International Portfolio Diversification: Currency, Industry and Country Effects Revisited

Bruno Gerard, Pierre Hillion, Frans de Roon, and Esther Eiling*†

July 23, 2007

Abstract

This paper analyzes the role of currency risk, industrial structure and country factors on international diversification strategies in the G7 countries over the past 30 years. We proposes a new test of the difference in Sharpe ratios of two portfolios that allows us to compare the relative efficiency of different portfolio strategies. We find that with monthly rebalancing, industry-based managed portfolios significantly outperform country-based managed portfolios. However, this outperformance critically depends on the ability to go short: with long-only constraints both strategies show a similar performance. Strikingly, currency deposits are crucial for achieving the full benefits from international portfolio strategies: under no short sale restrictions, adding managed currency deposits to either country or industry based strategies nearly doubles their Sharpe ratio. Furthermore, a style analysis reveals that including currency as style portfolios significantly improves our ability to replicate the returns of international portfolio strategies.

JEL classification: G11, G15

Keywords: International financial markets, mean-variance efficiency, style analysis, conditioning information, currency risk.

*This paper also circulated under the title "The Structure of Global Equity Returns: Currency, Industry, and Country Effects Revisited". We thank Francesca Carrieri, Vihang Errunza, Theo Nijman and seminar participants at McGill University, Tilburg University, Nijmegen University, the Norwegian School of Management-BI, Cal Poly San Luis Obispo, the Inquire meetings in Berlin, the SIRIF Asset Allocation Conference in Glasgow, and the EFA meetings in Berlin for helpful discussions.

†Gerard is with Mellon Capital Management, 595 Market Street, Suite 3000, San Francisco Ca 94105, tel:+1-415-975 3569, email: brunog@mcm.com; Hillion is with INSEAD and CEPR, email: pierre.hillion@insead.edu; DeRoon is with the Department of Finance and CentER, Tilburg University, P.O.Box 90153, 5000 LE Tilburg, The Netherlands, email: F.A.deRoon@uvt.nl; Eiling is with the Rotman School of Management, University of Toronto, 105 St. George Street, Toronto, Ontario M5S 3E6, tel:+1-416-946-3121, email: Esther.Eiling@Rotman.Utoronto.Ca, and with the Dept. of Mgmt, University of Toronto at Scarborough. Support for this research has been provided by a grant from INQUIRE Europe. The views expressed in this paper are our own and do not necessarily reflect the views of Mellon Capital Management.

1 Introduction

Although the benefits of international diversification arising from the relatively low level of correlation among national equity markets are now well documented (e.g. Solnik, 1974, Elton and Gruber, 1992, De Santis and Gerard, 1997), the issue of which factors drive these correlations remains controversial among both academics and professional portfolio managers. This paper revisits the relative importance of country and industry effects on cross-country returns, but, in contrast to the large extant literature, explicitly considers the role of currency exposure in conjunction to local equity risk and industry structure. We attempt to disentangle the respective impact of these three factors on international portfolio diversification strategies in the seven major developed economies over the past 30 years.

We conduct our investigation from a portfolio perspective. We propose a new test to measure and evaluate the statistical significance of the diversification gains of some portfolio strategies over others. Our test provides a direct comparison of the mean variance efficiency of two optimal portfolios by comparing their Sharpe ratios. Our test is designed to evaluate the benefits of alternative portfolio strategies constructed from the same set of primitive assets. No-short sales constraints and conditioning information can be easily incorporated. This test also yields a measure of the diversification gains of including currencies in international portfolios. Furthermore it has wide applicability beyond the empirical issue investigated in this paper. To complement the efficiency tests we perform a style analysis in which we assess performance in terms of the ability of a set of portfolios to replicate the returns of other strategies. Such tests provide evidence about, for example, the extent to which country portfolio returns variance is explained by the country's industry structure. Whereas mean-variance efficiency tests are a function of both mean returns and variances, style analysis is based on the covariance structure only. This is a clear advantage of style analysis, as it is typically more difficult to accurately estimate means than variances.

We first consider the relative importance of country and industry effects by comparing the performance of country- and global industry-based portfolios. Our unconditional results indicate that in terms of mean variance efficiency, country and industry portfolios perform similarly. There are no significant differences between their maximum Sharpe ratios, with or without no-short sales constraints.

To account for predictable variations in expected returns, volatility and correlations, we expand our analysis to consider strategies conditioned on a subset of the information that investors can use to manage their portfolios. In this case we detect a clear industry outperformance. The maximum annualized Sharpe ratio of unconstrained managed industry portfolios is significantly larger than that of country portfolios: 1.78 versus 1.20. However, this outperformance of the dynamic industry portfolio hinges on the ability to take short positions and disappears when no-short sales restrictions are imposed. In this case country and industry managed portfolios have comparable Sharpe ratios of 0.70 and 0.80 respectively.

Both the unconditional and conditional style analyses indicate that countries are better able to mimic industries than vice versa, even when the country indices exclude all stocks from the industry that is replicated. For investors that are not allowed to take short positions, such as mutual funds, country-based strategies perform at least as well as industry-based strategies. However, investors that are not subject to long-only constraints, such as hedge funds, may achieve superior performance in terms of mean-variance efficiency by investing in actively managed global industry portfolios.

Secondly, we examine the role of currency risk by analyzing the performance of country, industry and world portfolios when currency deposits are included as distinct assets. According to Adler and Dumas (1980), the risk premium on currency deposits is compensation for currency risk. Dumas and Solnik (1995) and De Santis and Gerard (1998) show that currency risk premiums can only be detected in a conditional framework. Indeed, while our unconditional tests do not report outperformance of portfolios including currency deposits, we show that with monthly portfolio rebalancing, managed currency deposits add substantial diversification and return enhancement benefits to international portfolios. Strikingly, adding currency deposits to managed country or industry portfolios doubles their annual no-short sale Sharpe ratios. For country-based portfolios the annual Sharpe ratios increases from 0.70 to 1.51 and for industry-based portfolios the increase is from 0.80 to 1.55. Moreover, style analyses which include currency deposits among the benchmark assets provide significantly improved replications of international portfolio strategies. In sum, currency deposits are crucial in order to achieve optimal portfolio performance. The benefits from adding currencies to a portfolio may arise from positive expected excess returns on currency deposits as well as from the currency risk exposure of equity returns and hedging benefits of combining equities and currencies.

All our results are robust over the three 10-year non-overlapping sub periods in our sample, which shows that they are not sub-sample specific. To the contrary, we find that the gains from investing in currency deposits are persistent over time: the additional diversification benefits from including currencies in an international portfolio are as substantial in the 70s and 80s, in the 90s as in recent years.

The role of industrial structure in explaining cross-country return differences and covariability was first investigated by Lessard (1974). Renewed attention to the issue and a voluminous literature was sparked by the work of Roll (1992), Heston and Rouwenhorst (1994) and Griffin and Karolyi (1998). Indeed, the debate on the relative importance of country and industry factors in international equity returns is still ongoing.[1] With the exception of Roll (1992), papers comparing country and industry factors typically do not assess the role of currency risk explicitly. However, it is now well established that exposure to currency risk is a major determinant of international equity returns.[2] Using

[1]Some papers provide evidence in favor of country factor dominance (amongst others, Grinold, Rudd and Stefek, 1989, Drummen and Zimmerman, 1992, Heston and Rouwenhorst, 1994, Griffin and Karolyi, 1998, Brooks and Del Negro, 2004, Bekaert, Hodrick and Zhang, 2005, Ehling and Ramos, 2006), while other papers conclude on the increasing importance of industry factors (e.g. Cavaglia, Brightman and Aked, 2000, Isakov and Sonney, 2004, Eiling, Gerard and De Roon, 2005, Baele and Inghelbrecht, 2005).

[2]See for example Dumas and Solnik (1995), De Santis and Gerard (1998), De Santis, Gerard and Hillion (2003), Dahlquist and Sällström (2002), Chang, Errunza, Hogan and Hung (2005).

three years of daily data for 24 countries over the 1988 to 1991 period, Roll (1992) finds that approximately 40% of country returns volatility is explained by industry factors, while approximately 20% is attributable to exchange rate changes.

The typical approach to examine the relative importance of country and industry effects builds on a factor model. The methodology first proposed by Heston and Rouwenhorst (1994) and later modified by Griffin and Karolyi (1998) is based on regressions using country and industry dummies as regressors. However, this approach assumes a unit exposure to the global market shock, which may lead to biases in comparing country and industry factors (Baele and Inghelbrecht 2005). Moreover, it does not explicitly include currency risk into the analysis.

This paper contributes to the existing literature by examining the relative importance of country, industry *and* currency risk effects on international equity returns. We investigate the issue from an investor's perspective and rather than estimating a factor model we use efficiency tests and style analysis to compare the benefits to investors of different international diversification strategies. The paper proceeds as follows. Section 2 develops the empirical framework and introduces our new test. Section 3 describes the data. Section 4 reports the performance evaluation in terms of diversification benefits of the different portfolios in both a static and a dynamic framework. Section 5 discusses our alternative methodology, the style analysis. Section 6 presents the robustness check for three sub periods and Section 7 concludes. The appendix details the derivation of some econometric results.

2 Empirical framework

To investigate the relative importance of country and industry factors as determinants of international equity returns, we take a portfolio perspective. I.e., we compare the performance of country and industry equity portfolios. Consider L countries and N industries. Although investors can in principle invest in the full set of $L \times N$ local industry returns in all countries, we focus on L country returns and N global industry returns. Optimally diversifying over all $L \times N$ local industry returns may lead to a better in-sample portfolio performance than diversifying over the L country or N global industry portfolios in which the local industry or country weightings respectively are fixed. However, we are specifically interested in whether country or industry factors dominate for optimal international portfolio strategies. This research question can be better answered when comparing country-based versus global industry-based investment strategies. Second, estimating optimal portfolio weights for the full set of $L \times N$ returns may be relatively straightforward in-sample. However, in practice, for portfolio managers it is much more challenging to estimate the out-of sample weights, as this involves the estimation of a very large covariance matrix.

Furthermore, we investigate the role of currency risk by including a number of currency forwards in the investment universe, in addition to country, industry or world index portfolios. For simplicity the methodological section focuses on the comparison of country-based versus industry-based portfolios. In the empirical section, we expand the comparison to consider portfolios that include currency deposits.

2.1 Spanning tests

Suppose all differences across countries are due to differences in industrial structure. By directly diversifying across global industry portfolios, investors should be able to achieve optimal diversification more directly and more efficiently than by diversifying across countries, as country portfolios constrain the extent to which industry diversification can be achieved. If country specific factors are the primary determinants of returns differences across countries, diversifying across global industries will result in an efficiency loss.

One way to examine the relative performance of country- or industry-based portfolios is, for instance, to analyze whether investors should invest in country or in industry portfolios, or whether restricting to either country or industry portfolios is suboptimal relative to investing in both of them. The latter question comes down to testing whether in terms of the familiar Jensen measure, industry portfolios outperform country portfolios or vice versa. In our framework, investors can base their portfolio on a set of industries with excess return vector r_t^y, or a set of countries with excess return vector r_t^x. The combined set of assets will be denoted by the return vector $r_t = (\ r_t^{x\prime} \quad r_t^{y\prime}\ )'$. If it suffices for an investor to invest in the set x or y only, then the intercepts a_y or a_x in the regressions

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

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

should be equal to zero. If the Jensen measure $a_y = 0$, then investors can base their portfolios on the countries r_t^x only, whereas if the Jensen measure $a_x = 0$ investors can base their portfolios on the industries r_t^y only. The independent variables in these regressions are referred to as the benchmark assets and the dependent variables are referred to as the test assets. If the Jensen measure is different from zero, mean-variance efficiency can be improved by extending the investment set of the benchmark assets with the test assets. Note that if for instance the global industry indices are the benchmark assets and the countries are the test assets, both sets have overlapping components. Hence, rather than extending the investment set of global industries with the countries, a significant Jensen measure a_x requires changing the country weights in the global industry portfolios.

Having Jensen measures a_y or a_x that are different from zero, indicates that portfolios that are based on countries or industries only are inefficient relative to portfolios in which countries or industries are combined. It may be the case though that portfolios that are based on both countries and industries are indeed more efficient than portfolios based on countries or on industries exclusively, but that there is no difference in the efficiency of country- and industry-only portfolios. Since the interest in this paper is also in the relative efficiency of country- versus industry-based portfolios, we need a test for the relative efficiency of two portfolios.

2.2 Sharpe ratio tests

If country- and industry-only portfolios are equally efficient, then the maximum Sharpe ratios of the two sets must be equal. The maximum Sharpe ratios of set x and y will be denoted θ_x and θ_y respectively, whereas the maximum Sharpe ratio of the combined set is θ. It is well known that there is a straightforward relationship between the maximum Sharpe ratios θ_x, θ_y, and θ on the one hand and the Jensen regressions (1) on the other (see Gibbons, Ross and Shanken, 1989). The increase in the maximum Sharpe ratios is determined by the adjusted Jensen measures, using:

$$\theta^2 - \theta_x^2 = a_y' \Omega_{yy}^{-1} a_y, \tag{1c}$$
$$\theta^2 - \theta_y^2 = a_x' \Omega_{xx}^{-1} a_x, \tag{1d}$$

where Ω_{ii} is the covariance matrix of ε_t^i in (1). The hypothesis of interest is whether θ_x equals θ_y. Taking the difference of (1c) and (1d) gives

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

Therefore, the hypothesis that the two sets x and y are equally efficient can be formulated as $H_0 : \lambda = 0$.

A test for the hypothesis that λ equals zero may be based on the weighted least squares type regressions

$$\Omega_{yy}^{-\frac{1}{2}} r_t^y = c_y + D_y r_t^x + u_t^y, \tag{3a}$$
$$\Omega_{xx}^{-\frac{1}{2}} r_t^x = c_x + D_x r_t^y + u_t^x. \tag{3b}$$

Since this regression amounts to a simple linear transformation of the dependent variables in the regressions in (1) it follows immediately that

$$c_y = \Omega_{yy}^{-\frac{1}{2}} a_y,$$
$$c_x = \Omega_{xx}^{-\frac{1}{2}} a_x,$$

and therefore that

$$\lambda = c_y' c_y - c_x' c_x. \tag{4}$$

Thus, the hypothesis that the two sets of assets, x and y are equally efficient can be tested by estimating the regression in (3) and testing the hypothesis that $c_y' c_y - c_x' c_x = 0$. Since this is a single nonlinear restriction on the intercepts, a Wald test statistic for this restriction will, under the null-hypothesis and standard regularity conditions, asymptotically be χ_1^2-distributed. Of course, in practice the test will require a two-step estimation, where in the first step we estimate the regression in (1). This estimation will yield consistent estimates of the covariance matrices Ω_{xx} and Ω_{yy} which in the second step can be used to estimate the transformed regression in (3). Naturally, this implies that we will have estimation error in the dependent variables in (3). Further since both country and global industry portfolios include some common primitive assets, the estimation errors are correlated. Appendix A describes how consistent estimates of the covariance matrix of the parameters c and D can be obtained, taking into account both the estimation error in $\widehat{\Omega}_{xx}$ and in $\widehat{\Omega}_{yy}$ and their correlation.

The test we propose allows for a direct comparison of the optimal country and the optimal industry portfolios in terms of mean variance efficiency. Basak, Jagannathan and Sun (2002) also propose a direct test of mean variance efficiency of two portfolios. Their approach compares the efficiency of the optimal portfolio of countries (industries) with respect to a possibly suboptimal industry (country) portfolio constrained to have the same mean return. However, this restriction is not necessarily satisfied. Moreover, evaluating the relative the performance of the two optimal portfolios is less straightforward, as this approach does not yield a direct comparison of the two optimal portfolios. In contrast, our test allows the researcher to make a direct comparison between two optimal portfolios. Further advantages are that no-short sales constraints and conditioning information can be easily incorporated.

2.3 Relation spanning and Sharpe ratio tests

The spanning tests and the Sharpe ratio tests are clearly related, as can be seen from equation (2). In order to fully understand the different efficiency tests it is important to investigate how the hypotheses are related and whether there are any nested hypotheses. For instance, if countries span industries and vice versa, is it still possible to find a significant difference in their Sharpe ratios? This question and related questions are answered below.

First, we discuss to what extent we can make inferences on the Sharpe ratio test by looking at the spanning test results. In other words, what can we conclude on λ based on a_x and a_y alone? Consider a situation in which countries are spanned by industries; i.e., $a_x = 0$. This means that the mean-variance efficiency of an industry portfolio cannot be improved by adding country returns, or equivalently, $\theta_y = \theta$. Now, in addition suppose that industries are spanned by countries, i.e. $a_y = 0$ and hence $\theta_x = \theta$. In this situation the Sharpe rations of the country and industry portfolios must be equal, since $\theta_y = \theta = \theta_x$. Next, suppose that countries are not spanned by industries, but industries are spanned by countries. In other words, investing in industries alone is inefficient and country returns should be added, while investing in country portfolios alone is already mean-variance efficient and industries do not have to be added. This implies that $\theta > \theta_y$ and $\theta = \theta_x$. Consequently, the industry Sharpe ratio must be smaller than the country Sharpe ratio, since $\theta_y < \theta = \theta_x$. Third, suppose that countries are not spanned by industries, but industries are not spanned by countries either. Now we cannot make any inferences on the outcome of the Sharpe ratio test, as $\theta > \theta_y$ and $\theta > \theta_x$. This third situation clearly illustrates the need for a Sharpe ratio test. Whereas in the first two situations inferences on the relative performance of country- and industry-only portfolios can be made based on the spanning tests only, in the third situation this is not possible. In order to make a direct comparison of country- and industry-based strategies we need to perform a Sharpe ratio test.

In addition, we discuss to what extent we can make inferences on the spanning tests based on the outcome of the Sharpe ratio test. First consider the outcome that $\lambda = 0$, i.e., $\theta_x = \theta_y$. This situation can occur when either both countries span industries and vice versa, or countries do not span industries and industries do not span countries. To see this, consider the case that $\lambda = 0$, countries are not spanned by industries, but industries are spanned by countries. This would imply that $\theta > \theta_y$ and $\theta = \theta_x$. This is a contradiction, as we would have that $\theta_y < \theta_x$ while we assumed that $\lambda = 0$.

Second, consider the case when $\lambda > 0$, i.e., industry returns have a higher Sharpe ratio than country returns. This can occur in two situations. First, when spanning is rejected for both country and industry returns (since $\theta > \theta_y$ and $\theta > \theta_x$ does not imply anything for θ_y versus θ_x). Second, when countries do not span industries but industries span countries, since $\theta > \theta_x$ and $\theta = \theta_y$ implies that $\theta_y > \theta_x$.

This discussion illustrates that the hypotheses of the different mean-variance efficiency tests are related. In certain cases, but not in all cases, one can make inferences on the outcome of the Sharpe ratio tests by looking at the spanning test results only. However, each possible outcome of the Sharpe ratio test may arise due to various possible outcomes of the spanning tests. Hence, to compare the relative performance of two portfolio strategies, it is important to perform both tests. In addition, in this discussion it is assumed that short sales are allowed and that all country or industry tests assets have the same set of benchmark assets.

2.4 Conditional strategies

Investors typically rebalance their portfolio regularly in response to changing market conditions. Dynamic strategies may heighten the difference between the performance that can be extracted from alternative sets of assets and more clearly delineate their differences. Furthermore, several papers (see Dumas and Solnik, 1995, and De Santis and Gerard, 1998) suggests that the impact of currency risk on equity returns varies considerably over time and may be difficult to detect in an unconditional framework. Conditional strategies are easily incorporated by using managed portfolios.

Assume that K instruments z_t can be used to predict asset returns, in particular the returns on the benchmarks. It is assumed that the instruments in z_t are normalized such that

$$0 \leq z_{kt} \leq 1, \qquad \forall k, t.$$

One way to normalize the instrument is to consider the transformation

$$\Phi\left(\frac{z_t - m_z}{s_z}\right),$$

where m_z is the mean of z_t, s_z is the standard deviation of z_t, and $\Phi(\cdot)$ is the cumulative normal distribution function.

Since the tests described above rely on the use of excess returns, the return space can be increased by considering returns on managed portfolios, $z_{k,t-1}r_{i,t}$ where $z_{k,t-1}$ is the value an instrument takes at time $t-1$. The managed portfolio strategy implies that each period a position with a size $z_{k,t-1}$ in asset i is chosen. If there are L assets and K instruments, excluding a constant, then we have a total of $(K+1)\times L$ assets in this way:

$$\{r_{i,t}\ ,\ z_{k,t-1}r_{i,t}\ , i = 1, ..., L \text{ and } k = 1, ..., K.\}$$

For this set of $(K+1)\times L$ assets we calculate the optimal (tangency) portfolio weights. Denote ω_{i0} the weight of asset with return $r_{i,t}$ in the tangency portfolio and ω_{ik} the weight of managed return $z_{k,t-1}r_{i,t}$. The total position in asset i is now equal to

$$w_{it} = \omega_{i0} + \sum_{k=1}^{K}\omega_{ik}z_{kt-1}. \tag{5}$$

Incorporating no-short sales constraints in the conditional analysis requires additional steps to guarantee positive aggregate weights of the assets in the tangency portfolio. Since we normalized the instruments to take values between zero and one only, the maximum value of z_{kt} is always one, and positivity of the net position in asset i is guaranteed if

$$\begin{aligned}
\omega_{i0} &\geq 0, \\
\omega_{i0} + \omega_{ik} &\geq 0, \quad k = 1, ..., K \\
\omega_{i0} + \omega_{ik} + \omega_{il} &\geq 0, \quad k, l = 1, ..., K, l \neq k \\
&\vdots \\
\omega_{i0} + \sum_{k=1}^{K}\omega_{ik} &\geq 0.
\end{aligned} \tag{6}$$

This implies a total of 2^K positivity constraints per asset. If ω_{i0} plus any combination of the ω_{ik}s is positive, then the total position in asset i will always be positive.

3 Data

We use monthly data on country indices for the G7 countries and for ten major (level 3) industry indices, provided by Datastream. Monthly US dollar based returns are used for the period from February 1975 to February 2005 (361 observations). Both the country and the industry indices have dividends reinvested. As market values for the different indices are also available, we construct global industry returns from the G7 country and industry indices only as well as a value-weighted world market index composed only of the G7 country indices. Hence in this case, the geographical span of the global industry portfolios is exactly identical to that of the country and world indices. In addition to the seven country and ten industry sector returns, we use returns on a value-weighted world index and on the forward contracts for the different currencies. The forward returns are constructed from the exchange rates and one-month Eurocurrency rates.

Summary statistics of the returns for the seven countries, ten industry sectors and seven currency deposits are reported in Table 1. These show that the country indices have somewhat higher mean returns than the industry indices, but the standard deviations appear to be somewhat higher as well. The p-values for the Wald test statistics that the mean returns are equal to zero show that this hypothesis is easily rejected for both the countries and the industries. The hypothesis that the mean returns are equal cannot be rejected for either the countries or the industries or the combined set. Therefore, according to those tests, the cross-sectional variation in the mean returns is not very high, neither within the sets of countries and industries nor between the two sets. For the currency deposits, the Canadian Dollar and the German Mark have noticeably lower mean returns than the other currencies. The Pound Sterling has the highest average return.

Next we examine the average correlations of each country, industry and currency with the set of countries, industries and currencies respectively. Thus, the third column shows the average correlation of each individual index with the seven country indices. The correlation of each index with itself is always excluded from the mean. Similarly, the fourth and fifth columns show the average correlation of each individual index with the ten industry portfolios and with the currency deposits. As our sample contains three Euro-zone countries, we use the Japanese Yen, the Pound Sterling, the Canadian Dollar and the spliced series of the German Mark up to January 1999 and the Euro thereafter to compute the correlation with the currencies. The table shows that the average correlation between the country returns is noticeably lower than the average correlation between the industry returns, while the difference in mean returns between countries and industries is small. This suggests that differences between countries are more pronounced than differences between industries and cross-country strategies may provide more diversification opportunities. Lastly, the correlations between currency forward returns and country or industry returns are of similar magnitude and they are typically less than half the average correlation between country and/or industry returns.

4 Diversification effects

In this section we analyze whether the differences in the characteristics between country and industry returns and currency deposits also translate into portfolio differences by examining the performance of country- and industry-based portfolios. In order to investigate more explicitly the role of currency risk, we also consider portfolios that include a number of foreign currency deposits. A straightforward alternative to country- or industry-based portfolios are the portfolios suggested by the International CAPM (ICAPM) (Sercu, 1980, Adler and Dumas, 1983) and its empirical implementations (Dumas and Solnik, 1995, De Santis and Gerard, 1998): the world portfolio and a number of foreign currency deposits. If the ICAPM is a valid pricing model, then neither industries nor countries should be able to outperform the world portfolio and foreign currency deposits. The maximum Sharpe ratio that can be obtained with the ICAPM portfolios should be no worse than the maximum Sharpe ratio that can be obtained with either the country or the industry portfolios. Moreover, since there is no reason for the industry and country portfolios to constitute efficient portfolios, it may very well be the case that the ICAPM portfolios outperform the country or the industry portfolios.

Our specification of the ICAPM uses the value-weighted portfolio of the G7 countries as the world portfolio plus three currency deposits: the British Pound, the Japanese Yen and the spliced series of the Deutschemark (up to January 1999) and the Euro (thereafter). The Canadian Dollar is excluded because of its high correlation with the US Dollar. Similarly, because of the fact that the Deutschemark, the French Franc, and the Italian Lira are all highly correlated and stem from Euro-zone countries, we only use one of those currencies in our ICAPM (see also De Santis, Gerard, and Hillion, 2003). Thus, according to our specification of the spanning tests, we should have that for each asset with excess return $r_{i,t}$, the intercept α_i in the regression

$$r_{i,t} = \alpha_i + \beta_i r_t^w + \sum_{j=1}^{3} \delta_{ij} f_{j,t} + \varepsilon_{i,t}. \tag{7}$$

is zero. Here r_t^w is the excess return on the world portfolio and $f_{j,t}$ are the forward returns on the currency deposits. The performance of the ICAPM-based portfolio is affected by both the world index and the currency deposits. As we are interested in the relative impact of country, industry and currency effects, we also consider country and industry portfolios in combination with the currency deposits as well as the passive world benchmark.

4.1 Unconditional efficiency tests

4.1.1 Spanning tests

A sufficient condition for a country-based portfolio to be efficient for the entire set of country and industry indices, is if the country indices span the industry indices. In the case of excess returns this comes down to a zero Jensen measure of each of the industries relative to the seven country indices. Similarly, a zero Jensen measure of each country relative to the ten industries is a sufficient condition for the existence of an industry portfolio that is efficient for the entire set of indices. Panel A of Table 2 shows the Jensen measures of each industry relative to the seven countries and the Jensen measures of each country relative to the ten industries. We find that none of the individual Jensen measures is significant. Panel B reports p-values associated with the spanning test-statistic, i.e. a test of whether all Jensen measures are jointly equal to zero. These p-values confirm the results of Panel A: the industries do not outperform the countries and the countries do not outperform the industries either. Thus, this first test suggests that it does not matter whether an investor constructs a portfolio from industries or from countries. When a portfolio is constructed from countries (industries), its unconditional Sharpe ratio cannot be improved upon by changing the industry (country) weights.

We extend the analysis by considering the world portfolio and three currency deposits as well. We cannot reject the hypothesis that the ICAPM portfolios span the countries, i.e., we cannot reject the validity of the (unconditional) ICAPM, which follows from the p-value of 0.505. By the same token, countries span the unconditional ICAPM portfolios, as is shown by the p-value of 0.559.[3] This suggests that investors are indifferent between an investment in the ICAPM portfolios and an investment in the country portfolios. In principle of course, the countries should be able to mimic the world portfolio. To see whether this is indeed the case, we repeat the same tests for the countries versus the world portfolio, excluding the currency deposits. In this case again, neither the hypotheses that the countries span the world portfolio or that the world portfolio spans the country portfolio can be rejected. This suggests that the world portfolio is efficient relative to the country portfolios.

In contrast, neither the world portfolio nor the ICAPM portfolios is efficient with respect to the global industry portfolios. In both tests spanning is rejected at a 10% significance level. On the other hand, while global industry portfolios do span the ICAPM portfolio, they fail to span the world portfolio alone. The spanning test reports that currencies do not have to be added to the investment set, as they are spanned by countries, industries and the world portfolio.

Investing in the optimal portfolios used for the spanning tests can require substantial short positions, which may not always be implementable in realistic investment settings. It is also well known that the tangency portfolios computed on the basis of a particular sample historical mean returns and covariance matrix often yields extreme long and short positions (e.g. Jagannathan and Ma, 2003). Therefore, we repeat our spanning tests imposing no-short sales constraints. Notice that in Panel A the stocks that were included in the country test asset were also included in the industry benchmark assets. Therefore, a negative Jensen measure for a country implied that the industry-based portfolio was

[3] More precisely, we cannot reject the null hypotheses of mean-variance spanning. For ease of exposition we refer to this as "assets x span assets y".

underweighted with respect to that country. A similar reasoning applies when industry portfolios are test assets. So we cannot infer from negative Jensen measures that short positions should be taken in the test asset. Hence, in order to impose no-short sales constraints, we first remove overlapping components between test and benchmark assets.

Since the Datastream industry indices as well as their market value are available at the country level, for each country and industry, we recompute the G7 industry indices excluding each country's component and country indices excluding each industry's component. Hence, when we regress for instance Canada on the global industry indices, none of the global industry indices will include Canadian stocks. All our recomputed indices are value-weighted across their remaining components. We then replicate the spanning tests for industries and countries imposing no-short sales constraints. Notice that this joint test is not a spanning test in the traditional sense (e.g., Huberman and Kandel, 1987, DeRoon, Nijman, and Werker, 2001), since the benchmark assets are different in each regression (i.e., each regression excludes a different industry).

Denoting the return of country i excluding industry j as $r_{i,t}^{x\backslash j}$ and the return of industry j excluding country i as $r_{j,t}^{y\backslash i}$, our tests are now based on the following regressions:

$$r_{j,t}^{y} = a_j + \sum_{i=1}^{L} b_{ij} r_{i,t}^{x\backslash j} + \varepsilon_{j,t}^{y}, \tag{8a}$$

$$r_{i,t}^{x} = a_i + \sum_{j=1}^{N} b_{ji} r_{j,t}^{y\backslash i} + \varepsilon_{i,t}^{x}, \tag{8b}$$

where L is the number of countries and N is the number of industries. When the world portfolio is (part of) the benchmark, the country or industry test asset is excluded from the world portfolio. On the other hand, we cannot perform these exclusions when the world portfolio is the test asset, as all countries or industries combined are the assets in the world index. The currency deposits are not affected by these exclusions, as they do not have components in common with other portfolios.

Since in the Jensen regressions (8) the test assets and the benchmark assets are mutually exclusive we are now able to incorporate no-short sales constraints in these regressions. We follow the procedure outlined in DeRoon, Nijman, and Werker (2001) to incorporate short sales constraints on both the test assets and the benchmark assets in each of the regressions in (8). As currency deposits are in practice easy to short, they are not subject to no-short sales constraints. Panel C of Table 2 reports the p-values of the spanning tests when short positions in country, industry or world portfolios are not allowed. These results generally confirm the findings in Panel B: countries span industries and vice versa, currencies do not have to be added to country or industry portfolios and industries are not spanned by the ICAPM or world portfolios. However, when short sales are not allowed, countries are no longer spanned by the world or ICAPM portfolios.

The results from the spanning tests without and with no-short sales constraints may differ due to the constraints or due to the removal of overlapping components. In order to examine to what extent our spanning results are affected by the use of benchmark indices that exclude the test asset, we also perform spanning tests excluding overlapping components but allowing for short positions. These tests may be somewhat less interesting from an investment perspective. For instance, the test examines whether an investor who invests in global industry indices that exclude Canadian stocks should extend her investment set with Canadian stocks. However, in reality investors can easily include in their portfolio industries from all G7 countries that we consider. Nevertheless, these spanning tests can be interpreted in the light of the country-industry debate: are country or industry factors driving international equity returns? By excluding a certain country from a set of industry benchmark portfolios one can investigate whether that country is a missing factor. Also note that we focus on the joint test for all country or industry test assets, rather than looking at individual Jensen measures. Excluding from the benchmark portfolio any overlapping components with the test asset actually gives the benchmark portfolio a disadvantage with respect to the test asset. Therefore we expect to find that spanning is more easily rejected after removal of overlapping components.

The results are reported in Panel D. We indeed find that after removal of overlapping components, all p-values drop. This can be seen by comparing Panels B and D. We again find that countries span industries and vice versa. The ICAPM portfolios (excluding the country of interest) span the country portfolios, as in the standard spanning tests. Furthermore, similar to Panel B we again find that the ICAPM portfolios and the world portfolio excluding the industry of interest fail to span the industry portfolios. However, spanning is now rejected at a 5% level, whereas the usual spanning tests reject spanning at the 10% level. The main difference between the usual spanning tests and those excluding overlapping components is that the world portfolio no longer spans the country portfolios. By comparing Panels D and C, we can see that all p-values drop even further after imposing no-short sales constraints. In particular, the ICAPM portfolios no longer span the country portfolios.

In conclusion, part of the country and industry outperformance with respect to the ICAPM and world portfolios that is reported in Panel C is due to the exclusion of overlapping components from the benchmark assets and part is due to the no-short sales constraints.

4.1.2 A direct comparison: Sharpe ratio tests

In the previous section we tested whether it is optimal to extend an initial set of assets with additional assets. The spanning tests compare the performance of the benchmark assets to the performance of the combined set including both benchmark and test assets. In this section we make a direct comparison between two portfolios by testing the difference in their maximum Sharpe ratios.

Table 3 reports the maximum Sharpe ratios of the six portfolios under consideration:

country, industry and world portfolios, with and without currency deposits. Panel A shows the maximum annualized Sharpe ratios and Panel B reports the p-values for the tests of the pair-wise differences in the maximum Sharpe ratios between the six portfolios. The first row of Panel A shows that the maximum annualized Sharpe ratio for a portfolio constructed from the global industry indices is 0.76 whereas for the countries it is 0.61. Although this difference is economically meaningful, the p-value for the Wald test of whether the difference in Sharpe ratios is zero (reported in Panel B) is 0.334. Hence we cannot reject the hypothesis that the two Sharpe ratios are equal, which is consistent with the results of the spanning tests. If we add currencies to both industry- and country-based portfolios, their Sharpe ratios increase only marginally (to 0.62 and 0.79 respectively), thereby confirming the spanning test results that adding currency deposits does not improve mean-variance efficiency. The difference between these two Sharpe ratios is again insignificant, as a p-value of 0.278 indicates. The ICAPM and world portfolios have lower Sharpe ratios, 0.49 and 0.44 respectively, and the difference with the other portfolios is insignificant at the 5% level.

In Section 2.3 we discussed how the different hypotheses of the spanning tests and the Sharpe ratio tests are related. This can also be seen from the results. For instance, in Table 2 we find that countries span industries and vice versa. This implies that $\lambda = 0$ and indeed, Table 3 shows that the difference between the country and industry Sharpe ratios is insignificant. The theoretical relations between the different hypotheses always hold when looking at the empirical results, with one exception. We find that the ICAPM portfolios do not span the industries but industries do span the ICAPM portfolios. According to the theory, this should imply that the industry Sharpe ratio should exceed the ICAPM Sharpe ratio. However, Table 3 shows that the equality of Sharpe ratios cannot be rejected, with a p-value of 0.14. However, this does not mean that the results of the two tests are contradictory, as the estimated industry Sharpe ratio of 0.76 exceeds the ICAPM Sharpe ratio of 0.49 and although it lies above conventional significance levels, the p-value of the Sharpe ratio test is still relatively low. Not being able to reject a hypothesis does not mean that we accept the null hypothesis.

The portfolios that yield these maximum Sharpe ratios presented in Table 3 may require short positions which may not always be implementable in realistic investment settings. Therefore, the second row of Panel A shows the maximum attainable Sharpe ratios when short selling is prohibited. The third row reports the p-values of the test of whether imposing the no short sale constraint leads to an efficiency loss, i.e., a significant drop in the maximum Sharpe ratio. Note that for the world and ICAPM portfolios the Sharpe ratios are unaffected by the no-short sales constraints, as currencies are not subject to these constraints and for the world portfolio they are not binding. For the other four portfolios, the maximum Sharpe ratios decrease when restricting to only long positions. Even though this is statistically insignificant for all four portfolios, it is economically meaningful, especially for the industry portfolio where the annual Sharpe ratio is lowered from 0.76 to 0.66. Panel C reports the p-values of the tests of differences in these no-short sale Sharpe ratios. It confirms the results in Panel B: whenever the difference in the unrestricted Sharpe ratios is significant, it is also significant for the no-short sale Sharpe ratios. In other words, our results are robust for no-short sales constraints.

Summarizing, the unconditional spanning tests suggest that there is not a material difference in portfolio performance when portfolios are constructed from either countries or industries. Investing in either one of the two sets is mean-variance efficient. Moreover, the maximum Sharpe ratios of country- and industry-based portfolios are indistinguishable. These results also suggest that in an unconditional framework, including currency deposits is of little benefit to portfolio performance. This is consistent with the evidence reported by De Santis and Gerard (1998).

4.2 Dynamic portfolios

The inability of our unconditional efficiency tests to find statistically significant performance difference between industry- and country-based portfolios, with or without currency deposits, is not surprising. A large body of evidence documents not only predictable variations in asset expected returns as market and economic conditions change, but also significant time variation in asset volatility and correlations. In particular, Dumas and Solnik (1995) and De Santis and Gerard (1998) argue that the currency risk premium can only be detected in a conditional setting. Hence, we expand our analysis to consider strategies conditioned on a subset of the information that investors can use to manage their portfolios.

To describe the investor's information set, we use a set of variables similar to those used in previous research. The instruments for country and industry returns and the return on the world index (as part of the ICAPM portfolios) are the short term US interest rate, the dividend price ratio on the world equity index in excess of the one-month Euro-US$ rate, the US term premium and the US default premium, measured by the yield difference between Moody's BAA and AAA rated bonds. In order to predict changes in currency risk premiums we use the following instruments: the short term US interest rate and the spreads between the UK and US interest rate, the Japanese and US interest rate, and the German and US interest rate, which we refer to as interest rate differentials. All variables are used with a one–month lag, relative to the return series. If we denote the K instruments by the K-vector z_{t-1} (excluding a constant), then conditioning information can be implemented by adding for each asset i the K managed portfolio returns $z_{k,t-1}r_{i,t}$, where each period a position of size $z_{k,t-1}$ in asset i is chosen. Next to the returns on the managed portfolios, we also include the returns on the country, industry and ICAPM portfolios themselves. In this way we get a total of $(K+1)\times L$ assets, where L is the number of country, industry or ICAPM portfolios.

4.2.1 Conditional spanning tests

Table 4 reports the results of the conditional spanning tests. Panel A reports the p-values of the spanning tests when short positions are allowed. Whereas in the unconditional analysis countries span industries and vise versa, we now find that countries no longer span industries, while industries do span countries. This indicates an outperformance of dynamic industry portfolios: investing in these portfolios alone is mean-variance efficient, while investing in dynamic country portfolios alone is inefficient and industries should be considered as well. This industry outperformance with respect to the countries can also be concluded from the findings that whereas the dynamic ICAPM portfolio spans dynamic country portfolios, it fails to span dynamic industry portfolios.

Furthermore, while in the unconditional analysis we do not find any added benefits from considering currency deposits in the investment set, we now detect a striking outperformance of managed portfolios that include currencies. The ICAPM portfolios as well as the currency deposits alone are not spanned by the country or industry portfolios. This implies that in order to achieve mean-variance optimality, currency deposits have to be included in the portfolio. In a next section we further explore why this remarkable currency outperformance is only detected in a conditional framework.

The managed portfolios may not always be implementable due to possibly large short positions. Therefore, in the next step we impose no-short sales constraints on the test and benchmark assets. Note that, as for the spanning tests in the previous section, we first have to exclude any overlapping components between the test and benchmark assets. Furthermore, as the total position in any asset depends on the instruments, we restrict the total weight functions to be strictly positive functions of the instruments by imposing the constraints given in (6). The currency deposits are not subject to no-short sales constraints.

Panel B of Table 4 reports the spanning test results when no-short sales constraints are imposed. We find that the no-short sale constraint dramatically affects the performance of industry based strategies. Whereas Panel A shows a clear outperformance of dynamic industry portfolios, in Panel B it has disappeared completely. Industries are spanned by countries and vice versa and they are both spanned by the ICAPM portfolio. Hence, the long-only dynamic country and industry portfolios exhibit similar performance. These results show that no-short sales constraints are especially binding for industry portfolios. In other words, the superior performance of the industry portfolios in terms of the spanning test is highly dependent on the ability to short the industry portfolios, and therefore they may not be attainable for many investors or in equilibrium strategies. Unreported results show that the R^2s from regressions of the returns on the instruments are generally higher for the industries than for the countries. This higher predictability may explain the better performance of the industry portfolios if short selling is allowed. However, apparently, the predictability leads investors to take many short positions and when this is precluded it no longer leads to superior portfolio performance. Similar to Panel A, the currency returns are not spanned by countries or industries. This currency outperformance indicates that the no-short sale dynamic country and industry portfolios should be extended by dynamic currency deposits.

In order to determine to what extent the results in Panel B are affected by the exclusion of overlapping components, we also perform the conditional spanning tests when short sales are allowed, but the benchmark assets do not have any components in common with the test assets. As we argued in the previous section, the ability of a set of benchmark assets to span a set of test assets is negatively affected by the exclusion of overlapping components from the benchmark assets. Similar to the unconditional results reported in Table 2, we again find that the p-values generally decrease after exclusion of overlapping components. Hence, when spanning is already rejected in Panel A, it will most likely also be rejected in Panel C. Indeed, while countries are still spanned by the industry and ICAPM portfolios, the dynamic industry portfolios again outperform the country and ICAPM portfolios. Note that whereas for the unconditional tests, the p-values become even lower when imposing no-short sales constraints, this pattern is not present for the conditional tests. Here the p-values in Panel B (with no-short sales constraints) are higher than those in Panel C (exclusion of overlapping components) and the industry outperformance disappears when imposing no-short sales constraints.

4.2.2 Conditional Sharpe ratio tests

Next, we compare the managed portfolios directly by testing the difference in their maximum Sharpe ratios. These results are shown in Table 5. First, comparing the maximum Sharpe ratios of the dynamic portfolios to those obtained in the unconditional analysis in Table 3 is indicative of the value of information and dynamic strategies in enhancing portfolio returns. Indeed, Panel A of Table 5 shows that all Sharpe ratios are remarkably higher. The most dramatic increase takes place for the portfolio consisting of industries and currency deposits: the maximum annual unconstrained Sharpe ratio nearly triples from 0.79 to 2.25 when rebalancing the portfolio every month. Again, industries have a higher Sharpe ratio than countries (1.78 versus 1.20) and in contrast to the unconditional tests, the difference is now statistically significant at a 1% level, as is reported in Panel B. When currencies are added to these portfolios, both Sharpe ratios increase substantially. This is consistent with the finding that managed currency deposits improve the mean-variance efficiency of a portfolio. After adding currencies, industries also outperform countries. Thus, both the spanning tests and the Sharpe ratio test suggest that, in the absence of short selling restrictions, dynamic industry portfolios are more attractive than dynamic country portfolios. Countries and industries have higher Sharpe ratios than the dynamic ICAPM portfolio, but the differences are insignificant. They become significant when currencies are added to the dynamic country and industry portfolios.

After imposing no-short sales constraints, the country and industry Sharpe ratios drop remarkably. Again, the ICAPM portfolio is unaffected by the constraints. The maximum annualized Sharpe ratio for the managed industry portfolios drops from 1.78

to 0.80. For the managed country portfolios, the decrease is from 1.20 to 0.70. In contrast to the unconditional analysis, the efficiency loss due to the no-short sales constraints is both economically and statistically significant. The same holds for the country and industry portfolios that also include currency deposits. Akin the conditional spanning tests, the industry performance is affected most by the constraints. With no-short sales constraints, managed country portfolios and managed industry portfolios (with and without currencies) yield indistinguishable Sharpe ratios.

We can again detect a clear outperformance of portfolios that include managed currency returns. The dynamic ICAPM portfolio outperforms both dynamic country and dynamic industry portfolios. Also, whereas countries and industries have similar no-short sales Sharpe ratios, a dynamic portfolio consisting of country (industry) returns and currencies significantly outperforms a dynamic industry (country) portfolio. We document a dramatic increase in no-short sales Sharpe ratios when currency deposits are added to managed country or industry portfolios. The annual industry Sharpe ratio nearly doubles from 0.80 to 1.55 when currencies are added. The country Sharpe ratio increases from 0.70 to 1.51.

Concluding, the conditional efficiency tests suggest that the outperformance of managed industry portfolios with respect to managed country portfolios hinges on the ability to short global industries. When short sales are not allowed, dynamic industry and country portfolios perform similarly. On the other hand, dynamic portfolios including currencies clearly outperform by a very large and statistically significant margin.[4]

4.3 A further look at currencies

Our results suggest that in order to fully exploit international diversification opportunities investors need to include currency deposits in their managed portfolios. Now, why would investors optimally hold foreign currency deposits? If purchasing power parity is violated, international investors hold positions in foreign equity as well as in foreign currencies thereby being exposed to currency risk. If currency risk is not compensated for, investors should fully hedge against foreign exchange rate risk. However, Dumas and Solnik (1995) and de Santis and Gerard (1998) report significant currency risk premiums. Also, the main part of the risk premium on currency deposits is indeed a compensation for currency risk. Hence, next to hedging demand, investors can also have speculative demand for currency deposits in case of positive expected excess returns.[5]

[4] The outperformance of dynamic portfolios including currencies is not likely to be driven by extreme positions in currencies. Over the full sample period the average total position in the three currency deposits is approximately 10%. The total position in currencies lies between -100% and +100% in nearly every month.

[5] Campbell, Serfaty-de Medeiros and Viciera (2006) investigate currency hedging demand and support the importance of including currencies in international portfolios. In this paper we do not distinguish explicitly between hedging and speculative demand, but we show that in order to fully exploit the benefits from international diversification, currency deposits should be included in an international portfolio.

De Santis and Gerard (1998) show that the role of foreign exchange risk can only be shown when the currency risk premium is allowed to be time-varying. This is in line with our finding that only in a conditional framework do currency deposits improve portfolio performance. This outperformance could be due to time variation in the hedging properties of currencies, which is exploited by using instruments. Alternatively, it could be caused by predictability in time variation in the expected returns.

We examine this informally by looking at 60-month moving window correlations between currencies and equities and average currency deposit returns. Figure 1 Panel A reports the average correlations between the country and industry returns and the three currency deposits under consideration (Japanese Yen, British Pound and German Mark - Euro) for each of the 60-month windows. Indeed, these correlations vary substantially over time and seem to display a downward trend. Whereas in the first part of the sample period (up to the mid 1980s) the average correlation is close to 0.4, the correlation decreases remarkably and even becomes close to zero in 5-year windows ending in 2000. In recent years the correlation between equities and currencies has increased slightly to approximately 0.2. This suggests that the hedging properties of currencies indeed vary over time and especially in the late 1990s currencies were attractive hedging instruments.

Panel B of Figure 1 displays the average (excess) returns on currency deposits over 60-month moving windows. While the full sample average returns on currency deposits are very low (see Table 1) the figure shows that they are highly time-varying. The average monthly returns on currency deposits (with the USD as a base currency) vary from -1% in 5-year windows from 1980 to 1985 to +1% in windows from 1985 to 1990. At the end of the sample period the average returns are about 0.2%. Hence, whereas the full sample average returns on currency deposits are close to zero and currency deposits do not enhance portfolio performance, using instruments to take advantage of the predictability in expected returns does indeed lead to a remarkable outperformance.

Although not reported here, we find that the R^2s of regressions of the returns on the instruments higher for currency deposits than for equity returns. This suggests that the instruments have most predictive power for the currency deposit returns. In sum, exploiting the higher degree of predictability in the hedging properties and in the expected excess returns on currency deposits by using actively managed portfolios dramatically improves portfolio performance.

5 Style analysis

An alternative way to compare country and industry portfolios is to look at their 'replicating abilities '. If industry factors are at the root of cross-country differences in returns, it ought to be easy to construct from global industry portfolios a portfolio that mimics the country returns, while the reverse would be more difficult. Style analysis (Sharpe, 1992) provides a tool to study mimicking portfolios. The objective is to find a positive weight portfolio of the benchmark assets, such that this portfolio return mimics as closely as possible the returns on a target fund, the test asset. Whereas mean-variance efficiency tests require the estimation of mean returns, style analysis depends on their covariance structure only. This is a clear advantage, as it is more challenging to accurately estimate mean returns than to estimate covariances.

The style of global industry j in terms of the countries is determined by estimating the regression:

$$R^y_{j,t} = \alpha_j + \sum_{i=1}^{L} \beta_{i,j} R^x_{i,t} + e^y_{j,t}, \tag{9a}$$

$$\text{s.t. } \beta_{i,j} \geq 0 \quad \forall i,j, \qquad \sum_{i=1}^{L} \beta_{i,j} = 1. \tag{9b}$$

where $R^y_{j,t}$ ($R^x_{i,t}$) is the total, not excess, return for industry j (country i) during month t and L is the number of countries in the mimicking portfolio. The restrictions that the coefficients $\beta_{i,j}$ are all positive and that they sum to one imply that they form a positive weight portfolio, which is known as the *style* of the industry. This yields the country portfolio which mimics industry j best, in the sense that this is the portfolio which minimizes the variance of the tracking error. To the extent that a particular industry is concentrated in one country, we may also expect that the coefficient $\beta_{i,j}$ for this country will be relatively large. The R^2 of the style regression gives us an estimate of how well an industry can be mimicked by countries and vice versa. The style coefficients together with the R^2 provide information on the risk characteristics of countries in terms of industries and vice versa.

We examine the ability to replicate these test asset returns for five different portfolios: country and industry returns, both also extended with the three currency deposits, and the ICAPM portfolio returns. As the returns on currency deposits are excess returns, they are not subject to portfolio constraints. We take this into account by performing the full style regressions in terms of excess returns rather than total returns whenever currency deposits are included. In that case we do not impose the portfolio constraint. Moreover, currency deposits are not subject to no-short sales constraints and hence the nonnegativity constraints only apply to the country, industry or world returns.

5.1 Replicating abilities

We first consider the replicating abilities of countries and global industries. Table 6, Panel A shows the styles of industry portfolios in terms of country portfolios. Similarly, in Panel B the styles of the countries are given in terms of industry portfolios. For instance, according to the coefficients in Panel A, Finance is an important industry for Japan, whereas Noncyclical Consumer Goods are relatively important for the US. The table also presents the R^2s of the individual style regressions. We see, for instance, that the country replicating portfolio can explain about 44% of the return variation of the global Resources portfolio. General Industries and Consumer Goods are best mimicked by the country portfolios; these explain 85% of the return variation. The R^2 of 14% indicates that Utilities is the sector that is most difficult to replicate. As far as the country styles in terms of industries are concerned, global industries perform best at replicating the US: the style portfolio can replicate 80% of the US return variation. Italy is most difficult to replicate, its R^2 is only 22%.

In order to examine the general ability of countries to replicate global industry returns, we take an equally weighted average over all individual R^2s of Table 6 Panel A. In general, we take the average over all individual style regression R^2s for a certain set of test assets.[6] Table 7 Panel A reports an overview of the replicating abilities of the five benchmark portfolios under consideration. We find that, on average, countries can explain about 62% of industry return variation, while industries can only explain 51% of country return variation. This suggests that countries possess superior mimicking abilities to industries. We employ the procedure outlined in Eiling, Gerard and De Roon (2005) for simulating the empirical distribution of the style regressions R^2. This allows us to test the difference of country and industry mimicking abilities. Panel C of Table 5 shows the p-values of the tests whether differences in average R^2s are significant for various comparisons. The p-value of 0.008 in the upper left cell shows that the null hypothesis that the average country and industry R^2s are equal can in fact be rejected. This implies that country returns explain a significantly larger share of industry return variation than vice versa, at the 1% significance level. The country outperformance also becomes visible when the ICAPM portfolios are the test assets. Countries can explain a larger share of ICAPM portfolio return variation than industries can (44% versus 37%). Panel C shows that the difference is significant at the 1% level.

When the ICAPM portfolios are used as benchmark assets, we find that they possess better replicating abilities than country and industry replicating portfolios. On average, the ICAPM portfolios can explain 66% of the variation in global industry returns, which exceeds the share of industry return variation explained by countries (which is 62%). The difference however, is not statistically significant. Furthermore, the ICAPM portfolios account for 53% of the country return variation, which indicates their outperformance with respect to global industries, as the table shows that industries can explain 51% of country return variation. Even though the difference is small, it is statistically significant. The ICAPM outperformance is remarkable, considering that this portfolio only consists of four assets, while the country and industry benchmark portfolios consist of seven and ten assets respectively.

In order to further investigate the impact of including currency deposits in the benchmark portfolio, we also add currency deposits to country and industry benchmark port-

[6] We also calculate the value-weighted average R^2, where the weights are determined by the average weights of the countries and industries in the G7 market index, over the full sample period. However, we focus on the equally weighted average R^2, as in a value weighting scheme, the US results receive a weight that is greater than 50%, and drive the aggregate results. Since we consider the seven major developed economies, we do not run the risk of overemphasizing smaller countries.

folios. As expected, the average R^2s increase. Whereas industries can explain on average 51% of country return variation, the benchmark portfolio of industries and currencies can explain on average 58%. For country benchmarks the average R^2 increases from 62% to 67% when including currencies. Panel C of Table 7 shows that both increases are statistically significant. These results again imply that countries posses superior replicating abilities to industries and that their performances are affected in similar ways when adding currencies. More importantly, these portfolios now outperform the ICAPM portfolio. The portfolio of industry and currency benchmark assets can significantly better replicate country returns than the ICAPM portfolio can. The same holds for the country and currency benchmark portfolio. This suggests that adding currencies as additional benchmark assets is important to improve the replicating ability of a portfolio. If the ICAPM portfolio outperformance would be due to the world index rather than the currency deposits, one would expect that it would still outperform the benchmark portfolios of countries or industries combined with currencies.

The ability of benchmark assets to replicate a test asset is expected to be positively affected when the test and benchmark assets have many components in common. Hence, in a next step we look at the mimicking abilities of countries (industries) for a particular industry (country), when that industry (country) is removed from the country (industry) benchmark indices. This is similar to the spanning test regressions when overlapping components are excluded from the benchmark assets, which is discussed in Section 2. Thus, we are now using the analysis as in (9) but with (9a) replaced by

$$r_{j,t}^{y} = \alpha_j + \sum_{i=1}^{L} \beta_{ij} r_{i,t}^{x\backslash j} + e_{j,t}^{y} \tag{10}$$

and we make a similar adjustment for the country regression. We refer to these style regressions as 'exclusive' style analysis, while the style analysis discussed previously is referred to as 'simple' style analysis. When the ICAPM portfolios are the test assets, it is not possible to exclude overlapping components from the country or industry benchmark assets. Hence, in the exclusive style analysis we only consider country and industry test assets. If the ICAPM portfolios are the benchmark assets, the world index excludes the country or industry test asset.

Table 7 Panel B reports the equally weighted average R^2s of the exclusive style regressions. Compared to the simple style results of Panel A, we see that all R^2s are lower. Indeed, a test asset is more difficult to replicate if the benchmark assets do not contain any component that overlaps with the test assets. By analyzing the difference in R^2 of the simple and exclusive analysis we can infer the impact of removing overlapping components on the mimicking abilities of the benchmark assets. We simulate the empirical distributions of these average R^2s similarly to those of the simple style R^2s and we test whether the change is significant. Unreported results show that in all cases the deterioration in replicating abilities is statistically significant at the 1% level. Remarkable is the large decrease in R^2 for the industries' abilities to replicate country returns due to the exclusion of overlapping components. The average R^2 in Panel A (simple regression) is 51% while in Panel B (exclusive regression) it is only 29%. Unreported results show that although the reduction in R^2 is minimal for Italy, France, Germany and Canada, it is larger for the UK and extremely dramatic for Japan and the US. For instance, the R^2 of the US regression in drops from 80% to 4%. A closer look at the loadings on the industry portfolios[7], shows that in both regressions the US mimicking portfolio comprises the same three industries with similar loadings. This suggests that the domestic component of the industry portfolios is critical in the ability of industry portfolios to mimic country indices, especially for the larger economies.

Despite the worsening of replicating abilities, the exclusive style regressions confirm all previous findings. Given the high R^2 of the style analysis regressions of the industries in terms of countries, portfolios of country indices perform very well to mimic the returns of industry portfolios, even when the country indices exclude all stocks from that industry. This suggests that global industry portfolios have a "country structure" that can be duplicated well with stocks outside of that industry. On the other hand it is much more difficult to replicate the returns of country portfolios with industry portfolios, especially when that country's stocks are excluded for the industry portfolios. The superior performance of the ICAPM portfolios and the country and industry benchmark portfolios that also include currency deposits shows that adding currencies to a benchmark portfolio significantly improves its performance in terms of mimicking abilities.[8]

5.2 Conditional style analysis

As with the efficiency tests, we also want to include conditional strategies in style analysis. To the best of our knowledge we are the first to show how to implement this. Again, consider the K instruments z_t that can be used to predict asset returns, in particular the returns on the benchmarks. It is assumed that the instruments in z_t are normalized and the vector z_t does *not* include a constant in our setup. We consider the returns on managed portfolios $z_{kt-1}R^x_{it}$ as additional benchmark assets in the style regression. In this way we get a total of $(K+1)\times L$ benchmark assets. Consider the expanded style

[7] These results are available upon request from the authors.

[8] The value-weighted average R^2 in the simple style analysis is generally higher than the equally weighted average R^2, expecially when the countries are the test assets. We now find that the industries are slightly better at mimicking country styles than vice versa: the weighted average R^2s are 0.69 and 0.66 respectively. When currencies are added to both portfolios industries also outperform countries. After excluding overlapping components countries clearly outperform industries. The difference between country and industry performance becomes even more pronounced than for the equally weighted averages: the weighted average R^2s become 0.57 for country funds and only 0.15 for industry funds. As these results are to a large extent determined by the US test asset (which has the largest weight in the G7 index), we focus on equally weighted averages.

regression

$$R_t^y = \alpha + \sum_{i=1}^{L} \beta_{i0} r_{it}^x + \sum_{i=1}^{L} \sum_{k=1}^{K} \beta_{ik} z_{kt-1} R_{it}^x + e_t^y. \tag{11}$$

The issue is how to incorporate the portfolio and positivity constraints with respect to each asset. A way to make sure that the total asset positions sum to one is to impose the constraints

$$\begin{aligned} \sum_{i=1}^{L} \beta_{i0} &= 1, \\ \sum_{i=1}^{L} \beta_{ik} &= 0, \qquad \forall k. \end{aligned} \tag{12}$$

In this way, the net effect of each instrument z_{kt} is zero, no matter what the value of that instrument is, and the total portfolio positions will always sum to one. The nonnegativity constraints are similar to those for the managed portfolio returns in the efficiency tests, as discussed in Section 2.3. We impose a total of 2^K positivity constraints per asset. The restrictions in conditional style analysis are therefore given by (12) and (6), a total of $(1 + K + L \times 2^K)$ restrictions.

Table 8 reports the equally weighted average R^2s of the conditional style regressions. Compared to the unconditional results of Table 5 we find a slight improvement of replicating abilities when conditioning information is used. The average R^2s increase slightly, by 1% to 5%. We first consider the simple style regressions (Panel A), which are based on full country, industry and world indices. We find the exact same patterns as in Table 5 Panel A, namely countries have superior replicating abilities to industries and adding currencies to the benchmark assets significantly improves the performance in terms of replicating the test asset. These findings are confirmed in Panel B, where in each regression the industry (country) of interest is excluded from the benchmark indices. Most importantly, these results instill confidence in the conclusions drawn from the unconditional style analysis.

6 Robustness check: sub-sample analysis

Whereas nowadays most investors hold international portfolios, in the early 70s and even in the 80s investing internationally and holding currency deposits was not common at all. In order to make sure our results are not driven by a particular period during our 30-year sample period, we perform a robustness check by performing the analysis for three nonoverlapping 10-year sub-sample periods. Hence, the three sub-sample periods run from February 1975 to January 1985, from February 1985 to January 1995 and from February 1995 to February 2005. To be concise we only report part of the results of the conditional analysis in Tables 9 and 10.

Unreported results of unconditional efficiency tests show that country and industry portfolios are equally mean-variance efficient in all three sub-sample periods. Countries span industries and vice versa and the difference in maximum Sharpe ratios is insignificant, thereby confirming our full sample results. On the other hand, whereas over the full sample country and industry portfolios span currency deposits, spanning is rejected in all three sub-samples, at least at a 10% significance level. These findings hold with and without no-short sales constraints. The importance of currency deposits is confirmed in the conditional tests, as can be seen in Table 9. In all three sub-sample periods currencies should be added to managed country and industry portfolios in order to achieve mean-variance optimality. The tests also report outperformance of managed industry portfolios when short sales are allowed. In the three sub-sample periods industries are not spanned by countries. However, in contrast to the full sample results, managed country portfolios are not spanned by managed industry portfolios either. When we make a direct comparison between the two portfolios, we find that in the first two sub-samples industry-based portfolios have a significantly higher Sharpe ratio than country-based portfolios. In accordance with the full sample results, this outperformance disappears when no-short sales constraints are imposed. Furthermore, in all three sub-samples we find that the both the managed country and industry no-short sales Sharpe ratios double when currencies are added.

The results of the unconditional and conditional style analysis for the three sub-sample periods are very similar, therefore we discuss only the conditional results that are reported in Table 10. These concern the simple style regressions. Similar to the full sample results, we find that countries possess better replicating abilities than industries, at least in the first two sub-sample periods. In contrast, in the 1995-2005 period we find that industries can better replicate country returns than vice versa. In all three sub-samples the ICAPM portfolios outperform country-, and industry-based portfolios. However, when currencies are added as additional benchmarks to country and industry benchmark portfolios, these outperform the ICAPM portfolios. These findings are in line with our full sample results that suggest that adding currencies to a set of benchmark portfolios significantly improves the replicating abilities.

In sum, our results are confirmed for three 10-year non-overlapping sub-sample periods, suggesting that our findings are not likely to be caused by one specific sub-sample period. The gains from including currency deposits in a country- or industry-based portfolio are substantial and they are persistent over time: currencies add diversification benefits in the 70s, 80s, 90s and in recent years.

7 Conclusions

This paper investigates the role of currency risk, country factors and industrial structure on cross-country equity returns and attempts to disentangle their respective impact on international portfolio diversification strategies. We compare the performance of global industry, country and world portfolios, combined with a number of currency deposits for the seven major developed economies over the last 30 years. We develop a new test to measure and evaluate the statistical significance of the diversification gains of some portfolio strategies over others. The test is based on a comparison of the maximum Sharpe ratios of the strategies and can easily accommodate no-short sales constraints and conditioning information. We use style analysis as a complementary approach, in which we compare the replicating abilities of the different portfolios.

When comparing solely country- and global industry-based portfolios, our unconditional tests do not report significant differences in terms of mean-variance efficiency. Their Sharpe ratios are indistinguishable and investing in either country- or industry-based portfolios is optimal. However, when we take time varying investment opportunities into account by using conditioning information we detect clear differences between cross-country and cross-industry diversification strategies. The maximum annualized Sharpe ratio of unconstrained managed industry portfolios of 1.78 is significantly larger than that of country portfolios, which is 1.20. However, the outperformance of the dynamic industry portfolio critically depends on the ability to take short positions. With no-short sales restrictions it vanishes and country- and industry-based managed portfolios have comparable Sharpe ratios of 0.70 and 0.80 respectively. On the other hand, both the unconditional and conditional style analyses indicate that countries are better able to mimic industries than vice versa, even when the country indices exclude all stocks from that industry. Hence, for investors that are not allowed to take short positions, such as mutual funds, country-based strategies perform at least as well as industry-based strategies. However, investors that are not subject to long-only constraints, for instance hedge funds, may be able to achieve superior performance in terms of mean-variance efficiency by investing in actively managed global industry portfolios. Although, in practice, taking short positions in industry portfolios is typically rather expensive.

We find that currency deposits are crucial in order to achieve optimal portfolio performance. Dumas and Solnik (1995) and De Santis and Gerard (1998) show that the main share of the risk premium of currency deposits is compensation for currency risk and this risk premium can only be detected in a conditional framework. Indeed, whereas our unconditional tests do not document any benefit of including currency deposits in the investment universe, with monthly rebalancing, currency deposits add substantial diversification benefits to dynamic international equity portfolios. For instance, under no-short sales constraints, adding currency deposits to a managed industry portfolio nearly doubles the annual Sharpe ratio from 0.80 to 1.55. Similarly, the annual no-short sales Sharpe ratio of a managed country portfolio increases from 0.70 to 1.51 when currency deposits are added. The benefits from adding currency strategies to dynamic equity portfolios arise both from positive expected excess returns on currency strategies and from the hedging benefits from combining equities and currencies. Our analysis further shows that the gains from investing in currency deposits are persistent over time and that the benefits from adding active currency strategies to dynamic international equity portfolios as high in recent years as in the preceding decades.

A The asymptotic covariance of the Sharpe ratio test

For ease of exposition, consider the regression models

$$\begin{aligned} y_t &= b'x_t + \varepsilon_t, & \text{(13a)} \\ \Omega^{-\frac{1}{2}} y_t &= B'x_t + u_t. & \text{(13b)} \end{aligned}$$

Here $\Omega = Var[\varepsilon_t]$. Notice that we can always rewrite our regressions in this way. The problem that we face is that in (13b) we have to use an estimated covariance matrix $\widehat{\Omega}$ rather than the true covariance matrix Ω.

Denoting $\widehat{y_t} = \widehat{\Omega}^{-\frac{1}{2}} y_t$, the OLS estimate of B is

$$\widehat{B} = \left(\sum_t x_t x_t' \right)^{-1} \left(\sum_t x_t \widehat{y}_t' \right).$$

Defining $\eta_t = \left(\widehat{\Omega}^{-\frac{1}{2}} - \Omega^{-\frac{1}{2}} \right) y_t$, we get

$$\begin{aligned} \widehat{B} &= \left(\sum_t x_t x_t' \right)^{-1} \left(\sum_t x_t \left(x_t' B + u_t' + \eta_t' \right) \right) \\ &= B + \left(\sum_t x_t x_t' \right)^{-1} \left(\sum_t x_t \left(u_t' + y_t' \left(\widehat{\Omega}^{-\frac{1}{2}} - \Omega^{-\frac{1}{2}} \right) \right) \right). \end{aligned}$$

Since the last terms converge to zero, $\widehat{B}$ is a consistent estimator of B.

From the last equation we obtain

$$\sqrt{T} \left(\widehat{B} - B \right) = \tag{14a}$$

$$\sqrt{T} \left(\sum_t x_t x_t' \right)^{-1} \left(\sum_t x_t u_t' \right) + \sqrt{T} \left(\sum_t x_t x_t' \right)^{-1} \left(\sum_t x_t y_t' \left(\widehat{\Omega}^{-\frac{1}{2}} - \Omega^{-\frac{1}{2}} \right) \right)$$

$$\sqrt{T} \left(\widehat{B} - B \right) = \sqrt{T} \left(\sum_t x_t x_t' \right)^{-1} \left(\sum_t x_t u_t' \right) + \widehat{\beta} \sqrt{T} \left(\widehat{\Omega}^{-\frac{1}{2}} - \Omega^{-\frac{1}{2}} \right). \tag{14b}$$

The first term in the limiting distribution is standard, the interest here is in the second term, which arises because we have to use the estimated covariance matrix $\widehat{\Omega}$.

A.1 Limiting distribution of $\widehat{\Omega}$

In a standard regression framework, the limiting distribution of $\widehat{\Omega}$ is

$$\sqrt{T} \left(vech \left(\widehat{\Omega} \right) - vech \left(\Omega \right) \right) \to N \left(0, V \right).$$

We want to derive an expression for the covariance matrix V.

Consider the simple example where Ω is 2×2:

$$\Omega = \begin{pmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{pmatrix},$$

in which case we need the limiting distribution of

$$\sqrt{T}\begin{pmatrix} \widehat{\omega}_{11} - \omega_{11} \\ \widehat{\omega}_{12} - \omega_{12} \\ \widehat{\omega}_{22} - \omega_{22} \end{pmatrix} = \frac{1}{\sqrt{T}}\begin{pmatrix} \Sigma_t \varepsilon_{1t}^2 - T\omega_{11} \\ \Sigma_t \varepsilon_{1t}\varepsilon_{2t} - T\omega_{12} \\ \Sigma_t \varepsilon_{2t}^2 - T\omega_{22} \end{pmatrix}$$

The elements of the limiting covariance matrix can be written as

$$\begin{aligned} Var[\varepsilon_{1t}^2] &= E[\varepsilon_{1t}^4] - \omega_{11}^2 \\ Var[\varepsilon_{1t}\varepsilon_{2t}] &= E[\varepsilon_{1t}^2\varepsilon_{2t}^2] - \omega_{12}^2 \\ Cov[\varepsilon_{1t}^2, \varepsilon_{1t}\varepsilon_{2t}] &= E[\varepsilon_{1t}^3\varepsilon_{2t}] - \omega_{11}\omega_{12} \\ Cov[\varepsilon_{1t}^2, \varepsilon_{2t}^2] &= E[\varepsilon_{1t}^2\varepsilon_{2t}^2] - \omega_{11}\omega_{22}, \\ & \text{etc.} \end{aligned}$$

Thus, the covariance matrix looks like

$$V = \begin{bmatrix} E[\varepsilon_{1t}^4] - \omega_{11}^2 & E[\varepsilon_{1t}^3\varepsilon_{2t}] - \omega_{11}\omega_{12} & E[\varepsilon_{1t}^2\varepsilon_{2t}^2] - \omega_{11}\omega_{22} \\ E[\varepsilon_{1t}^3\varepsilon_{2t}] - \omega_{11}\omega_{12} & E[\varepsilon_{1t}^2\varepsilon_{2t}^2] - \omega_{12}^2 & E[\varepsilon_{1t}\varepsilon_{2t}^3] - \omega_{12}\omega_{22} \\ E[\varepsilon_{1t}^2\varepsilon_{2t}^2] - \omega_{11}\omega_{22} & E[\varepsilon_{1t}\varepsilon_{2t}^3] - \omega_{12}\omega_{22} & E[\varepsilon_{2t}^4] - \omega_{22}^2 \end{bmatrix}.$$

In general, the element of V corresponding to the covariance between $\widehat{\omega}_{ij}$ and $\widehat{\omega}_{lm}$ is $E[\varepsilon_{it}\varepsilon_{jt}\varepsilon_{lt}\varepsilon_{mt}] - \omega_{ij}\omega_{lm}$.

A.2 The limiting distribution of $\sqrt{T}\left(\widehat{\Omega}^{-\frac{1}{2}} - \Omega^{-\frac{1}{2}}\right)$

We know that

$$\sqrt{T}\left(vech\left(\widehat{\Omega}\right) - vech\left(\Omega\right)\right) = \sqrt{T}vech\left(\frac{1}{T}\sum_t \varepsilon_t\varepsilon_t' - \Omega\right).$$

For later use we will need the limiting distribution of $vec\left(\widehat{\Omega}\right)$ rather than of $vech\left(\widehat{\Omega}\right)$, but this one is obtained immediately from the above. Notice that $vec\left(\widehat{\Omega}\right)$ will have a singular covariance matrix, but this is not a problem in our application. Using a linear expansion, for the limiting distribution of $\sqrt{T}\left(\widehat{\Omega}^{-\frac{1}{2}} - \Omega^{-\frac{1}{2}}\right)$ we need the differential of $\Omega^{-\frac{1}{2}}$ with respect to Ω.

Following Magnus and Neudecker (1988)[9], start with the matrix function $F(X) = X^{\frac{1}{2}}$. Since $X^{\frac{1}{2}}X^{\frac{1}{2}} = X$ we get

$$\begin{aligned}
\left(\mathbf{d}X^{\frac{1}{2}}\right)X^{\frac{1}{2}} + X^{\frac{1}{2}}\left(\mathbf{d}X\frac{1}{2}\right) &= \mathbf{d}X, \Rightarrow \\
\left(X^{\frac{1}{2}} \otimes I_K\right) vec\left(\mathbf{d}X^{\frac{1}{2}}\right) + \left(I_K \otimes X^{\frac{1}{2}}\right) vec(\mathbf{d}X^{\frac{1}{2}}) &= vec(\mathbf{d}X) \Leftrightarrow \\
\left[X^{\frac{1}{2}} \otimes I_K + I_K \otimes X^{\frac{1}{2}}\right] \mathbf{d}vec\left(X^{\frac{1}{2}}\right) &= \mathbf{d}vec(X),
\end{aligned}$$

and therefore the differential of $X^{\frac{1}{2}}$ with respect to X is obtained from

$$\mathbf{d}vec\left(X^{\frac{1}{2}}\right) = \left(X^{\frac{1}{2}} \otimes I_K + I_K \otimes X^{\frac{1}{2}}\right)^{-1} \mathbf{d}vec(X). \tag{15}$$

The interest here is not in $X^{\frac{1}{2}}$, but in $F(X) = X^{-\frac{1}{2}}$, for which we have

$$\mathbf{d}X^{-\frac{1}{2}} = -X^{-\frac{1}{2}}\left(\mathbf{d}X^{\frac{1}{2}}\right)X^{-\frac{1}{2}}.$$

Taking *vec*'s gives

$$\mathbf{d}vec\left(X^{-\frac{1}{2}}\right) = \left(-X^{-\frac{1}{2}} \otimes X^{-\frac{1}{2}}\right)\mathbf{d}vec\left(X^{\frac{1}{2}}\right),$$

which can be combined with (15) to obtain

$$\mathbf{d}vec\left(X^{-\frac{1}{2}}\right) = \left(-X^{-\frac{1}{2}} \otimes X^{-\frac{1}{2}}\right)\left(X^{\frac{1}{2}} \otimes I_K + I_K \otimes X^{\frac{1}{2}}\right)^{-1} \mathbf{d}vec(X). \tag{16}$$

If ε_t is a N-vector, then define the $N^2 \times N^2$ matrix A as

$$A = \left(-\Omega^{-\frac{1}{2}} \otimes \Omega^{-\frac{1}{2}}\right)\left(\Omega^{\frac{1}{2}} \otimes I_N + I_N \otimes \Omega^{\frac{1}{2}}\right)^{-1}. \tag{17}$$

The limiting distribution of $vec\left(\widehat{\Omega}^{-\frac{1}{2}}\right)$ is then obtained from

$$\sqrt{T}\left(vec\left(\widehat{\Omega}^{-\frac{1}{2}}\right) - vec\left(\Omega^{-\frac{1}{2}}\right)\right) = \sqrt{T}A\left(vec\left(\frac{1}{T}\sum_t \varepsilon_t\varepsilon_t' - \Omega\right)\right). \tag{18}$$

[9] We thank Jan Magnus for showing us the necessary steps.

A.3 The limiting distribution of $\sqrt{T}\left(\widehat{B}-B\right)$

We are now in a position to derive the limiting distribution of$\sqrt{T}\left(\widehat{B}-B\right)$. Taking vec's of (14), we obtain

$$
\begin{aligned}
&\sqrt{T}\left(vec\left(\widehat{B}\right)-vec\left(B\right)\right)\\
= &\left(I_N\otimes\left(\sum_t x_t x_t'\right)^{-1}\right)\sqrt{T}vec\left(\sum_t x_t u_t'\right)+\left(I_N\otimes\widehat{\beta}\right)\sqrt{T}\left(vec\left(\widehat{\Omega}^{-\frac{1}{2}}\right)-vec\left(\Omega\right)\right)\\
= &\left(I_N\otimes\left(\sum_t x_t x_t'\right)^{-1}\right)\sqrt{T}vec\left(\sum_t x_t u_t'\right)+\\
&\qquad\left(I_N\otimes\widehat{\beta}\right)\sqrt{T}A\left(vec\left(\frac{1}{T}\sum_t \varepsilon_t\varepsilon_t'\right)-vec\left(\Omega\right)\right).
\end{aligned}
$$

The limiting distribution follows from this immediately.

References

[1] Adler, Michael, and Bernard Dumas, 1983, International portfolio choice and corporation finance: A synthesis, *Journal of Finance* 38, 925-984.

[2] Baele, Lieven, and Koen Inghelbrecht, 2005, Structural versus temporary drivers of country and industry risk, Unpublished working paper, Tilburg University.

[3] Basak, Gopal, Ravi Jagannathan, Guoqiang Sun, 2002, A direct test for the mean variance efficiency of a portfolio, *Journal of Economic Dynamics and Contro*l 26, 1195-1215.

[4] Beckers, Stan, Richard Grinold, Andrew Rudd, and Dan Stefek, 1992, The relative importance of common factors across the European equity markets, *Journal of Banking and Finance* 16, 75-95.

[5] Bekaert, Geert, Robert J. Hodrick, and Xiaoyan Zhang, 2005, International Stock Return Comovements, Unpublished working paper.

[6] Brooks, Robin, and Marco del Negro, 2004, A latent factor model with global, country and industry shocks for international stock returns, Federal Reserve Bank of Atlanta, Working paper 2002-23b.

[7] Campbell, John Y., Karine Serfaty-de Medeiros, and Luis Viciera, 2006, Global Currency hedging, Working paper, Harvard University.

[8] Cavaglia, Stefano, Christopher Brightman, and Michael Aked, 2000, The increasing importance of industry factors, *Financial Analyst Journal* 56, 41-54.

[9] Chang, Jow-ran, Vihang Errunza, Ked Hogan, and Mao-wei Hung, 2005, An international asset pricing model: Theory and empirical evidence, *European Financial Management* 11, 173-194.

[10] Dahlquist, Magnus and Torbjörn Sällström, 2002, An evaluation of international asset pricing models, CEPR Discussion paper No. 3145.

[11] De Roon, Frans.A., Theo.E. Nijman, and Bas J.M. Werker, 2001, Testing for mean-variance spanning with short sales constraints and transaction costs: The case of emerging markets, *Journal of Finance* 56, 723-744.

[12] De Santis, Giorgio and Bruno Gerard, 1997, International asset pricing and portfolio diversification with time-varying risk, *Journal of Finance* 52, 1881-1912.

[13] ———, 1998, How big is the premium for currency risk? *Journal of Financial Economics* 49, 375-412.

[14] De Santis, Giorgio, Bruno Gerard and Pierre Hillion, 2003, The relevance of currency risk in the EMU, *Journal of Economics and Business* 55, 427-462.

[15] Drummen, Martin, and Heinz Zimmerman, 1992, The structure of European stock returns, *Financial Analyst Journal* 48, 15-26.

[16] Dumas, Bernard and Bruno Solnik, 1995, The world price of foreign exchange risk, *Journal of Finance* 50, 445-479.

[17] Ehling, Paul, Sofia Brito Ramos, 2006, Geographic versus industry diversification: constraints matter, *Journal of Empirical Finance* 13, 396-416.

[18] Eiling, Esther, Bruno Gerard, and Frans de Roon, 2005, International Diversification in the Euro-zone: The Increasing Riskiness of Industry Portfolios, CentER discussion paper, No. 2005-02

[19] Elton, Edwin J., and Martin J. Gruber, 1992, International diversification, in Summer N. Levine, ed.: *Global Investing* (Harper Business, New York, NY).

[20] Gibbons, Michael R., Stephen A. Ross, and Jay Shanken, 1989, A test of the efficiency of a given portfolio, *Econometrica* 57, 1121-1152.

[21] Griffin, John M. and Andrew Karolyi, 1998, Another look at the role of the industrial structure of markets for international diversification strategies, *Journal of Financial Economics* 50, 351-373.

[22] Grinold, Richard, Andrew Rudd, and Dan Stefek, 1989, Global factors: Fact or fiction? *Journal of Portfolio Management* 16, 79-88.

[23] Heston, Steven L., K. Geert Rouwenhorst, 1994, Does industrial structure explain the benefits of international diversification?, *Journal of Financial Economics* 36, 3-27.

[24] Isakov, Dusan, Frederic Sonney, 2004, Are practitioners right? On the relative importance of industrial factors in international stock returns, *Swiss Journal of Economics and Statistics* 140.

[25] Jagannathan, Ravi, Tongshu Ma, 2003, Risk reduction in large portfolios: Why imposing the wrong constraints helps, *Journal of Finance* 58, 1651-1684.

[26] Lessard, Donald R., 1974, World, national and industry factors in equity returns, *Journal of Finance* 29, 379-91.

[27] Magnus, Jan R., and Heinz Neudecker, 1988, Matrix differential calculus with applications in statistics and econometrics, John Wiley & Sons, Inc.

[28] Sercu, Piet, 1980, A generalization of the international asset pricing model, *Revue de l'Association Francaise de Finance* 1, 91-135.

[29] Roll, Richard, 1992, Industrial structure and the comparative behavior of international stock market indices, *Journal of Finance* 47, 3-42.

[30] Sharpe, William F., 1992, Asset allocation: Management style and performance measurement, *Journal of Portfolio Management* 18, 7-19.

[31] Solnik, Bruno, 1974c, Why not diversify internationally rather than domestically?, *Financial Analysts Journal* 30, 48-54, reprinted in *Financial Analysts Journal* 51, 1995, 89-94.

Table 1: Summary statistics

The table contains summary statistics for monthly returns on country and industry indices and the currency deposit (excess) returns from Datastream. Mean returns and standard deviations are in percentages. 'c(ctry)', 'c(ind)', 'c(cur)' give respectively the average correlation of each index with the seven country indices, the ten industry indices, and the currency deposits, where the correlation of each index with itself is excluded. The correlation of the countries and industries with the currency deposits is based on Canadian Dollar, Yen, Pound Sterling and the spliced series of German Mark up to Jan 99 and Euro thereafter. The summary statistics of the French Franc, German Mark and Italian Lire are based on the period up to January 1999 and those of the Euro are based on the period starting in January 1999. 'min' and 'max' are the minimum and maximum returns (in percentages) respectively. 'weight' is the average weight (in percentages) of the index in the G7 world index over the sample period. The rows 'average' give the average over all country or industry summary statistics. Values in brackets are p-values associated with Wald test statistics for the null-hypotheses mentioned. Returns are calculated in US dollars for the period February 1975 until February 2005 (361 observations). The 10 industries are: Resources (Res), Basic Industries (BasI), General Industries (GenI), Cyclical Consumer Goods (CCGd), Non-Cyclical Consumer Goods (NCGd), Cyclical Services (CS), Non-Cyclical Services (NCS), Utilities (UT), Information Technology (IT), and Financials (Fin).

Panel A: Country Indices								
	mean	stdv	c(ctry)	c(ind)	c(cur)	min	max	weight
Canada	1.03	5.08	0.470	0.524	0.194	-23.35	16.16	2.88
France	1.36	6.41	0.516	0.501	0.282	-25.71	19.69	3.01
Germany	1.04	5.64	0.477	0.482	0.307	-18.26	20.07	4.56
Italy	1.18	7.43	0.399	0.370	0.175	-22.57	28.26	1.67
Japan	1.05	6.67	0.533	0.606	0.326	-22.80	25.11	27.69
UK	1.40	5.72	0.499	0.557	0.305	-21.51	26.80	9.61
US	1.15	4.17	0.486	0.637	0.071	-21.18	14.50	50.58
average	1.17	5.88	0.457	0.525	0.237	-21.91	21.51	
World (G7)	1.07	4.14	0.663	0.792	0.287	-11.90	14.21	
H_0: country means are zero								(0.000)
H_0: country means are equal								(0.831)

Panel B: Industry indices								
	mean	stdv	c(ctry)	c(ind)	c(cur)	min	max	weight
Res	1.27	5.05	0.449	0.452	0.193	-18.16	18.27	8.26
BasI	0.99	5.03	0.584	0.686	0.315	-15.07	15.10	9.24
GenI	1.11	4.62	0.626	0.711	0.222	-18.13	16.88	10.36
CCGd	1.01	4.88	0.560	0.656	0.199	-17.16	15.65	6.16
NCGd	1.21	3.91	0.504	0.585	0.224	-15.34	14.40	13.69
CS	1.05	4.59	0.616	0.719	0.244	-13.67	15.08	12.29
NCS	0.96	4.58	0.480	0.541	0.193	-15.78	16.41	7.35
UT	1.11	4.18	0.355	0.449	0.306	-14.26	23.62	5.73
IT	1.16	6.75	0.524	0.537	0.125	-25.88	23.37	8.88
Fin	1.22	5.31	0.555	0.660	0.300	-16.28	25.34	18.04
average	1.11	4.89	0.525	0.600	0.232	-16.97	18.41	
H_0: industry means are zero								(0.000)
H_0: industry means are equal								(0.866)
H_0: country and industry means are equal								(0.939)

Panel C: Currencies							
	mean	stdv	c(ctry)	c(ind)	c(cur)	min	max
Canadian $	0.03	1.53	0.285	0.261	0.194	-5.78	4.11
French Franc	0.12	3.23	0.210	0.191	0.630	-9.24	8.55
German Mark	0.01	3.33	0.192	0.180	0.626	-10.09	8.51
Italian Lira	0.11	3.18	0.210	0.168	0.571	-13.57	9.00
Japanese Yen	0.11	3.59	0.258	0.314	0.376	-9.75	17.64
Pound Sterling	0.20	3.11	0.220	0.193	0.440	-12.62	14.41
Euro	0.19	2.93	0.182	0.099	0.205	-5.22	7.38

Table 2: Unconditional spanning tests

This table presents the unconditional spanning tests. Panel A reports performance tests of the industries relative to the seven countries (first three columns) and of the countries relative to the ten industries (last three columns). $a(\%)$ gives the Jensen measure as a percentage per month and is estimated from the regressions

$$r_t^y = a_y + B_y r_t^x + \varepsilon_t^y \text{ and } r_t^x = a_x + B_x r_t^y + \varepsilon_t^x$$

where r_t^y and r_t^x are excess returns on industry and country indices. The table gives estimates of a (in percentages) as well as the associated t-values. Panels B to D report p-values of tests for the joint signficance of a set of Jensen measures. These are Wald tests for the hypotheses that the sets of assets listed in the column headers span the sets of assets listed in the first column. 'Currencies' are returns on 3 currency deposits: the spliced series of Deutschemark (until January 1999) and the Euro (as of January 1999), the Japanese Yen and the Pound Sterling. The ICAPM portfolio consists of the world index (the value-weighted G7 index) plus the three currency deposits. While in Panel B short positions are allowed, Panel C imposes no-short sales constraints on country, industry and world portfolios. Currency deposits are not subject to no-short sales constraints. In order to impose no-short sales constraints on the country or industry portfolios, overlapping components are excluded from the benchmark portfolios. For instance, when the ICAPM portfolios are the benchmark assets, the world index excludes the country or industry of interest. Panel D reports the test results when short sales are allowed, but the overlapping components have been excluded from the benchmarks.

Panel A: Individual Jensen measures					
Ind. test assets, Ctr. benchmark assets			Ctr. test assets, Ind. benchmark assets		
	$a(\%)$	t-value		$a(\%)$	t-value
Res	0.19	(0.97)	Canada	-0.04	(-0.20)
BasI	-0.17	(-1.30)	France	0.21	(0.79)
GenI	-0.04	(-0.45)	Germany	0.00	(0.01)
CCGd	-0.09	(-0.64)	Italy	0.21	(0.60)
NCGd	0.14	(1.16)	Japan	0.00	(0.02)
CS	-0.15	(-1.53)	UK	0.21	(1.06)
NCS	-0.07	(-0.41)	US	0.00	(-0.04)
UT	0.27	(1.44)			
IT	-0.15	(-0.69)			
Fin	0.07	(0.52)			

Panel B: Spanning tests p-values: short sales allowed				
	Benchmark portfolios are based on:			
Test assets:	Countries	Industries	ICAPM	World
Countries	n.a.	(0.948)	(0.505)	(0.445)
Industries	(0.596)	n.a.	(0.090)	(0.086)
ICAPM	(0.559)	(0.133)	n.a.	n.a.
World	(0.148)	(0.016)	n.a.	n.a.
Currencies	(0.905)	(0.726)	n.a.	(0.705)

Panel C: Spanning tests p-values: no-short sales constraints				
	Benchmark portfolios are based on:			
Test assets:	Countries	Industries	ICAPM	World
Countries	n.a.	(0.288)	(0.047)	(0.020)
Industries	(0.319)	n.a.	(0.002)	(0.001)
Currencies	(0.884)	(0.665)	n.a.	n.a.

Panel D: p-values: excl. ctr. and ind. overlapping components				
	Benchmark portfolios are based on:			
Test assets:	Countries	Industries	ICAPM	World
Countries	n.a.	(0.427)	(0.198)	(0.097)
Industries	(0.401)	n.a.	(0.026)	(0.018)

Table 3: Unconditional Sharpe ratio tests

The table presents the results of the tests for differences in unconditional Sharpe ratios. Panel A reports the annualized Sharpe ratios for country, industry and world portfolios. Furthermore, three currency deposits are added to each of these portfolios. The ICAPM portfolios thus consist of the world portfolio, i.e. the value-weighted G7 index and the three currency deposits (German Mark - Euro, Japanse Yen and Pound Sterling). The first Panel reports the maximum Sharpe ratios (annualized) achievable from each set of assets, without and with no-short sales (nss) restrictions, and the p-values (in parentheses) associated with a Wald test for the hypothesis of zero loss of efficiency due to the no-short sales restrictions. This hypothesis is tested by testing the difference in maximum Sharpe ratios with and without no-short sales constraints. Panel B reports the p-values of the Sharpe ratio tests between the different portfolios when short position are allowed. Panel C shows the p-values when short sales are prohibited. The currency deposits are not subject to no-short sales constraints.

Panel A: Unconditional Sharpe ratios						
	Countries	Industries	Ctr + curr	Ind + curr	ICAPM	world
Sharpe p.a.	0.605	0.762	0.621	0.793	0.485	0.435
Sharpe (nss) p.a.	0.582	0.657	0.601	0.697	0.485	0.435
Eff. loss nss	(0.654)	(0.299)	(0.676)	(0.312)		

Panel B: Test of difference of unrestricted Sharpe ratios				
	Countries	Industries	Ctr + curr	Ind + curr
Countries vs	n.a.			
Industries vs	(0.334)	n.a.		
Ctr + currencies vs	n.a.	(0.399)	n.a.	
Ind + currencies vs	(0.254)	n.a.	(0.278)	n.a.
ICAPM vs	(0.341)	(0.139)	(0.207)	(0.082)
world vs	(0.187)	(0.078)	(0.166)	(0.062)

Panel C: Test of difference of no-short sales Sharpe ratios				
	Countries	Industries	Ctr + curr	Ind + curr
Countries vs	n.a.			
Industries vs	(0.526)	n.a.		
Ctr + currencies vs	n.a.	(0.667)	n.a.	
Ind + currencies vs	(0.366)	n.a.	(0.416)	n.a.
ICAPM vs	(0.413)	(0.221)	(0.227)	(0.090)
world vs	(0.209)	(0.084)	(0.188)	(0.075)

Table 4: Conditional spanning tests

This table presents the results of the conditional spanning tests. The null hypothesis that managed country portfolios span managed industry portfolio is based on the regression

$$r_t^{man,y} = a_y + D_y r_t^{man,x} + \varepsilon_t^y,$$

where $r_t^{man,y}$ and $r_t^{man,x}$ are excess returns on managed industry and country portfolios. The regressions for other sets of test and benchmark assets are similar. The instruments used for the countries, industries and world portfolio are a constant (i.e., the returns on the indices themselves are included), the short term US interest rate, the US term spread, the US default spread, and the spread between the dividend yield on the world portfolio and the US interest rate spread. The instruments for the currency deposits are a constant, the short term US interest rate, and the spreads between the UK and US interest rate, the Japanese and US interest rate, and the German and US interest rate. The first panel reports the p-values associated with a Wald test for the hypothesis that the sets of assets listed in the column headers span the sets of assets listed in the first column when short positions are allowed. In Panel B no-short sales constraints are imposed on country, industry and world portfolios. Currency deposits are not subject to no-short sales constraints. In order to impose no-short sales constraints, overlapping components of the test and benchmark assets are excluded from the benchmark assets. Panel C provides p-values of the tests whether in a regression of the countries or industries on the industries, countries and ICAPM portfolios excluding the country or industry of interest, the intercepts are zero. Short positions are allowed.

Panel A : Spanning tests p-values: short sales allowed

	Benchmark portfolios are based on:		
Test assets:	Countries	Industries	ICAPM
Countries	n.a.	(0.655)	(0.758)
Industries	(0.009)	n.a.	(0.012)
ICAPM	(0.001)	(0.000)	n.a.
Currencies	(0.000)	(0.000)	n.a.

Panel B: Spanning tests p-values: no-short sales constraints

	Benchmark portfolios are based on:		
Test assets:	Countries	Industries	ICAPM
Countries	n.a.	(0.862)	(0.612)
Industries	(0.968)	n.a.	(0.520)
Currencies	(0.001)	(0.000)	n.a.

Panel C: p-values: excl. ctr. and ind. overlapping components

	Benchmark portfolios are based on:		
Test assets:	Countries	Industries	ICAPM
Countries	n.a.	(0.445)	(0.516)
Industries	(0.008)	n.a.	(0.016)

Table 5: Conditional Sharpe ratio tests

The table presents the results of the tests for differences in conditional Sharpe ratios for dynamic country, industry and ICAPM (world plus currency deposits) portfolios. Furthermore, 3 currency deposits are added to the country and industry portfolios. The instruments used for the countries, industries and world portfolio are a constant, the short term US interest rate, the US term spread, the US default spread, and the spread between the dividend yield on the world portfolio and the US interest rate spread. The instruments for the currency deposits are a constant, the short term US interest rate, and the spreads between the UK and US interest rate, the Japanese and US interest rate, and the German and US interest rate. The first panel reports the maximum Sharpe ratios (annualized) achievable from each set of assets, without and with no-short sales (nss) restrictions, and the p-values (in parentheses) associated with a Wald test for the hypothesis of zero loss of efficiency due to the no-short sales restrictions. Panel B reports the p-values of the Sharpe ratio tests between the different portfolios when short position are allowed. Panel C shows the p-values when short sales are prohibited. The currency deposits are not subject to no-short sales constraints.

Panel A: Conditional Sharpe ratios

	Countries	Industries	Ctr + curr	Ind + curr	ICAPM
Sharpe p.a.	1.197	1.780	1.744	2.246	1.462
Sharpe (nss) p.a.	0.704	0.797	1.513	1.554	1.462
Eff. loss nss	(0.006)	(0.000)	(0.022)	(0.000)	

Panel B: Test of difference of unrestricted Sharpe ratios

	Countries	Industries	Ctr + curr	Ind + curr
Countries vs	n.a.			
Industries vs	(0.008)	n.a.		
Ctr + currencies vs	n.a.	(0.877)	n.a.	
Ind + currencies vs	(0.000)	n.a.	(0.008)	n.a.
ICAPM vs	(0.231)	(0.193)	(0.014)	(0.000)

Panel C: Test of difference of no-short sales Sharpe ratios

	Countries	Industries	Ctr + curr	Ind + curr
Countries vs	n.a.			
Industries vs	(0.421)	n.a.		
Ctr + currencies vs	n.a.	(0.002)	n.a.	
Ind + currencies vs	(0.000)	n.a.	(0.539)	n.a.
ICAPM vs	(0.003)	(0.006)	(0.456)	(0.244)

Table 6: Simple style analysis: countries vs industries

The table presents the style estimates of each industry in terms of country portfolios (Panel A) and country styles in terms of global industry portfolios (Panel B), based on style regressions

$$r_{j,t}^{test} = \alpha_j + \sum_{i=1}^{L} \beta_{i,j} r_{i,t}^{bench} + e_{j,t}^{y},$$
$$\text{s.t. } \beta_{i,j} \geq 0 \quad \forall i, j, \text{ and } \quad \sum_{i=1}^{L} \beta_{i,j} = 1,$$

where $r_{j,t}^{test}$ is the return on the test asset and $r_{i,t}^{bench}$ is the return on benchmark asset i. α is the intercept in the style regression (in percentage). The last rows of both panels report the R^2s of the style regressions.

Panel A: Industry styles in terms of countries

	Res	BasI	GenI	CCGd	NCGd	CS	NCS	UT	IT	Fin
α(%)	0.08	-0.15	-0.01	-0.09	0.04	-0.11	-0.16	0.00	0.04	0.09
Canada	0.27	0.12	0.08	0.06	0.00	0.00	0.00	0.00	0.07	0.00
France	0.06	0.05	0.00	0.01	0.00	0.01	0.00	0.04	0.00	0.00
Germany	0.00	0.04	0.12	0.12	0.00	0.04	0.09	0.14	0.06	0.04
Italy	0.00	0.01	0.00	0.01	0.02	0.02	0.06	0.03	0.02	0.06
Japan	0.08	0.40	0.31	0.39	0.16	0.28	0.27	0.34	0.17	0.47
UK	0.26	0.16	0.07	0.01	0.14	0.13	0.02	0.03	0.00	0.12
US	0.32	0.23	0.42	0.40	0.67	0.52	0.56	0.41	0.68	0.31
R^2	0.44	0.77	0.85	0.73	0.60	0.85	0.51	0.14	0.59	0.75

Panel B: Country styles in terms of industries

	Can	Fra	Ger	Ita	Jap	UK	US
α(%)	-0.15	0.26	-0.06	0.07	-0.06	0.25	-0.04
Res	0.37	0.21	0.04	0.02	0.00	0.32	0.18
BasI	0.07	0.11	0.00	0.10	0.23	0.05	0.00
GenI	0.08	0.19	0.49	0.10	0.00	0.00	0.00
CCGd	0.00	0.01	0.04	0.01	0.27	0.00	0.00
NCGd	0.17	0.00	0.02	0.06	0.00	0.20	0.47
CS	0.00	0.21	0.00	0.00	0.00	0.40	0.04
NCS	0.03	0.11	0.13	0.21	0.00	0.00	0.04
UT	0.00	0.11	0.21	0.07	0.00	0.00	0.00
IT	0.26	0.05	0.08	0.13	0.00	0.04	0.28
Fin	0.00	0.00	0.00	0.30	0.51	0.00	0.00
R^2	0.53	0.40	0.38	0.22	0.66	0.55	0.80

Table 7: Unconditional style analysis

This table reports the results of the unconditional style analysis. Panel A presents the equally weighted average R^2s of the 'simple' style regressions

$$r_{j,t}^{test} = \alpha_j + \sum_{i=1}^{L} \beta_{i,j} r_{i,t}^{bench} + e_{j,t}^{y}.$$

The style coefficients are subject to portfolio and nonnegativity constraints. The equally weighted average R^2 of the style regressions for all industry test assets represents the ability of the country benchmark returns to mimick industry returns. Country, industry and ICAPM portfolios are used as test assets. The ICAPM portfolios consist of the value-weighted G7 market index returns and the returns on three currency deposits (German Mark - Euro, Japanese Yen and Pound Sterling). The benchmark assets consist of the country and industry portfolios including the three currency deposits as well as the ICAPM portfolios. As the returns on currency deposits are excess returns, the style regressions are performed using excess returns whenever currencies are included in the style regression. Consequently the portfolio constraint no longer applies. Moreover, currency deposits not subject to no-short sales constraints. Panel B reports the equally weighted average R^2s of the exclusive style regressions where overlapping components between the test and benchmark assets have been removed from the benchmark assets. Panel C reports the p-values of the tests for the significance of the differences in average R^2s of Panel A. These p-values are calculated based on the empirical distribution of the differences in average R^2s. "CtrT, IndB" indicates the regression of country styles (country Test assets) in terms of industries (industry Benchmark assets).

Panel A: Simple style regressions, EW average R^2

		Benchmark assets				
		Countries	Industries	ICAPM	Ctr + curr	Ind + curr
Test assets	Countries	n.a.	0.51	0.53	n.a.	0.58
	Industries	0.62	n.a.	0.66	0.67	n.a.
	ICAPM	0.44	0.37	n.a.	n.a.	n.a.

Panel B: Exclusive style regressions. EW average R^2

		Benchmark assets				
		Countries	Industries	ICAPM	Ctr + curr	Ind + curr
Test assets	Countries	n.a.	0.29	0.42	n.a.	0.45
	Industries	0.53	n.a.	0.59	0.60	n.a.

Panel C: p-values: test for differences in EW average R^2, simple style regr.						
	CtrT, IndB	IndT, CtrB	CtrT, icapmB	IndT, icapmB	icapmT, CtrB	CtrT, IndcurrB
IndT, CtrB	(0.008)	n.a.				
CtrT, icapmB	(0.040)		n.a.			
IndT, icapmB		(0.886)	(0.003)	n.a.		
icapmT, CtrB		(0.000)	(0.011)		n.a.	
icapmT, IndB	(0.000)			(0.000)	(0.002)	n.a.
CtrT, IndcurrB	(0.000)		(0.000)			
IndT, CtrcurrB		(0.000)		(0.000)		(0.006)

Table 8: Conditional style analysis

The table presents the equally weighted average R^2s for conditional style regressions

$$r_t^{test} = \alpha + \sum_{i=1}^{L} \beta_{i0} r_{it}^{bench} + \sum_{i=1}^{L} \sum_{k=1}^{K} \beta_{ik} z_{kt-1} r_{it}^{bench} + e_t^y,$$

where r_t^{test} and r_t^{bench} are the returns on test and benchmark assets. $z_{k,t-1}$ is instrument k. The benchmark assets are returns on managed portfolios. The instruments used for the country, industry and world index returns are a constant (i.e., the returns on the indices themselves are included), the US interest rate, the US term spread, the US default spread, and the excess dividend yield on the world portfolio. The instruments for the currency deposits are a constant, the short term US interest rate, and the spreads between the UK and US interest rate, the Japanese and US interest rate, and the German and US interest rate. When currency deposits are included in the style regression we use excess returns and remove the portfolio constraint. Panel A presents the equally weighted average R^2s of the simple conditional style regressions, while Panel B reports the results of the exclusive conditional style regressions where overlapping components between test and benchmark assets have been removed from the benchmark indices.

Panel A: Simple style regressions, EW average R^2						
		Benchmark assets				
		Countries	Industries	ICAPM	Ctr + curr	Ind + curr
Test assets	Countries	n.a.	0.53	0.57	n.a.	0.63
	Industries	0.64	n.a.	0.68	0.71	n.a.
	ICAPM	0.47	0.38	n.a.	n.a.	n.a.

Panel B: Exclusive style regressions. EW average R^2						
		Benchmark assets				
		Countries	Industries	ICAPM	Ctr + curr	Ind + curr
Test assets	Countries	n.a.	0.32	0.46	n.a.	0.51
	Industries	0.56	n.a.	0.62	0.64	n.a.

Table 9: Conditional efficiency tests: sub-samples

The table reports the results of the conditional efficiency tests for three 10-year sub-samples: from February 1975 to January 1985, from February 1985 to January 1995 and from February 1995 to February 2005. Panel A presents the p-values of the conditional spanning tests when short sales are not allowed. Panel B presents the conditional Sharpe ratios (annualized) with and without no-short sales constraints. The currency deposits are not subject to no-short sales constraints. It also reports the p-values of the test for efficiency loss due to the no-short sales constraints. The tests are based on excess returns on managed portfolios.

Panel A: Conditional spanning test p-values, no-short sales

		Benchmark assets		
		Countries	Industries	ICAPM
Sub-sample 1: 1975-1985				
Test assets	Countries	n.a.	(0.948)	(0.908)
	Industries	(0.997)	n.a.	(0.301)
	Currencies	(0.007)	(0.002)	n.a.
Sub-sample 2: 1985-1995				
Test assets	Countries	n.a.	(0.978)	(0.892)
	Industries	(0.998)	n.a.	(0.442)
	Currencies	(0.001)	(0.042)	n.a.
Sub-sample 3: 1995-2005				
Test assets	Countries	n.a.	(0.968)	(0.850)
	Industries	(0.957)	n.a.	(0.902)
	Currencies	(0.030)	(0.008)	n.a.

Panel B: Conditional Sharpe ratios

	Countries	Industries	ICAPM	Ctr + curr	Ind + curr
Sub-sample 1: 1975-1985					
Sharpe p.a.	2.138	3.215	2.270	3.378	4.685
Sharpe (nss) p.a.	0.960	1.111	2.270	2.448	2.456
Eff. Loss nss	(0.005)	(0.000)		(0.005)	(0.000)
Sub-sample 2: 1985-1995					
Sharpe p.a.	1.884	3.226	2.219	2.953	4.686
Sharpe (nss) p.a.	0.957	0.997	2.219	2.279	2.262
Eff. Loss nss	(0.011)	(0.000)		(0.021)	(0.000)
Sub-sample 3: 1995-2005					
Sharpe p.a.	3.039	3.454	2.113	3.966	4.790
Sharpe (nss) p.a.	0.953	0.959	2.113	2.014	2.139
Eff. Loss nss	(0.000)	(0.000)		(0.000)	(0.000)

Table 10: Conditional style analysis: subsamples

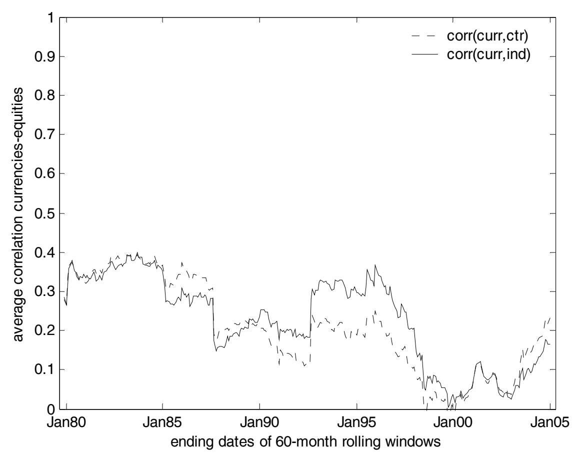
The table reports the results of the conditional style analysis for three 10-year subsamples: from February 1975 to January 1985, from February 1985 to January 1995 and from February 1995 to February 2005. The table reports the equally weighted average R^2 of the simple style regressions. The benchmark assets are returns on managed portfolios.

Conditional style regressions, EW average R^2						
		Benchmark assets				
		Countries	Industries	ICAPM	Ctr + curr	Ind + curr
Subsample 1: 1975-1985						
Test assets	Countries	n.a.	0.52	0.62	n.a.	0.70
	Industries	0.69	n.a.	0.73	0.79	n.a.
	ICAPM	0.66	0.50	n.a.	n.a.	n.a.
Subsample 2: 1985-1995						
Test assets	Countries	n.a.	0.53	0.59	n.a.	0.69
	Industries	0.76	n.a.	0.77	0.82	n.a.
	ICAPM	0.48	0.41	n.a.	n.a.	n.a.
Subsample 3: 1995-2005						
Test assets	Countries	n.a.	0.69	0.76	n.a.	0.80
	Industries	0.55	n.a.	0.68	0.71	n.a.
	ICAPM	0.36	0.35	n.a.	n.a.	n.a.

Figure 1: Currency deposits characteristics: 60-month moving averages

Panel A displays the average correlation between the returns on the country and industry indices and the returns on the currency deposits. The dashed line represents the average correlation between country returns and currencies and the solid line reports the average correlation between industry returns and currencies. We consider returns on three currency deposits: the British Pound, the Japanse Yen and the spliced series of the German Mark (before 1999) and the Euro (after 1999). For each 60-month moving window the average is computed over all countries (industries) and currencies. Panel B reports the average return on the 3 currency deposits over 60-month moving windows.

Panel A: 60-month moving window average correlations between equities and currencies



Panel B: 60-month moving window average returns on currency deposits