Risks of Sector Rotation Strategies

Structuring global equity portfolios.

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Over the most recent decades, the global equity landscape has been characterized by two striking and complementary trends: an increasing integration of economies and capital markets, and accelerating globalization of business activities. These phenomena have far-reaching implications for the pricing of securities and hence for the investment management profession.

Institutional arrangements among public and private entities have been fundamentally altered in favor of supranational organizations. Increased economic policy coordination among OECD member countries (and in particular EMU member countries), the decline in trade barriers resulting from the growing importance of the World Trade Organization, and the emergence of large trading blocks all suggest that differences in national economic fundamentals are likely to diminish. Indeed, the dispersion in short-term interest rates and in various indicators of political risk (as reported by the Political Risk Services Group) has markedly declined over the past 15 years.

In this more open landscape, corporations have sought to consolidate and to rationalize enterprise activities globally. This is seen in the explosion of cross-border mergers and acquisitions, rising from an average of $40 billion per year over the 1989-1993 period to an average of $400 billion per year over the 1994-2000 period, as reported by the Interactive Data Corporation. Indeed, the emergence of supranational corporations has prompted index vendors (FTSE and S&P) to construct benchmarks aimed at measuring the performance of a new asset class: the multinational.

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These institutional developments suggest that global factors should play an increasingly important role in the pricing of securities. Until recently, empirical evidence has suggested that local factors are the dominant determinant of security returns.[1]

Diermeier and Solnik [2000] provide strong contrary evidence for corporations domiciled in the seven largest developed capital markets. Starting from the first principles of valuation analysis, they demonstrate that a corporation should be regarded as a portfolio of international activities. They provide empirical support for this hypothesis by demonstrating that firm-level sensitivities to non-domestic factors are related to firms' foreign sales activities.

Their findings imply a new model for investment managers. Firm-level fundamental data should be used to understand the local and global risk factors that impact security returns; these bottom-up estimates can then be aggregated to obtain the relevant risk exposures for a portfolio of securities. Local factor risk exposures and regional sector factor exposures are poorly proxied by country of domicile alone.

In related research, Cavaglia, Brightman, and Aked [2000] identify the increasing importance of global industry factors relative to country factors as determinants of security returns; they show that diversification across industries now provides greater risk reduction than diversification across countries. As first suggested by Cavaglia, Melas, and Miyashita [1994], it follows that there is more to international allocation than choosing winning countries; a cross-country, cross-industry matrix approach is needed to capture the maximal reward-to-risk benefits of international equity diversification.

The purpose of this study is to gain a better understanding of the sources of global pricing, or rather "non-domestic" pricing, that are documented in Diermeier and Solnik [2000]. We focus here on industry factors. We first extend the risk model developed by Heston and Rouwenhorst [1994] to account for an investment style that is becoming increasingly popular: *regional* sector rotations.

We recognize that finding the best risk model is a worthy endeavor, but our objective is narrower. We aim to build a model that is well-grounded in financial theory, that is empirically supported, and that is consistent with a current investment style.

In an examination of security-level fundamental data for the constituents of the 22 developed markets that constitute the FT World Index, we find that firm-level regional sector exposures can be explained by the extent of firms' regional sales over the 1990-2000 period. This suggests that the reduced form of the structural model we estimate is a reasonable representation of the economic phenomena we observe. Furthermore, foreign sales data provide valuable information that can be used to condition factor loading estimates in the construction of global equity risk models.

METHODOLOGY

We first postulate a model of security returns. We posit that the local excess returns of security j at time t $R_j(t)$ are determined by the relationship:

$$\begin{aligned} R_j(t) = {} & \beta_1\,[\text{World Market Excess Return } (t)] + \\ & \beta_2\,[\text{Country Market Excess Return } (t)] + \\ & \beta_3\,[\text{North America Sector Excess Return } (t)] + \\ & \beta_4\,[\text{Europe Sector Excess Return } (t)] + \\ & \beta_5\,[\text{Asia-Pacific Sector Excess Return } (t)] + \varepsilon(t) \end{aligned} \quad (1)$$

Note that the country of domicile and the sector to which security j belongs are the relevant explanatory variables in Equation (1). Thus, for instance, the return on General Motors stock is driven by the world market factor, the U.S. market factor, and regional consumer durables factors. Equation (1) extends and nests Heston and Rouwenhorst [1994] and Diermeier and Solnik [2000].[2]

Heston and Rouwenhorst [1994] impose the strong assumption that industry factors are global in structure. This is particularly unrealistic in relation to the practice of active portfolio management. Suppose an asset manager is long Japanese autos, short U.S. autos, long U.S. banks, and short Japanese banks. If industry factors are global in nature, these portfolio holdings result in neutral country positions and neutral industry positions. This might lead to the misleading conclusion that the portfolio is exposed to security-specific risk only to the extent this has not been diversified away. Clearly, the asset manager has made an explicit decision to bear the risk and reward benefits of regional sector rotations. The risk model should capture this aspect of the decision process; we thus allow for regional sector effects.[3]

In Diermeier and Solnik [2000], non-domestic risks are captured by regional market factors (Asia, North America, and Europe) and currency factors. We allow here for two sources of non-domestic factors: the world market and regional sector effects.[4]

As is discussed in Heston and Rouwenhorst [1994, 1995], estimating Equation (1) or variants of it is rather difficult. They suggest that it is desirable to control for dif-

fering industrial structures across countries and for the differing country composition of global industries. To do so, it is necessary to impose some identifying restrictions.

One can assume that country and industry factor loadings are given (unitary or zero representing primary membership); cross-sectional dummy variable regressions can then be estimated to obtain the relevant pure country and industry factor returns. The pure returns provide a useful investment interpretation—they are the returns from sector (country) tilts that are country (industry) neutral.

Marsh and Pfleiderer [1997] argue that this procedure results in an unnecessary loss of information. Harvey, Solnik, and Zhou [1994] demonstrate that differences in risk loadings are important in accounting for the cross-sectional variation in industry and country equity returns. Marsh and Pfleiderer [1997] propose an iterative estimation approach aimed at obtaining more precise estimates of the factor loadings.

In the first step, values for the factor loadings are assumed as above, and a cross-sectional regression yielding the pure country and industry factor returns is estimated. In the second step, the time series of the pure factor returns is used in ordinary least squares estimates of Equation (1) to obtain factor loadings. Finally, the factor loadings are utilized to estimate the constrained Equation (1) regression. This procedure is repeated until convergence is obtained. We adopt this approach although we stop at the first iteration (the second step).

Having estimated Equation (1), we examine the cross-section of factor loadings (the estimated betas) and their consistency with the theoretical international valuation model of Diermeier and Solnik [2000]. If rational international asset pricing is reflected in security prices, then we would expect to find empirical support for hypotheses as follows:

Hypothesis 1: Firm-level exposures to the global risk factor are positively related to the extent of firms' foreign activities.

Hypothesis 2: Firm-level exposures to the domestic risk factors are inversely related to the extent of firms' foreign activities.

Hypothesis 3: Firm-level exposures to the regional sector risk factors are positively related to the extent of firms' regional activities.

We test these hypotheses through cross-sectional regressions of the estimated betas on the relevant foreign sales-to-total sales ratios, which are used to proxy firms' foreign activities.[5] Thus, for instance, Hypothesis 1 is tested via a cross-sectional regression of the $\hat{\beta}_1$ on the foreign sales to total sales for all firms in our sample.

Several robustness checks are performed. We examine the extent to which our findings are stable over time by estimating year-by-year cross-sectional regressions over the 1990-1999 period. We also examine whether our results are sensitive to country of domicile; for instance, we examine whether companies domiciled in Europe behave differently from those in the rest of the world. Finally, we examine the residuals of our estimated factor model and review whether they are systematically related to currency factors.

DATA

The constituents of the FT World Index for 22 developed equity markets define our universe of securities. This universe covers the top 85%-95% market capitalization of each country and the generally more liquid securities. Exhibit 1 provides the number of companies by country at year-end for the time period of analysis.

The empirical estimation is conducted on weekly excess returns. Hence, the results can be viewed as currency hedged from any investor's perspective.[6] Excess returns are obtained from local total returns as reported by FTSE International less the one-month Eurodeposit rates (appropriately scaled for the weekly holding-period horizon) reported in Standard & Poor's DRI Fixed Income and Money Markets Database.

Securities are classified into ten broad sectors for three regions: North America, Asia-Pacific, and Europe. We use MSCI industry classifications as released in 1999. We acknowledge that there is some look-ahead bias in using an industry classification scheme developed in 1999 for the pre-1999 period. The sector categorization is quite broad, however, and is largely consistent with industry classification schemes available as far back as 1985 (e.g., the FT industry classification scheme).

When this research was conducted, MSCI industry classifications were not available for securities that were in the index prior to 1999. We create a back-history by mapping pre-1999 FT industry classifications and Factset industry classifications onto MSCI industry classifications. In some instances, we were unable to identify an appropriate mapping; these securities are classified in an extra "multi-industry" sector. Stocks belonging to multi-industries are included in the determination of factor returns but are excluded from the sample of companies used to test our hypotheses, since factor loadings on a "multi-industry" factor are somewhat difficult to interpret.

EXHIBIT 1
FT UNIVERSE—COMPANY COVERAGE*

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Australia	85	76	69	69	69	91	82	78	83	76
Austria	19	24	20	18	17	29	27	28	23	21
Belgium	68	63	46	41	43	34	35	31	25	21
Canada	121	131	115	113	107	104	129	129	122	131
Denmark	38	41	38	33	33	33	36	31	33	33
Finland	27	27	15	24	25	25	28	28	29	29
France	126	132	109	104	107	103	101	98	85	76
Germany	96	93	65	62	59	59	63	60	61	55
Hong Kong	48	56	55	55	56	61	62	67	67	74
Ireland	16	18	17	16	14	17	16	17	18	17
Italy	97	102	78	76	75	62	60	64	55	54
Japan	455	484	474	472	469	498	483	489	487	445
Netherlands	44	42	31	29	27	19	19	19	27	26
New Zealand	18	17	14	14	18	14	17	14	18	18
Norway	33	32	25	23	23	34	38	41	41	37
Portugal	0	0	0	0	0	0	0	0	19	18
Singapore	22	37	34	35	42	40	40	39	38	45
Spain	43	58	52	48	43	38	38	35	33	30
Sweden	35	29	31	35	35	49	47	47	47	44
Switzerland	73	72	65	63	48	46	39	36	32	31
United Kingdom	309	301	235	228	222	213	226	217	221	208
United States	547	562	524	525	522	682	643	671	657	623
Total	2320	2397	2112	2083	2054	2251	2229	2239	2221	2112

** Number of companies that are constituents of the FT index at year-end.*

EXHIBIT 2
FOREIGN SALES DATA—COMPANY COVERAGE

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Australia	59	75	75	86	94	95	86	85	84	76
Austria	9	12	9	12	13	19	19	22	21	17
Belgium	25	38	22	24	25	28	36	34	32	18
Canada	95	103	67	97	117	122	125	121	109	85
Denmark	19	27	26	29	32	33	35	36	35	26
Finland	13	21	19	27	30	32	31	33	31	24
France	96	103	82	97	102	100	96	99	91	63
Germany	65	72	67	74	79	79	80	79	81	68
Hong Kong	28	44	53	56	58	59	63	63	61	48
Ireland	8	11	9	12	15	15	16	17	15	11
Italy	36	45	60	60	54	59	66	67	50	29
Japan	213	224	181	66	113	94	101	98	86	76
Netherlands	27	29	29	30	32	30	31	30	29	20
New Zealand	9	16	17	17	19	19	19	24	25	22
Norway	23	30	26	33	36	39	38	36	35	30
Portugal	0	0	0	2	8	7	8	10	10	2
Singapore	37	40	38	44	46	46	46	46	45	41
Spain	22	39	32	33	30	30	35	33	24	9
Sweden	37	42	36	48	46	46	45	46	45	30
Switzerland	33	39	44	54	52	51	45	48	46	46
United Kingdom	195	258	231	252	271	266	253	247	223	189
United States	0	0	624	629	638	634	636	622	608	580
Total	1049	1268	1747	1782	1910	1903	1910	1896	1786	1510

Sources: Foreign sales data are from WorldVest for companies domiciled outside the United States, and from Worldscope for companies domiciled in the United States.

EXHIBIT 3
Percentage of Capitalization Covered by Foreign Sales Data

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Australia	58.7	64.0	72.1	72.8	79.0	74.0	68.8	65.6	60.6	62.4
Austria	31.3	27.7	36.4	41.3	42.0	59.2	63.3	70.7	63.5	52.0
Belgium	36.5	65.1	42.3	48.4	47.6	48.9	58.0	52.5	45.0	11.9
Canada	74.4	75.3	43.8	61.9	84.2	85.4	75.7	72.4	55.7	42.3
Denmark	23.7	45.5	38.9	35.6	54.2	55.3	64.3	56.0	57.4	56.2
Finland	18.6	43.1	39.3	61.1	76.7	86.0	85.9	84.2	84.8	90.4
France	74.3	82.1	79.8	81.5	87.2	85.3	89.9	88.3	87.2	78.3
Germany	55.8	57.2	56.3	56.8	66.8	66.5	71.6	64.1	68.5	69.9
Hong Kong	47.6	62.8	73.5	77.4	78.7	82.0	80.9	80.4	81.3	63.3
Ireland	18.7	39.1	29.3	43.7	52.9	49.8	49.9	41.6	34.4	33.7
Italy	17.5	33.5	36.3	47.6	46.3	40.3	55.6	47.1	40.4	35.5
Japan	34.0	35.7	31.7	16.2	31.2	28.0	33.1	36.3	33.1	31.7
Netherlands	17.5	18.0	16.0	21.9	31.5	29.0	26.3	22.8	24.0	19.2
New Zealand	31.8	97.6	99.5	61.9	97.2	92.2	85.5	100.0	100.0	96.7
Norway	61.7	68.4	56.8	78.9	81.5	66.8	80.0	73.3	66.0	63.7
Portugal									65.6	11.0
Singapore	56.9	76.0	69.9	76.3	79.8	77.5	71.9	75.3	71.5	33.2
Spain	19.8	55.0	63.4	59.0	58.5	62.7	67.4	56.4	59.9	52.4
Sweden	76.9	76.3	71.9	82.9	74.8	73.1	74.7	70.5	70.1	64.9
Switzerland	57.3	61.3	54.2	61.1	69.8	69.0	72.0	66.9	66.4	66.8
United Kingdom	49.5	71.3	67.9	59.8	68.9	66.6	65.6	61.8	64.4	65.0
United States	0.0	0.0	86.8	85.1	85.6	85.0	85.9	86.9	82.7	88.7

Regional sales data are obtained from two data sources. For the U.S. domiciled companies, we use Worldscope starting in 1992. For all other companies, we obtain a complete sales breakdown by country or region from WorldVest starting in 1990.[7] The breadth and depth of these data are noteworthy.

In Exhibit 2 we report the number of companies in the FT universe for which we have relevant foreign sales data. Exhibit 3 shows the percentage of FT market capitalization covered by our foreign sales data; generally speaking, we cover about 60% of the capitalization of each country.

EMPIRICAL RESULTS

The primary objective of the empirical analysis is to use fundamental data to gain a better understanding of the statistically estimated factor loadings in Equation (1). We also aim to gain confidence in the reasonableness and consistency over time of the model's structural form.

We estimate Equation (1) via the two-pass methodology we have outlined for each year over the 1990-1999 period. A rolling 52-week window of data is used to estimate factor loadings. We then examine the hypotheses at each year-end.

Results for the cross-sectional regressions of factor loadings on the relevant foreign sales ratios are reported in Exhibit 4.

Hypothesis 1

Firm-level exposures to the global risk factor are positively related to the extent of firms' foreign activities. This can be tested via a cross-sectional regression of the form:

$$\beta_1^j(t) = \text{Constant} + \delta_1\left[\frac{\text{Total Foreign Sales}}{\text{Total Sales}}(t)\right]^j + \varepsilon(t) \qquad (2)$$

We use the latest available foreign sales data; if a company has not reported its foreign sales in the most recent period, we use the last period's values. The estimated β_1 at year-end are used as the left-hand side variables. The slope coefficients are positive, thus confirming the hypothesis. The coefficient is, however, rather small in size and marginally statistically significant over time. Exhibit 5 provides a scatterplot of the estimated regression for the 1999 period.

Hypothesis 2

Firm-level exposures to the domestic risk factor are inversely related to the extent of firms' foreign activities. This can be tested via a cross-sectional regression of the form:

EXHIBIT 4
ANALYSIS OF FACTOR LOADINGS—YEAR-BY-YEAR CROSS-SECTIONAL REGRESSIONS: FACTOR LOADINGS ON SALES RATIOS

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Global Factor[a]	constant	0.98	0.93	0.98	0.98	1.00	0.98	0.97	0.98	0.99	0.97
	SE	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	t-stat	-0.90	-3.62	-1.07	-1.03	0.24	-1.09	-1.62	-0.95	-0.68	-1.55
	slope	0.07	0.16	0.05	0.07	0.01	0.08	0.08	0.09	0.04	0.09
	SE	0.05	0.04	0.05	0.05	0.04	0.05	0.04	0.04	0.03	0.04
	t-stat	1.47	3.83	1.19	1.30	0.26	1.63	2.29	2.41	1.21	1.96
Domestic Factor[b]	constant	1.00	1.07	0.95	0.99	0.99	1.01	1.03	1.01	1.03	1.02
	SE	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.04
	t-stat	-0.05	2.01	-0.32	-0.32	-0.44	0.44	1.06	0.47	0.89	0.40
	slope	-0.01	-0.12	0.03	0.00	0.00	-0.03	-0.03	-0.03	-0.06	-0.03
	SE	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05
	t-stat	-0.22	-2.51	0.65	-0.10	-0.11	-0.76	-0.64	-0.80	-1.38	-0.51
European Sector Factor[c]	slope	0.97	0.93	1.01	1.00	1.10	1.03	1.00	1.05	0.94	0.91
	SE	0.12	0.10	0.08	0.08	0.07	0.08	0.07	0.07	0.07	0.08
	t-stat	7.90	9.46	12.01	11.91	15.48	13.55	13.42	14.40	13.50	11.87
North American Sector Factor[d]	slope	0.63	0.33	1.09	1.11	1.13	1.14	1.09	1.09	1.13	1.03
	SE	0.13	0.10	0.07	0.05	0.06	0.06	0.05	0.06	0.06	0.06
	t-stat	4.78	3.43	16.67	21.17	19.65	20.80	22.41	19.26	19.43	17.65
Asian-Pacific Sector Factor[e]	slope	1.12	0.78	0.97	0.99	0.96	1.02	1.07	1.10	1.01	0.85
	SE	0.08	0.08	0.08	0.07	0.08	0.08	0.07	0.06	0.07	0.08
	t-stat	14.24	9.27	12.35	14.95	12.52	13.58	14.29	17.13	14.15	11.25

[a] The global factor betas are regressed on the ratio of total foreign sales to total sales. We test whether the constant term is different from 1.0; we test whether the slope differs from zero.
[b] The domestic factor betas are regressed on the ratio of domestic sales to total sales. We test whether the constant term is different from 1.0; we test whether the slope differs from zero.
[c] The European sector betas (in excess of sector means) are regressed on the ratio of European sales to total sales (in excess of sector means). We test whether the slope differs from zero.
[d] The North American sector betas (in excess of sector means) are regressed on the ratio of North American sales to total sales (in excess of sector means). We test whether the slope differs from zero.
[e] The Asian-Pacific sector betas (in excess of sector means) are regressed on the ratio of Asian-Pacific sales to total sales (in excess of sector means). We test whether the slope differs from zero.

$$\beta_2^j(t) = \text{Constant} + \delta_2\left[\frac{\text{Total Foreign Sales}}{\text{Total Sales}}(t)\right]^j + \varepsilon(t) \qquad (3)$$

The slope coefficients are negative, confirming the hypothesis. They are generally not statistically significant, however.

Hypothesis 3

Firm-level exposures to the regional sector risk factor are positively related to the extent of firms' regional activities. This can be tested via cross-sectional regressions of the form:

$$\beta_3^j(t) = \text{Constant} + \delta_3\left[\frac{\text{North American Sales}}{\text{Total Sales}}(t)\right]^j + \varepsilon(t) \qquad (4\text{-A})$$

$$\beta_4^j(t) = \text{Constant} + \delta_4\left[\frac{\text{Asian-Pacific Sales}}{\text{Total Sales}}(t)\right]^j + \varepsilon(t) \qquad (4\text{-B})$$

$$\beta_5^j(t) = \text{Constant} + \delta_5\left[\frac{\text{European Sales}}{\text{Total Sales}}(t)\right]^j + \varepsilon(t) \qquad (4\text{-C})$$

EXHIBIT 5
GLOBAL RISK FACTOR EXPOSURE

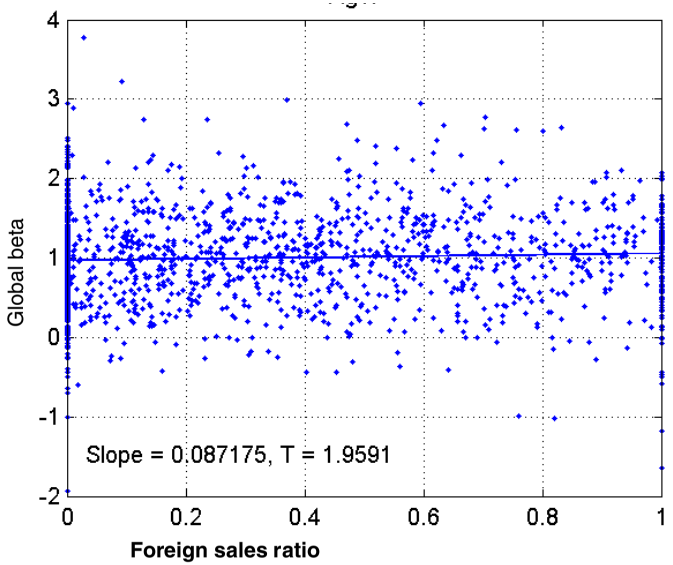

EXHIBIT 6
NORTH AMERICAN SECTOR RISK FACTOR EXPOSURE

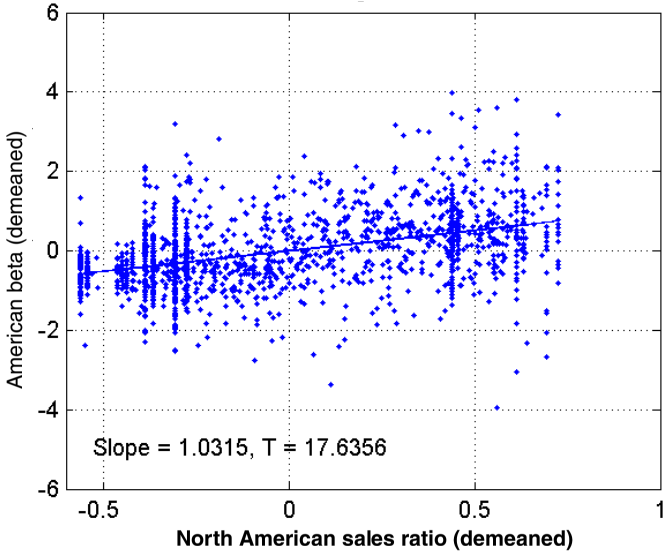

EXHIBIT 7
ASIAN-PACIFIC SECTOR RISK FACTOR EXPOSURE

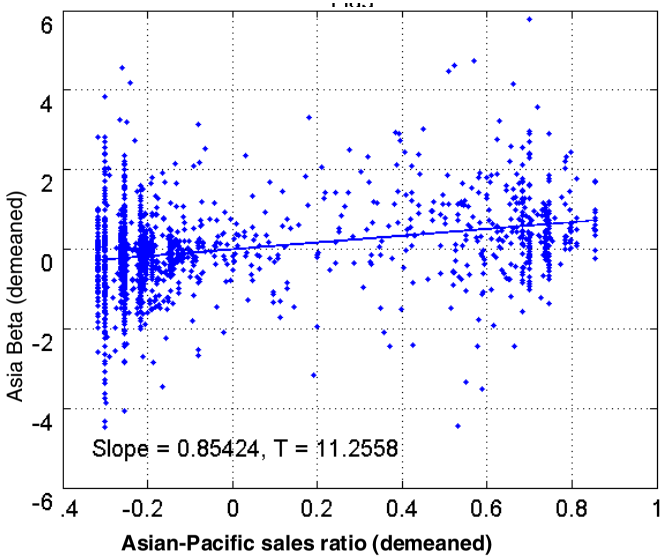

EXHIBIT 8
EUROPEAN SECTOR RISK FACTOR EXPOSURE

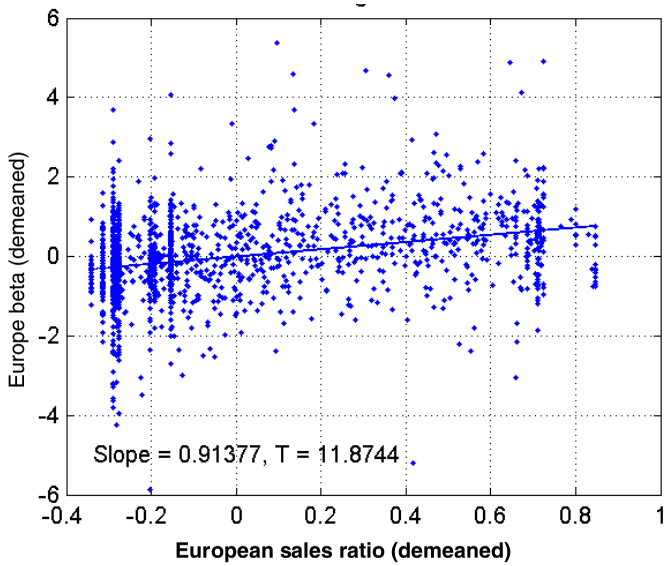

EXHIBIT 9
North American Sector Exposure Analysis—Tests for Differential Slopes
Year-by-Year Cross-Sectional Regressions *

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Companies Domiciled in Europe	slope	-0.46	-0.28	-0.11	0.23	-0.04	-0.11	0.03	0.21	0.15	0.01
	SE	0.33	0.24	0.19	0.15	0.17	0.16	0.14	0.16	0.16	0.17
	t-stat	-1.38	-1.18	-0.6	1.54	-0.21	-0.66	0.19	1.28	0.90	0.06
Companies Domiciled in North America	slope	0.46	0.43	0.59	0.19	0.69	0.33	0.09	0.25	0.06	-0.02
	SE	0.32	0.23	0.27	0.22	0.24	0.23	0.20	0.23	0.23	0.23
	t-stat	1.41	1.92	2.17	0.86	2.84	1.42	0.43	1.05	0.27	-0.1
Companies Domiciled in Asia-Pacific	slope	-0.05	-0.34	-0.19	-0.35	-0.31	-0.06	-0.07	-0.32	-0.18	0.00
	SE	0.48	0.31	0.20	0.16	0.17	0.17	0.14	0.16	0.16	0.16
	t-stat	-0.11	-1.1	-0.95	-2.22	-1.79	-0.34	-0.48	-1.99	-1.09	0.01

**We test whether the coefficient of the interaction term is significantly different from zero.*

In these equations, we implicitly assume that the slope coefficients are identical across all industries. Some industries, however, are on average characterized by higher foreign sales ratios; for instance, utilities sell primarily in their region of domicile, while pharmaceuticals sell across all regions.

To control for this possibly confounding effect we estimate each equation having removed sector means from each side of the equation. The results provide strong corroborating evidence in support of our hypothesis; the betas are positive and statistically significant over the full sample period. Exhibits 6–8 provide scatterplots of the data and fitted regressions for (4-A)–(4-C) for the 1999 period.

Our annual estimations confirm the stability of the relationships over time. As a further check on the robustness of our results, we examine whether the estimated slope coefficients in Equations (4-A)–(4-C) differ for companies domiciled in different regions. This is to ensure that any one group of securities not unduly determine the general results. This analysis is undertaken by introducing relevant regional interaction terms in Equations (4-A)–(4-C).

Consider, for instance, (4-A). To test whether European companies have a differential slope, we fit:

$$\beta_3^j = \text{Constant} + \delta_3\left[\frac{\text{North American Sales}}{\text{Total Sales}}(t)\right]^j + \gamma 3\left[\frac{\text{North American Sales}}{\text{Total Sales}}(t)\right]^j \times \left[\text{Dummy for Europe }(t)\right]^j + \varepsilon(t) \quad (5)$$

We then examine whether the interaction term is significantly different from zero. Similarly, we can examine Equation (5) with interaction terms that test for different slope effects for Asian-Pacific and for North American companies. The results of these tests are reported in Exhibit 9. In Exhibits 10 and 11 we provide the analogous tests for Equations (4-B) and (4-C).

By and large, we find the relationship between regional factor sensitivities and regional sales exposure to be similar across firms, regardless of their country of domicile. The only exception appears to be European companies, where there is a somewhat perverse effect; the relationship between a firm's sensitivity to European sector factors and the extent of its European sales activities is weaker than that of other firms. This may be attributable to some interaction effect between local market factors and European sector factors.

As further verification of the model structure postulated in Equation (1), we examine whether the fitted residuals are systematically related to currency effects. Diermeier and Solnik [2000] present evidence to indicate that currency factors are priced into security returns. We thus regress the residuals onto weekly effective exchange rate returns for the German mark, the U.S. dollar, and the Japanese yen.

On a cross-sectional basis, currency factor loadings are found to be centered about zero. Moreover, the loadings are not significantly related (either positively or negatively) to firms' foreign activities.[8]

Our results are not inconsistent with those of Diermeier and Solnik [2000], as it is possible that currency risks in our model could be systematically related to regional sector risks.

EXHIBIT 10
Asian Sector Exposure Analysis—Tests for Differential Slopes: Year-by-Year Cross-Sectional Regressions*

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Companies Domiciled in Europe	slope	-0.21	0.33	-0.08	-0.08	-0.28	0.18	0.32	0.18	0.16	0.32
	SE	0.33	0.34	0.28	0.23	0.27	0.27	0.26	0.23	0.26	0.28
	t-stat	-0.65	0.95	-0.29	-0.36	-1.04	0.68	1.22	0.79	0.63	1.15
Companies Domiciled in North America	slope	0.20	-0.30	0.06	0.00	0.06	0.10	-0.22	-0.03	0.02	-0.18
	SE	0.39	0.42	0.29	0.24	0.27	0.27	0.27	0.23	0.26	0.27
	t-stat	0.51	-0.71	0.22	-0.01	0.21	0.37	-0.81	-0.12	0.08	-0.66
Companies Domiciled in Asia-Pacific	slope	0.22	-0.32	0.06	0.24	0.60	-0.78	-0.27	-0.36	-0.46	-0.32
	SE	0.58	0.53	0.48	0.38	0.44	0.44	0.41	0.35	0.41	0.43
	t-stat	0.39	-0.60	0.13	0.62	-1.76	-1.76	-0.65	-1.03	-1.12	-0.76

**We test whether the coefficient of the interaction term is significantly different from zero.*

EXHIBIT 11
European Sector Exposure Analysis—Tests for Differential Slopes: Year-by-Year Cross-Sectional Regressions *

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Companies Domiciled in Europe	slope	-1.90	0.50	-0.68	0.12	-0.58	0.32	0.29	-0.09	-0.65	-0.67
	SE	0.56	0.45	0.38	0.38	0.31	0.33	0.31	0.29	0.28	0.31
	t-stat	-3.40	-1.12	-1.81	0.33	-1.85	0.97	0.93	-0.32	-2.30	-2.19
Companies Domiciled in North America	slope	-0.52	0.49	-0.02	-0.08	0.05	-0.08	-0.07	0.07	0.43	0.26
	SE	0.47	0.36	0.26	0.26	0.22	0.24	0.24	0.23	0.22	0.24
	t-stat	-1.11	1.35	-0.09	-0.33	0.24	-0.33	-0.31	0.29	1.93	1.08
Companies Domiciled in Asia-Pacific	slope	1.30	-0.12	0.35	0.03	0.24	-0.08	-0.09	-0.01	-0.03	0.17
	SE	0.39	0.31	0.26	0.27	0.23	0.24	0.24	0.24	0.23	0.25
	t-stat	3.31	-0.38	1.35	0.10	1.09	-0.36	-0.40	-0.04	-0.14	0.69

**We test whether the coefficient of the interaction term is significantly different from zero.*

CONCLUSIONS

The internationalization of capital markets suggests that global factors are playing an increasingly important role in the pricing of securities. Identifying the sources of those global factors and structuring portfolios that exploit the reward-to-risk opportunities from variation in these factors presents a new challenge.

We develop a risk model that explicitly accounts for regional sector rotation decisions. Application of the model to data in three regions for the decade of the 1990s indicates to what degree statistically estimated factor risk exposures are related to firm-level economic activities. The finding that sensitivities to foreign factors are positively associated with the extent of firms' foreign sales activities provides support for the model, suggesting that foreign sales data can be used as a conditioning variable to obtain economically sensible risk factor sensitivities.

ENDNOTES

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[1]See, for instance, Rouwenhorst [1999], Griffin and Karolyi [1998], Beckers, Connor, and Curds [1996], and Grinold, Rudd, and Stefek [1989].

[2]There are alternative ways to estimate Equation (1). As reviewed in Cavaglia, Brightman, and Aked [2000], there is no single best way of estimating all the relevant parameters.

[3]Cavaglia et al. [1995] provide evidence that local industry returns are predictable. They present the performance of simulated strategies and demonstrate that active sector rotation across countries provides an additional source of alpha beyond simplistic country rotation strategies.

[4]Note that regional sector effects are estimated controlling for differing country composition across sectors. Thus, for instance, the geographic composition of European financial sector returns is identical to that of the European consumer durables sector.

[5]Foreign income would be a better indicator of foreign activities, but these data are more difficult to obtain.

[6]As demonstrated in Singer and Karnosky [1995], this conclusion follows from the arbitrage relationship that interest differentials equal the forward discount.

[7]WorldVest Base Inc. is a respected international financial information provider to the investment banking community (http://www.wvb.com).

[8]Results of this analysis are available from the authors on request.

REFERENCES

Beckers, Stan, Gregory Connor, and Ross Curds. "National versus Global Influences on Equity Returns." *Financial Analysts Journal*, Vol. 52, No. 2 (March-April 1996), pp. 31-39.

Cavaglia, Stefano, Christopher Brightman, and Michael Aked. "The Increasing Importance of Industry Factors." *Financial Analysts Journal*, Vol. 56, No. 5 (September-October 2000), pp. 41-54.

Cavaglia, Stefano, Dimitris Melas, and Osamu Miyashita. "Efficiency Across Frontiers." *Risk*, Vol. 7, No. 10 (October 1994), pp. 56-61.

Cavaglia, Stefano, Dimitris Melas, George Tsouderos, and Keith Cuthbertson. "Industrial Action." *Risk*, Vol. 8, No. 5 (May 1995), pp. 32-36.

Diermeier, Jeffrey, and Bruno Solnik."Global Pricing of Equity." Presented at the Q-Group-Inquire conference, October 2000.

Griffin, John M., and G. Andrew Karolyi. "Another Look at the Role of the Industrial Structure of Markets for International Diversification Strategies." *Journal of Financial Economics*, Vol. 50, No. 3 (December 1998), pp. 351-373.

Grinold, Richard, Andrew Rudd, and Dan Stefek. "Global Factors: Fact or Fiction?" *The Journal of Portfolio Management*, Vol. 16, No. 1 (Fall 1989), pp. 79-89.

Harvey, Campbell, Bruno Solnik, and Guofu Zhou. "What Determines Expected International Asset Returns." Working Paper W4660, NBER, 1994.

Heston, Steven L., and K. Geert Rouwenhorst. "Does Industrial Structure Explain the Benefits of Industrial Diversification?" *Journal of Financial Economics*, Vol. 36, No. 1 (August 1994), pp. 3-27.

——. "Industry and Country Effects in International Stock Returns." *The Journal of Portfolio Management*, Vol. 21, No. 3 (Spring 1995), pp. 53-58.

Marsh, Terry, and Paul Pfleiderer."The Role of Country and Industry Effects in Explaining Global Stock Returns." Working paper, 1997.

Rouwenhorst, Geert. "European Equity Markets and the EMU." *Financial Analysts Journal*, Vol. 55, No. 3 (May-June 1999), pp. 57-64.

Singer, Brian, and Denis Karnosky. "The General Framework for Global Investment Management and Performance Attribution." *The Journal of Portfolio Management*, Vol. 21, No. 2 (Winter 1995), pp. 84-92.