The Increasing Importance of Industry Factors

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Previous studies of the relative importance of industry and country factors in determining equity returns generally concluded that country factors dominate industry factors. We present evidence that industry factors have been growing in relative importance and may now dominate country factors. Furthermore, our evidence suggests that over the past five years, diversification across global industries has provided greater risk reduction than diversification by countries. These findings suggest that industry allocation is an increasingly important consideration for active managers of global equity portfolios and that investors may wish to reconsider home-biased equity allocation policies.

Understanding the factors that drive stock returns around the world has long challenged academics and professional portfolio managers. Numerous studies (e.g., Grinold, Rudd, and Stefek 1989; Beckers, Grinold, Rudd, and Stefek 1992; Beckers, Connor, and Curds 1996) postulated that security prices are determined by a global equity market factor, country-specific factors, global and/or local industry factors, and common company characteristics (for instance, size, success, and value). Investment managers thus strive to construct portfolios that maximize the return-to-risk trade-offs among these underlying factors. Lessard (1974, 1976) suggested that country factors are the dominant driver in security-price returns. In his seminal research on the gains from international diversification, Solnik (1974) demonstrated that diversification across countries provides greater risk reduction than diversification across industries. Accepting these conclusions, traditional top-down managers have adopted country selection as the critical tactical decision for portfolio construction.

In recent years, the decline in trade barriers resulting from the General Agreement on Tariffs and Trade agreements, the emergence of large trading blocks—the European Community, North American Free Trade Agreement, and Association of Southeast Asian Nations—and increased economic policy coordination [in particular, for the European Monetary Union (EMU) member countries] have fostered increasing economic integration among developed countries and have supported globalization of business enterprise. Thus, the relative importance of country factors may be diminishing as that of global industry factors is increasing. Freiman (1998) presented evidence that the correlations between European markets tripled, on average, from the mid-1970s until the end of 1996. He concluded that

> active portfolio managers will have increasing difficulty adding value by using a top-down strategy through European country allocation. (p. 40)

Indeed, the increasing globalization of companies' revenues and operations and the increasing proportion of intra-industry mergers and acquisitions lend support to this thesis.[1] Brinson (1998) and Weiss (1998) thus concluded that global industry factors will constitute an increasingly important dimension of investment strategy.

The scope for active strategies along the industry dimension will be determined by the relative importance of industry factors in explaining security returns and by managers' abilities to predict the future evolution of these factors. We review alternative measures of the relative importance of industry factors that have been documented in previous research. We then present a factor model of security returns and describe new findings suggesting that industry factors are economically significant and are growing in importance relative to country factors.

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Measuring the Importance of Industry Factors

The goal of a growing literature has been to quantify the factor returns embedded in international security prices. Broadly, each such study has aimed to estimate a factor model of security returns across countries. Some authors have separated the effects of currency from country returns by examining return series in excess of the local risk-free rate; others have left currency effects embedded in the country returns. Various statistics were then obtained from the factor returns to review alternative hypotheses about the relative importance of industry and country factors. Some of these studies' inferences may have been sensitive to the treatment of currency effects.

Nearly all the authors examined the average R^2 model statistic to measure the extent to which the cross-sectional variation of security prices can be explained by industry factors alone and by industry factors once other factors have been accounted for. In the studies we reviewed, the estimated R^2 statistics for a factor model comprising global industry factors ranged from 5 percent (Beckers et al. 1996) up to 40 percent (Roll 1992).[2] The marginal contribution of industry factors, after country factors were accounted for, ranged from 4 percent (Beckers et al. 1996) to 15 percent (Grinold et al.). These results suggest that, although industry factors alone may account for an important proportion of the cross-sectional variation of security returns, once country factors are included in the model, industry factors add little explanatory power. The marginal R^2 should be interpreted with caution, however, because some of the estimation procedures in these factor models may have biased this statistic downward for industries in relation to countries.[3]

Another measure of the importance of industry factors examined in the literature is the frequency with which industry factors have been significant contributors to excess returns. Recognizing that factor returns are estimated with some degree of uncertainty, these researchers applied statistical tests at specific points in time to assess whether industry-factor returns are significantly different from zero. The studies reported the proportion of time one can conclude that an industry factor is different from zero with a reasonable degree of certainty. The values for this particular statistic ranged from a low of 9 percent (Beckers et al. 1996) to a high of 71 percent (Grinold et al.). With increasing economic integration over time, one would expect this statistic to rise, but the literature does not uniformly support this thesis. On the one hand, Grinold et al. reported that 32 of the 36 industries they examined exhibited increasing significance of the industry factor in the 1986–88 period compared with the 1983–85 period. On the other hand, Beckers et al. (1996) reported a decline in the average number of months for which industry factors were significant for the period August 1986 to March 1990 compared with the period January 1983 to July 1986.

A third measure of the importance of industry factors that has been examined in the literature is the volatility of the factor contribution of industries and of countries. To examine these statistics, Griffin and Karolyi (1998) and Heston and Rouwenhorst (1994, 1995) used a factor model that controls for different industrial structures among countries (we reestimate this model in the next section). They found that country factors have been more volatile than global industry factors; the ratio of the median volatility of countries to the median volatility of industries ranged from 3.4 to 2.5. Thus, although these studies documented significant industry factors, country factors dominated.

A broader measure of the relative importance of country versus industry factors is the "average absolute effect" of each factor from a global perspective. Rouwenhorst (1999) found that the average country effect is twice as large as the average industry effect; moreover, he did not uncover any significant change in the relative importance of these effects in the most recent period (1993–1998) for European countries or the subset of EMU member countries. Urias, Sharaiha, and Hendricks (1998) computed analogous statistics.[4] However, their results can be interpreted as supporting the view that the relative importance of industry factors has risen over time for European countries and that industry factors are now larger in absolute importance than country factors.

On balance, the studies suggest that industry factors have been relatively less important than country factors. These conclusions are sensitive, however, to the model that was estimated, the countries considered, the industry definitions used, and the time period analyzed.

The Study

We estimated a factor model for 21 developed equity markets for January 1, 1986, through November 3, 1999. The data covered the 21 countries that constitute the current MSCI World Developed Markets universe. We used the FT/S&P 36 industry-level *national* total return indexes to measure the performance of portfolios of securities belonging to the same industry within a country. Because not all industries are represented in every country, our data

Table 1. Country Returns, January 1, 1986, through November 3, 1999

	Local Total Returns		Local Excess Returns				
	Mean	Standard Deviation	Mean	Standard Deviation	Minimum Number of Companies	Maximum Number of Companies	Average Market-Cap Weight
Australia	13.3%	18.3%	3.3%	18.3%	68	96	1.4%
Austria	6.3	20.5	0.5	20.6	12	27	0.1
Belgium	16.1	15.9	8.7	16.0	21	65	0.7
Canada	10.4	14.1	2.8	14.1	98	135	2.1
Denmark	12.0	15.1	3.7	15.2	30	39	0.3
Finland	25.6	25.7	16.3	25.8	0	29	0.2
France	16.2	19.7	8.3	19.8	70	131	3.1
Germany	9.8	19.2	3.9	19.3	51	102	3.7
Hong Kong	17.5	28.6	10.7	28.6	43	69	1.4
Ireland	18.9	21.6	9.3	21.6	11	19	0.2
Italy	12.0	24.2	1.5	24.3	52	102	1.6
Japan	4.1	20.5	0.6	20.6	441	485	28.3
Netherlands	16.9	16.6	10.5	16.6	19	43	1.8
New Zealand	6.6	20.3	–4.0	20.4	13	31	0.2
Norway	9.2	23.0	0.0	23.1	22	41	0.1
Singapore	12.0	28.8	8.0	28.8	24	48	0.3
Spain	20.9	21.4	9.1	21.5	29	55	1.0
Sweden	22.0	22.3	11.9	22.4	25	50	0.8
Switzerland	12.6	18.1	7.8	18.1	28	68	2.0
United Kingdom	15.9	15.8	6.1	15.8	195	354	10.1
United States	17.4	15.3	10.6	15.3	503	656	40.9

Note: Mean returns are the annual geometric rates of return for the estimation period. The standard deviation of returns is stated on an annualized basis and was computed from the weekly standard deviations of the logarithmic returns multiplied by the square root of 52.0. The average market-cap weight is a time-weighted cap weight over the sample period.

set ranged from a minimum of 380 to a maximum of 425 industry portfolios covering the country universe in the sample period. With these data, we constructed a capitalization-weighted world benchmark index.

Our choice of countries contrasts to the choices of other recently published studies. Griffin and Karolyi included several emerging market countries in their global sample, but because these developing countries are less economically integrated with developed countries, including them may have distorted the estimated relative importance of country factors. Rouwenhorst examined only the countries in Europe, but the increasing integration of developed country markets means that European regional models may provide imprecise estimates of global industry effects. For instance, because Europe accounts for only 9 percent of the world index computer software and hardware industry, the European regional factor returns may not provide representative estimates of the factor returns for this industry.

We also defined "industry" differently from Rouwenhorst. The FT/S&P 36-industry classification provides a more homogeneous grouping of securities than Rouwenhorst's choice of 7 broad industry categories; for instance, the broad "consumer goods and services" industry aggregates the automobile, health and personal care, and computer software industries. In our analysis, these distinct economic activities are treated as separate industries.

Summary statistics for the data are in **Table 1** and **Table 2**; for ease of exposition, we aggregated the country industry returns to obtain world industry returns on a cap-weighted basis. We used Wednesday-to-Wednesday closing prices.[5] We computed and also reported local returns in excess of the local risk-free rate; we used the relevant daily one-month Eurodeposit rates obtained from Standard & Poor's DRI Fixed Income and Money Markets Database to proxy for the risk-free rate. Our empirical analysis was conducted on weekly local excess returns. Thus, our results can be viewed as currency hedged from the perspective of any developed market investor.[6]

Table 2. Global Industry Returns, January 1, 1986, through November 3, 1999

Industry	FT/S&P Industry #	Local Total Returns: Mean	Local Total Returns: Standard Deviation	Local Excess Returns: Mean	Local Excess Returns: Standard Deviation	Minimum Number of Companies	Maximum Number of Companies	Average Market-Cap Weight
Commercial banks	101	10.3%	19.7%	4.7%	19.7%	124	185	12.4%
Financial institutions	102	11.5	23.7	5.6	23.7	70	100	3.7
Life insurance	103	15.8	16.9	7.8	17.0	19	30	0.7
Property insurance	104	11.9	16.1	5.2	16.1	66	89	3.7
Real estate	105	7.4	21.3	1.1	21.3	53	72	1.3
Diversified holdings	106	13.1	16.2	5.3	16.3	24	75	1.8
Oil	107	15.0	14.6	7.8	14.6	57	71	5.8
Non-oil energy	108	9.2	25.0	2.7	25.0	13	20	0.5
Utilities	109	15.5	12.7	8.8	12.7	118	158	10.4
Transportation/storage	110	6.3	15.8	1.0	15.8	74	98	2.8
Automobiles	111	9.9	17.8	4.5	17.8	25	31	3.0
House durables/appliances	112	7.6	21.8	3.2	21.8	25	30	1.3
Diversified consumer goods/services	113	12.2	18.1	5.4	18.1	9	26	0.6
Textiles/apparel	114	6.7	17.6	1.1	17.6	21	48	0.5
Beverage/tobacco	115	16.2	15.1	8.9	15.1	45	71	3.5
Health/personal care	116	18.5	15.6	11.8	15.6	77	96	7.2
Food/grocery products	117	14.7	12.8	8.1	12.9	80	116	3.7
Entertainment/leisure/toys	118	10.1	14.8	4.0	14.8	56	74	2.1
Media	119	14.5	15.3	7.6	15.3	54	73	2.3
Business services/computer software	120	23.3	21.4	16.5	21.5	21	61	1.4
Retail trade	121	14.8	14.7	8.0	14.7	100	115	4.6
Wholesale trade	122	5.8	20.9	1.3	21.0	26	35	1.0
Aerospace/defense	123	10.0	17.4	3.5	17.4	11	30	0.8
Computers/communications/office	124	13.1	20.8	6.7	20.8	42	68	3.6
Electrical equipment	125	15.6	16.1	9.4	16.2	32	50	2.7
Electronics and instrumentation	126	14.2	22.1	8.6	22.1	53	73	3.0
Machine and engineering services	127	7.6	16.3	1.8	16.3	66	94	1.7
Auto components	128	8.3	16.0	2.8	16.0	38	56	1.0
Diversified industries	129	12.1	15.3	5.0	15.4	31	48	1.4
Heavy industry/shipbuilding	130	3.6	23.9	–0.6	23.9	15	24	0.6
Construction/building materials	131	6.0	17.1	0.3	17.1	84	131	2.4
Chemicals	132	10.4	15.2	4.4	15.2	80	120	3.9
Mining/metal/minerals	133	6.8	17.7	0.8	17.7	64	92	2.4
Precious metals/minerals	134	2.9	23.6	–3.7	23.7	19	29	0.4
Forestry/paper products	135	9.9	17.6	3.3	17.6	50	67	1.4
Fabricated metal products	136	6.1	17.8	0.5	17.6	11	35	0.4

We used a factor model that focuses on the industry and the country characteristics of asset returns: Define $R_i(t)$ to be the excess return on security i at time t, $A(t)$ to be a global factor return common to all securities determined at time t, $RS_j(t)$ to be the factor return on industry (sector) j at time t, $RC_k(t)$ to be the factor return on country k at time t, and $LS_{i,j}(t)$ and $LC_{i,k}(t)$ to be the factor loadings on the respective factor returns for asset i at time t. Then,

$$R_i(t) = A(t) + LS_{i,j}(t)RS_j(t) + LC_{i,k}(t)RC_k(t) + \varepsilon_i(t), \quad (1)$$

where $\varepsilon_i(t)$ is an idiosyncratic disturbance.

Note that Equation 1 abstracts from other common characteristic factors of security returns, such as size and value (see Grinold, Rudd, and Stefek) or macroeconomic factors (see Chen, Roll, and Ross 1986). As in Heston and Rouwenhorst (1995) and Griffin and Karolyi, we postulated that factor loadings are fixed over time with values of 0 or 1; furthermore, the return on security i is affected by the global factor, the industry, the country to which the stock belongs, and by an idiosyncratic disturbance. Thus, for the return for security i that belongs to industry j in country k, Equation 1 can be rewritten as

$$R_i(t) = A(t) + RS_j(t) + RC_k(t) + \varepsilon_i(t). \quad (2)$$

The model represented by Equation 2, although somewhat restricted, provides a tractable representation of economic reality. Most notably, we assumed that industry effects are global in nature whereas strong regional effects may arise from differences in capital–labor ratios among countries. Furthermore, we assumed that securities in the same country have similar exposures to domestic and global factors; Ford Motor Company and Winn-Dixie Stores, for example, are assumed to be affected by the United States factor and the global factor in the same fashion. This assumption is somewhat unrealistic because companies' proportions of foreign sales to total sales indicate that companies have different exposures to non-U.S. factors.[7] Finally, we did not consider company style factors; however, casual observation suggests that the recent performance of some style factors—size, for instance—has been unstable. The results of our empirical analysis are thus conditioned on the extent to which our estimates of the country and industry factors are independent of company characteristics and the extent to which our simplifying assumptions provide a sufficiently close representation of economic phenomena.

The framework in Equation 2 enabled us to determine the relative importance of country and industry factors in driving security returns. Excess returns on securities were "observable"; we needed to estimate the "unobservable" factor returns for the purposes of inference. These returns could be obtained from cross-sectional regressions with indicator variables proxying for the factor loadings: Let $S_j(t)$ be a dummy variable defined as 1 if security i belongs to industry j and 0 otherwise, and let $C_k(t)$ be a dummy variable defined as 1 if security i belongs to country k and 0 otherwise. Then, the following model can be fitted:

$$R_i(t) = A(t) + \beta_j(t)S_i(t) + \gamma_k(t)C_k(t) + \varepsilon_i(t). \quad (3)$$

Fitting Equation 3 for securities at a given point in time T yields estimates of $\beta_j(T)$ for $j = 1, 2, \ldots, 36$ and $\gamma_k(T)$ for $k = 1, 2, \ldots, 21$. These estimates can be interpreted as the empirical estimates of industry-factor returns $RS_j(T)$ and country-factor returns $RC_k(t)$. This cross-sectional regression can then be estimated over time to obtain a time series of $\hat{R}S_j(t)$ and $\hat{R}C_k(t)$.

Estimating Equation 3 with ordinary least squares was not possible because the design matrix exhibited perfect multicollinearity. We thus imposed the additional restriction that

$$\sum_j W_j(t-1)\beta_j(t) = 0 \quad (4a)$$

and

$$\sum_k V_k(t-1)\gamma_k(t) = 0, \quad (4b)$$

where $W_j(t)$ and $V_k(t)$ represent the capitalization weights (in our world index portfolio of 21 developed countries) of industry j and country k at time t. Imposing these restrictions and estimating the equation via weighted least squares (where the weights on the observations equaled the capitalization weights) ensured that $A(t)$ equaled the cap-weighted return on the world portfolio.

We estimated the model with 35 industry dummies and 20 country dummies; we obtained the remaining parameter estimates through the appropriate matrix algebra transformations.[8] The resulting model estimates of $\beta_j(t)$ and $\gamma_k(t)$, which are often referred to as the "pure" industry and "pure" country returns, have useful investment interpretations. The industry return, $\hat{A}(t) + \hat{\beta}_j(t)$, is the return on a *geographically* diversified portfolio in industry j; that is, the geographical composition of $\hat{\beta}_j(t)$ equals that of the world portfolio. Similarly, $\hat{A}(t) + \hat{\gamma}_k(t)$equals the return on country k with the same industry composition as that of the world portfolio. As Heston and Rouwenhorst (1995) argued, $\beta_m(t)$ can be interpreted as the return in excess of benchmark at time t from a tilt in global industry m with neutral country exposure and $\gamma_n(t)$ can be interpreted as the return in excess of benchmark at time t from a tilt in country n with neutral industry exposure. Therefore, this framework is particularly useful for analyzing portfolio return attribution. Consider the cap-weighted return for country k at time t:

$$R_k(t) = \hat{A}(t) + \sum_j Z_{k,j}(t-1)\hat{\beta}_j(t) + \hat{\gamma}_k(t), \tag{5}$$

where $Z_{k,j}(t)$ equals the capitalization weight of industry j in country k at time t, and therefore, $\sum_j Z_{k,j}(t) = 1.0$.

Equation 5 means that the return in country k in excess of the world index, $\hat{A}(t)$, is determined by $\hat{\gamma}_k(t)$, the extent to which companies in country k outperformed their industry peers in the rest of the world, and by the Z's, which measure the extent to which the industry composition of country k differs from that of the world index. Note that several highly successful companies located in one country may generate a high country-specific return. Consider, for instance, Nokia Corporation and UPM-Kymene of Finland; whether their success is "idiosyncratic" or reflects a "structural" Finnish factor is difficult to ascertain quantitatively.

Our estimates of $\beta_j(t)$ and $\gamma_k(t)$ were obtained from industry-level return series within the 21-country universe. Griffin and Karolyi demonstrated that the point estimates from this estimation are equal to those obtained from individual security returns. Some intuition for this result can be obtained by noting that the Heston–Rouwenhorst (1994) framework aims to explain how much of the cross-sectional dispersion of "individual" security returns is accounted for by differences in the dispersion of returns for "groups" of securities (countries and industries). Our regression estimates provide a measure of the mean difference of returns for two alternative "groupings" of securities—country- and industry-based groupings. These mean differences can be obtained either from an average of the mean of the "individuals" or from the means of the groups; the approaches are computationally equivalent.

Empirical Results

Our review of the results of the factor-model estimations focuses on recent financial market trends and the quantification of the relative importance of industry and country factors in determining investment performance. Summary statistics for cross-sectional estimates of the factor returns (the $\hat{A}$'s, $\hat{\beta}$'s, $\hat{\gamma}$'s) for the period January 1, 1986, through November 3, 1999, and three subperiods are in **Table 3**.

The mean return estimates clarify the relative performance of various markets. Thus, comparing Panels A and B shows that the recent underperformance of Japan relative to the world index is largely attributable to a countrywide factor rather than an industry structure that differs from that of the rest of the world; in contrast, the recent underperformance of the Australian market is largely attributable to its large exposure to basic goods industries.

Mean factor return estimates, or more precisely the time series of factor returns, can be used to measure the opportunities for outperforming the world index with systematic industry or country tilts. Rouwenhorst proposed the mean absolute deviation (MAD) from the index return as a measure of the relative importance of industry and country factors. MADs can be thought of as the cap-weighted returns of "perfect foresight" strategies that are exclusively based on either industry or country tilts. In a sense, this statistic captures how "mad" an investor can be for having missed out on being on the right side of the market. Formally, the industry MAD is defined as

$$\text{MAD}(t) = \sum_j W_j(t-1)\left|\hat{\beta}_j(t)\right| \tag{6}$$

and would be defined analogously for countries.

Figure 1 contains plots of 52-week moving averages of the industry and country MADs. Our results are significantly different from Rouwenhorst's. He found that country-based tilts (denominated in German marks and as captured by the MAD measure) always dominated industry-based tilts in Europe for the 1978–98 period. We found that since early 1997, the return opportunities from industry tilts have dominated those emanating from country tilts. **Figure 2** contains a plot, the dark solid line, of the ratio of industry effects to country effects for the 36 industries and 21 countries (the other line is discussed later). The graph clearly shows that industry opportunities have grown increasingly larger over the time period studied.

The risk profile of our factor returns is also markedly different from that reported by Rouwenhorst. He found that the standard deviation of most country factors (the $\hat{\gamma}$'s) are larger than even the most volatile industry factor. We found that in several instances, industry factors are more volatile than country factors. Thus, for instance, the oil industry factor returns are more volatile (12.5 percent annualized standard deviation for the period January 1, 1986, through November 3, 1999) than

Table 3. Pure Factor Returns

Group	Mean Returns 1/1/86 to 11/3/99	1/1/86 to 12/26/90	12/26/90 to 12/27/95	12/27/95 to 11/3/99	Volatility of Returns 1/1/86 to 11/3/99	1/1/86 to 12/26/90	12/26/90 to 12/27/95	12/27/95 to 11/3/99
World Index	6.6%	2.7%	4.8%	14.3%	13.5%	15.6%	10.3%	14.3%
A. Industry								
Commercial banks	0.3	–1.5	3.6	–1.7	10.6	12.8	8.8	9.3
Financial institutions	1.1	–3.5	3.3	4.5	12.0	13.7	9.6	12.6
Life insurance	–0.4	–3.0	–1.1	4.0	8.5	8.9	8.0	8.5
Property insurance	–0.7	–1.0	0.2	–1.4	6.8	6.9	5.7	7.9
Real estate	–4.1	–3.0	–1.4	–9.0	10.4	13.0	7.5	9.9
Diversified holdings	–2.1	–2.2	1.1	–6.0	6.8	5.9	5.2	9.3
Oil	–1.3	4.7	–3.4	–5.8	12.5	12.9	9.5	15.0
Non-oil energy	–5.6	–0.3	–7.8	–9.3	21.2	17.3	16.2	29.6
Utilities	0.2	0.3	–1.4	2.4	8.5	10.0	6.3	8.8
Transportation/storage	–3.7	–1.9	–1.4	–8.8	7.3	9.4	5.1	6.7
Automobiles	0.8	–3.7	3.7	3.2	10.7	11.0	9.8	11.5
House durables/appliances	–0.1	–4.3	0.7	4.3	16.3	21.5	11.7	13.5
Diversified consumer goods/services	–4.3	1.4	–0.4	–15.5	10.3	8.5	8.3	13.9
Textiles/apparel	–3.5	–0.4	–3.5	–7.4	9.9	8.5	7.5	13.7
Beverage/tobacco	0.6	11.6	–0.4	–10.8	9.3	7.6	8.2	12.0
Health/personal care	2.5	4.1	1.6	1.6	8.4	7.1	9.0	9.0
Food/grocery products	–0.5	5.4	–2.8	–4.8	7.5	6.3	6.3	9.8
Entertainment/leisure/toys	–2.6	–1.0	–1.1	–6.3	7.6	7.7	6.2	9.0
Media	–0.4	–1.6	–0.2	0.8	6.7	7.1	4.9	8.1
Business services/computer software	7.7	–1.8	12.2	15.2	13.6	12.5	13.0	15.4
Retail trade	0.9	2.0	–2.2	3.6	7.0	6.8	6.2	8.1
Wholesale trade	–1.6	1.1	–2.5	–3.7	11.2	13.9	7.9	10.8
Aerospace/defense	–6.1	–6.4	4.7	–18.2	12.1	8.4	9.7	17.4
Computers/communications/office	–0.2	–9.2	–3.5	17.6	13.1	10.5	10.8	17.6
Electrical equipment	1.8	–1.2	0.5	7.5	7.3	7.5	6.3	8.2
Electronics and instrumentation	3.3	–6.2	5.7	13.7	15.8	16.9	11.7	18.7
Machine and engineering services	–3.3	2.4	–2.9	–10.7	8.5	8.8	6.3	10.4
Auto components	–1.2	–0.8	1.9	–5.6	8.0	8.4	6.6	9.2
Diversified industries	–2.5	–2.6	0.7	–6.5	7.4	7.9	5.9	8.4
Heavy industry/shipbuilding	–2.6	7.1	0.0	–16.7	15.0	20.1	9.2	13.1
Construction/building materials	–3.5	5.1	–4.9	–11.8	9.0	10.3	6.4	9.9
Chemicals	–2.0	–1.9	1.8	–7.0	7.0	6.9	5.2	8.9
Mining/metal/minerals	–3.2	5.1	–2.1	–14.2	11.1	13.1	7.6	11.9
Precious metals/minerals	–9.3	–4.3	–0.1	–25.5	22.2	21.2	18.8	26.8
Forestry/paper products	–3.8	3.0	–3.5	–12.2	10.9	8.9	8.8	14.9
Fabricated metal products	–4.1	1.2	–1.9	–13.1	10.2	9.7	8.1	12.7
B. Country								
Australia	–2.2	–7.8	3.6	–2.0	15.1	19.1	12.0	12.8
Austria	–4.8	1.7	–13.0	–1.8	19.5	24.9	16.8	14.1
Belgium	1.5	–0.7	0.1	6.3	13.9	16.8	11.0	13.1
Canada	–3.4	–8.6	–1.6	1.4	9.9	11.2	9.5	8.3
Denmark	–4.2	–3.6	–9.6	2.3	15.2	16.1	14.6	14.8
Finland	8.4	–11.6	4.7	32.7	22.1	17.4	25.3	20.7

Table 3. Pure Factor Returns (continued)

France	1.5	–1.0	–3.8	12.6	14.9	18.8	12.5	11.7
Germany	–2.1	–6.7	–4.4	7.3	14.4	17.4	12.9	11.4
Hong Kong	5.4	7.4	18.1	–11.3	24.7	26.4	23.1	24.2
Ireland	3.0	–0.4	2.1	8.9	17.8	19.7	16.3	17.0
Italy	–4.4	–8.6	–7.1	5.1	21.5	22.5	22.3	18.9
Japan	–5.1	4.3	–8.1	–12.5	14.1	12.2	14.0	16.4
Netherlands	3.6	–5.8	6.6	13.0	11.9	12.3	9.5	13.9
New Zealand	–10.0	–20.1	4.5	–13.7	19.4	23.5	16.3	16.9
Norway	–4.7	–7.2	–4.3	–2.0	19.4	21.9	19.2	16.0
Singapore	1.9	9.2	8.6	–14.1	24.0	25.1	18.0	28.9
Spain	2.1	–0.8	–4.0	14.7	17.9	21.2	15.7	15.7
Sweden	5.1	1.9	5.4	8.8	17.4	19.8	17.2	13.9
Switzerland	0.2	–11.7	7.8	7.2	14.1	16.5	12.1	12.8
United Kingdom	–0.7	–3.1	2.9	–2.0	11.3	13.3	10.5	9.4
United States	3.2	0.7	6.3	2.7	7.8	9.3	7.5	5.7
Cap-weighted industry					9.7	10.3	7.8	10.9
Cap-weighted country					11.6	12.2	11.1	9.8

Note: All of the summary statistics are stated on an annualized basis as in Tables 1 and 2. Volatility is standard deviation of returns, measured as in Tables 1 and 2.

Figure 1. Cap-Weighted Pure Factor MADs, January 1, 1986, through November 3, 1999
(52-week moving average)

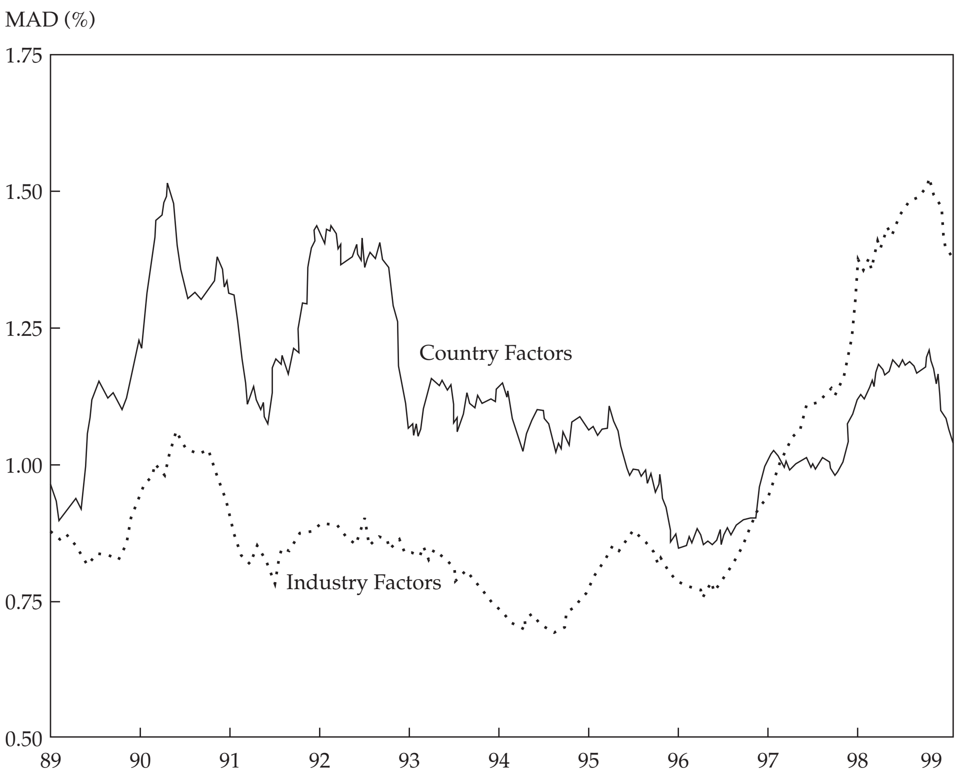
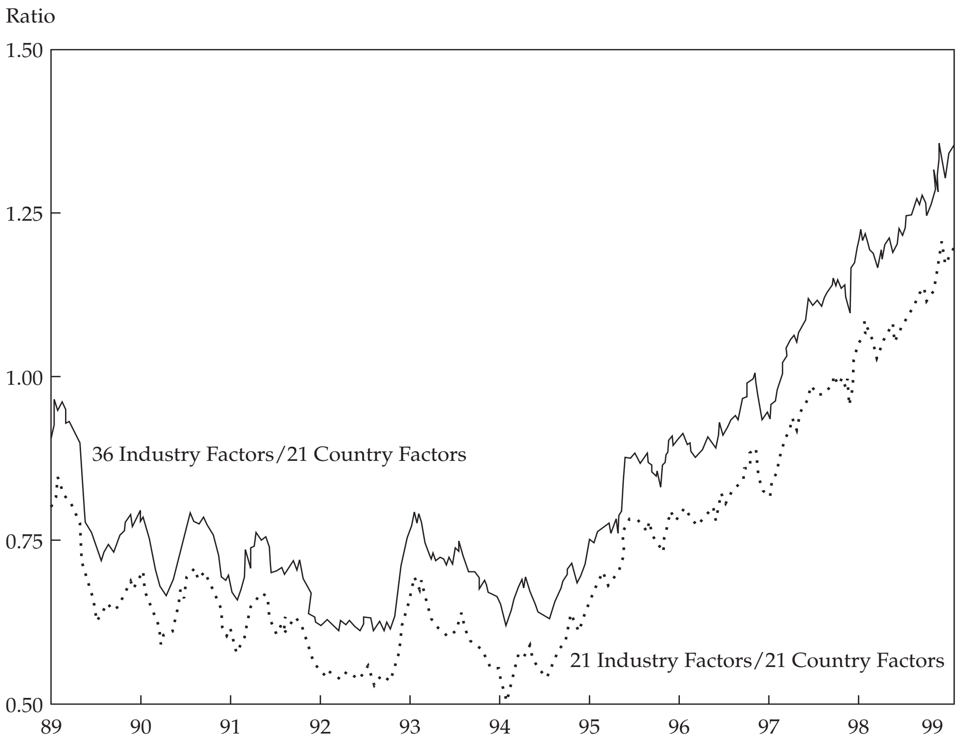


Figure 2. Ratio of Cap-Weighted Pure Factor MADs, January 1, 1986, through November 3, 1999
(52-week moving average)



the Dutch country-factor returns (11.9 percent annualized standard deviation for the same period).

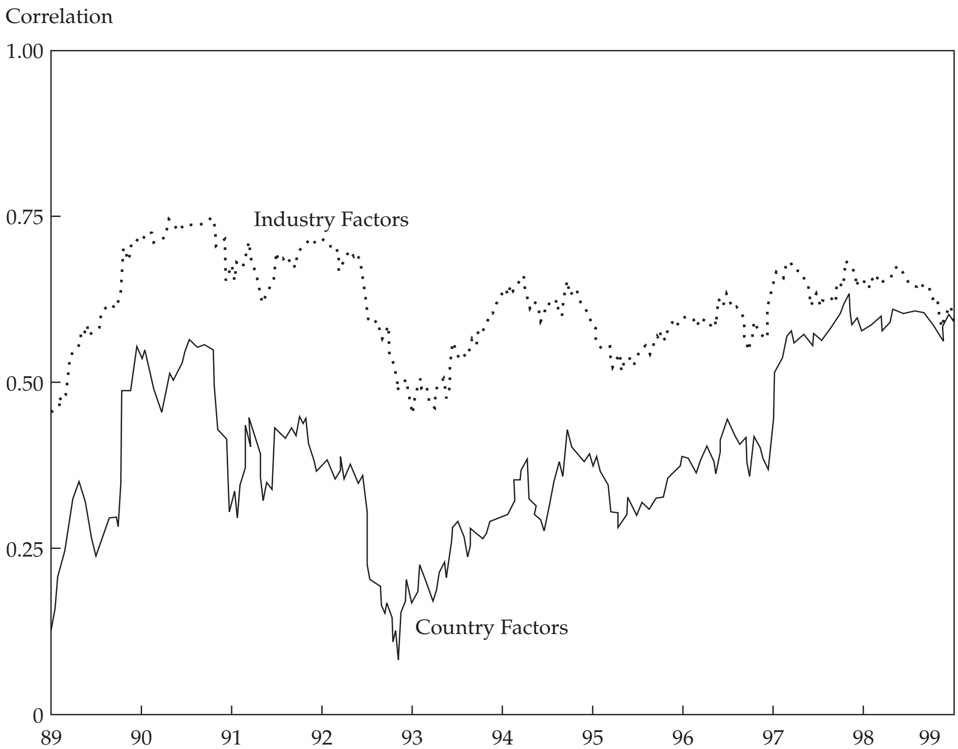
Note that the differences we found probably do *not* originate from the differences in granularity (that is, what is included in the groupings) of the industry data in the two studies. In particular, for instance, the "energy sector" in Rouwenhorst's analysis is composed of what are the oil and non-oil energy industries in our study. In general, and not surprisingly, industry-factor returns belonging to the same sector are more highly correlated among themselves than they are with other sectors.[9] In the particular case of the energy sector, the component industries exhibit high volatility of returns (12.5 percent for oil companies and 21.2 percent for non-oil companies for our study period; see Table 3) and a high correlation in returns (0.55 for the study period).

To explore the impact of industry granularity on our results, we examined a factor model of 21 countries and 21 industries. Industries were grouped on the basis of economic fundamentals, rather than the historical correlation matrix, so the auto parts industry was grouped with auto components and consumer durables, for instance, and the computer and office equipment industry was grouped with software. The dotted line in Figure 2 is a plot of the ratio of the resulting industry MAD to the country MAD. Clearly, industry granularity does not affect the result that industry factors have grown increasingly important relative to country factors.[10]

Factor-model estimates can also be used to draw inferences about the relative merits of international diversification by industry and by country. **Figure 3** provides a time-series plot of the cap-weighted correlations of factor returns from a rolling 52-week window of data.[11] The graph confirms the findings of Beckers et al. (1996) and Solnik and Roulet (1999): Increasing economic integration has been associated with a rise in the correlation of country-factor returns.[12] Thus, the gains from diversifying by country are likely to be diminishing. The plot for the cap-weighted correlation of the industry-factor returns in Figure 3 shows that these returns have been relatively stable in the recent decade. By November 1999, using the most recent 52-week window of data, the cap-weighted correlation of country-factor returns equaled that of industry-factor returns.

Heston and Rouwenhorst (1995) illustrated how their factor model can be exploited to re-examine Solnik's 1974 insight into the gains from international

Figure 3. Cap-Weighted Factor Correlations, January 1, 1986, through November 3, 1999
(52-week moving average)

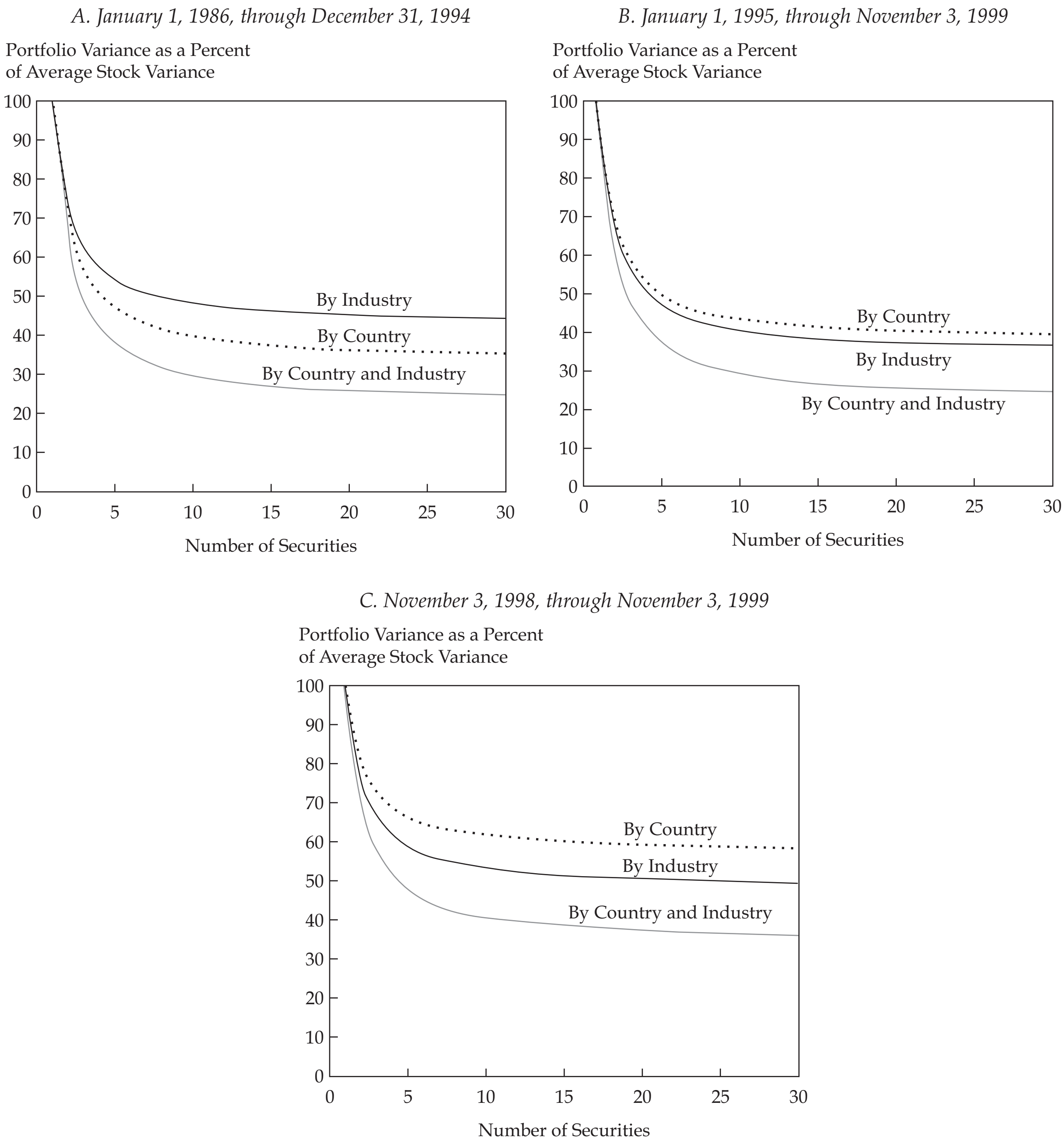


diversification: Assume that the average security has an annualized variance of 28.8^2.[13] An equally weighted portfolio of n such securities will have a variance of $[28.8^2/n] + [(n - 1)/n]$ multiplied by the average covariance of these securities. As n increases in size, the variance of the portfolio is determined primarily by the average covariance of the securities. Thus, the ratio of the average covariance of the securities to the average security variance provides the "limits" from the gains of diversification. The average covariance for a large group of stocks is equal to the variance of an equally weighted index, but a cap-weighted index covering a large number of securities can provide a close approximation to the equally weighted index. So, the world index provides a benchmark for alternative diversification strategies.

As discussed in our review of the factor model, the sum of $A(t)$ and $\gamma_k(t)$ can be viewed as the return from a strategy that is diversified across industries. Similarly, the sum of $A(t)$ and $\beta_j(t)$ can be viewed as the return from a strategy that is diversified across countries. Following Heston and Rouwenhorst (1994), we computed the cap-weighted volatility of these factor returns for our universe of securities from the beginning of January 1986 to the end of December 1994; we could then use these parameter estimates to obtain the previously documented empirical regularity that diversification across countries dominates diversification across industries, as illustrated in Panel A of **Figure 4**.[14] However, as suggested by the results we have presented, the relative asset returns reveal a marked structural change in the importance of country and industry factors in the past several years. The volatility estimates when we used the last five years of data (Panel B) suggest that the gains from diversifying across industries are slightly superior to those from diversifying across countries. Panel C shows that volatility estimates obtained when a 52-week history is used imply that the gains from diversifying by industry are now larger than the gains from diversifying by country. Clearly, however, the most benefit comes from diversifying by both factors.

An alternative way of examining the gains from diversifying by industry and by country considers exploiting the factor structure of equity returns. The model we estimated suggests that both the volatility *and* the return of securities vary by country and by industry. Portfolios that aim to maximize the Sharpe ratio will thus reflect the return-to-risk trade-offs of alternative strategies. **Table 4** reports the maximal historical Sharpe ratios that are obtained from three strategies: (1) taking

Figure 4. International Diversification Strategies



positions in industries only, (2) taking positions in countries only, and (3) taking positions in industries and countries. The optimizations used the historical variance–covariance matrix estimated over the full sample period (January 1, 1986, through November 3, 1999) and the historical mean returns for the full sample period, as reported in Table 3. We allowed short sales. Because we recognize that the results of such portfolio construction exercises are driven by the mean return vector, we also examined the Sharpe ratio portfolios under the agnostic assumption that the mean country and industry-factor return vectors are zero; in some sense, this second experiment is analogous to that performed in Figure 4, but this exercise allowed short sales and was independent of the weighting scheme that Heston and Rouwenhorst (1994) used or that we used. The Sharpe ratios of the industry-factor portfolios dominate those of the country-factor portfolios, and diversification across industries and countries is

Table 4. Maximal Sharpe Ratio Portfolios, January 1, 1986, through November 3, 1999

Portfolio	Historical Mean and Historical Risk Matrix	Null Mean Vector[a] and Historical Risk Matrix
Industry factor	1.41	0.67
Country factor	1.28	0.58
Industry and country factors	1.84	0.75

Note: The Sharpe ratios are stated on an annualized basis.

[a]Country and industry factor expected returns were set to zero; the world expected return was set to its historical mean.

clearly most optimal. Thus, our results suggest that industries provide interesting risk-to-return trade-offs for the global investor.

Conclusions

We have reviewed and extended the empirical evidence relating to the economic significance of global industry factors and their growing importance relative to country factors in determining security returns. Past studies generally demonstrated that both country and industry factors have been significant determinants of equity security returns but that country factors have been relatively more important. Previous evidence related to the growing relative importance of industry factors appears mixed.

Our results suggest that industry factors have become an increasingly important component of security returns. More importantly, diversification across industries now provides greater risk reduction than diversification across countries. Given the increasing geographical integration of markets, we expect these phenomena to persist and even strengthen.

Our analysis contains several implications for passive and active portfolio management. First, unintended industry exposures that result from equity benchmarks that are biased toward the home market may result in increasingly inefficient global asset allocations. Consider, for instance, the U.K. market. It has a small exposure to the information technology industry (about 1.5 percent) in comparison with the world market (about 11.3 percent). A home-biased U.K. portfolio would thus tilt the portfolio away from the global allocation to the information technology industry. The empirical evidence we presented suggests that such a tilt would materially affect the portfolio's return to risk. Second, active global equity investment management will increasingly need to balance the return-to-risk trade-offs of global industry allocations in addition to country allocations.[15] Finally, stock-selection opportunities may increasingly be found by comparing stocks across countries but within common global industries. This possibility will be explored in further research.

The authors gratefully acknowledge discussions with B. Solnik, A. Karolyi, J. Cochrane, C. Harvey, and G. Rouwenhorst. The usual disclaimer applies.

Notes

1. The increased globalization of companies' activities is reflected, in part, by the increasing importance of foreign sales as a percentage of total sales; this ratio rose from 24 percent in 1988 to 31 percent in 1998 for the constituents of the Morgan Stanley Capital International World Index. Intrasector mergers and acquisitions as a percentage of total cross-border M&As rose from 51 percent for the 1989–93 period to 64 percent for 1994 through the first quarter of 1999.
2. The estimate Roll obtained was probably biased upward because he was unable to separate the world equity factor from world industry factors.
3. Factor models are often estimated in a sequential fashion; that is, the researcher fits regressions of equity returns onto country market returns and then fits the residuals from this first pass to industry index returns. Alternatively, the researcher uses the first-pass regression to obtain a factor loading on the country market return and the second-pass regression imposes factor loadings obtained from observable variables. The limitations of this approach are obvious when one considers a company such as Nokia Corporation, which represents 70 percent of the market capitalization of the Finnish market. Clearly, the residuals of the first-pass regression for Nokia will be relatively small; thus, the electronics and instrumentation industry return will appear to account for a relatively small portion of Nokia's volatility. If one were to reverse the order of the two passes—regressing Nokia's return on its industry returns first—the variance decomposition would quite likely ascribe greater explanatory power to the industry return.
4. Urias et al. postulated that the return on security i is determined by either the country or the industry to which it belongs. They used observable country and index returns that were scaled to have the same variance; the estimated factor loadings thus measured the relative importance of the country and industry factors. They computed the capitalization-weighted sum of the factor loadings and found that the weighted industry beta has risen over time and has recently exceeded the weighted country beta. This result held for the 16 European countries examined as well as for the subset of EMU member countries.

5. Beginning dates of January 1 given on the tables and figures reflect data from the close of December 31.
6. As demonstrated in Singer and Karnosky (1995), this conclusion follows from the arbitrage relationship that interest differentials equal the forward discount. We abstract from considerations of "optimal" currency hedge ratios.
7. Marsh and Pfleiderer (1997), using a framework similar to that represented by Equation 1, provided evidence that factor loadings differ among industries.
8. A description of the appropriate matrix manipulations is available from the authors.
9. The full correlation table is available on request from the authors.
10. The factor model we presented allows for a convenient exploration of alternative groupings of countries and industries; factor returns for groups of industries can be estimated by using weighted least squares and imposing constraints on the relevant dummy variables.
11. The data used for this analysis consisted of the sum of the country factor returns with the world return. The weighting matrix for the estimated correlations was obtained from the cross-product of the capitalization; the cross-products were then rescaled so that the sum of the weights added to 1. An equal-weighting scheme yielded similar results.
12. Beckers et al. (1996) estimated various measures of relative variability that formally test the increasing integration of markets. In brief, these measures quantify the extent to which the cross-sectional dispersion of returns is accounted for by industry and by country factors. When we estimated these measures, our results were similar to theirs but with higher statistical significance. These results are available from the authors.
13. This estimate was obtained from the cap-weighted volatility of the constituents of the FT/S&P Actuaries World Index (covering the 21 countries in our universe) as of October 31, 1999. The volatility for each security was obtained from the most recent 60 months of data (where available). This estimate is relatively unimportant, however, for the presentation of the next figure because it serves to scale the gains from alternative diversification strategies.
14. Heston and Rouwenhorst (1994) weighted the volatilities by the number of securities in each country. We used the capitalization weights to maintain broad consistency with the other results we have presented.
15. Cavaglia, Melas, Tsouderos, and Cuthbertson (1995) presented evidence that industry returns across countries are predictable. If so, active asset allocation strategies can be developed to exploit this anomaly.

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