high coefficients disappear after the elimination of overlapping elements, whereas in other cases the weights remain high. For instance, the results displayed in table 3, panel A show that in the simple style analysis the Financial industry portfolio generally receives high weight in the replicating portfolios for individual countries. In the exclusive style analysis, when the country test asset is removed from the benchmark industry indices, the coefficients of the Financial industry remain high. Hence Financials are important for mimicking country portfolios. Germany and France, the two main economies in our sample, are important elements of the replicating portfolios for most industries, as can be seen in panel B. Conversely, the weight of Information Technology in the mimicking portfolio of Finland drops from 71% to 23% after the exclusion of the Finnish components. The difference is even more pronounced for the Dutch index as a benchmark for Resources. In the simple style analysis it forms 58% of the replicating portfolio, while without its Resources component it is no longer part of the replicating portfolio for that industry.

Overall, the coefficients seem not to be affected much by the exclusion of test asset-specific components from the benchmarks. To shed some light on this, we compute the Spearman rank correlation between the coefficients of the simple style regressions and those of the exclusive style regressions. These are presented in the last rows of panels A and B. The rank correlation shows the level of association between the two sets of coefficients. A large positive association implies that the elimination of the overlapping components has not affected the relative importance of the benchmark indices to a great extend. Indeed, we see that for many countries (Italy is the main exception) and for all industries the rank correlations are significant and positive.

We evaluate country and industry performance by considering the weighted average R^2s over all (country- or industry-) test assets, which are reported in table 4. When country styles are replicated by industry benchmarks, the average R^2 is 0.82. Replicating industry styles in terms of country benchmarks leads to an average R^2 of 0.77. After removal of overlapping components, the average R^2s both decrease (by 10% and 8% respectively), as it is more difficult to mimic a test asset if the benchmark indices do not contain any common asset with that test portfolio. Both analyses show that industry benchmark portfolios can explain a larger fraction of country variance than vice versa. Next, we test whether the difference in average R^2s is significant. Appendix A describes how the empirical distributions of the average R^2s of the style regressions are simulated. Both for the simple and the exclusive style regressions the difference in average R^2 is insignificant, as shown by the *p*-values of 0.620 and 0.825. This implies that the mimicking abilities of countries and industries over the full sample period are not significantly different. As with the efficiency tests, countries and industries show similar performance over the full sample period.

4.2.2 Sub-sample style analysis

We repeat the style analysis on the three sub-samples corresponding to the different phases of the EMU convergence process. In order to test whether an out-performance is significant, the empirical distributions of the differences in average R^2s in the three sub-samples are simulated. We allow for changes in covariances over time by estimating different distributions for the three periods.

The results for the pre-convergence, convergence and Euro periods are presented in table 4. We can now detect clear differences between the sub-samples. The simple style analysis results in an average R^2 of 0.80 of the country styles in terms of industries in the pre-convergence period. The style regressions for industry styles in terms of country benchmarks result in an average R^2 is 0.89. This indicates an out-performance of countries in the first period. The difference in average R^2s is significant as is shown by the *p*-value of 0.001. In the convergence period countries slightly outperform industries: the average R^2 is 0.84 when industries are the benchmark assets and 0.85 when countries are the benchmark assets. This difference is insignificant, both economically and statistically. Finally, in the Euro period industries outperform countries. The average R^2 taking industries as benchmark assets is 0.88 and it is 0.74 when countries are the benchmark assets. Even though the difference is large, it is statistically insignificant (the *p*-value is 0.246). The exclusive style analysis yields lower levels of average R^2 but displays similar patterns.

4.2.3 Rolling window style analysis

We conduct 60-month rolling window style analyses to investigate further how the replicating abilities of countries and industries change over time. Figures 4.A and 5 display the time series of weighted average R^2 for the simple and exclusive style analysis respectively. The weights depend on the average index weights of the test assets in the Euro-wide index during the estimation window.

In the first half of the sample, industry styles can be replicated more closely with country portfolios than country styles with Euro-wide industries. The average R^2s are 0.87 and 0.80 when using the countries and industries respectively as benchmark assets. In the second half of the sample, the situation is completely reversed. The regressions for country styles in terms of industry benchmarks yield an average R^2 of 0.88, which is about 14 percentage points above that of the industry styles in terms of country benchmarks. The exclusive style analysis yields similar results, although the averages R^2s are lower and the differences in mimicking abilities are somewhat larger[11]. The reversal in the mimicking

[11] At the beginning of the sample period, the style regressions average R^2 was about 0.82 when replicating industries with a portfolio of country indices and 0.60 when replicating countries with

performance ranking of industry and country portfolios occurs in both figures around the same time period, after the introduction to the Euro on January 1st 1999. It occurs in the window ending in June 1999 for the simple style analysis and in the window ending in February 2000, for the exclusive style analysis. In both cases there is only one point where the lines of the R^2s cross. This suggests that prior to the introduction of the single currency, countries have better mimicking abilities than industries, while the opposite is true after the adoption of the Euro.

5 Discussion

So far, the evidence suggests that on one hand, country- and industry-based portfolios exhibited similar mean-variance efficiency over the past 13 years, while, on the other hand, the structure of Euro-zone equity returns changed significantly over the same period. Whereas in the early 1990s country returns were more volatile, less correlated and possessed superior mimicking abilities compared to industry returns, the data suggests the opposite is true in the late 1990s and early 21st century.[12] Thus, for mean-variance investors country- and industry-based strategies have comparable performance before and after the introduction of the Euro. However, for investors with alternative objectives, performance criterions and constraints, the evidence suggests that optimal strategies were more likely to be country based prior to the introduction of the Euro and industry-based afterwards. In this section we examine these results in more detail by investigating the riskiness of country and industry portfolios. Next, we quantify the gains derived from alternative international diversification strategies. Last we discuss to what extent our findings may be influenced by the Euro launch and the EMU convergence process.

5.1 Idiosyncratic risk

The two approaches we use to compare country and industry performance lead to seemingly contradictory results. The key to clarify this paradox is idiosyncratic risk. The standard error of the style regressions can be interpreted as the test asset idiosyncratic volatility with respect to its mimicking style portfolio of benchmark assets. Panel B of figure 4 shows the weighted average standard errors of the style regressions (where the weights are the average country

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industries. At the end of the sample, the average R^2 was about 0.65 when replicating industries with countries and 0.85 when replicating countries with industries.

[12] Interestingly, figures 1, 4 and 5 exhibit a clear turning point: average volatilities, correlations and standard errors shift in 5-year windows that end at the beginning of 2000. Thus, the change in the structure of equity returns occurs in the period that include four years preceding the introduction of the Euro and one year following it. To assess whether the weighting of the components of the averages influences the dating of the reversal, we also compute equally weighted averages. We again find a clear turning point. However, the windows in which the reversal occurs now end in the last months of 2002 and in early 2003.

and industry index weights in the Euro-wide market index). The plot shows that, for country portfolios, the volatility of the component of country returns orthogonal to their industry mimicking portfolio has remained relatively stable over time. In contrast, the plot highlights the dramatic increase of industry idiosyncratic risk, which has more than doubled over the last 13 years. This suggests that the fraction of industry return volatility due to the country composition of industries has decreased substantially over the sample period. However, country and industry-specific risks are mostly diversified away in optimal portfolios, which provide the same risk-return trade-off.[13]

Our results for the Euro-zone are consistent with the findings of Ferreira and Gama (2005) who extend the methodology of Campbell, Lettau, Malkiel and Xu (2001) to an international setting. For a global sample they find that both global and local industry risk have increased substantially during the late 90s, while world and country risk have remained relatively stable.[14] Similarly, Baele and Inghelbrecht (2005) report an increase in global industry-specific risk during the late 90s.

5.2 Gains from international diversification

The significant increase in Euro-wide industry portfolio idiosyncratic risk suggests that diversifying across countries within a Euro-wide industry may fail to yield the full benefits of international diversification. Furthermore, the increasing cross-country correlations may negatively affect the benefits from cross-country diversification. In this section we shed further light on these issues by quantifying the additional benefits from cross-country (cross-industry) diversification compared to investing in a single country (industry).

To estimate the average magnitude of the diversification benefits forfeited by investing in a single country or Euro-wide industry, we employ a measure inspired by the M^2 measure of Modigliani and Modigliani (1997) that considers risk-adjusted returns. We use this measure to quantify the gains from different diversification strategies rather than to test the performance of country- versus industry-based portfolios. The gains from optimally diversifying across all industries instead of investing solely in industry i can be measured as the difference between the excess return of industry i and the return of a position in the

[13] Further light can be shed on this issue by performing a new set of rolling window style analyses. Consider the optimal country or industry portfolios as test assets. We take all individual industry and country indices respectively as benchmark assets. In these optimal portfolios the idiosyncratic risk that is difficult to mimic is mostly diversified away and we now find similar country and industry performance.

[14] Note that the underlying model Ferreira and Gama (2005) use to calculate industry idiosyncratic risk is different from our approach. They decompose global industry returns as the (excess) return on the world market portfolio and an error term.

optimal industry portfolio (i.e. the tangency portfolio with short sales constraints)[15] levered up to have a volatility equal to industry i's volatility:

$$Gains_i = \theta^{opt} \cdot \sigma_i - \mu_i = \left(\theta^{opt} - \theta^i\right) \cdot \sigma_i \tag{10}$$

The excess return on the diversified industry portfolio adjusted for the risk of industry i is computed as the product of the Sharpe ratio of the optimal portfolio, θ^{opt}, and the volatility of industry i, σ_i. We are interested in the changes over time of these diversification gains. However, as our rolling window summary statistics (figure 1, panel A) show, the average individual industry and country volatility are both increasing for most of the sample period. Hence, we decompose total volatility σ_i into a systematic and an idiosyncratic part, to make sure our inferences are not based only on changes in total volatility. We split industry i's volatility into a systematic component (due to the country structure) and an idiosyncratic component and we decompose the gains accordingly:

$$Gains_i = \left(\theta^{opt} - \theta^i\right) \cdot \frac{\sigma_i^{2,syst}}{\sigma_i} + \left(\theta^{opt} - \theta^i\right) \cdot \frac{\sigma_i^{2,idiosyncr}}{\sigma_i} \tag{11}$$

The idiosyncratic volatility is the error term of the style regression of industry i's style in terms of the country portfolios. Last, we average the gains over all industries. The average gains from cross-country diversification are calculated in a similar fashion. To focus on the changes in diversification benefits arising from the changes in the covariance matrix of returns rather than those arising from the variations in sub-sample mean returns, we use constant mean returns for all sub-periods, based on the full sample average.

Table 5 reports full sample and subsample results[16]. First, the average benefits from optimal international diversification are substantial for both industry- and country-based portfolios. From 1990 to 2003 the average risk adjusted gains from optimal cross-country and cross-industry diversification in the Euro-zone are 5.1% and 6.0% per annum. However the sub-sample results exhibit strikingly different patterns over time. Panel A reports decreasing gains from cross-country diversification from 8.1% per year in the pre-convergence period to 5.8% in the convergence period and 5.1% in the Euro period. When we decompose the gains into systematic and idiosyncratic components, we find that the decrease in gains holds for both the part influenced by systematic volatility as well as the gains influenced by

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[15] We also consider the equally weighted country or industry portfolio as a benchmark (instead of the optimal portfolios). This is a more conservative benchmark for diversification benefits. Moreover, DeMiguel, Garlappi and Uppal (2005) argue that equally weighted allocation strategies show similar out-of-sample performance as optimal allocation policies due to the typically large estimation error of optimal strategies. The results of the equally weighted portfolio generally support our findings, although the average diversification gains are slightly lower. Our paper compares the in-sample performance of country- and industry-based strategies and we therefore focus on the optimal portfolio as a benchmark for gains from international diversification.

[16] Note that the optimal country and industry Sharpe ratios in this table are slightly different from those reported in table 2. In this section we use the full sample average returns as estimate of mean returns for all subsamples.

idiosyncratic volatility. However, the main component that causes the decrease in total gains is the idiosyncratic component. These findings are confirmed by the 60-month rolling window result of figure 8 panel A. As Euro-wide industries can replicate country returns increasingly well, they leave a smaller fraction of the country returns unexplained. This decreases country-specific risk and thereby decreases the geographical diversification potential. In sum, we show a decline in country idiosyncratic risk and decreasing gains from diversifying across countries.

Panel B of table 5 reports the average gains from cross-industry diversification, which increase from 7.2% per year in the pre-convergence period to 9.7% in the post-Euro period, after a brief decline to 5.2% per annum in the convergence period. This pattern holds for both the systematic and the idiosyncratic components. In fact, we find that the fraction of the total gains due to industry idiosyncratic volatility have almost tripled from 0.7% in the convergence to 2.0% in the Euro period. Figure 8 panel B reports a similar pattern for 60-month moving windows. Due to this increasing industry idiosyncratic risk, investing in one Euro-wide industry fails to deliver full international diversification benefits. The gains from diversifying across industries rather than investing in one Euro-wide industry have almost doubled from the second half of the 90s to the Euro period. These results stress the importance of international diversification, within the Euro-zone, both across countries and across Euro-wide industries.[17]

5.3 Impact of the EMU convergence process

We document a change in the relative importance of country and industry factors for Euro-zone equity returns. Our style analysis results suggest that whereas in the first half of the 90s country factors dominate, approximately when the Euro is introduced this reverses and industry factors become more important. The increasing relative importance of industry factors has been documented for global samples as well (see, for instance, Baca, Garbe and Weiss 2000 and Cavaglia, Brightman and Aked 2000). In this section we elaborate on the question to what extent our results are likely to be caused by the launch of the Euro and the EMU convergence process.

The Euro-countries are characterized by the elimination of intra-Euro-zone currency risk as of January 1999, as well as by their monetary and economic convergence. These are all

[17] As an alternative measure for diversification gains we consider the volatility reduction associated with the diversification strategies. Here we disregard any differences in mean returns and we take the difference between an individual industry (country) portfolio's volatility and the diversified industry (country) portfolio's volatility and averaging over all industries (countries). This analysis yields broadly similar results and support our finding that the gains from cross-country diversification (compared to investing in one country) have decreased, while the gains from cross-industry diversification have increased dramatically. The results are reported in the document containing all auxiliary results.

issues that increase the level of financial market integration in this region. Indeed, Fratzscher (2002) shows that Euro-countries have become highly integrated, which is largely explained by the reduced exchange rate uncertainty and the monetary policy convergence (see also Hartmann, Maddaloni and Manganelli 2003, Baele et al. 2004, Hardouvelis, Malliaropulos and Priestley 2006). A consequence of the more integrated markets is a decreasing exposure to country-specific factors and an increasing in exposure to Euro-wide or global factors. Bartram and Karolyi (2006) also report a decreasing exposure of Euro-zone equity returns to country factors due to the reduction of foreign exchange rate risk. Hence, the Euro-countries can be distinguished from other markets by the increasing level of integration due to the EMU convergence process.

In order to examine the impact of the integration of Euro-zone countries on the country-industry debate we assume a simple three-factor model for local industry returns, with a market factor (global or Euro-wide), a country factor and a Euro-wide industry factor:

$$r_{ijt} = \xi_{ijt} M_t + \beta_{ijt} C_{it} + \gamma_{ijt} I_{jt} + \varepsilon_{ijt} \qquad (12)$$

where r_{ijt} is the (excess) return on the index of local industry j in country i. M_t is the market factor, C_{it} is the country factor for country i, I_{jt} is the Euro-wide industry factor for industry j and ε_{ijt} is the idiosyncratic return component. Everything is assumed to be time-varying and for simplicity we remove the time subscript for the remainder of the discussion. We denote countries by x and industries by y. If we aggregate across all N local industries we get the following expression for the return on the index of country i (w_{ji} is the weight of industry j in the index of country i):

$$\sum_{j=1}^{N} w_{ji} r_{ij} = \sum_{j=1}^{N} w_{ji} \xi_{ij} M + \sum_{j=1}^{N} w_{ji} \beta_{ij} C_i + \sum_{j=1}^{N} w_{ji} \gamma_{ij} I_j + \sum_{j=1}^{N} w_{ji} \varepsilon_{ij}$$

$$r_i^x = \xi_i^x M + \beta_i^x C_i + \sum_{j=1}^{N} w_{ji} \gamma_{ij} I_j + \varepsilon_i^x \qquad (13)$$

We define the exposures of the country return to the market factor and to the country factor as the weighted sum of the local industry exposures to these factors, and the country idiosyncratic return is the weighted sum of the local industry idiosyncratic returns. Similarly, we can aggregate over all K countries within a certain industry to find the Euro-wide industry return (w_{ij} is the weight of country i in the index of Euro-wide industry j) :

$$\sum_{i=1}^{K} w_{ij} r_{ij} = \sum_{i=1}^{K} w_{ij} \xi_{ij} M + \sum_{i=1}^{K} w_{ij} \beta_{ij} C_i + \sum_{i=1}^{K} w_{ij} \gamma_{ij} I_j + \sum_{i=1}^{K} w_{ij} \varepsilon_{ij}$$

$$r_j^y = \xi_j^y M + \sum_{i=1}^{K} w_{ij} \beta_{ij} C_i + \gamma_j^y I_j + \varepsilon_j^y \qquad (14)$$

These expressions for country and Euro-wide industry returns can be related to the style regressions. The use of Euro-wide industry returns to replicate country returns and vice versa can be motivated by the exposure of the components of the country and industry indices (the local industries) to both country and industry factors. Consequently the country and Euro-wide industry indices are influenced by those factors as well.

What is the likely impact of the high integration of the Euro-countries on the country and Euro-wide industry returns? For these integrated country returns, common market factors matter rather than country-specific factors. Consequently the exposure to the country factor, β_i^x, will be low (close to zero). Carrieri, Errunza and Sarkissian (2004a) argue that a country is integrated if most of its local industries are integrated. Hence, the exposures of the local industries to the country factors, β_{ij}, are low. As the exposure of the country return to the country factor, β_i^x, is the weighted average of the local industry betas, this exposure will indeed be low and hence the country is integrated. Full integration, i.e. $\beta_i^x = 0$, implies the following for country returns:

$$r_i^x = \xi_i^x M + \sum_{j=1}^{N} w_{ji}\gamma_{ij} I_j + \varepsilon_i^x \qquad (15)$$

This suggests that a style regression in which we use Euro-wide industries to replicate the country return would work relatively well and industries have good replicating abilities. On the other hand, if most local industries are integrated into the Euro-zone market, their exposures to the country factors will be low and the Euro-wide industry return is mainly affected by the market factor and the industry-specific factor. Hence one could expect that a style regression in which industry returns are being replicated by country returns does not perform well. The countries' replicating abilities are worse and the industry return variation left unexplained, which we define as industry idiosyncratic risk, increases.

In this paper we document an increasing relative importance of industry factors (due to their superior replicating abilities) and increasing industry idiosyncratic risk for Euro-zone equity returns. We postulate that this is positively affected by the EMU convergence process. Due to the reduction of foreign exchange rate risk and the monetary convergence, the Euro-countries have become highly integrated (Fratzscher 2002). Consequently country-specific factors have become less important relative to common market factors. This improves the ability of Euro-wide industry returns to replicate country returns, while country returns become less capable of mimicking industry returns. As a result industry idiosyncratic risk increases.

In the discussion so far we implicitly assumed stable exposures to industry factors. Our aim is to examine to what extent our findings (of the style analysis in particular) can be explained by specific Euro-zone equity returns characteristics. The decreasing exposure to country factors was sufficient for our arguments. However, it is also possible that our results are related to increasing exposures to industry factors, since this would cause an increase in the importance of industry factors relative to country factors as well. However it is unclear to what extent the industry exposure would be different for Euro-countries compared to non-Euro-zone countries. Hence, in our discussion of the effect of the EMU on our findings we focus on the increased integration of the EMU countries and the decreasing exposure to country factors.

6 Sensitivity analysis

This section discusses a number of robustness checks. First, we propose 'pseudo style regressions' in which we eliminate estimation error in the style coefficients by taking observable predetermined weights. Second, we examine a number of possible confounding events that might affect our findings, such as time-varying aggregate market volatility, the internet bubble, intra Euro-zone currency risk before 1999 and the size of the rolling window.[18]

6.1 Pseudo style regressions

Sharpe (1992) suggests that the performance of a portfolio can be determined by comparing its return to the return on a replicating portfolio with the same style. The returns on the mimicking portfolio should represent returns of feasible trading strategies, i.e. they are subject to portfolio and short sales constraints. Due to these constraints however, the intercept of the style regressions cannot be interpreted as a measure of in-sample out-performance in the same way as the Jensen measure.[19] Rather, in the style analysis we focus on the R^2 as a measure of performance of the benchmark assets. Also, the style coefficients have to be estimated and consequently, they are subject to estimation error.

In this section we propose an alternative approach, referred to as pseudo style regressions. Here we form a mimicking industry portfolio for a specific country by using as coefficients the weights of the industry sub-indices in that country index. Thus the pseudo mimicking portfolio of the French index consists of a weighted sum of all Euro-wide industry indices, where the weights are the market value weights of the French industries in the French

[18] We also repeat the whole analysis for a subset of the countries over an extended sample period starting in February 1975. These results of this analysis are available at http://papers.ssrn.com/sol3/cf_dev/AbsByAuth.cfm?per_id=350036. Strikingly, over the 28 year period between 1975 and 2003, country- and industry-based portfolios are in general equally mean-variance efficient. The style analysis shows that in 5-year windows ending before 1985 industries can better replicate country styles than vice versa. Then, the mimicking abilities of industries and countries are quite close during a large part of the windows. Again, in the last windows (ending after 1999) industries outperform countries. In sum, the results for this extended sample period confirm our findings for the 1990-2003 period.

[19] Of course, if the slope coefficients in the Jensen regression satisfy the portfolio and positivity constraints the intercept in the style regression will coincide with the Jensen measure. Furthermore, the style regression intercept can be used as an out-of-sample performance measure (Sharpe 1992).

country index. The coefficients of the pseudo regressions are observable at the beginning of each period, they are time-varying and they do not suffer from estimation error. By construction, portfolio and positivity constraints on the weights are always satisfied. The pseudo regression can therefore be interpreted as a style regression with time-varying and predetermined slope coefficients and we can interpret the pseudo regression's R^2 as a measure of the mimicking abilities of the benchmark assets. At the same time, the pseudo mimicking portfolios are true trading strategies and constitute appropriate benchmarks to evaluate the performance of the test assets.[20] We can now interpret the intercept of the pseudo style regressions as a measure of out-performance of the test asset, because contrary to the style analysis we do not have to impose additional constraints on the pseudo regression. We test the joint significance of all country or industry intercepts, using a simple Wald test.[21] These pseudo style regressions link the style regressions and the regressions used for spanning tests.

First, we compare the weighted average R^2s of the pseudo regressions to the results of the style analysis. The results for the full sample and the sub-samples are reported in table 6, panel A. These results are directly comparable to the tests reported in table 4. Indeed, the patterns are very similar to those of the style analysis, but the average R^2s are a few percentage points lower. In the pre-convergence and convergence periods, industries can be replicated more closely with country investments than countries with Euro-wide industries, while the opposite is true in the Euro period as well as over the full sample. Notable is the decrease in the Euro period of the fraction of industry returns volatility explained by their ex-ante investable country mimicking portfolios relative to the ex-post country style benchmarks reported in table 4: average R^2s of 52% versus 74% for the simple analysis and 32% versus 63% for the exclusive regressions. This suggests that, in the post-Euro period, little of industry portfolio ex-ante volatility is related to country factors. Rolling windows average R^2s are very similar to those of the style analysis, except for the sharp decline in country performance in the Euro period. The reversal in the mimicking performance ranking of industry and country portfolios occurs in April and November 1999 for the simple and exclusive pseudo regressions respectively (two and three months earlier than in the corresponding style analysis). These results confirm and reinforce the results of the preceding sections.

Second, we test the significance of the intercepts of the pseudo regressions. The results of the tests for joint significance of all country and industry intercepts for the full sample and

[20] Therefore, the pseudo style regression can also be interpreted as a Jensen regression with the pseudo mimicking portfolio as the benchmark and a slope coefficient equal to one.

[21] We perform these pseudo regressions using raw returns, but the intercept is by construction exactly the same as when using excess returns.

the sub-samples are presented in panel B of table 6. These results are can be compared to the spanning tests reported in panel B of table 2. Although broadly similar, the pseudo spanning tests reject the null hypothesis of spanning more often and more strongly than the spanning tests in table 2. This is not surprising as the tests in table 2 consider all feasible strategies and select the one which ex-post generated the highest risk reward ratio while the tests reported in table 6 consider only one specific strategy. Table 6 is instructive as it evaluates a feasible ex-ante strategy that exactly matches the country exposure (in terms of index weights) of the Euro-wide industry portfolios or the industry exposure of the country indices and it tells us that in many instances even if this matching accounts for a large fraction of the volatility of the portfolio being matched, significant differences in the performance of the matching and matched portfolio remain. In the rolling window tests, we find that the intercepts are significantly different from zero in a large number of windows ending before January 2002. Thereafter the null hypothesis of zero intercepts generally cannot be rejected. In summary, the tests of the intercepts of the pseudo regressions are consistent with the results of our spanning tests.

6.2 Other robustness checks

Next to the pseudo regressions we conduct a number of further robustness checks. To be concise, we do not report our results but we briefly discuss them below.

First, in periods of high market volatility, a portfolio of benchmark assets may explain a smaller fraction of the variance of the test portfolio, not because of lower correlations but because of a higher aggregate variance. This may affect the results of both spanning tests and style analysis. We therefore adjust both methodologies to incorporate time-varying aggregate market volatility by using scaled returns. We divide the (excess) time $t+1$ return by the estimated conditional market volatility over the same period. Now we can interpret the scaled (excess) returns $\sigma_t^{-1} r_{t+1}$ as the payoff of an actively managed portfolio when each period σ_t^{-1} is invested in the assets that are included in the vector of (excess) returns r.[22] As the returns on the right hand side and the left hand side of the regressions are scaled by the same variable σ_t, which is always positive, the portfolio and nonnegativity constraints are still valid. Engle's ARCH test (Engle 1982) shows that the Euro-wide market index indeed exhibits volatility clustering. We estimate this time-varying market volatility using a simple GARCH(1,1) specification[23] (Bollerslev 1986), which we estimate by maximum likelihood. We find that the results of both style and efficiency tests are nearly identical after controlling for time-

[22] Note that there is a leverage effect. When the market is more volatile, less will be invested in the risky assets and more in the risk free asset.

[23] We also estimated two asymmetric models: EGARCH(1,1) and the GJR(1,1) model but we find that for both models the leverage parameter is insignificant. This suggests that asymmetry may not be present in our data.

varying market volatility. This suggests that the changes in the relative performance of industry and country-based portfolios cannot be accounted for by changes in aggregate market volatility.

A second possible concern is the impact of the internet bubble on our findings. At the end of the nineties, the world equity markets were affected by the dot.com mania. During 1999, the level of the Nasdaq composite index doubled. However, the internet and information technology bubble burst in the beginning of 2000 when on April 14th - “Black Friday”- the Nasdaq index dropped to a level more than 34% below the peak on 10 March[24]. Brooks and Del Negro (2004) suggest that the increasing importance of industry factors may be an artefact of the internet bubble, and show that controlling for the bubble accounts for most of the change in industry importance. To distinguish the impact of the introduction of the Euro at the beginning of 1999 from this internet bubble, we perform all efficiency tests and style analyses excluding the sector information technology (IT)[25]. In line with our previous results, we find that, when we exclude IT, industry and country portfolios are equally mean-variance efficient. The results of the style analysis also remain largely unaffected. Furthermore, the weighted average standard errors of the style regressions are very similar after exclusion of the IT sector. Hence the dramatic increase in industry idiosyncratic risk is not limited to the IT sector, which is consistent with Ferreira and Gama (2005). In summary, our results are robust for the internet bubble.

Third, since the elimination of intra Euro-zone currency risk due to the adoption of the Euro in 1999 could have significantly affected the covariance of returns of Euro-zone assets, we investigate whether using currency risk hedged returns prior to 1999 affects our results. For the period before the introduction of the Euro, we include returns on currency indices as additional benchmark assets in the style regressions, both when country and industry indices are the dependent variables[26]. In the spanning tests we use returns on forward currency contracts, which are zero-investment securities and the returns can therefore be interpreted as excess returns. As it is easy to take a short position in a forward currency contract, they are not subject to short sales constraints. Our findings that before the Euro launch country and industry portfolios are equally mean-variance efficient while country portfolios have superior replicating abilities are confirmed when controlling for intra-Euro-zone currency risk.

Last, by performing the rolling window analyses for 36-month windows, we examine the impact of the size of the windows on our results. We now have 127 windows in total. In

[24] Source: ‘After the gold rush’, The Economist, April 20th 2000

[25] We exclude the Euro-wide IT industry. Also, the country indices no longer contain IT components. Nevertheless this does not eliminate the impact of the IT bubble on the other (non-IT) stocks.

[26] The currency indices are computed by dividing the price index of a country’s industry expressed in the local currency by the same index denoted in German Mark.

particular, there are more windows after the introduction of the Euro. These 36-month moving window results instil confidence in our results.

7 Conclusion

In this paper we investigate the relative importance of country and industry factors as determinants of international equity returns in the Euro-zone over the period 1990 to 2003. The country-industry debate has been alive for over 30 years now. Most papers compare country and industry factors using the Heston and Rouwenhorst (1994) methodology or by comparing cross-country and cross-industry correlations. Whereas the former approach is based on the restrictive assumption of a unit exposure to the common market factor, the latter ignores risk and return characteristics of equity returns. Hence, we take a different perspective and compare the performance of industry- and country-based portfolios in terms of mean-variance efficiency and in terms of replicating abilities of style portfolios.

We find that even though country or industry portfolios yield statistically indistinguishable Sharpe ratios throughout the sample period, the underlying structure of Euro-zone equity returns has changed dramatically. In the first half of the 1990s, country returns were on average more volatile and less correlated than Euro-wide industry returns. In the late 1990s and early 21st century the situation is reversed: Euro-wide industry returns exhibit higher average volatility and lower cross-correlation than country returns. Style analysis shows that the fraction of industry returns variance that can be explained by the country returns decreases. Consequently, industry-specific idiosyncratic risk has more than doubled over the last decade while country-specific risk has remained relatively stable. After the Euro launch industry portfolios can better replicate country returns than vice versa. We argue that this increasing relative importance of industry factors may be explained by the high level of integration of Euro-zone countries, caused by the EMU convergence process.

While the benefits of cross-country diversification within the Euro-zone remain substantial at 5.1% per annum on a risk adjusted basis, our results highlight the risks of single Euro-wide industry strategies. Because of the large increase in Euro-wide industry idiosyncratic risk, a cross-border portfolio confined to a single industry within the Euro-zone fails to deliver the expected benefits of international diversification. Indeed, the average gains from optimal cross-industry diversification have increased dramatically from 5.2% per annum in the second half of the 90s to 9.7% per year in the Euro period, based on the M^2 measure. Hence, not only should investors diversify out of single country portfolios, they should also diversify out single Euro-wide industry portfolios.

A Test for differences in R^2 of style regressions

We evaluate the statistical significance of differences in replicating abilities of country and industry portfolios by performing Monte Carlo simulations for the style regressions average R^2s. More specifically, we test the difference between the average R^2s of the style regressions taking countries as benchmarks and taking industries as benchmarks.

We assume that the returns on the sub-indices are multivariate normally distributed. There are two issues that keep us from using the standard estimation techniques for the mean returns and the covariance matrix. First, not all sub-indices are available for the full sample period. Some sub-indices start later than March 1990 and others end before August 2003[27]. To make full use of the data, we implement the maximum likelihood estimators of the mean vector and covariance matrix proposed by Stambaugh (1997). These estimators use all data available on all series to estimate the moments of the returns distribution and exploit the fact that series with long histories provide additional information on the moments of shorter history sub-indices. The estimates of the means and covariances of shorter history sub-indices are based on regressions of these shorter history sub-indices on all longer history sub-indices (for the period in which they are all available)[28].

Second, the number of observations is small relative to the number of sub-indices. In this case, the usual sample covariance matrix imposes too little structure and can be singular for short sample periods. Ledoit and Wolf (2003) propose a shrinkage technique to alleviate this problem. The estimate of the covariance matrix is a weighted average of the sample covariance matrix and a shrinkage target, for which a single index model is used. We follow Ledoit and Wolf (2003) and we use the equally weighted Euro-wide market portfolio for this single index model. The weight of the shrinkage target (the shrinkage intensity) determines how much structure is imposed. The optimal shrinkage intensity depends on the correlation between the estimation error of the sample covariance matrix and the estimation error of the shrinkage target. The benefits of this approach increase as the correlation between the estimation error of the target and the sample estimate decreases and the shrinkage intensity increases. Also, a positive semidefinite covariance matrix is guaranteed.

[27] Out of 110 sub-indices, 6 are unavailable over the whole sample period. 85 sub-indices are available for the full sample, 17 are first available at a later date that the sample start date, 1 sub-index ends prior to the sample end date and 1 starts after and ends earlier than the sample initial and terminal dates.

[28] Because some sub-indices have a very short history, the number of independent variables would exceed the number of observations in the regressions. We therefore only select the sub-indices of the same country or the same industry as independent variables. Furthermore, Stambaugh assumes that all assets end at the same time *T* and survival probabilities are not taken into account. In our sample two sub-indices end earlier (they are ‘dead’ indices). As the ending dates are assumed to be deterministic and independent of the distributions, we apply the methodology for the different ending dates as well.

We use the first and second moments of the returns on sub-indices estimated with the Stambaugh (1997) and Ledoit and Wolf (2003) techniques to generate simulated returns for all sub-indices. We derive the empirical distribution of the style regressions' R^2s and test the significance of the difference in R^2. As starting values of the market values ($MV_{i,j,t}$) of the sub-indices we use the actual value of these sub-indices observed on the start date of our sample period. We then simulate the returns on the sub-indices for all T observations. When a certain sub-index is unavailable at time t, it is also unavailable at time t in the simulated time series. We construct the value-weighted country and Euro-wide industry indices from these simulated sub-indices and perform simple and exclusive style analyses using the returns on the simulated country and industry indices. We use the same algorithms to construct country and industry indices and to run the style regressions in the simulation as we use in the estimation. The only deterministic parameters that enter the simulations are T, K, N, the starting values of $MV_{i,j,t}$, the starting and ending dates of the sub-indices and the parameters of the normal distribution. Each simulation results in one value of the average R^2 taking countries as benchmarks and one value of the average R^2 taking industries as benchmarks. We perform 10,000 simulations and test the significance of the difference in mimicking abilities by considering the difference in average R^2s. We allow for changing volatilities and covariances over time by estimating the mean returns and the covariance matrix for the three sub-samples and for the full sample separately.

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Table 1: Summary statistics of Euro-zone country and Euro-wide industry portfolio returns

The table reports summary statistics of the monthly returns on EMU country and Euro-wide industry equity indices as well as the one-month Euro-Mark interest rate. ρ(1) is the first order autocorrelation. c(ctry) and c(ind) are the averages of the correlations of the index return with each of the country indices and with each of the industry indices. The columns 'weight' give the average weights of industries and countries in the Euro-wide market portfolio. The last two rows of panels A to C report Wald tests of the null hypotheses that all mean returns are zero and that all mean returns are equal (*p*-values in parentheses). The sample period extends from March 1990 to August 2003 (162 observations). Panel D reports summary statistics (averaged over all countries and industries) for the three sub-samples: the pre-convergence period runs from March 1990 to November 1994 (57 obs.), the convergence period is from January 1995 to November 1998 (47 obs.) and the Euro period extends from January 1999 to August 2003 (56 obs.). The last two columns report the Wald tests of the null hypotheses that all means are zero and that all means are equal respectively (*p*-values in parentheses). The mean, standard deviation, minimum and maximum returns are given as annual percentages.

Panel A: Returns on country indices

	mean (p.a.)	stdv (p.a.)	c(ctry)	c(ind)	min (p.a.)	max (p.a.)	ρ(1)	weight
Belgium	9.23%	16.58%	0.607	0.673	-161.51%	152.39%	0.134	3.86%
Germany	7.27%	19.84%	0.665	0.770	-219.05%	194.41%	0.090	27.45%
Finland	18.65%	36.68%	0.506	0.568	-314.45%	428.61%	0.205	2.82%
France	11.12%	20.12%	0.670	0.785	-179.31%	198.06%	0.090	24.97%
Greece	14.62%	36.98%	0.369	0.377	-299.39%	669.11%	0.080	1.07%
Ireland	12.62%	21.16%	0.565	0.609	-245.32%	273.79%	0.100	1.39%
Italy	7.87%	27.16%	0.544	0.635	-213.39%	313.77%	-0.048	12.03%
Netherlands	12.04%	17.86%	0.676	0.769	-235.21%	143.21%	0.053	15.76%
Austria	2.81%	18.54%	0.495	0.539	-220.85%	192.07%	0.017	1.26%
Portugal	5.61%	20.79%	0.556	0.582	-258.54%	356.59%	0.123	1.18%
Spain	12.01%	23.42%	0.629	0.691	-232.72%	271.41%	0.055	8.21%
Average	10.35%	23.56%	0.571	0.636	-234.52%	290.31%	0.082	
H_0: country means are zero						(0.382)		
H_0: country means are equal						(0.618)		

Panel B: Returns on industry indices

	mean (p.a.)	stdv (p.a.)	c(ctry)	c(ind)	min (p.a.)	max (p.a.)	ρ(1)	weight
Resources (Res)	13.99%	18.14%	0.494	0.523	-213.07%	215.48%	0.031	8.67%
Basic Industries (BasI)	8.59%	19.31%	0.694	0.732	-187.95%	177.09%	0.096	9.76%
General Industries (GenI)	8.65%	21.69%	0.697	0.759	-216.51%	180.45%	0.067	11.62%
Cyclical Consumer Goods (CCGd)	7.00%	23.39%	0.671	0.718	-264.18%	195.66%	0.117	5.81%
Non-Cyclical Consumer Goods (NCGd)	12.00%	14.68%	0.589	0.620	-133.20%	174.78%	0.118	9.06%
Cyclical Services (CS)	8.82%	20.00%	0.693	0.736	-212.48%	256.64%	0.136	7.25%
Non-Cyclical Services (NCS)	14.59%	24.77%	0.611	0.627	-227.98%	302.23%	0.168	9.59%
Utilities (UT)	11.37%	14.86%	0.576	0.588	-152.73%	132.00%	0.098	4.58%
Information Technology (IT)	20.42%	35.61%	0.619	0.647	-312.06%	408.92%	0.137	4.82%
Financials (Fin)	8.91%	20.45%	0.715	0.731	-241.56%	222.53%	0.059	28.83%
Average	11.43%	21.29%	0.636	0.668	-216.17%	226.58%	0.103	
H_0: industry means are zero						(0.006)		
H_0: industry means are equal						(0.426)		

Table 1 (continued)

Panel C: Interest rate Germany Euro-Mark 1 month middle rate

	mean (p.a.)	stdv (p.a.)	min (p.a.)	max (p.a.)
Interest rate	4.99%	0.65%	2.07%	9.40%
H_0: mean interest rate is zero		(0.000)		

Panel D: Summary statistics sub-samples

		average over all countries/ industries				H_0 on mean returns	
		mean (p.a.)	stdv (p.a.)	c(ctry)	c(ind)	zero means	equal means
Countries	Pre-convergence	5.51%	23.51%	0.513	0.641	(0.185)	(0.617)
	Convergence	26.08%	23.08%	0.674	0.726	(0.000)	(0.003)
	Euro	0.80%	22.88%	0.565	0.591	(0.284)	(0.348)
Industries	Pre-convergence	7.96%	16.81%	0.641	0.772	(0.029)	(0.179)
	Convergence	25.08%	20.23%	0.726	0.772	(0.000)	(0.002)
	Euro	2.47%	25.10%	0.591	0.563	(0.904)	(0.906)

Table 2: Efficiency tests for countries and industries

Panel A reports the Jensen measures ('α') as a annual percentage return and the corresponding *t*-values for the full sample period for each country and industry portfolio. Under the 'full indices' heading industry Jensen measures are computed using total country portfolios as benchmarks and conversely. Under 'Excl. overl.' the benchmark portfolios exclude overlapping components with the tests assets. Panel B gives results for the spanning test and the Sharpe ratios for the full sample period and three subperiods, on an annual basis. The *p*-values of the null hypothesis of mean-variance spanning are given in brackets. The spanning tests are reported first using total index portfolios as benchmarks, second, ('excl') using benchmark portfolios excluding overlapping with the test assets, and third, ('excl nss') with short sales constraints on both the test assets and the benchmark assets and no overlap between benchmark and test asset. 'Sharpe ratio nss' is the maximum Sharpe ratios when short sales are not allowed. The *p*-values of the null hypothesis of equal Sharpe ratios of industries and countries are given in parentheses.

Panel A: Jensen measures for full sample period

Industries					Countries				
	Full indices		Excl. overl.			Full indices		Excl. overl.	
	α (p.a.)	*t*-value	α (p.a.)	*t*-value		α (p.a.)	*t*-value	α (p.a.)	*t*-value
Res	2.82%	0.85	-5.33%	1.35	Belgium	-0.73%	-0.32	-0.29%	-0.12
BasI	-0.92%	-0.39	1.33%	-0.53	Germany	-1.08%	-0.65	-2.33%	-0.93
GenI	-0.43%	-0.25	0.70%	-0.34	Finland	-4.49%	-0.77	2.26%	0.31
CCGD	-2.43%	-0.75	3.11%	-0.89	France	-1.43%	-0.83	0.30%	0.11
NCGD	3.43%	1.44	-4.45%	1.73	Greece	7.56%	0.85	7.94%	0.88
CS	-1.36%	-0.67	1.05%	-0.47	Ireland	2.12%	0.53	2.55%	0.64
NCS	4.58%	1.35	-4.65%	1.09	Italy	-2.50%	-0.56	-4.64%	-0.89
UT	2.75%	1.17	-3.16%	1.20	Netherlands	1.16%	0.68	2.32%	1.05
IT	5.25%	1.37	-7.38%	1.44	Austria	-4.46%	-1.23	-4.34%	-1.18
Fin	-0.44%	-0.22	0.40%	-0.13	Portugal	-4.26%	-1.09	-3.99%	-1.00
					Spain	-0.72%	-0.20	2.23%	0.54

Panel B: Spanning tests and Sharpe ratios for full sample period and three sub-samples

	Full sample March 90-Aug 03	Pre-convergence March 90-Nov 94	Convergence Jan 95-Nov 98	Euro Jan 99-Aug 03
Spanning tests				
H_0: industries are spanned by countries	(0.039)	(0.101)	(0.025)	(0.704)
- excl	(0.044)	(0.278)	(0.162)	(0.773)
- excl, no short sales (nss)	(0.633)	(0.937)	(0.593)	(0.954)
H_0: countries are spanned by industries	(0.205)	(0.631)	(0.017)	(0.113)
- excl	(0.835)	(0.833)	(0.178)	(0.196)
- excl, no short sales	(0.994)	(0.977)	(0.961)	(0.969)
Sharpe ratios (p.a.)				
Industries	1.066	1.780	4.016	1.060
Countries	0.827	1.438	3.138	1.618
H_0: SR ind = SR ctr	(0.449)	(0.593)	(0.222)	(0.297)
Industries no short sales	0.581	0.355	1.713	0.301
Countries no short sales	0.444	0.388	1.595	0.307
H_0: SR ind nss = SR ctr nss	(0.403)	(0.910)	(0.734)	(0.987)

Table 3: Style analysis for countries and industries

The table reports the benchmark portfolios style regression coefficients and the regression R^2. The coefficients of each style regression are constrained to be positive and to sum to one. The regression R^2 represents the fraction of the test asset volatility accounted for by the volatility of test asset style portfolio of benchmark assets. and measures the mimicking ability of the benchmark assets with respect to the test assets. Panel A reports the style of countries in terms of industry benchmarks. while Panel B reports the style of industries in terms of country benchmarks. The columns ‘Norm.’ report the coefficients of the simple style analysis. while the columns ‘Excl.’ report the coefficients of the exclusive style analysis where the overlapping components with the test assets have been removed from the benchmark assets. In the exclusive style analysis. each test asset has a different set of benchmark assets. The last rows of both panels give the Spearman rank correlation for the association between the style regression coefficients estimated with or without overlapping components in the benchmark assets. *. **. *** denote significance at the 10. 5 and 1% levels respectively.

Panel A: Country styles in terms of industry benchmarks

	Belgium		Germany		Finland		France		Greece		Ireland		Italy		Netherlands		Austria		Portugal		Spain	
	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.
intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00
Res.	0.00	0.00	0.01	0.09	0.22	0.29	0.05	0.12	0.00	0.00	0.17	0.20	0.01	0.05	0.20	0.08	0.11	0.12	0.00	0.00	0.00	0.02
Bas.I.	0.18	0.18	0.03	0.02	0.03	0.03	0.02	0.05	0.32	0.23	0.11	0.07	0.00	0.11	0.10	0.25	0.42	0.39	0.00	0.00	0.00	0.00
Gen.I.	0.00	0.00	0.46	0.22	0.00	0.00	0.23	0.28	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
CCGd	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.11	0.23	0.06	0.10	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.18
NCGd	0.36	0.47	0.00	0.07	0.00	0.00	0.30	0.14	0.00	0.00	0.06	0.00	0.00	0.00	0.13	0.15	0.23	0.26	0.37	0.39	0.00	0.10
CS	0.00	0.00	0.09	0.29	0.00	0.00	0.09	0.00	0.11	0.16	0.20	0.20	0.00	0.25	0.26	0.14	0.00	0.00	0.15	0.20	0.00	0.21
NCS	0.00	0.02	0.10	0.05	0.01	0.45	0.10	0.20	0.09	0.06	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.26	0.23	0.26	0.23
UT	0.25	0.12	0.00	0.00	0.03	0.00	0.00	0.01	0.06	0.14	0.24	0.28	0.07	0.31	0.00	0.08	0.14	0.11	0.02	0.00	0.38	0.00
IT	0.00	0.00	0.00	0.04	0.71	0.23	0.13	0.01	0.00	0.00	0.00	0.00	0.00	0.16	0.06	0.09	0.00	0.00	0.00	0.00	0.03	0.00
Fin.	0.21	0.22	0.30	0.22	0.00	0.00	0.04	0.19	0.31	0.18	0.16	0.16	0.30	0.02	0.25	0.20	0.10	0.12	0.19	0.18	0.22	0.26
R^2	0.76	0.71	0.91	0.80	0.63	0.48	0.90	0.80	0.23	0.21	0.56	0.55	0.63	0.49	0.88	0.81	0.48	0.46	0.52	0.51	0.74	0.64
rankcorr.	0.87***		0.65*		0.23		0.3		0.87***		0.90***		-0.5		0.80***		0.98***		0.80***		0.22	

Table 3 (continued)

Panel B: Industry styles in terms of country benchmarks

	Res.		Bas.I.		Gen.I.		CCGd		NCGd		CS		NCS		UT		IT		Fin.	
	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.	Norm.	Excl.
intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Belgium	0.00	0.28	0.10	0.07	0.00	0.00	0.02	0.03	0.48	0.55	0.00	0.00	0.00	0.00	0.50	0.32	0.00	0.00	0.18	0.13
Germany	0.00	0.00	0.13	0.06	0.59	0.52	0.28	0.12	0.00	0.00	0.32	0.40	0.23	0.10	0.00	0.00	0.15	0.27	0.31	0.16
Finland	0.00	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.13	0.17	0.00	0.00	0.44	0.24	0.00	0.01
France	0.02	0.10	0.20	0.20	0.35	0.40	0.27	0.25	0.23	0.11	0.29	0.22	0.24	0.40	0.00	0.07	0.40	0.43	0.01	0.21
Greece	0.00	0.00	0.03	0.04	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04
Ireland	0.12	0.23	0.05	0.00	0.00	0.01	0.10	0.09	0.02	0.05	0.04	0.04	0.00	0.00	0.05	0.17	0.00	0.00	0.00	0.02
Italy	0.05	0.04	0.05	0.07	0.06	0.07	0.21	0.20	0.00	0.00	0.08	0.07	0.14	0.10	0.06	0.10	0.00	0.07	0.14	0.11
Netherlands	0.58	0.00	0.21	0.31	0.00	0.00	0.00	0.11	0.07	0.00	0.15	0.10	0.00	0.00	0.00	0.05	0.00	0.00	0.22	0.17
Austria	0.22	0.28	0.20	0.24	0.00	0.00	0.09	0.12	0.15	0.18	0.00	0.00	0.00	0.00	0.08	0.13	0.00	0.00	0.04	0.14
Portugal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.12	0.04	0.06	0.07	0.06	0.00	0.00	0.00	0.00	0.00	0.01
Spain	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.07	0.08	0.19	0.17	0.30	0.15	0.00	0.00	0.07	0.02
R^2	0.45	0.34	0.83	0.80	0.91	0.88	0.77	0.74	0.63	0.57	0.86	0.83	0.73	0.63	0.56	0.39	0.75	0.60	0.87	0.74
rankcorr.	0.60*		0.89***		0.95***		0.81***		0.75**		0.98***		0.90***		0.75**		0.77***		0.64**	

Table 4: Overview results style analysis

The table presents the results of the style analysis in the full sample and the three sub-samples. It reports the weighted average R^2s of the style analysis where the weights are determined by the weights of the test assets in the Euro-wide index. 'Simple' indicates the results of the simple style analysis (using full indices) and 'exclusive' points at regressions after removal of overlapping components of the test and benchmark assets. 'Ctr styles in terms of ind bench' reports the average R^2 of the style regression where industry benchmark assets replicate the style of country indices. 'Ind styles in terms of ctr bench' shows the results of the country benchmark assets replicating industry styles. The third and sixth rows give the *p*-values of the null hypothesis that the average R^2s taking countries and industries as test assets are equal. By simulating the distributions of the average R^2s we can test the significance of these differences. We allow for time-varying volatility by estimating different distributions for the three sub-samples.

	Full sample March 90-Aug 03	Pre-convergence March 90-Nov 94	Convergence Jan 95-Nov 98	Euro Jan 99-Aug 03
Simple				
Ctr styles in terms of ind bench	0.82	0.80	0.84	0.88
Ind styles in terms of ctr bench	0.77	0.89	0.85	0.74
H_0: R^2 ctr $=R^2$ ind	(0.620)	(0.001)	(0.393)	(0.246)
Exclusive				
Ctr styles in terms of ind bench	0.72	0.60	0.75	0.84
Ind styles in terms of ctr bench	0.69	0.82	0.79	0.63
H_0: R^2 ctr $=R^2$ ind	(0.825)	(0.023)	(0.217)	(0.210)

Table 5: Average gains from international diversification

This table reports the average benefits from cross-country and cross-industry diversification. In particular, it provides the average additional gains from investing in the optimal no-short sales country (industry) portfolio rather than in one country (industry). The gains are calculated in terms of risk-adjusted returns based on the M^2 measure. Panel A reports the gains from diversifying across countries. The extra gains from investing in the optimal country portfolio instead of investing in country *i* can be calculated as the difference in the return on country *i*'s index and the return on the optimal country portfolio, levered up to have the same volatility as country *i*. This comes down to multiplying the difference between country *i*'s Sharpe ratio and the optimal country Sharpe ratio by country *i*'s volatility. We split country *i*'s volatility into a systematic component (due to the industry structure) and an idiosyncratic component and we decompose the gains accordingly. The idiosyncratic volatility is the error term of the style regression of country *i*'s style in terms of the Euro-wide industry portfolios. We perform similar calculations for the industries; the results are reported in panel B. The mean excess returns are kept constant for all periods: they are estimated by the full sample averages. The gains are reported for the full sample period and the three sub-samples. All numbers are expressed on an annual basis.

Panel A: Average gains from cross-country diversification, on annual basis

	Full sample March 90-Aug 03	Pre-convergence March 90-Nov 94	Convergence Jan 95-Nov 98	Euro Jan 99-Aug 03
Av. country Sharpe ratio	0.224	0.224	0.229	0.230
Optimal ctr. portf. Sharpe ratio	0.444	0.575	0.482	0.454
Gains p.a.:				
Systematic	3.09%	4.25%	4.23%	3.50%
Idiosyncratic	2.05%	3.89%	1.55%	1.58%
Total gains	5.14%	8.14%	5.78%	5.08%

Panel B: Average gains from cross-industry diversification, on annual basis

	Full sample March 90-Aug 03	Pre-convergence March 90-Nov 94	Convergence Jan 95-Nov 98	Euro Jan 99-Aug 03
Av. industry Sharpe ratio	0.298	0.378	0.314	0.253
Optimal ind. portf. Sharpe ratio	0.581	0.811	0.575	0.644
Gains p.a.:				
Systematic	4.77%	6.29%	4.51%	7.69%
Idiosyncratic	1.19%	0.87%	0.70%	2.03%
Total gains	5.96%	7.16%	5.21%	9.72%

Table 6: Results pseudo regressions

This table reports the results of the pseudo regressions. Since the weights of each country component in a Euro-wide industry portfolio or the weights of each industry in country portfolio are known and observable at the beginning of each returns period we use them to conduct 'pseudo regressions' where the weights are used as time-varying and observable regression coefficients. These pseudo replicating portfolios truly represent trading strategies and do not suffer from estimation error. Panel A shows the weighted average R^2s that result from the pseudo regressions. In panel B the results of the tests for joint significance of all country and industry intercepts are reported. Under the null hypothesis of no out-performance of the test assets all country or industry intercepts are jointly equal to zero. This is tested using a Wald test and the *p*-values are given in parentheses. 'Excl.' indicates that benchmark indices excluding overlapping components with test assets are used.

Panel A: weighted average R^2s of pseudo regressions

	Full sample March 90-Aug 03	Pre-convergence March 90-Nov 94	Convergence Jan 95-Nov 98	Euro Jan 99-Aug 03
Simple				
Ctr styles in terms of ind bench	0.81	0.75	0.81	0.85
Ind styles in terms of ctr bench	0.73	0.87	0.81	0.52
Exclusive				
Ctr styles in terms of ind bench	0.69	0.53	0.67	0.79
Ind styles in terms of ctr bench	0.60	0.78	0.71	0.32

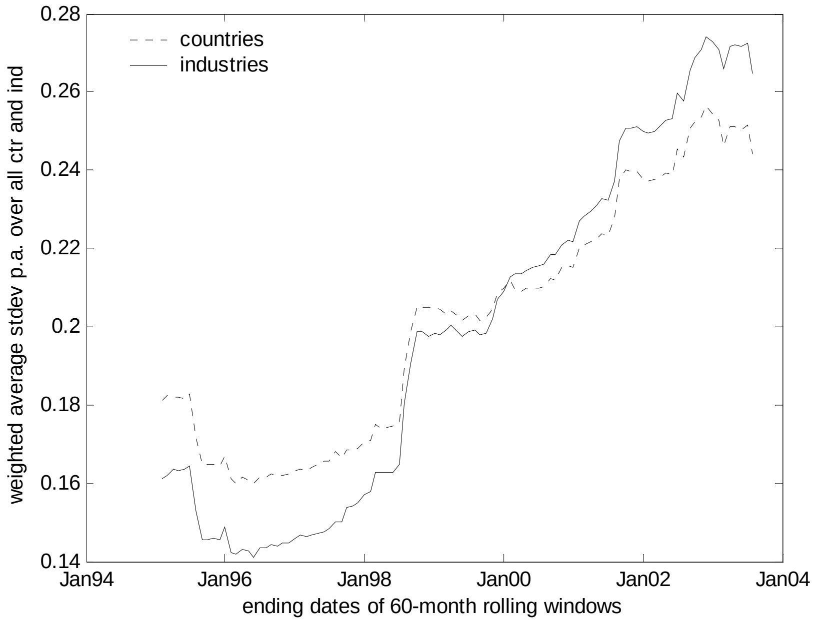
Panel B: Tests for joint significance of intercepts of pseudo regressions

	Full sample March 90-Aug 03	Pre-convergence March 90-Nov 94	Convergence Jan 95-Nov 98	Euro Jan 99-Aug 03
Industries as test assets. countries as benchmarks				
H_0: all industry intercepts equal zero	(0.003)	(0.007)	(0.000)	(0.347)
- excl	(0.045)	(0.065)	(0.000)	(0.573)
Countries as test assets. industries as benchmarks				
H_0: all country intercepts equal zero	(0.785)	(0.174)	(0.001)	(0.057)
- excl	(0.829)	(0.666)	(0.001)	(0.490)

Figure 1: Rolling window summary statistics

This figure plots 60-month rolling window weighted average volatilities and correlations. Panel A reports the weighted average country and industry volatility (per annum) where the weights are the average weights of the country or industry in the Euro-wide market index during that particular window. Panel B gives the weighted average cross-country and cross-industry correlations.

Panel A: weighted average volatility of returns on all country and industry indices per annum, over 60-month rolling windows



Panel B: weighted average cross-country and cross-industry correlations over 60-month rolling windows

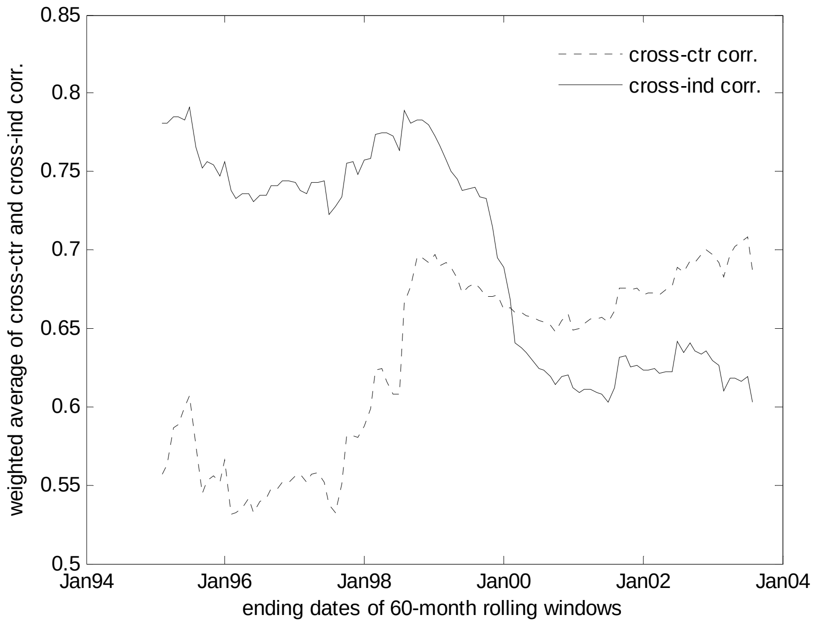


Figure 2: 60-month rolling window analysis of H_0: mean-variance spanning with short sales constraints

This figure plots the *p*-value of the spanning tests performed over 60-month rolling windows. The tests are based on indices excluding overlapping components. Short sales constraints are imposed on both the test assets and the benchmark assets. A *p*-value below 0.05 rejects the null hypothesis of mean-variance spanning.

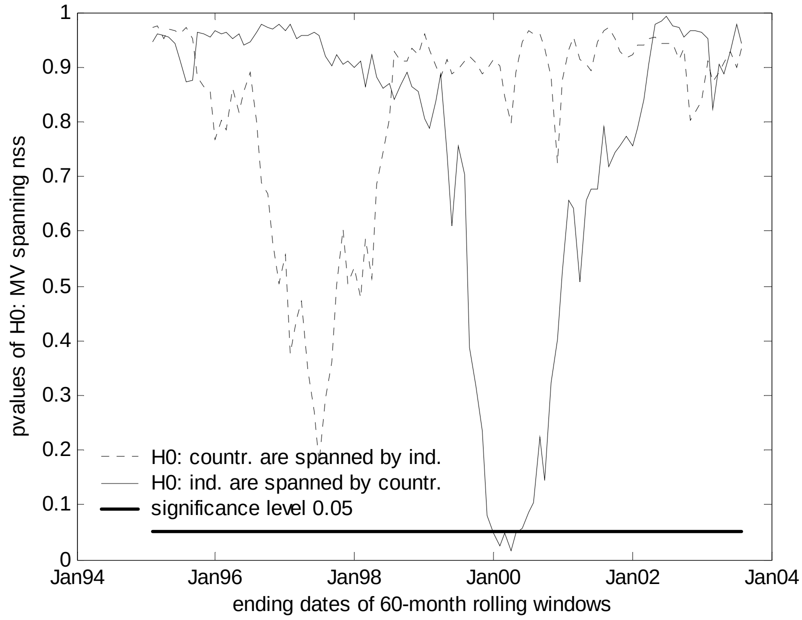
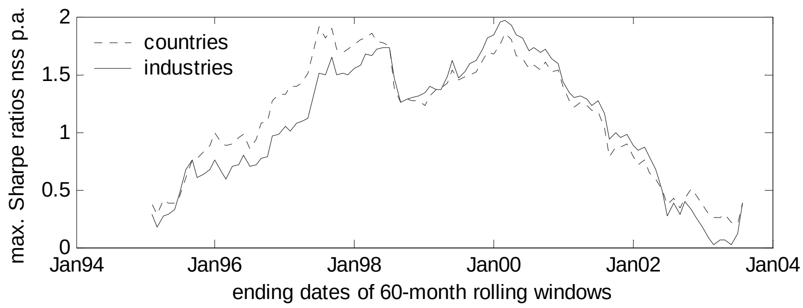


Figure 3: Maximum Sharpe ratios with short sales constraints

The upper figure plots the annual maximum Sharpe ratios of industry-based portfolios and of country-based portfolios over 60-month rolling windows. Short sales constraints are imposed. The lower figure plots the *p*-values corresponding to the null hypothesis of equal Sharpe ratios. If the *p*-values fall below 0.05 the null hypothesis is rejected at a 5% significance level.



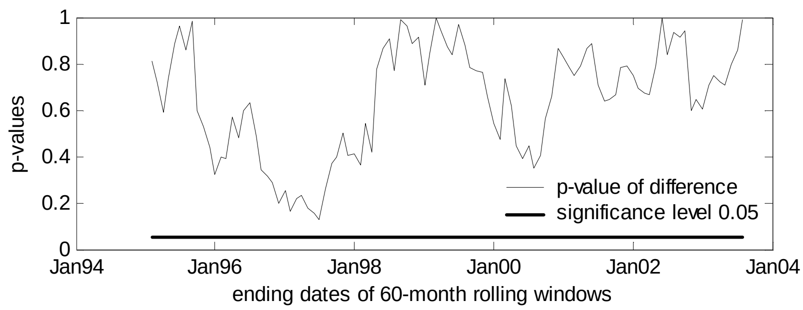
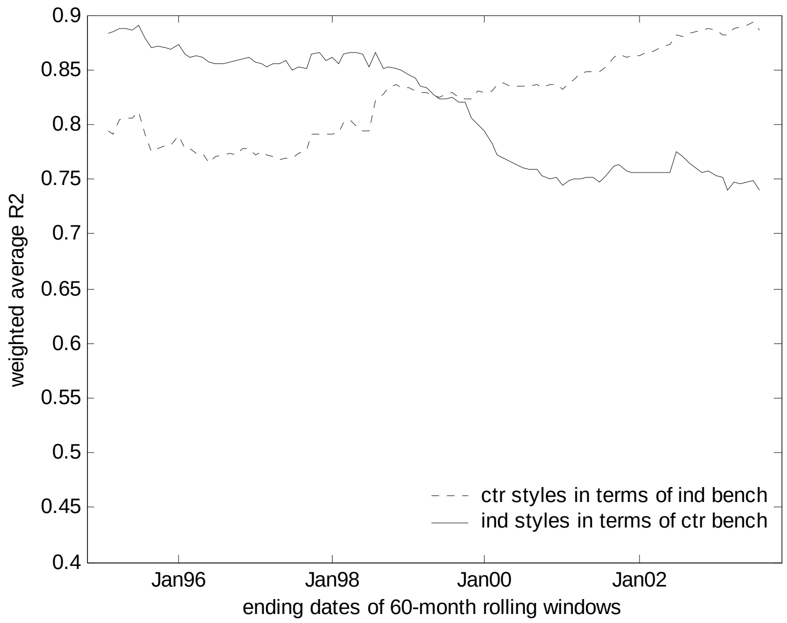


Figure 4: 60-month rolling window style analysis

The figure shows the results of the 60-month rolling window simple style analysis. Panel A plots the weighted average R^2s of the style regressions and panel B plots the weighted average standard errors (on an annual basis). For both panels the weights are determined by the average weights of the test assets in the Euro-wide index in the window used for the estimation of the style regression.

Panel A: weighted average R^2



Panel B: weighted average standard error, p.a.

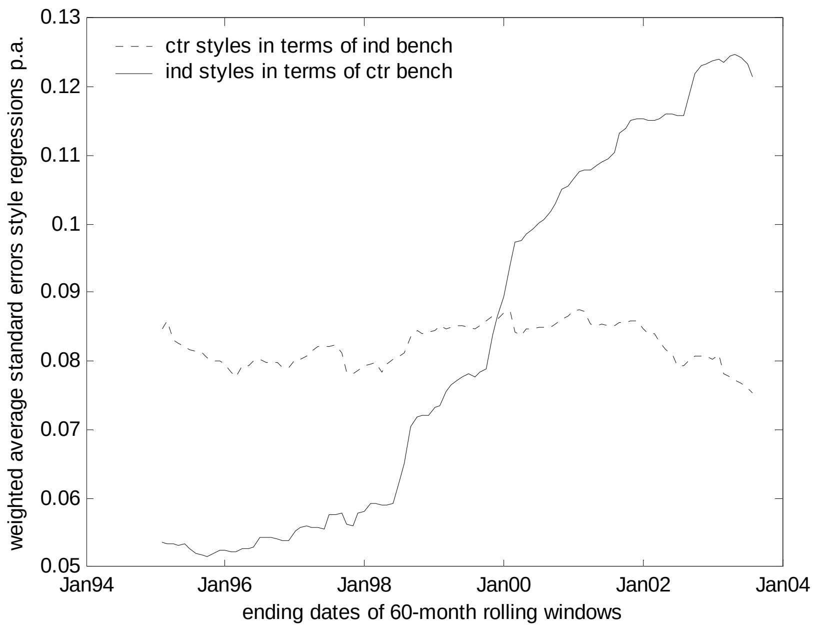


Figure 5: 60-month rolling window exclusive style analysis

The figure gives the weighted average R^2 for the 60-month rolling window exclusive style analysis. Overlapping components with the test assets have been removed from the benchmark indices. The weights are determined by the average weight of the fund in the Euro-wide index during the particular window.

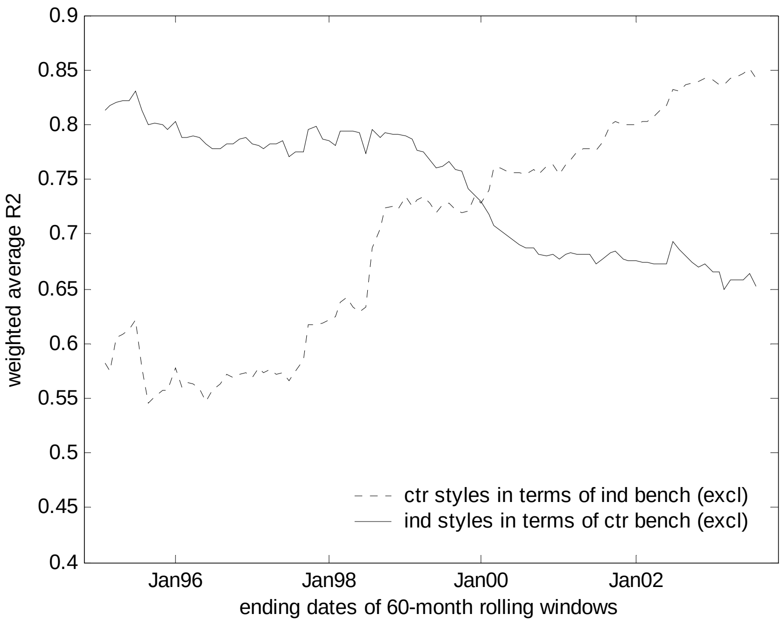
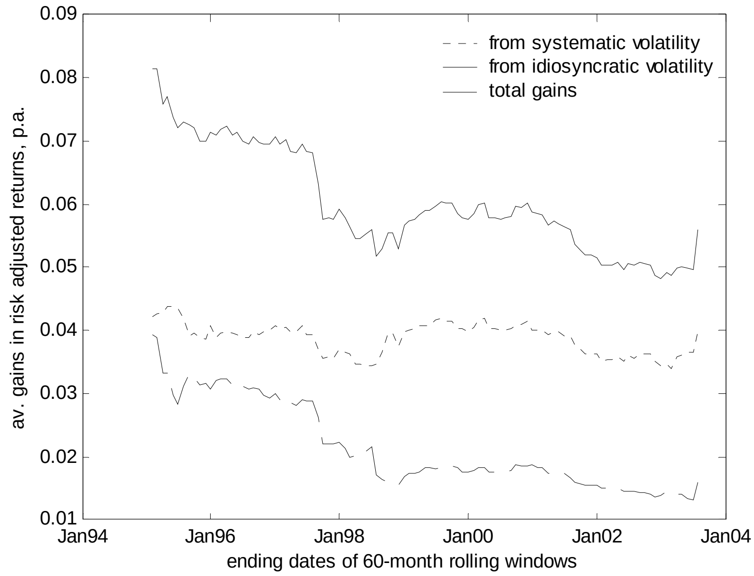


Figure 6: Average gains from international diversification

This figure plots the average annual gains from Euro-zone cross-country and cross-industry diversification over 60-month rolling windows. We estimate the average additional gains from investing in the optimal no-short sales country (industry) portfolio rather than in one country (industry) in terms of risk-adjusted returns (based on the M^2 measure). Panel A reports the gains from diversifying across countries. The extra gains from investing in the optimal country portfolio instead of investing in country *i* can be calculated as the difference in the return on country *i*'s index and the return on the optimal country portfolio, levered up to have the same volatility as country *i*. We split country *i*'s volatility into a systematic component (due to the industry structure) and an idiosyncratic component and we decompose the gains accordingly. The idiosyncratic volatility is the error term of the style regression of country *i*'s style in terms of the Euro-wide industry portfolios. We perform similar calculations for the industries; the results are reported in panel B. The mean excess returns are kept constant for all windows: they are estimated by the full sample averages. All numbers are expressed on an annual basis.

Panel A: Average annual gains from cross-country diversification



Panel B: Average annual gains from cross-industry diversification