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Asset Allocation in the Euro-zone:

Industry or Country Based?

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Abstract

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. We conduct our analysis from a portfolio performance perspective, using mean-variance spanning and efficiency tests as well as style analysis, and show how to adjust the tests for time varying market wide volatility. Although unconditional analysis over the full sample suggests that country-based or industry-based EMU-wide portfolios provide similar risk-return trade-offs, a rolling window analysis indicates a striking change in the structure of equity returns in the Euro-zone over the last decade. From 1992 to 1998 country-based strategies outperform industry-based strategies: country based strategies offer higher Sharpe ratios and higher diversification potential as indicated by both spanning tests and style analysis. In the pre-convergence period, equity returns in the EMU-zone clearly had a country structure. In contrast, after the introduction of the Euro the country outperformance has disappeared, both in terms of mean-variance efficiency and in terms of mimicking abilities. Industry factors and country factors are now equally important. Our findings suggest that following the adoption of the single currency, Euro-zone sector-based strategies, while not dominating country-based strategies, offer similar risk return trade-offs and diversification benefits.

JEL classification: G11, G15

Keywords: International financial markets, Mean-variance efficiency, Style analysis, EMU

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1 Introduction

This paper uses a portfolio 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. As the diversification benefits and the risk-return trade-off of global or regional portfolios depend critically on the covariance structure of returns of the component assets, it is of particular interest to study the factors that drive co-movements in asset returns.

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). 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 2003). In practice, fund managers conventionally employed a so-called top-down approach. They first selected the countries in which to invest, thereafter they chose the industries within the selected countries (Adjaouté and Danthine 2002).

As of the introduction of the Euro, currency risk between the Euro-countries has been eliminated. De Santis and Gerard (1998) show that currency risk premiums are large and economically significant. Different exchange rates across countries thus lead to different currency risk premiums, resulting in more market segmentation and lower cross-country correlations. Conversely, the elimination of currency risk between the Euro-countries would in theory lead to higher correlations between countries (i.e. fewer opportunities for cross-country diversification). This view is supported by Adjaouté and Danthine (2001). They document a significant increase in correlations between returns on Euro-countries equity indices after the introduction of the Euro. However, they find the same increase in correlations after adjusting for currency effects, suggesting that the elimination of currency risk is not the main cause. De Santis, Gerard and Hillion (2003) show similar results. During the 1990s international financial markets had a decreasing exposure to EMU currency risk, while exposures to non-EMU currency risk significantly increased. This suggests that the adoption of a single currency will probably have a limited impact on optimal diversification strategies for global investors.

This leads to an interesting puzzle. In spite of the expectation that the introduction of the Euro will have a limited impact on international equity returns, there is a significant increase in cross-country correlations in the Euro-zone. Furthermore, in practice many fund managers changed their asset allocation strategy after the single currency was introduced. For example, according to a survey by Goldman and Sachs, Watson and Wyatt (1998)[1] over 60% of fund managers claimed to switch their allocation strategy from country to industry based.

Several recent papers address this issue. The evidence however, is still inconclusive. Some papers find an increasing importance of industry factors in the Euro-zone, which would support the shift in asset allocation strategies. For example, Ferreira and Ferreira (2003) find that although industries are becoming more important, country factors still dominate in the Euro-zone. According to Adjaouté and Danthine (2002) industry factors have become superior to country factors. On the other hand, Rouwenhorst (1999) and Ehling and Ramos (2004) find evidence in favour of country dominance in the EMU-countries.

We contribute to the existing literature in several important ways. First, most of the recent papers that compare industry versus country factors use the empirical approach first proposed by Heston and Rouwenhorst (1994) and subsequently modified by Griffin and Karolyi. One drawback of this methodology is that it requires strong restrictions on the cross section of international equity returns to obtain identification. Brooks and Del Negro (2004) document that, in most cases, these restrictions are rejected by the data.

Instead, we conduct our analysis using two complementary methodologies: efficiency tests and style analysis. First we use mean–variance spanning tests to investigate whether adding regional industry portfolios would significantly enhance the risk-return trade-off of country-based portfolios and conversely. Using a test developed by Gerard, Hillion and De Roon (2003), we directly compare cross-country against 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 under short sales constraints. In a second stage, we perform a style analysis to compare the mimicking abilities of country-based versus industry-based portfolios. We examine whether it is easier to replicate regional industry portfolios with country equity indices or country indices with regional industry portfolios. In contrast to spanning and efficiency tests, style analysis does not depend on estimates of mean returns, but focuses only on the covariance structures that can be estimated more accurately.

Second, we extend the efficiency tests and style analysis approach proposed by Gerard, Hillion and de Roon (2003) in two important dimensions. First, the level of aggregate market wide volatility changed dramatically over the long samples we examine. Time-varying market wide volatility may significantly affect the results of our tests and hence needs to be controlled for. We show how to adjust the spanning tests and style analysis for changes in aggregate volatility and provide a portfolio interpretation of this adjustment. Second, we

[1] http://www.watsonwyatt.com/europe/pubs/investment/articles/1998_08_05.asp, visited on 16-02-2004

provide a test of the significance of the changes in R^2s of the style regressions over time by simulating the empirical distributions of the average R^2s of the style regressions.

Third, our sample contains monthly returns on country and industry indices for all countries that have adopted the Euro in January 1999[2]. Our sample period extends from April 1990 to September 2003 and covers close to five years after the adoption of the single currency. In addition to the analysis based on the full sample period we consider three separate subsamples: a pre-convergence period that ends in December 1994, a convergence period from January 1995 to December 1998 and the Euro period post adoption. Moreover, rolling window analyses allow us to examine the development of the relative performance of countries versus industries over time.

Fourth, the correlations between country and industry indices may be high because of the common components of the indices. Hence, all analyses and tests are repeated by excluding overlapping components from the benchmark indices to assess pure country and pure industry effects.

Brooks and Del Negro (2002) find that the increasing importance of industry factors disappears after controlling for the internet bubble. This suggests that it may be essential to control for the IT hype in our analysis – we replicate all our tests excluding the IT industry. Additionally, we control for the currency risk between Euro-countries prior to 1999 and for the size of the rolling windows. We also perform our analysis in an extended sample starting in 1975 to assess the relative importance of country and industry factors over a longer period.

The spanning tests over the full sample period suggest that countries do not outperform industries and industries do not outperform countries either. This finding is confirmed by the test of the difference in maximum Sharpe ratios. Under short sales constraints industries have a maximum Sharpe ratio of 0.183 and the country Sharpe ratio is 0.188. The difference is insignificant. In all three subsamples countries span industries and industries span countries when there are short sales constraints on both the test assets and the benchmark assets. Also, the difference in Sharpe ratios is insignificant in all subsamples.

The ability of style portfolios consisting of country indices to mimic regional industry portfolios and of regional industry style portfolios to replicate country indices is evaluated by considering the value-weighted average R^2 (taking all countries, respectively all industries as funds) of the style regressions. Over the complete sample period, industries and countries have similar mimicking abilities. The difference in the average R^2s is insignificant. When overlapping elements are removed from the benchmark indices, the ability of either set of benchmarks to mimic the other decreases and the difference remains insignificant. However, the subsample analysis shows a remarkable change over time. Whereas in the pre-

[2] Luxembourg is excluded, Greece, which adopted the Euro in 2001 is included.

convergence period countries possess significantly better mimicking abilities, the converse is true during the convergence period. In the post Euro adoption period the difference in mimicking abilities is statistically insignificant. These subsample results suggest a change in the relative performance of industries and countries.

The results of the rolling window analyses provide a sharper contrast between the pre and post single currency period. In the period from 1992 to 1998 countries outperform industries. Countries are not spanned by industries and up to 1997 they earn significantly higher Sharpe ratios. Also, the style analysis shows that countries had superior mimicking abilities over industries. In contrast, after the introduction of the Euro, the outperformance of the countries has disappeared. Countries are spanned by industries and vice versa, even though there are a few windows in which this is not the case. In this period, the Sharpe ratios of countries and industries are indistinguishable. The style analysis shows that after the introduction of the Euro, it is considerably more difficult to replicate regional industry portfolios with country benchmarks than to mimic country portfolios with Euro-zone industry indices. This pattern is strengthened when the fund-specific components are removed from the benchmark indices. Nevertheless, the subsample style analysis shows that the difference in mimicking abilities is not statistically significant in the Euro period.

This paper provides evidence of significant changes in the structure of equity returns in the Euro-zone over the period leading to the adoption of the single currency and following the introduction of the Euro. Whereas country factors dominate before the introduction of the Euro, thereafter industry factors and country factors are equally important. Our results demonstrate that investing in country-based portfolios is no longer necessary in order to achieve mean-variance efficiency. Fund managers employing sector-based asset allocation strategies are not foregoing any diversification benefits relative to country-based strategies. Our results remain unaffected after controlling for time varying market volatility. Thus, the differences in performance of country- and industry-based portfolios are not driven by changes in market volatility. Furthermore, our results are robust in an extended sample and for the internet bubble, the size of the rolling windows and currency risk prior to the introduction of the Euro.

The remainder of the paper is constructed as follows. Section 2 discusses the methodology. The first subsection focuses on the spanning tests and the test for the difference in maximum Sharpe ratios. The second subsection reviews the methodology of the style analysis based tests and describes how to test for differences in average R^2s of the style regressions. In the last subsection, we outline how to adjust all the tests for time varying market volatility. Section 3 describes the data and section 4 reports the results. Subsequently, the robustness checks are described in section 5 and section 6 concludes.

2 Methodology

The two methodologies we use, efficiency tests and style analysis, are both based on returns on country and industry indices. Throughout, countries will be indicated 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 will be referred to as subindices. To construct regional industry indices, we aggregate the subindices over the industries. Similarly, by aggregating them over countries we compute the country indices. As a result, the indices have overlapping components. The country and industry indices are all based on the same set of subindices. Therefore all country indices combined consist of the same assets as all industry indices combined. This allows us to directly compare countries versus industries. Appendix A provides full details on the calculation of the returns on the country and industry indices.

2.1 Efficiency tests

Are portfolio managers right when they focus on cross-industry diversification rather than cross-country diversification? Should investors in the Euro-countries invest in industries, in countries or in both? 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:

$$r_t^x = a_x + B_x r_t^y + \varepsilon_t^x \qquad \text{(1a)}$$

$$r_t^y = a_y + B_y r_t^x + \varepsilon_t^y \qquad \text{(1b)}$$

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. It follows from this set-up that 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 the portfolio of the benchmark assets and the test assets combined. A positive Jensen measure means outperformance of the test asset that can be accomplished by taking a long position in the test asset. Conversely, the test asset underperforms the benchmark assets in case of a negative Jensen measure. Then a short position in the test asset is required to attain the optimal portfolio. A zero Jensen measure implies mean-variance spanning. In that case the mean-variance frontiers of the benchmark assets only and of the benchmark assets and the test asset together coincide and it is sufficient to invest in the benchmark assets only.

In order 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. 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 regional industry portfolios and country indices are created from the same sample, implying that they have overlapping components. A country index consists of all industries in that country and an industry index consists of that industry in all countries. Thus, a positive (negative) Jensen measure implies that the benchmark assets are underweighed (overweighed) w.r.t. the test asset.

In order to distinguish pure country and pure industry effects we compute the Jensen measures after removal of the overlapping components from the benchmark assets. For example, if the index of France is the test asset, all French components are excluded from the industry indices (the benchmark assets). The regressions for country *i* and for industry *j* are as follows:

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

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

Here, $r_{j,t}^{y\backslash i}$ ($r_{i,t}^{x\backslash j}$) is the excess return from time *t-1* to *t* on the index of industry *j* (country *i*) excluding country *i* (industry *j*) from that index. 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 overlapping components have been removed, a positive (negative) Jensen measure indicates that a long (short) position should be taken in the test asset[3].

In practice it may not be possible to take short positions. At the same time it is well known that mean-variance efficient portfolios for a particular sample may often yield extreme long and short positions. We therefore especially focus on spanning tests under short sales constraints to avoid unrealistic positions. We impose short sales constraints on both the test

[3] The test whether all Jensen measures are jointly equal to zero is not a traditional spanning test (e.g. Jobson and Korkie 1989), as the test assets have different benchmark assets.

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).[4]

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 and De Roon (2003). 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

$$\theta^2 - \theta_x^2 = a_y'\Omega_{yy}^{-1}a_y \tag{4a}$$

$$\theta^2 - \theta_y^2 = a_x'\Omega_{xx}^{-1}a_x \tag{4b}$$

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

$$\lambda = \theta_y^2 - \theta_x^2 = a_y'\Omega_{yy}^{-1}a_y - a_x'\Omega_{xx}^{-1}a_x \tag{5}$$

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.

$$\Omega_{xx}^{-1/2} r_t^x = c_x + D_x r_t^y + u_t^x \tag{6a}$$

$$\Omega_{yy}^{-1/2} r_t^y = c_y + D_y r_t^x + u_t^y \tag{6b}$$

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:

$$c_x = \Omega_{xx}^{-1/2} a_x \tag{7a}$$

$$c_y = \Omega_{yy}^{-1/2} a_y \tag{7b}$$

Thus, the null hypothesis is equivalent to:

$$H_0 : \lambda = c_y'c_y - c_x'c_x = 0 \tag{8}$$

The Wald test statistic of this nonlinear constraint will be asymptotically χ_1^2-distributed. Gerard, Hillion and De Roon (2003) describe how to construct consistent estimates of the covariance matrices Ω_{ii}.

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[4] Note that 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 w.r.t. the test asset.

The portfolios that yield the maximum Sharpe ratios may require taking extreme long or short positions. Therefore, akin the spanning tests we focus on Sharpe ratios under short sales constraints. Only those country or industry indices that have positive weights in the tangency portfolios are considered when computing the maximum Sharpe ratios (De Roon, Nijman and Werker 2001).

The tests discussed above are first performed over the complete sample period, which runs from April 1990 to September 2003. It includes the period before the Euro was introduced as well as the convergence period and the period in which the single currency has been adopted. In order to examine whether the test results are different in the various stages of the EMU convergence process, we also perform the tests for three separate subsamples. The pre-convergence period is the first subsample. It is from April 1990 to December 1994 and ends just before the date of entry of the Maastricht Treaty in January 1995. The second subsample, the convergence period, is from February 1995 to December 1998[5]. It ends before the introduction of the Euro. The Euro-period is the last subsample and is from February 1999 to September 2003. By choosing them in this manner, we base them exogenous events that indicate new phases in the EMU convergence process. Also, all three subsamples have comparable sizes (57, 47 and 56 observations).

Moreover, we perform a rolling window analysis for the spanning hypothesis and for the maximum Sharpe ratios to further examine the development of our results over time. We choose 60-month windows, which are partly overlapping.

2.2 Style analysis

If asset class can easily replicate asset class *Y* but assets *Y* do a poor job in replicating assets *X*, this means that there is some variation in the returns on assets *X* that cannot be captured by assets *Y*. Therefore, one would prefer to invest in asset class *X* rather than *Y*. Investing in *X* yields the same investment possibilities as investing in *Y*, whereas the reverse is not true[6]. Using style analysis (Sharpe 1992), we can compare investing in industries to investing in countries. Hence, we assess country versus industry performance based on two complementary methodologies, efficiency tests and style analysis. Whilst the former compares mean-variance efficiency and depends also on the estimation of mean returns, the latter considers mimicking abilities by focusing 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 style regression looks as follows:

[5] The second subsample starts in February, because the return of January 1995 is based partly on the indices of December 1994. By starting in February, the subsamples are non-overlapping.
[6] That is, in terms of risk profiles. Our style analysis does not take into account mean returns.

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

The coefficients of the benchmark assets represent the style of the fund. In other words, they represent the weights of the benchmark assets in the replicating portfolio of the fund. Thus, these coefficients are constrained. They have to be nonnegative and they have to sum to one. Unlike the efficiency tests, we base our style analysis on total returns R_t rather than excess returns r_t. We look for the portfolio that replicates the fund's style best. The weights of the benchmark assets are chosen such that the variance of the error term e_{fund} is minimized. We compare the mimicking abilities of the benchmark assets using R^2. This is the proportion of the fund's variance that is explained by the benchmark assets. The performance of countries is measured by the weighted average R^2 over all industries as funds. The weights are determined by the average weights of the industries in the Euro-wide index. Similarly, industry performance is measured by the weighted average R^2 taking all countries as funds.

The returns on a country or industry index (the fund) are regressed on the returns on industry or country indices (the benchmark portfolios). The style regression for country styles in terms of industries is as follows:

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

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

and the style regression for industry styles in terms of countries is:

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

s.t. $\sum_{i=1}^{K} \beta_{ji} = 1$ and $\beta_{ji} \geq 0, i = 1,....,K$

where $R_{i,t}^x$ ($R_{j,t}^y$) is the return on the country index of country *i* (industry *j*) from time *t-1* to time *t*.

Industry and country indices are created from the same sample of subindices. This implies that they have overlapping components. If, for instance, financials has a large weight in the Dutch index, the benchmark financials could receive a larger weight in the replicating portfolio for the Netherlands because of the overlapping component. Similarly to the spanning tests, we eliminate overlapping components between the funds and benchmark indices in the 'exclusive' style analysis. This allows us to examine the pure country and pure industry effects. It implies that the different funds now have different benchmark indices. The 'exclusive' style regressions are given by the following equations:

$$R_{i,t}^{x} = \alpha_i + \sum_{j=1}^{N} \beta_{ij} R_{j,t}^{y\backslash i} + \varepsilon_{i,t}^{x} \qquad (10a)$$

$$R_{j,t}^{y} = \alpha_j + \sum_{i=1}^{K} \beta_{ji} R_{i,t}^{x\backslash j} + \varepsilon_{j,t}^{y} \qquad (10b)$$

Here, $R_{j.t}^{y\backslash i}$ ($R_{i,t}^{x\backslash j}$) is the return on the index of industry *j* (country *i*) excluding country *i* (industry *j*) from that index.

Akin the efficiency tests, we perform the style analysis for the full sample, for three subsamples and for 60-month rolling windows.

2.3 Test for differences in R^2 of style regressions

In this paper we measure outperformance of countries or industries in terms of mean-variance spanning, maximum Sharpe ratios and in terms of mimicking abilities. Differences in performance are tested formally in the efficiency tests. Concerning the style analysis, the empirical distributions of the average R^2s of the style regressions are simulated to test the differences in mimicking abilities. More specifically, we test the difference between the average R^2s of the style regressions taking countries as funds and taking industries as funds. This test is performed for the full sample and the three subsamples. Also, we test differences in average R^2 (for countries as funds or for industries as funds) between the three subsamples to determine the significance of changes over time.

We assume that the returns on the subindices 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 subindices are available for the full sample period. Some subindices start later than April 1990 and others end before September 2003[7]. We use the maximum likelihood estimators proposed by Stambaugh (1997). The general idea is that the longer histories of certain subindices provide additional information on moments of the returns on the longer history subindices as well as on the shorter history subindices. The estimates of the means and covariances of shorter history subindices are based on regressions of these shorter history subindices on all longer history subindices (for the period in which they are all available)[8]. This technique allows us to estimate the mean returns and the 'sample covariance matrix'.

[7] Out of the 110 subindices, 6 are unavailable for the full period. 85 subindices are available for the full period, 17 start later, 1 subindex ends earlier and 1 starts later and ends earlier.

[8] Because some subindices have a very short history, the number of independent variables would exceed the number of observations in the regressions. We therefore only select the subindices 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

Second, the number of observations is small relative to the number of subindices. The usual sample covariance matrix imposes too little structure and becomes singular when estimated for a subsample. Ledoit and Wolf (2003) impose additional structure on the estimator by the technique of shrinkage. The estimated covariance matrix is a weighted average of the sample covariance matrix and a shrinkage target. A single index model is used as a shrinkage target. The weight (the shrinkage intensity) of the shrinkage target 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. If the correlation is negative, there are more advantages of combining the two matrices and the shrinkage intensity is higher.

We select the starting values of the total return indices ($RI_{i,j,t}$) and market values ($MV_{i,j,t}$) of the subindices from our sample. Then we simulate the returns on the subindices for all T observations. When a certain subindex is unavailable at time t, it is also unavailable at time t in the simulated time series. We construct the country and industry indices from these simulated subindices and perform normal and exclusive style analyses using the returns on the country and industry indices. The construction of the indices and the style analyses for the simulated data are exactly the same as our calculations for the actual sample. The only deterministic parameters that enter the simulations are T, K, N, the starting values of $RI_{i,j,t}$ and $MV_{i,j,t}$, the starting and ending dates of the subindices and the parameters of the normal distribution. Each simulation results in one value of the average R^2 taking countries as funds and one value of the average R^2 taking industries as funds. 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 subsamples and for the full sample separately.

2.4 Control for time varying market volatility

It is a stylised fact that the volatility of asset returns is serially correlated. Large (positive or negative) returns tend to be followed by more large (positive or negative) returns. In other words, the market exhibits different volatility regimes. This time varying market volatility may affect the relative performance of country and industry based portfolios. We therefore adjust the spanning test and style analysis to incorporate time varying market volatility.

subindices 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.

2.4.1 Spanning test

Controlling for time varying market volatility resembles the use of instruments in spanning tests (DeRoon and Nijman 2001). The conditional volatility at time t is denoted as σ_t (for the period from time t to time $t+1$). Define the instrument Z_t as the inverse of the conditional market volatility: $Z_t \equiv \sigma_t^{-1}$. Now we can interpret the scaled excess returns $Z_t r_{t+1} = \sigma_t^{-1} r_{t+1}$ as the payoff of a strategy when each period Z_t is invested in the assets that are included in the vector of excess returns r. Thus, the scaled excess returns can be seen as excess returns on actively managed portfolios as the amount of Euros invested, Z_t, changes over time. 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. As we want to control for time varying market volatility, investors are only allowed to invest in the actively managed portfolios and not in the original assets directly.

In order to test for mean-variance spanning we can perform the following regressions (similar to (1a) and (1b)) for scaled excess returns:

$$(Z_t r_{t+1}^x) = a_x^Z + B_x^Z (Z_t r_{t+1}^y) + \varepsilon_{t+1}^{x,Z} \qquad (11a)$$

$$(Z_t r_{t+1}^y) = a_y^Z + B_y^Z (Z_t r_{t+1}^x) + \varepsilon_{t+1}^{y,Z} \qquad (11b)$$

The null hypothesis of mean-variance spanning using instruments (for equation (3a)) can be formulated as follows:

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

where μ_x^Z (μ_y^Z) is the expected scaled excess return on the country (industry) indices. This adjusted spanning test is very similar to the spanning test described in the previous section. We perform regressions based on scaled excess returns and test whether the intercept equals zero. Since the conditional market volatility is always positive, we can impose short sales constraints on scaled excess returns in the same way as we do for excess returns.

2.4.2 Style analysis

In a period of high market volatility it is possible that the replicating portfolio of countries or industries is able to explain a smaller portion of the total variance not because of lower correlations but because of a higher total variance. Thus, next to the spanning test we also control for time varying market volatility in the style analysis. The style regressions are now performed on standardized returns:

$$\frac{R_{i,t+1}^x}{\sigma_t} = a_i + \sum_{j=1}^{N} b_{ij} \frac{R_{j,t+1}^y}{\sigma_t} + e_{i,t+1}^x \qquad (12a)$$

$$\frac{R_{j,t+1}^y}{\sigma_t} = a_j + \sum_{i=1}^{K} b_{ji} \frac{R_{i,t+1}^x}{\sigma_t} + e_{j,t+1}^y \qquad (12b)$$

The returns are scaled by the conditional market volatility[9]. These regressions can be compared to weighted least squares type regressions, but here the weights change over time. Since the variables are scaled by a term that is time varying, the coefficients of the style regressions on scaled returns are different from those of the usual style regressions. As has been explained in the previous section, the scaled return $\sigma_t^{-1}R_{t+1}$ can be interpreted as the return on an actively managed portfolio. At time $t+1$ the investor holds an amount of σ_t^{-1} Euro in the asset and receives return $\sigma_t^{-1}R_{t+1}$. Consequently, the coefficients b of the style regression on the scaled returns can be interpreted as the weights of the actively managed portfolios of the benchmark assets in the mimicking portfolio of the actively managed portfolio of the fund.

As the returns on the right hand side and the left hand side of the style regression are scaled by the same variable σ_t which is always positive, the portfolio and nonnegativity constraints in (9a) and (9b) are still valid.[10]

3 Data

We use monthly returns on ten EMU-zone industry indices and eleven country indices from April 1990 to September 2003, a total of 162 observations. The country/industry subindices[11] 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.

3.1 Summary statistics

Table 1 displays summary statistics for the returns on the country and industry indices as well as the interest rate. The average market weights of the countries and industries in the Euro-wide market index are also reported. The country with the highest mean return is Finland, the mean return is 2.90%. This is significantly higher than the average over all other countries of 1.08%. 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. 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. This hints at higher industry performance in terms of

[9] Since σ_t is the conditional volatility for the period from time t to time $t+1$ and R_{t+1} is the return over period t to $t+1$ we scale returns by the current volatility.

[10] When we impose that the weights of the actively managed portfolios add to one, we impose that the holdings of the actual benchmark assets at time $t+1$ add to σ_t^{-1}. However, as the returns on the fund are also scaled by σ_t^{-1}, the portfolio of benchmark assets replicates the return on the actively managed portfolio of the fund. In other words, it replicates at time $t+1$ the investment of σ_t^{-1} in the fund. Thus, the portfolio constraint on the coefficients in the style regression on scaled returns is appropriate. A similar argument applies to the nonnegativity constraint.

[11] e.g. resources in France

mean returns. The null hypothesis that all means are equal cannot be rejected, for countries or for industries.

Over all industries, the financial sector has the largest weight in the Euro-wide market index, namely about 29%. Not surprisingly given that they are the two main economies of the Euro-zone, Germany and France constitute more than half of the Euro-wide market index. The industry weights in the country indices and the country weights in the regional industry indices[12] are similar to the weights in the Euro-wide index. The financial sector is the largest component of the country indices and Germany and France are the main components of the industry indices.

The mean correlation of country indices with industry indices is 0.535. This is higher than the cross-country and cross-industry correlation (0.466 and 0.494 respectively). Generally the returns on countries are less correlated than the returns on industries, implying more benefits from cross-country diversification. However, the difference in correlations is small and the average is based on the complete sample period. Therefore this correlation structure gives us limited insights into the relative importance of country and industry factors for international equity returns and the development over time.

3.2 Volatility of Euro-wide market index

In order to determine whether the Euro-wide market index indeed exhibits time varying volatility, we first compute the autocorrelation in squared returns on the index and find that autocorrelation is present. To quantify this we perform Engle's ARCHtest (Engle 1982) for 1 up to 12 lags. The null hypothesis that the ARCH parameters for the specified lags are equal to zero is rejected at a 5% significance level for all lags. We can therefore conclude that the returns on the market index exhibit volatility clustering.

To control the spanning tests and style analysis for time varying market volatility, we use a GARCH(1,1) model[13] (Bollerslev 1986) that is specified as follows:

$$R_{t+1} = \mu + \varepsilon_{t+1}$$

$$\varepsilon_{t+1} \sim N(o, \sigma_t^2)$$

$$\sigma_t^2 = \sigma^2(1-\alpha-\beta) + \alpha\varepsilon_t^2 + \beta\sigma_{t-1}^2$$

where R_{t+1} is the return on the Euro-wide market index, μ is its mean and ε_{t+1} is the innovation at time $t+1$. The conditional variance of the return on the market index is σ_t^2. It is the variance for the period from t to $t+1$ conditional on the information at time t. We estimate the model

[12] These can be made available upon request from the authors.

[13] 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 indicates that asymmetry is not present in the data.

by maximum likelihood and we find the following coefficients (the standard errors are given in parentheses).

$$R_{t+1} = 0.011 + \varepsilon_{t+1}$$
$$\quad (0.005)$$
$$\sigma_t^2 = 0.001 + 0.221\varepsilon_t^2 + 0.435\sigma_{t-1}^2$$
$$\quad (0.001) \quad (0.129) \quad (0.320)$$

Figure 1 shows the estimated conditional variance. The plot clearly demonstrates the different volatility regimes in our sample period. Up to 1998 the market variance was relatively low. As of 1998 the variance has increased substantially. We perform an ARCHtest for 1 up to 12 lags on the innovations divided by their conditional standard deviations. Indeed, we cannot reject the null hypothesis that all ARCH parameters are zero for the specified lags. This indicates that the GARCH(1,1) model captures the volatility clustering. We will use these conditional variance estimates to scale the raw and excess returns for the style analysis and spanning tests.

4 Results

4.1 Efficiency tests

We first compare countries and industries in terms of mean-variance efficiency. Countries outperform industries when they are not spanned by industries or when their maximum Sharpe ratio is significantly higher than that of the industries. We perform three kinds of efficiency tests. First, we consider the individual Jensen measures of the industry or country test assets. Subsequently we perform 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 mean-variance efficient portfolios for a particular sample often yield extreme long or short positions, we focus especially on the results when 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 complete sample. Except for Finland, which significantly outperforms the industry indices, none of the individual Jensen measures is significant. Finland’s Jensen measure is 1.46%. This outperformance is not surprising, given the high average return on the Finnish index. When country or industry components have been removed from the benchmark assets, all individual Jensen measures are insignificant. Next to the significance of the individual Jensen measures, we test the joint significance of the Jensen measures of all countries and of all industries. When short sales are allowed, mean-variance spanning implies that the Jensen measures jointly do not differ significantly from zero. Under short sales constraints, spanning implies that they are jointly smaller than or equal to zero. When the benchmark assets span the test assets, the portfolio of benchmark assets is mean-variance efficient and does not have to be extended by the test assets. The results are presented in panel B of table 2. In all cases, we find that mean-variance spanning is not rejected. Also, when short sales are prohibited, spanning cannot be rejected at a 5% significance level. Countries are spanned by industries and industries are spanned by countries. In other words, it is sufficient to invest in country indices or in industry indices only.

In absence of short sales, countries have a slightly higher Sharpe ratio than industries (0.188 versus 0.183). When short sales are allowed, the maximum Sharpe ratio of the industries is 0.267 and exceeds the country Sharpe ratio of 0.255. In both cases, the difference between the Sharpe ratio of the countries and that of the industries is insignificant, both statistically and economically. The fact that industries are affected more by short sales constraints illustrates that in the tangency portfolio of the industries more short positions are taken than in the tangency portfolio of the countries. Overall, the Sharpe ratios are lower when short sales are not allowed.

In summary, based on the full sample both the spanning tests and the Sharpe ratios suggest that countries and industries are equally efficient.

4.1.2 Subsample analysis

So far, our analysis has been based on the full sample period from April 1990 to September 2003. This period contains a number of important events in light of the EMU, such as the introduction of the Euro. The situation in the beginning of the sample period is quite different from the situation at the end and this may not be visible from the tests on the complete sample period. Therefore, we perform the analysis for three different subsamples: a pre-convergence period, a convergence period and a Euro period. The summarized results are presented in panel B of table 2. We focus on the spanning tests and the Sharpe ratios and we do not report the individual Jensen measures.

Under short sales constraints, industries span countries and countries span industries in all three subsamples. When short sales are allowed, spanning is rejected in a number of periods. In the pre-convergence and the convergence periods, industries are not spanned by countries. In the Euro period countries do span industries. Countries are spanned by industries in all three periods when we consider full indices. However, after removal of overlapping components, spanning is rejected in the convergence period. These outperformances can only be achieved by taking short positions, which may be infeasible in practice.

Although the differences in Sharpe ratios are larger in some subperiods than in the full sample period, they remain insignificant for all periods both with and without short sales. Industries are affected more by the short sales constraints; their Sharpe ratios are noticeably lower. This implies that the higher Sharpe ratio of industries when short sales are allowed is difficult to attain in practice.

In general, the subsample results show that in all three subsamples countries and industries are equally efficient. It is sufficient to invest in either country-based or in industry-based portfolios.

4.1.3 Rolling window analysis

Our results of the subsample analysis may be affected by the choice of the subsamples. Therefore we also perform a 60-month rolling window analysis to examine the development over time of the mean-variance efficiency of industry- and country-based portfolios. As has been explained in the methodology section, the windows are overlapping. The first window is from April 1990 to March 1995, the second window runs from May 1990 to April 1995 etceteras. The horizontal axes of the figures give the ending dates of the windows.

First, we plot the p-values of the null hypothesis that there is mean-variance spanning. We use indices excluding overlapping components and we impose short sales constraints on both the test assets and the benchmark assets. The results are show in figure 2. If the p-values fall below the horizontal line at 0.05, mean-variance spanning is rejected at a 5% level. When we closely examine the time series of p-values we find that out of the 103 windows, spanning is rejected for countries in 14 windows and for industries in 6 windows. The period in which countries outperform falls before the introduction of the Euro. In the 14 windows ending between April 1997 and May 1998 spanning is rejected when countries are the test assets. So in the period from 1992 to 1998 countries outperform industries. During this period the p-values of the null hypothesis that industries are spanned by countries are close to one. In the six windows ending between July and December 2000 industries are not spanned by countries. Generally, after the single currency was introduced countries span industries and vice versa. The p-values are close to one at the end of the sample period implying that countries and industries are equally efficient.

Although the pattern of the p-values is quite similar when short sales are allowed, there are differences. The p-values fluctuate more and spanning is rejected more often. However, at the end of the sample period we again cannot reject the null hypotheses that countries are spanned by industries and vice versa.

The findings of the rolling window spanning tests are confirmed by the 60-month rolling window analysis of the maximum Sharpe ratios. Figure 3 shows the Sharpe ratios under short sales constraints. The maximum Sharpe ratios are quite close during most of the period. In the beginning they are about 0.1 after which they increase to 0.5 halfway the 1990s. At the end of the sample they are again approximately 0.1, which reflects the performance of the stock market in these periods. Similarly to the rolling window spanning tests countries outperform industries in a number of windows before the Euro. The Sharpe ratio of countries is significantly higher than that of industries in four 60-month windows ending in June, July, August and October 1997. This implies that in the period of approximately 1992 to 1997, countries earned a significantly better risk-return trade-off than industries. After the introduction of the single currency the Sharpe ratios are indistinguishable, which reinforces the results of the spanning tests.

When short sales are allowed, the period in which countries have a significantly higher Sharpe ratio is longer. In 17 60-month windows ending between March 1997 and August 1998 the difference is significant. The window in which countries no longer have a significantly better risk-return trade-off is roughly the one in which the introduction of the Euro is included. In the second half of the sample, the Sharpe ratios are virtually the same and the difference is insignificant.

Generally, in the period from 1992 to 1998 countries outperform industries in terms of mean-variance efficiency. Often they are not spanned by industries and up to 1997 they have a significantly higher Sharpe ratio. After the introduction of the single currency countries are spanned by industries and vice versa, although there are a few windows in which this is not true. The difference in Sharpe ratios is insignificant in all windows ending after 1997. In conclusion, whereas before the Euro counties outperform industries, thereafter countries and industries are equally efficient.

4.1.4 Spanning tests with time varying market volatility

In order to determine whether the relative performance of countries and industries in terms of mean-variance efficiency is affected by different volatility regimes, we adjust our spanning tests. We scale excess returns by the conditional time varying market volatility. This volatility is estimated by a GARCH(1,1) model as is discussed in section 3.2.

Panel C of table 2 presents the p-values of the spanning test when time varying market volatility is accounted for. For both industries and countries as test assets and for the full sample and the three subsamples the p-values are similar to those in panel B (without controlling for volatility). Indeed, the null hypothesis of mean-variance spanning is rejected whenever it is also rejected for the spanning tests in panel B. The conclusions of the 60-month rolling window spanning tests also remain unaffected. The period in which countries are not spanned by industries is shifted only marginally by one window. In 14 windows ending between March 1997 and June 1998 countries outperform. The same holds for the industry outperformance. In 6 windows ending between August 2000 and January 2001 industries are not spanned by countries. In conclusion, the results of the spanning tests are robust for time varying market volatility.

4.2 Style analysis

4.2.1 Full sample style analysis

Focusing on the covariance structure of country and industry returns, we use style analysis as a complementary methodology to assess the relative importance of country and industry factors. The set of assets with the best mimicking abilities (i.e. the highest average R^2) is considered to show superior performance. We test the significance of the differences in average R^2s using simulated empirical distributions. The style regressions are performed for full benchmark indices ('normal' style analysis) and for benchmark indices that exclude overlapping components with funds ('exclusive' style analysis). The results of the normal style analysis are presented in table 3 and those of the exclusive style analysis in table 4. The test for the difference in mimicking abilities can be found in panel B of table 5. We first discuss the weights of the replicating portfolios, and then we examine the mimicking abilities of the benchmarks.

By comparing the coefficients of the normal 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 fund or because its ability to mimic the fund. 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, in the normal style analysis the index of financials receives high weights in the replicating portfolios of the countries. When the components of financials are removed from the country indices, the coefficients remain high. This indicates that this industry is important for mimicking the country portfolios. Also, Germany and France, the two main economies in our sample, are important elements of the replicating portfolios for the industries. Conversely, the weight of information technology in the mimicking portfolio of Finland drops from 76% to 40% after the exclusion of the Finnish components. The difference is even more pronounced for the Dutch index as a benchmark for resources. In the normal style analysis it forms 90% of the replicating portfolio, while without its resources component it only receives a weight of 6%.

Overall, the coefficients do not seem to be affected much by the exclusion of fund-specific components from the benchmarks. To shed some light on this, we compute the Spearman rank correlation between the coefficients of the normal style regressions and those of the exclusive style regressions. These are presented in table 4. 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 except for Italy and resources all styles have significant positive rank correlations that are very close to one.

The mimicking abilities of the benchmark indices are evaluated by considering the weighted average R^2s over all (country- or industry-) funds. The weights are determined by the average weights of the funds in the Euro-wide index over the full sample period. When the countries are the funds, the average R^2 is 0.70. The replicating portfolios for industries have an average R^2 of 0.68. After removal of overlapping components, the average R^2s both decrease by 10%. Both analyses show that the mimicking abilities of industries and countries are very similar. Also, exclusion of overlapping components affects countries and industries in similar ways. R^2s for the exclusive style regressions are lower, as it is more difficult to mimic a fund if the benchmark indices do not contain any elements of that fund.

In section 2.3 of this paper it is explained how the empirical distributions of the average R^2s are simulated. We use these to test the significance of the difference between the average R^2 taking countries as funds and that taking industries as funds. Both for the normal and the exclusive style regressions the difference in average R^2 is 2%. The p-values of 0.734 and 0.626 for the normal and exclusive analysis respectively indicate that the differences are insignificant. This implies that the mimicking abilities of countries and industries over the full sample period are not significantly different.

4.2.2 Subsample style analysis

Similar to the efficiency tests, we perform the style analysis on three different subsamples in three different phases of the EMU convergence process. The results for the pre-convergence, convergence and Euro periods are presented in panel A of table 5. Whereas the average R^2s of countries as funds and industries as funds are very close for the full sample, we can now detect clear differences. The normal style analysis results in an R^2 of 0.73 of the country styles in terms of industries in the pre-convergence period. When we take industries as funds, the average R^2 is 0.84. This indicates an outperformance of countries in the first period. In the convergence period industries slightly outperform countries in terms of mimicking abilities. The average R^2 is 0.78 when countries are the funds and 0.74 when industries are the funds. Finally, in the Euro period industries outperform countries. The average R^2 taking countries as funds is 0.74 and it is 0.65 when industries are the funds. The exclusive style analysis shows similar results, but on a lower level.

In order to test whether an outperformance is significant, the empirical distributions of the differences in average R^2s in the three subsamples are simulated. We allow for changing covariances over time by estimating different distributions for the three periods. First, we test whether the differences in average R^2 when taking countries as funds and when taking industries as funds are significant. In other words, we test whether the outperformance of the countries in the pre-convergence period and that of the industries in the convergence and Euro periods are significant. Panel B of table 5 shows the differences in average R^2 and the corresponding p-values. We find that the outperformance of the countries in terms of mimicking abilities is significant in the pre-convergence period. For the normal style analysis the p-value of the difference in average R^2 is 0.002 and for the exclusive style analysis it is 0.003. The difference in R^2 in the convergence period is significant for the normal style analysis at a 5% level and for the exclusive style analysis at a 10% level. This implies that industries possess significantly better mimicking abilities than countries in the convergence period. Although the actual differences in R^2 are larger in the Euro period, they are statistically insignificant (the p-values are 0.353 and 0.189 for the normal and exclusive analyses).

We also test the difference in mimicking abilities between the different subsamples for countries and industries separately. This allows us to assess the significance of the changes over time. First, the performance of industries is stable over time. The differences in average R^2 (taking countries as funds) between the three subsamples are all insignificant, both for the normal and the exclusive style analysis. The mimicking abilities of countries are decreasing over time. The average R^2s taking industries as funds in the convergence period and in the Euro period are significantly lower than in the pre-convergence period. The p-values are 0.008 and 0.030 for respectively for the normal style analysis. This also holds for the exclusive style analysis (the p-values are 0.026 and 0.053). The mimicking abilities of countries in the convergence and in the Euro periods are not significantly different. This evidence shows that the ability of countries to mimic industries is decreasing over the three subsamples.

In conclusion, whereas the efficiency tests show similar country and industry performance in all three subsamples, the style analysis reveals differences in the pre-convergence and convergence periods. While the mimicking abilities of industries are stable, countries have a significantly decreasing performance. In the pre-convergence period countries significantly outperform industries and in the convergence period this is reversed. After the introduction of the single currency, countries and industries possess similar mimicking abilities.

4.2.3 Rolling window style analysis

A 60-month rolling window style analysis allows us to monitor the progress over time of the mimicking abilities of countries versus industries. Figure 4 shows the average R^2 for the normal style analysis and figure 5 presents the results for the exclusive style analysis. The weights depend on the average weights of the funds in the Euro-wide index during the particular window. They do not remain constant over the rolling windows.

In the first part of the sample countries have better mimicking abilities than industries. The average R^2s are about 0.84 and 0.72 taking industries respectively countries as funds. At the end of the sample, the situation has reversed. Taking countries as funds yields an R^2 of roughly 0.75, which is about ten percentage points above that of the industries. The exclusive style analysis results in the same picture, although the averages are lower and the differences in mimicking abilities are somewhat larger[14]. Thus, in both figures the average R^2 is higher for the industry funds in the beginning of the sample period and this reverses approximately at the time when the Euro is adopted. In the normal style analysis the reversal takes place in the window that runs from November 1993 to October 1998. In the exclusive style analysis the lines cross in the window from January 1995 to December 1999. In both cases there is only one point where the lines of the R^2s cross. This implies that before the introduction of the single currency, countries had better mimicking abilities than industries. After, industries can more easily replicate the style of the countries.

These results confirm our findings of the subsample analysis. Similar to those results, the performance of countries is decreasing while the performance of industries seems quite stable. However, when we focus on pure country and industry effects (in the exclusive style analysis) we see an increasing industry performance. The country outperformance in terms of mimicking abilities before the Euro reinforces the results of the rolling window efficiency tests. In this period there are a number of windows in which countries are not spanned by industries and in which countries yield a significantly higher Sharpe ratio. However, after the Euro was introduced industries outperform countries in terms of mimicking abilities but countries and industries perform similarly in terms of mean-variance efficiency. As the subsample style analysis indicates that the outperformance of industries in the Euro period is insignificant, we conclude that after the introduction of the Euro countries and industries show similar performance.

4.2.4 Style analysis with time varying market volatility

In order to examine whether changes in mimicking abilities are affected by changes in market volatility, we control for this time varying volatility in our style analysis. Using the GARCH(1,1) model from section 3.2 we scale the returns by the conditional volatility. The full sample and subsample results are presented in panel C of table 5. The average R^2s are very similar to those in panel A, which implies that the relative performance of country and

[14] In the beginning of the sample period, the average R^2 was about 0.75 for industry funds and 0.50 for country funds. At the end of the sample countries have become easier to mimic. The average R^2s of country and industry funds are 0.70 and 0.55 respectively.

industry based portfolios is unaffected by the different volatility regimes. For brevity, the results of the 60-month rolling window analysis are not given in the paper.[15] Again in the first part of the windows countries possess superior mimicking abilities. The window in which this changes ends in February 1999, which is four windows later than without controlling for volatility. In general, the conclusion that whereas before the introduction of the Euro countries outperform and thereafter countries and industries show similar performance, remains valid.

5 Robustness check

In this paper we assess the performance of country-based and industry-based portfolios in the Euro-zone. So far our analysis is based on monthly data from April 1990 to September 2003. We find that before the Euro was introduced countries outperform industries in terms of mean-variance efficiency and in terms of mimicking abilities. After the adoption of the single currency countries and industries perform similarly. This section discusses a number of robustness checks. First, we consider a longer sample starting in February 1975 to assess the country and industry performance before 1990. Also we control for the internet bubble at the end of the 1990s by excluding the information technology sector. Furthermore the size of the rolling windows is reduced to 36 months and the currency risk between the Euro-countries before 1999 is controlled for.

5.1 Extended dataset

Up to now our analysis is based on monthly data starting in April 1990. As a robustness check we also consider a longer sample period, starting in February 1975. While we are able to construct all ten industry indices from that date on, we have to restrict ourselves to six countries due to a lack of data. The five countries that are unavailable are Finland, Greece, Austria, Portugal and Spain. As can be seen in table 1, these countries have small weights in the Euro wide index for the period covered by our initial sample. This implies that their weights in the industry indices are relatively small. Besides, their coefficients in the replicating portfolios are quite low and their weights in the value-weighted average R^2 are low. Hence, the results of the style analysis will probably not be affected much by the exclusion of these countries. Furthermore, the correlations between the five small countries are lower than those between the remaining six countries. Thus, excluding them leads to an increase in average cross-country correlations (when looking at the same period as the initial sample). This has a negative impact on the performance of countries in terms of diversification benefits. Therefore, the mean-variance efficiency of country-based portfolios

[15] They can be made available upon request from the authors.

may be expected to be lower. As we are interested in diversification strategies for Euro-countries we will concentrate on the initial sample including all Euro-countries (except for Luxembourg). The extended sample merely provides us with additional insights in the performance of countries versus industries before 1990. Since the style analysis is probably least affected by the fact that we now have fewer countries than industries, we will focus mainly on those results.

The summary statistics of this extended sample show similar patterns as those of our initial sample and we therefore discuss the main differences without providing the actual figures[16]. Whereas on average the mean returns on country and industry indices are higher than in the initial sample (1.26% and 1.32% for countries and industries respectively) the standard deviations are somewhat lower (6.41% and 6.62%). The cross-country and cross-industry correlations are lower than in the initial sample, and, as expected, cross-country correlations exceed cross-industry correlations. Whereas in the initial sample the null hypothesis that all country returns equal zero could not be rejected, now it is rejected at a 5% significance level. The null hypothesis that all industry returns are zero is rejected as well and the null hypotheses of equal country and equal industry returns cannot be rejected.

5.1.1 Efficiency tests

The summarized results of the full sample efficiency tests are presented in panel A of table 6. Again, we avoid possible extreme long or short positions by focusing on the results under short sales constraints. Similar to the initial sample, countries span industries and industries span countries. Thus, over this extended sample, industries and countries are equally efficient. When short sales are allowed, industries are not spanned by countries (excluding overlapping industry components). However this outperformance can only be attained by taking short positions, as it disappears under short sales constraints. The Sharpe ratios of industries exceed those of countries, with and without short sales constraints. The differences between countries and industries are insignificant.

Out of the 285 60-month windows, under short sales constraints countries are not spanned by industries in four windows and industries outperform countries in seven windows. These windows are spread over the sample period and there are no subsequent periods of outperformance. The rolling window analysis of the Sharpe ratios shows that the Sharpe ratios under short sales constraints of countries and industries are very close and the differences are insignificant in all windows. Overall, the rolling window analysis supports the conclusion that countries and industries are equally efficient over this extended sample. Note

[16] These are available from the authors upon request.

that the fact that we now have six countries versus ten industries has a negative impact on the relative performance of country-based portfolios.

5.1.2 Style analysis

Panel B of table 6 presents the summarized results of the full sample style analysis of the extended sample. The average R^2 is 0.66 when countries are the funds and 0.63 when industries are funds. After exclusion of overlapping components, the R^2s decrease to 0.43 and 0.51 respectively. Thus, in the normal style analysis the mimicking abilities of industries and countries are very similar. In the exclusive style analysis, countries have better mimicking abilities. Rolling window analysis provides us with more understanding. Figure 6 presents the results for the normal and exclusive style regressions. The mimicking abilities of industries and countries are quite close when we consider the normal style analysis. In the first period industries outperform countries. When country styles are replicated by industries, the R^2 is 0.85 and when industries are funds it is 0.75. During the sample period the lines cross several times. As of the window ending around the year 2000, industries again possess superior mimicking abilities. At the end of the sample the average R^2 is 0.8 when countries are the funds, 0.2 above the average R^2 when industry are funds. The difference between the lines is surprisingly large when the overlapping components have been removed. In the first period, the average R^2 even becomes negative when countries are the funds. This is caused by Germany, which is the main part of the Euro-wide index during the first part of the sample period. Excluding the German components makes industries incapable of replicating the German index, which may explain why the full sample exclusive style analysis shows superior country performance.

Thus, our extended sample provides additional insights in the period before April 1990[17]. We find that over the extended sample period, countries and industries are equally efficient. Style analysis shows that in the beginning of this period, industries outperform countries in terms of mimicking abilities, while at the end of the 1980s countries outperform industries. This connects to the results of our initial sample. We must keep in mind that the performance of countries is negatively affected by the exclusion of five countries due to a lack of data.

[17] We also perform the efficiency tests and style analysis for the period from February 1975 to March 1990 to measure the performance before the start of our initial sample. Our results are virtually the same as for the full extended sample period.

5.2 *Impact of internet bubble*

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[18]. In order 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). In this section we briefly discuss the most remarkable results. The results of the full sample and subsample efficiency tests are not noticeably affected by the removal of IT. Similar to our previous results, we find that for the full sample period countries span industries and industries span countries (with and without short sales constraints). This also results from the spanning tests for the pre-convergence and Euro periods. However, in the convergence period countries are not spanned by industries when IT is excluded. This outperformance disappears when we impose short sales constraints. With short sales constraints, industries and countries have Sharpe ratios of 0.183 and 0.150 respectively. The difference is insignificant. In all three subsamples industries have a slightly higher Sharpe ratio, but again the difference with the country Sharpe ratios is insignificant. Although the country outperformance before the Euro is somewhat less pronounced, the general pictures of the rolling window efficiency tests remain unchanged. The overall conclusions from the efficiency tests are unaffected by the internet bubble.

In the full sample style analysis, most changes have occurred in the coefficients of the replication portfolios in which IT previously had a high weight. The exclusion of IT has the largest impact on Germany, which has become easier to mimic. The R^2 when Germany is the fund has increased from 0.61 to 0.79 after removal of IT. Germany has also become a more popular benchmark portfolio, it receives larger weights in the replicating portfolios of the industries. In general, the average R^2s are higher when IT is excluded. When countries are the funds, the average R^2s are about 4% higher and when industries are the funds they are about 1% higher[19]. The subsample analysis shows the same image as before. Whereas countries have better mimicking abilities in the pre-convergence period, industries possess superior mimicking abilities in the convergence and Euro periods. The mimicking abilities of the industries are slightly negatively affected by the internet bubble. In summary, the general

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[18] Source: 'After the gold rush', The Economist, April 20th 2000

[19] After removal of IT the average R^2 for industries as funds is 0.69 and for countries as funds it is 0.74. The exclusive style analysis shows average R^2s of 0.58 and 0.63 respectively.

conclusions on the mimicking abilities of the portfolios have not changed after exclusion of IT.

Figure 7 shows the results of the rolling window style analysis after the removal of IT. Now there is an apparent difference in the mimicking abilities of the industries with the results including IT (figure 4). Figure 4 shows a large decrease in R^2 for the country funds in the window from July 1995 to June 2000, which is one of the first windows that include the burst of the internet bubble. Indeed when IT is removed, the steep decrease in R^2 is no longer visible. So in this period the industry benchmark portfolios are less capable of mimicking the countries when the dot.com bubble is included. Nevertheless, the outperformance of countries before the Euro and the outperformance of industries after the Euro remain. In fact, the point of reversal (where the two lines cross) is exactly the same window as when IT is included in the sample. Hence our results are robust for the internet bubble.

5.3 Size of rolling windows

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 particular, there are more observations after the introduction of the Euro.

The rolling window spanning tests with short sales constraints show that whereas countries span industries in all windows, industries do not span countries in seven windows. Four windows fall in the period in which countries outperform based on 60-month windows. These four 36-month windows end in September and October 1995 and in April and May 1998. Remarkable are the three other 36-month windows in which countries outperform: those ending in May, June and July 2003. However the p-values fluctuate heavily, so we cannot infer much from these results. The number of windows in which countries or industries outperform when there are no short sales constraints is much larger. Now, mean-variance spanning is rejected at a 5% level for more than half of the windows for both countries and industries.

The rolling window figures of the Sharpe ratios under short sales constraints are similar to the 60-month figures. In the first part of the sample, industries and countries have Sharpe ratios of 0.2 and 0.05 respectively. During the sample period they increase to 0.6 and 0.8. However, at the end industries and countries are approximately on the same level as in the beginning of the sample. The main difference occurs in the last few windows. There, in contrast to the 60-month results, the Sharpe ratio of the industries is significantly higher than that of the countries. Thus, when we consider shorter windows, we find that under short sales constraints, industries outperform countries at the end of the sample. Again, caution is required to generalize this result. The p-values of the spanning hypothesis fluctuate heavily and there is no clear trend towards rejection.

The 36-month rolling window style analysis shows a similar level of mimicking abilities in the first part of the sample. At the end of the sample however, the average R^2s are higher for short windows. When countries are funds, the 60-month windows show an R^2 of 0.75 at the end of the sample. The 36-month style analysis results in an R^2 of 0.85. For industry funds the R^2 is 0.65 at the end of the sample, which increases by five percentage points when shorter windows are used. This is similar for the exclusive style analysis. Again, in the first part the mimicking abilities of countries exceed those of industries. In the window that runs from October 1995 to September 1998 this is reversed for the normal style analysis. For the exclusive style analysis the reversal takes place one window later. This confirms the findings of the 60-month rolling window style analysis. In conclusion, the size of the rolling windows only has a minor impact on the results.

5.4 Currency risk

After the adoption of the single currency, all currency risk between the Euro-countries has disappeared. Nevertheless, before the first of January 1999 currency risk was present. We control for this by including returns on currency indices as additional benchmark assets both when country and industry indices are the dependent variables.

The currency indices are computed by dividing the price index of a certain industry in a country denoted in the local currency by the same index denoted in German Mark. In the spanning tests we use returns on forward currency contracts. These forward contracts are zero-investment securities and the returns can therefore be interpreted as excess returns. In these returns the difference between the local interbank rates and the German interbank rates is taken into account. As it is easy to take a short position in a forward currency contract, they are not subject to short sales constraints. Thus the spanning tests do impose short sales constraints on the test assets and the country or industry benchmark assets, but not on the currency indices. In the style analysis, the total returns on the currency are included as additional benchmark assets. After the introduction of the Euro, the currency indices are constant. Therefore, in the subsample analysis we only include them in the pre-convergence and convergence periods. The results for the Euro period remain unchanged. In the rolling window analysis we include returns on currency indices in all windows that end before the introduction of the Euro.

In the pre-convergence and convergence periods mean-variance spanning cannot be rejected for both countries and industries under short sales constraints. The rolling window analysis shows that although the number of windows in which countries are not spanned by industries decreases, there still is an outperformance of countries in windows that fall before the adoption of the single currency. In this period industries are spanned by countries. Overall, our conclusions from the efficiency tests are robust for currency risk.

The results of the style analysis are nearly unaffected by the currency indices. The average R^2s are slightly higher, which is analogous to the inclusion of more explanatory variables. For instance, the subsample results indicate that in the pre-convergence period it has increased from 0.73 to 0.76 when taking countries as funds. When industries are the funds, the average R^2 has increased from 0.84 to 0.85. Overall, countries have better mimicking abilities than industries in the pre-convergence period. In the convergence period, industries slightly outperform countries. As the currency indices are not included in the Euro period, those results remain the same. The reversal that follows from the rolling window analysis now takes place one period later: in the window from December 1993 to November 1998. For the exclusive style analysis the turnaround takes place in the same window as before. Thus, our results of the style analysis are robust for currency risk.

6 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. In particular, we assess whether the relative performance of country-based and regional industry-based portfolio allocation strategies has changed after the introduction of the single currency. We conduct our analysis using two complementary methods. First, we compare countries versus industries in terms of mean-variance efficiency. We perform spanning tests and we test for the difference in maximum Sharpe ratios, both focusing on short sales constraints. Second, we perform a style analysis to determine the ability of a country-based portfolio to mimic the style of an industry-based portfolio. We extend these methodologies in several ways. First, we incorporate time varying market volatility into the spanning tests and style analysis. Also, by simulating the empirical distributions of the average R^2s of the style regressions, we are able to test the differences in mimicking abilities of countries and industries. Additionally, we consider the full sample period, three subsamples and 60-month rolling windows to determine the development over time. Furthermore we compare pure industry and pure country performance by excluding overlapping components from the indices.

Overall our results indicate a striking change in the structure of equity returns in the Euro-zone over the last decade. In the period from 1992 to 1998 country-based strategies outperform industry-based strategies. Countries are not spanned by industries and up to 1997 they earn significantly higher Sharpe ratios. Also, in the pre-convergence period they possess significantly better mimicking abilities than industries. In contrast, after the introduction of the Euro the country outperformance has disappeared, both in terms of mean-variance efficiency and in terms of mimicking abilities. Our findings show that after the adoption of the single currency, sector-based asset allocation strategies in the Euro-zone are not foregoing any diversification benefits relative to country-based strategies any more. Country factors and industry factors are equally important determinants of equity returns in the Euro-zone.

The relative performance of countries and industries in terms of mean-variance efficiency and mimicking abilities is unaffected by the different volatility regimes. Furthermore, our results are robust in an extended sample, and they are robust for the internet bubble, the size of the rolling windows and the currency risk between the Euro-countries prior to the introduction of the Euro.

A Construction of the indices

In general, we consider K countries (i=1,….,K) and N industries (j=1,….,N). Our sample consists of monthly returns from April 1990 to September 2003. We use the industry/country subindices constructed and provided by Datastream to create ten industry indices (N=10) and eleven country indices (K=11). These indices have overlapping components, as they are created from the same set of subindices. Not all 110 subindices are available for the complete sample period; the country and industry indices are based on all available subindices. The weights of the industries in the country indices and of the countries in the industry indices are determined by the markets values (MV) at the beginning of the period, which are denoted in Euro. The total return indices (dividends are reinvested) for the industry/country subindices ($RI_{i,j,t}$ and $RI_{j,i,t}$[20]) are denoted in DM before the first of January 1999 and in Euro after this date[21]. Below, the formulas used to compute the indices are presented.

$$II_{j,t} = \sum_{i=1}^{K} \left(\frac{MV_{j,i,t-1}}{\sum_{i=1}^{K} MV_{j,i,t-1}} \cdot RI_{j,i,t} \right) \tag{A.1a}$$

$$CI_{i,t} = \sum_{j=1}^{N} \left(\frac{MV_{i,j,t-1}}{\sum_{j=1}^{N} MV_{i,j,t-1}} \cdot RI_{i,j.t} \right) \tag{A.1b}$$

Excluding a certain country or industry implies that the specific market value is set equal to zero resulting in a zero weight in the total index, while the remaining weights sum to one. The weights of the countries and industries in the Euro-wide index are calculated by computing the total market value of a certain country or industry as a percentage of the total market values of all country indices (which is the same as the total market value of all industry indices). Below, an overview is given of the 10 industries and the 11 countries that form our sample.

Industry (mnemonic)	Country
Resources (Res)	Belgium
Basic Industries (BasI)	Germany
General Industries (GenI)	Finland
Cyclical Consumer Goods (CCGd)	France
Non-Cyclical Consumer Goods (NCGd)	Greece
Cyclical Services (CS)	Ireland
Non-Cyclical Services (NCS)	Italy
Utilities (UT)	Netherlands
Information Technology (IT)	Austria
Financials (Fin)	Portugal
	Spain

[20] Note that $RI_{i,j,t} = RI_{j,i,t}$ and $MV_{i,j,t} = MV_{j,i,t}$

[21] The index of January 1999 has to be computed twice. The return on the index from December 1998 to January 1999 is based on the indices of these two months in DM. The return on the index from January 1999 to February 1999 is based on the indices of January 1999 and February 1999 in Euro.

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Table 1: Summary statistics of country and regional industry returns

The table reports summary statistics of the returns on EMU country and regional 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 index. Also, a Wald test is performed to test the null hypotheses that all mean returns are zero and that all mean returns are equal (p-values in parenthesis). The sample period extends from April 1990 to September 2003 (162 observations).

Panel A: Returns on country indices

	mean	stdv	c(ctry)	c(ind)	min	max	ρ(1)	weight
Belgium	0.88%	4.96%	0.470	0.565	-13.40%	13.98%	0.156	3.86%
Germany	0.80%	7.31%	0.478	0.577	-20.51%	29.65%	0.189	27.45%
Finland	2.90%	14.42%	0.386	0.478	-37.11%	44.99%	0.339	2.82%
France	1.02%	6.01%	0.554	0.709	-14.85%	16.89%	0.094	24.97%
Greece	1.38%	11.99%	0.294	0.316	-39.56%	54.49%	0.138	1.07%
Ireland	1.30%	6.29%	0.450	0.541	-19.59%	23.09%	0.082	1.39%
Italy	0.74%	8.54%	0.457	0.582	-17.34%	26.54%	-0.003	12.03%
Netherlands	0.93%	4.98%	0.521	0.646	-18.34%	15.78%	-0.037	15.76%
Austria	0.10%	6.25%	0.343	0.396	-18.12%	21.22%	0.063	1.26%
Portugal	0.72%	7.44%	0.435	0.478	-29.77%	30.30%	0.169	1.18%
Spain	1.13%	7.14%	0.519	0.595	-18.93%	26.04%	0.082	8.21%
average	1.08%	7.76%	0.446	0.535	-22.50%	27.54%	0.115	
H0: country means are zero							(0.281)	
H0: country means are equal							(0.505)	

Panel B: Returns on industry indices

	mean	stdv	c(ctry)	c(ind)	min	max	ρ(1)	weight
Res	1.18%	6.05%	0.394	0.367	-19.56%	24.24%	0.081	8.67%
BasI	0.88%	6.12%	0.604	0.564	-18.30%	22.24%	0.109	9.76%
GenI	0.75%	6.75%	0.616	0.582	-20.03%	19.41%	0.074	11.62%
CCGd	0.40%	7.87%	0.537	0.499	-21.86%	22.63%	0.097	5.81%
NCGd	1.12%	4.56%	0.491	0.458	-11.48%	15.41%	0.195	9.06%
CS	0.66%	5.99%	0.630	0.584	-19.37%	21.21%	0.169	7.25%
NCS	1.38%	7.58%	0.546	0.507	-26.53%	26.94%	0.084	9.59%
UT	1.42%	8.99%	0.324	0.288	-18.22%	92.47%	0.003	4.58%
IT	1.09%	10.81%	0.573	0.525	-28.17%	40.42%	0.151	4.82%
Fin	0.83%	6.10%	0.635	0.562	-17.72%	19.20%	0.043	28.83%
average	0.97%	7.08%	0.535	0.494	-20.12%	30.42%	0.105	
H0: industry means are zero							(0.036)	
H0: industry means are equal							(0.781)	

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

	mean	stdv	min	max
Interest rate	0.41%	0.19%	0.17%	0.78%
H0: mean interest rate is zero			(0.000)	

Table 2: Efficiency tests for countries and industries

Panel A presents the individual Jensen measures ('alpha') as a monthly percentage and the corresponding t-values for the full sample period. The columns 'Excl. overl.' concern the indices where the country or industry-specific components of the test assets are eliminated from the benchmark assets. Panel B gives results for the spanning test and the Sharpe ratios for the full sample period and three subperiods. The p-values of the null hypothesis of mean-variance spanning are given in brackets. The spanning tests are based on full indices, indices after removal of overlapping components ('excl') and with short sales constraints on both the test assets and the benchmark assets ('nss'). Also, the maximum Sharpe ratios are given. 'Sharpe ratio nss' is the maximum Sharpe ratios when short sales are not allowed. In the upper part of panel B the p-values of the null hypothesis of equal Sharpe ratios of industries and countries are given in brackets next to the industry Sharpe ratios. Panel C presents the p-values of the spanning tests that take time varying market volatility into account.

Panel A: Jensen measures for full sample period

Industries					Countries				
	Full indices		Excl. overl.			Full indices		Excl. overl.	
	alpha	t-value	alpha	t-value		alpha	t-value	alpha	t-value
Res	0.32%	0.94	0.28%	0.65	Belgium	-0.04%	-0.18	-0.02%	-0.06
BasI	-0.01%	-0.05	-0.01%	-0.04	Germany	-0.01%	-0.02	0.01%	0.03
GenI	-0.23%	-0.82	-0.25%	-0.85	Finland	1.46%	1.78	1.31%	1.42
CCGD	-0.41%	-0.99	-0.46%	-1.07	France	-0.08%	-0.49	0.11%	0.43
NCGD	0.36%	1.35	0.42%	1.48	Greece	0.40%	0.47	0.44%	0.52
CS	-0.33%	-1.36	-0.35%	-1.40	Ireland	0.44%	1.28	0.55%	1.52
NCS	0.23%	0.65	0.29%	0.72	Italy	-0.06%	-0.14	-0.07%	-0.13
UT	0.50%	1.04	0.43%	0.92	Netherlands	0.02%	0.12	0.11%	0.50
IT	-0.52%	-1.33	-0.08%	-0.17	Austria	-0.57%	-1.41	-0.57%	-1.39
Fin	-0.06%	-0.27	-0.05%	-0.16	Portugal	0.08%	0.17	0.07%	0.16
					Spain	0.33%	0.93	0.35%	0.95

Panel B: Spanning tests and Sharpe ratios for full sample period and three subsamples

	Full sample Apr 90-Sept 03	Pre-convergence Apr 90-Dec 94	Convergence Febr 95-Dec 98	Euro Febr 99-Sept 03
Industries as test assets				
Spanning test	(0.473)	(0.026)	(0.007)	(0.658)
Spanning test (excl)	(0.458)	(0.016)	(0.003)	(0.739)
Spanning test (excl) nss	(0.830)	(0.854)	(0.592)	(0.957)
Sharpe ratio	0.267 (0.897)	0.631 (0.151)	1.142 (0.355)	0.299 (0.497)
Sharpe ratio nss	0.183 (0.928)	0.128 (0.799)	0.511 (0.981)	0.124 (0.902)
Countries as test assets				
Spanning test	(0.675)	(0.776)	(0.374)	(0.403)
Spanning test (excl)	(0.689)	(0.821)	(0.005)	(0.325)
Spanning test (excl) nss	(0.835)	(0.991)	(0.751)	(0.966)
Sharpe ratio	0.255	0.343	0.926	0.411
Sharpe ratio nss	0.188	0.104	0.513	0.139

Panel C: Spanning tests when controlling for time varying market volatility

	Full sample Apr 90-Sept 03	Pre-convergence Apr 90-Dec 94	Convergence Febr 95-Dec 98	Euro Febr 99-Sept 03
Industries as test assets				
Spanning test	(0.415)	(0.012)	(0.003)	(0.800)
Spanning test (excl)	(0.445)	(0.008)	(0.001)	(0.799)
Spanning test (excl) nss	(0.769)	(0.865)	(0.500)	(0.942)
Countries as test assets				
Spanning test	(0.767)	(0.522)	(0.527)	(0.477)
Spanning test (excl)	(0.806)	(0.675)	(0.004)	(0.455)
Spanning test (excl) nss	(0.903)	(0.988)	(0.830)	(0.887)

Table 3: Style analysis

The table present the estimates of the coefficients of the benchmark indices in a style regression. The coefficients of each style regression are constrained to be positive and to sum to one. Panel A concerns the country styles in terms of industries and the R^2 represents the mimicking abilities of the industries. Panel B shows the industry styles in terms of countries. The last rows of both panels show the average R^2. This a weighted average where the weights of the funds are their weights in the Euro-wide index (average over the full sample period).

Panel A: Country styles in terms of industries

	Belgium	Germany	Finland	France	Greece	Ireland	Italy	Netherlands	Austria	Portugal	Spain
intercept	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
Res.	0.00	0.02	0.09	0.12	0.00	0.10	0.00	0.31	0.10	0.00	0.00
Bas.I.	0.25	0.00	0.00	0.10	0.55	0.00	0.00	0.00	0.30	0.05	0.00
Gen.I.	0.00	0.11	0.00	0.18	0.00	0.00	0.00	0.08	0.00	0.10	0.04
CCGd	0.00	0.01	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.04	0.11
NCGd	0.46	0.09	0.00	0.19	0.00	0.20	0.00	0.19	0.19	0.17	0.00
CS	0.00	0.34	0.00	0.01	0.00	0.25	0.00	0.21	0.00	0.40	0.41
NCS	0.00	0.05	0.10	0.19	0.11	0.00	0.25	0.01	0.00	0.08	0.10
UT	0.04	0.00	0.06	0.06	0.00	0.04	0.19	0.00	0.01	0.04	0.11
IT	0.00	0.13	0.76	0.16	0.00	0.00	0.07	0.02	0.00	0.05	0.01
Fin.	0.24	0.25	0.00	0.00	0.34	0.41	0.14	0.18	0.40	0.08	0.22
R^2	0.64	0.61	0.50	0.89	0.21	0.55	0.67	0.77	0.31	0.42	0.64
av. R^2	0.70										

Panel B: Industry styles in terms of countries

	Res.	Bas.I.	Gen.I.	CCGd	NCGd	CS	NCS	UT	IT	Fin.
intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	0.00	0.22	0.07	0.02	0.48	0.03	0.00	0.09	0.00	0.17
Germany	0.00	0.05	0.13	0.04	0.00	0.15	0.00	0.00	0.13	0.10
Finland	0.01	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.28	0.00
France	0.00	0.33	0.53	0.04	0.20	0.27	0.67	0.37	0.58	0.02
Greece	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
Ireland	0.00	0.04	0.09	0.13	0.04	0.15	0.00	0.08	0.00	0.19
Italy	0.01	0.00	0.07	0.37	0.00	0.09	0.25	0.34	0.00	0.20
Netherlands	0.90	0.12	0.04	0.21	0.21	0.14	0.00	0.00	0.00	0.15
Austria	0.08	0.15	0.01	0.12	0.05	0.00	0.00	0.00	0.00	0.12
Portugal	0.00	0.02	0.02	0.00	0.01	0.05	0.00	0.00	0.00	0.00
Spain	0.00	0.01	0.03	0.06	0.00	0.11	0.03	0.12	0.00	0.01
R^2	0.45	0.72	0.75	0.59	0.50	0.78	0.70	0.29	0.72	0.79
av. R^2	0.68									

Table 4: Style analysis exclusive

This table presents the results of the exclusive style analysis; the country or industry components of the funds are eliminated from the benchmark indices. Thus, each fund has a different set of benchmark indices. Panel A gives country styles in terms of industries and panel B gives industry styles in terms of countries. 'Av. R^2' is the weighted average R^2 depending on the weights of the funds in the Euro-wide index. The last rows of both panels give the Spearman rank correlation coefficients for the association between the normal and the exclusive style coefficients. The asterisks indicate the significance levels.

Panel A: Country styles in terms of industries

	Belgium	Germany	Finland	France	Greece	Ireland	Italy	Netherlands	Austria	Portugal	Spain
intercept	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
Res.	0.01	0.07	0.19	0.10	0.00	0.14	0.02	0.18	0.11	0.00	0.00
Bas.I.	0.27	0.00	0.00	0.08	0.55	0.00	0.00	0.11	0.29	0.06	0.00
Gen.I.	0.00	0.04	0.00	0.32	0.04	0.00	0.15	0.09	0.00	0.11	0.07
CCGd	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.03	0.10
NCGd	0.47	0.03	0.00	0.13	0.00	0.17	0.02	0.19	0.22	0.18	0.00
CS	0.00	0.48	0.00	0.10	0.00	0.26	0.51	0.16	0.00	0.39	0.44
NCS	0.00	0.06	0.40	0.12	0.08	0.00	0.00	0.00	0.00	0.11	0.11
UT	0.01	0.00	0.01	0.11	0.00	0.05	0.13	0.02	0.01	0.01	0.07
IT	0.00	0.07	0.40	0.05	0.00	0.00	0.17	0.02	0.00	0.05	0.02
Fin.	0.24	0.25	0.00	0.00	0.33	0.35	0.01	0.23	0.37	0.07	0.19
R^2	0.61	0.57	0.40	0.74	0.20	0.50	0.46	0.64	0.28	0.42	0.62
av. R^2	0.60										
rankcorr.	0.95*	0.88*	0.99*	0.73**	0.88*	0.97*	-0.44	0.73**	1.00*	0.94*	0.96*

* significant at a 1% level
** significant at a 5% level

Panel B: Industry styles in terms of countries

	Res.	Bas.I.	Gen.I.	CCGd	NCGd	CS	NCS	UT	IT	Fin.
intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	0.32	0.26	0.08	0.03	0.55	0.03	0.00	0.00	0.00	0.20
Germany	0.12	0.04	0.11	0.02	0.01	0.16	0.09	0.00	0.04	0.05
Finland	0.07	0.01	0.00	0.00	0.00	0.00	0.11	0.00	0.17	0.02
France	0.01	0.26	0.45	0.09	0.14	0.29	0.36	0.55	0.67	0.08
Greece	0.01	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.04
Ireland	0.22	0.00	0.10	0.14	0.02	0.14	0.02	0.19	0.00	0.06
Italy	0.00	0.01	0.09	0.31	0.00	0.09	0.23	0.20	0.13	0.12
Netherlands	0.06	0.19	0.06	0.20	0.15	0.13	0.00	0.00	0.00	0.21
Austria	0.18	0.13	0.02	0.13	0.09	0.00	0.00	0.00	0.00	0.16
Portugal	0.00	0.04	0.03	0.00	0.04	0.03	0.10	0.00	0.00	0.01
Spain	0.00	0.01	0.04	0.08	0.00	0.12	0.09	0.06	0.00	0.05
R^2	0.18	0.70	0.73	0.56	0.42	0.77	0.59	0.23	0.58	0.65
av. R^2	0.58									
rankcorr.	0.19	0.86*	1.00*	0.98*	0.99*	0.99*	0.80*	0.87*	0.85*	0.73**

* significant at a 1% level
** significant at a 5% level

Table 5: Style analysis, tests for differences in mimicking abilities

The table presents the mimicking abilities of countries and industries in the full sample and the three subsamples. The average R^2 when countries are funds indicates the mimicking abilities of industries. Panel A presents the weighted average R^2s of the style analysis. 'Normal' indicates the results of the normal style analysis (using full indices) and 'exclusive' indicates the results based on the benchmark indices after removal of overlapping components. Panel B gives the differences in average R^2 between countries and industries as funds and between the three subsamples. By simulating the distributions of the average R^2s we can test the significance of the differences. The average R^2s of countries as funds and of industries as funds have different distributions in the three subsamples. The p-values of the one-sided test with the null hypothesis that the positive or negative difference is zero are given in brackets. Panel C shows the results when controlling for time varying market volatility.

Panel A: Overview of results of full sample and subsample style analysis

		Full sample Apr 90-Sept 03	Pre-convergence Apr 90-Dec 94	Convergence Febr 95-Dec 98	Euro Febr 99-Sept 03
Normal	Country funds	0.70	0.73	0.78	0.74
	Industry funds	0.68	0.84	0.74	0.65
Exclusive	Country funds	0.60	0.53	0.69	0.69
	Industry funds	0.58	0.77	0.67	0.53

Panel B: Differences in average R^2 and p-values

Difference R^2 country funds – R^2 industry funds

	Full sample	Pre-convergence	Convergence	Euro
Normal	0.02	-0.11	0.04	0.10
	(0.743)	(0.002)	(0.045)	(0.353)
Exclusive	0.02	-0.24	0.01	0.16
	(0.626)	(0.003)	(0.095)	(0.189)

Difference R^2 country funds in subsamples

	Pre-convergence - Convergence	Pre-convergence - Euro	Convergence - Euro
Normal	-0.05	-0.01	0.03
	(0.224)	(0.352)	(0.347)
Exclusive	-0.16	-0.16	0.00
	(0.155)	(0.159)	(0.522)

Difference R^2 industry funds in subsamples

	Pre-convergence - Convergence	Pre-convergence - Euro	Convergence - Euro
Normal	0.11	0.20	0.09
	(0.008)	(0.030)	(0.619)
Exclusive	0.10	0.24	0.14
	(0.026)	(0.053)	(0.543)

Panel C: Results style analysis when controlling for time varying market volatility

		Full sample	Pre-convergence	Convergence	Euro
Normal	Country funds	0.69	0.73	0.77	0.73
	Industry funds	0.69	0.84	0.75	0.65
Exclusive	Country funds	0.57	0.53	0.67	0.67
	Industry funds	0.59	0.77	0.68	0.54

Table 6: Summarized results of efficiency tests and style analysis for the extended sample

The table presents summarized results of the efficiency tests and style analysis for the extended sample. This sample consists of monthly returns on six country indices and 10 industry indices from February 1975 to September 2003. Panel A gives the p-values of the spanning tests. The second row concerns the spanning test when the industry or country specific components have been removed from the benchmark assets. The third row shows the results under short sales constraints on both the test assets and the benchmark assets. The maximum Sharpe ratios when short sales are allowed and when they are prohibited are given in the lower part of panel A. The values in brackets in the middle column are the p-values of the null hypothesis that countries and industries have equal Sharpe ratios. Panel B gives the individual R^2s of the country and industry funds and the averages over all funds. The weighted averages are computed in a similar manner as for the initial sample. The panel B also gives the Spearman rank correlation coefficients for the association between the normal and exclusive style coefficients. The asterisks indicate the significance levels.

Panel A: Summary results efficiency tests

	Industries		Countries
Spanning test	(0.161)		(0.312)
Spanning test excl. overlapping components	(0.041)		(0.434)
Spanning test excl. overlapping components nss	(0.109)		(0.436)
Sharpe ratio	0.246	(0.300)	0.201
Sharpe ratio nss	0.223	(0.503)	0.200

Panel B: Summary results style analysis

Country styles in terms of industries											
		Belgium	Germany	France	Ireland	Italy	Netherlands				
Normal	R^2	0.49	0.60	0.77	0.36	0.60	0.74				
	av. R^2	0.66									
Exclusive	R^2	0.42	0.46	0.42	0.34	0.31	0.44				
	av. R^2	0.43									
rankcorr.		0.87*	0.56***	N.A.	0.93*	-0.64**	0.50				
Industry styles in terms of countries											
		Res.	Bas.I.	Gen.I.	CCGd	NCGd	CS	NCS	UT	IT	Fin.
Normal	R^2	0.62	0.67	0.72	0.46	0.57	0.72	0.60	0.23	0.53	0.68
	av. R^2	0.63									
Exclusive	R^2	0.23	0.63	0.67	0.41	0.51	0.71	0.54	0.16	0.48	0.50
	av. R^2	0.51									
rankcorr.		0.71	0.83**	1.00*	0.89**	1.00*	1.00*	0.94*	0.94*	0.90**	0.77***

* significant at a 1% level
** significant at a 5% level
*** significant at a 10% level

Figure 1: Estimated conditional variance of Euro-wide market index

This figure presents the conditional variance of the Euro-wide market index that is estimated by a GARCH(1,1) model.

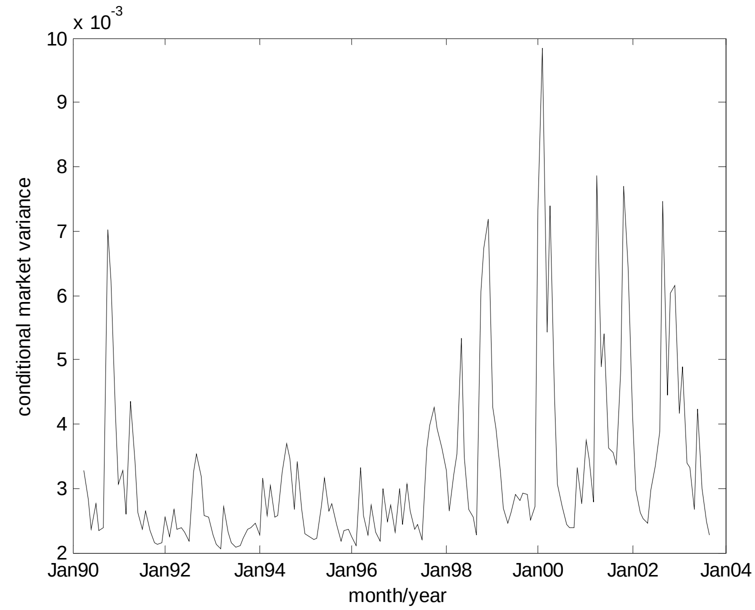

Figure 2: 60-month rolling window analysis of H_0: mean-variance spanning under short sales constraints

This figure shows the results of the 60-month rolling window spanning tests. The tests are based on indices excluding overlapping components. Short sales constraints are imposed on both the test assets and the benchmark assets. The development over time of the p-value corresponding to the null hypothesis of mean-variance spanning is plotted. If the p-value is below 0.05, the H_0 of spanning is rejected at a 5% significance level.

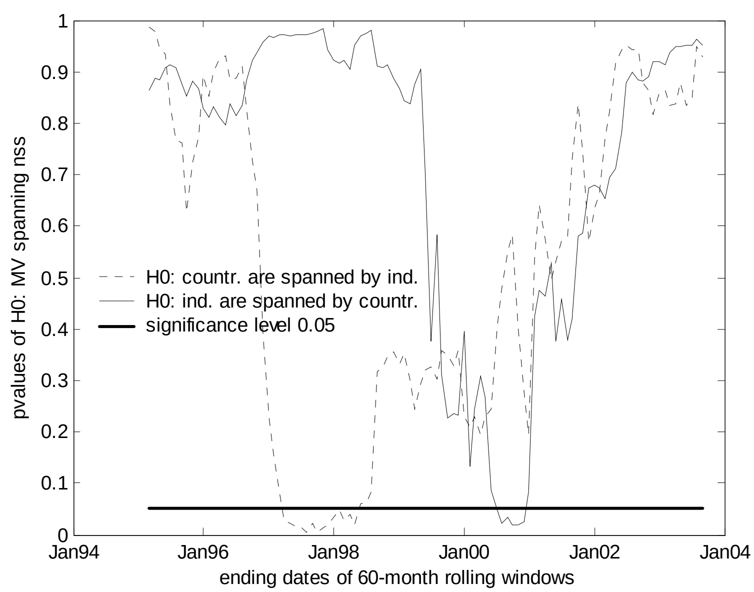

Figure 3: Maximum Sharpe ratios under short sales constraints

This figure presents the maximum Sharpe ratios of industries and countries for 60-month rolling windows. Short sales constraints are imposed. The lower part of the figure shows 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.

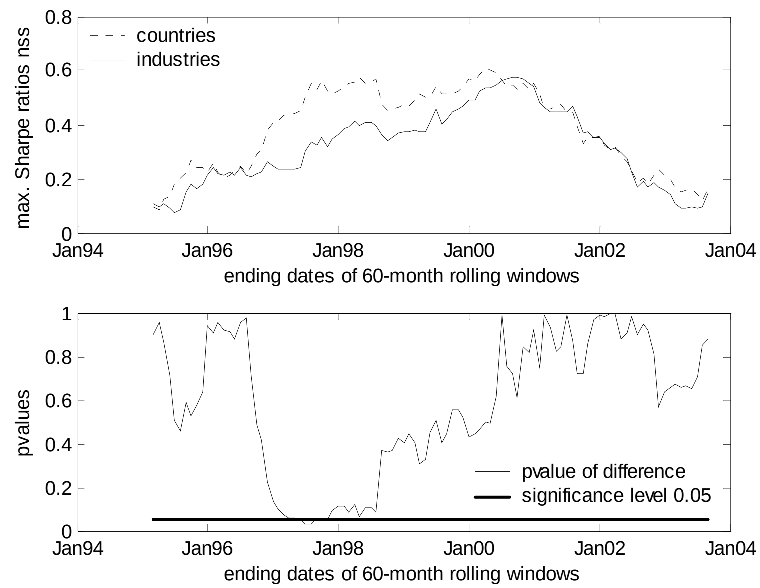

Figure 4: 60-month rolling window style analysis

The figure gives the weighted average R^2 for the 60-month rolling window normal style analysis. The weights are determined by the average weight of the fund in the Euro-wide index during the particular window. Therefore, the weights change over time as well.

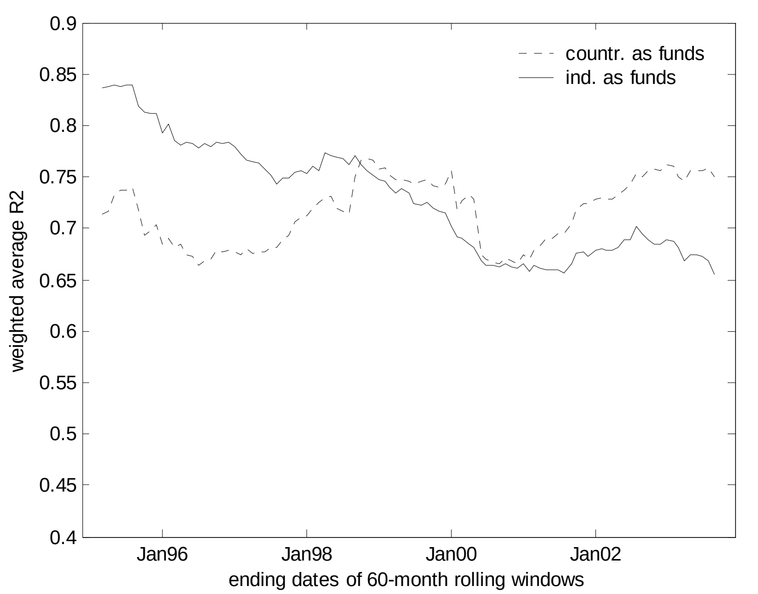

Figure 5: 60-month rolling window exclusive style analysis

The figure gives the weighted average R^2 for the 60-month rolling window exclusive style analysis. The overlapping components 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.

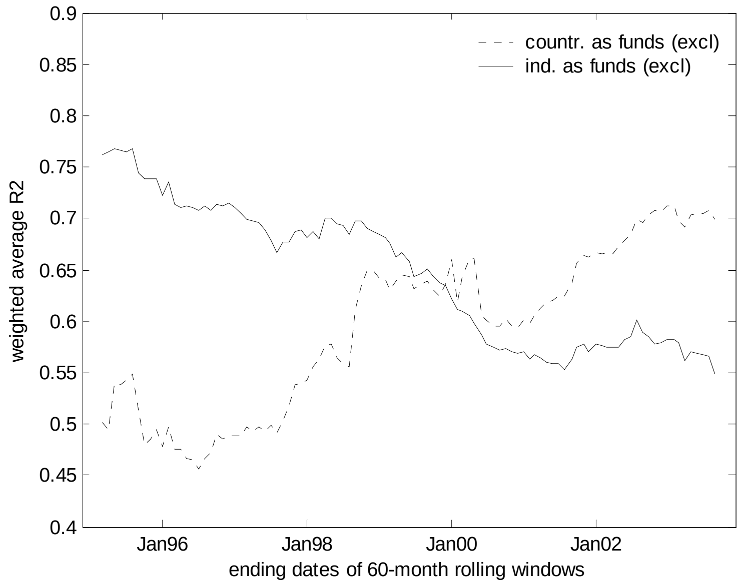

Figure 6: Extended sample, 60-month rolling window style analysis

This figure presents the weighted average R^2s of the 60-month rolling window style analysis for the extended sample. This sample starts in February 1975 and contains six Euro-countries and ten industries. The results for both the normal and the exclusive style regressions are given.

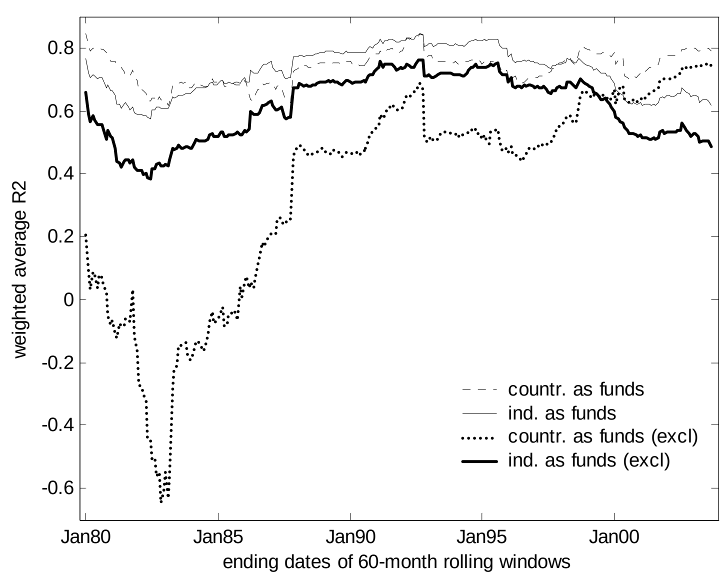

Figure 7: 60-month rolling window style analysis excluding IT

The figure shows the results of the 60-month rolling window normal style analysis for the sample excluding information technology. Thus, when industries are funds there is one fund less and when countries are funds there is one benchmark index less. Moreover, country indices no longer include the IT components.