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ABSTRACT

Stock Price Indices are compared across countries in an attempt to explain why they exhibit such disparate behavior. Three separate explanatory influences are empirically documented. First, part of the behavior can be attributed to a technical aspect of index construction; some indices are more diversified than others. Second, each country's industrial structure plays a major role in explaining stock price behavior. Third, for the majority of countries, a portion of national equity index behavior can be ascribed to exchange rate behavior. Exchange rates explain a significant portion of common currency denominated national index returns, although the amount explained by exchange rates is less than the amount explained by industrial structure for most countries.

THE COMPARATIVE BEHAVIOR OF equity indices from major international markets is attracting increasing attention, yet puzzling features exist. (1) Volatility is systematically higher in some national equity markets than in others. (2) The intercorrelation among markets is surprisingly low[1] given global financial integration. (3) Macroeconomic variables explain only a modest amount of the observed movements in equity prices.[2] Each of these empirical facts awaits an explanation.

The evidence offered in this paper provides at least a partial resolution of these puzzles. Three separate causative influences are uncovered. First,

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[1]A number of authors have documented the low degree of intermarket correlation of price changes. See, for instance, Dwyer and Hafer (1988).

[2]Asprem (1989), for instance, finds significant but small explanatory power in ten European countries from such macroeconomic variables as employment, imports, and interest rates. Much more of the variability in equity returns is "explained" by a broad market index constructed from returns averaged across all countries.

equity *index* behavior is partly attributable simply to the technical procedures of index construction. Some market indexes have a small number of stocks (less than thirty) while others have a large number. Some national markets are industrially concentrated while others are very diversified. These diversification elements explain part of the observed intermarket differences in price *index* (not individual stock) behavior.

Second, nations vary in their industrial composition and have industries that are inherently more or less volatile. We can think of the index from a country as analogous to a managed portfolio with particular industry sector "bets." Even a large portfolio can be influenced by disproportionate investments in certain industries.

Third, exchange rates play a significant role. With returns expressed in a nation's own (local) currency, part of a stock index' return volatility is induced by monetary phenomena such as changes in anticipated and actual local inflation rates. However, converting local currency returns into common currency returns (e.g., the U.S. dollar) does not entirely eliminate the exchange rate's influence. This suggests that exchange rates themselves are not entirely driven by monetary phenomena. A real aspect of exchange rate behavior explains part of the observed equity price movements. We shall see that there are substantial cross-country differences in the relative importance of the real and monetary components of exchange rate behavior.

Existing literature on this topic is sparse. Only a few papers in the large literature on international diversification have attempted to answer *why* equity market volatility differs so substantially across countries. Grinold, Rudd, and Stefek (1989) is the closest paper I could find to this one. They investigated the decomposition of local currency-denominated *individual* stock returns into a local market factor return, an industry return, and certain "common" factor returns based on company attributes such as size, yield, and "success." Using a cross-sectional (interfirm) model, they find that both industry and country explain part of the typical stock's return behavior. The results of this paper are consistent with their findings. However, the emphasis is this paper is on explaining the broad differences among country returns in the aggregate; e.g., why South Africa is more volatile than Canada or why the Netherlands responds more than Belgium to energy shocks.

Two earlier papers by Lessard (1974, 1976) found significance of an industry factor on the proportion of an individual stock's return that was unexplained by a world market factor. To the extent that countries differ in their industrial composition, an implication of Lessard's results is that industry plays a role in explaining national market volatility, although he did not attempt to document the empirical magnitude of this role.

The remainder of the paper is separated into six sections. Section I describes the data, daily stock index returns from 24 countries for three complete calendar years. Section II presents evidence about the effects on stock index behavior of two influences: (1) the number of firms included in the index and (2) their industrial diversification. Section III describes and implements a method for constructing *global* industry indexes. Section IV uses global industry indexes along with exchange rates to explain the time-series behavior of each national market's daily return. Section V investigates the pattern of correlations across countries and investigates whether the pattern can be attributed to the industrial compositions of the country indexes. Section VI presents a summary and a conclusion.

I. The Data Sample

The basic data are equity price indexes for 24 countries; they are published daily in the London *Financial Times* as the "FT Actuaries/Goldman Sachs International Indexes."[3] Index levels are available for a relatively extended period for most countries and have been used elsewhere to investigate other topics concerning international equities.[4]

Identity of the constituent stocks within each country's index and of the industry for each constituent stock are available to this author beginning at the end of March 1988. Most of the analysis below was done with data updated through March 1991. Thus, the sample period of the paper is April 1988 through March 1991, inclusive, a total of three years of daily observations.

This was a relatively volatile time for equity markets. The sample period does not include the Crash of October 1987, but it does include the strong bull markets since then, especially during the early part of 1989, and it also includes the U.S. "minicrash" of October 1989, the large Japanese market decline of early 1990, and approximately eight months of the Kuwait Invasion/Desert Storm period (since August 2, 1990).

The sample period was short because the data were not available over a longer period. However, the nature of the analysis makes this acceptable because one would not expect the international industrial structure to remain constant over a very long time. Countries whose industries are faring poorly will eventually gravitate to other industrial activities. Thus, since there is no a priori reason to anticipate stationarity, there is no scientific imperative to collect data over a longer time.

II. Stock Index Volatility and Index Concentration

A comparison of countries during the sample period is provided in Table I. Among other things, it shows annualized means and standard deviations of

[3]These indexes are value-weighted averages of the more liquid stocks in each national market.
[4]For instance, see Roll (1989).

Table I

National Stock Market Indexes (April 1988–March 1991)

Descriptive statistics for the FT Actuaries/Goldman Sachs National Equity Market indexes. Daily observations for three full calendar years, April 1988–March 1991 inclusive. The number of stocks and the Herfindahl Concentration Index are averaged over the 36 sample months. The Herfindahl Index would be 100 if every stock in the local market were in the same three-digit industry; its minimum value is 1/97 since there are 97 different industries in the database. The number of daily returns differs across countries because of holidays. Dollar-denominated returns are obtained for each day by adjusting local-currency price indexes for the local-currency/dollar exchange rate.

		Dollar-Denominated Index Returns (%)					
	Number of Daily Returns	Mean	Standard Deviation (Annualized)*	Minimum (in one day)	Maximum (in one day)	Average Number of Stocks	Herfindahl Concentration Index
Australia	754	5.88	18.51	−8.73	4.68	84	11.63
Austria	748	23.97	22.83	−6.85	7.82	18	21.25
Belgium	740	0.23	15.10	−3.78	7.48	62	13.15
Canada	756	4.20	9.97	−3.26	3.08	122	5.71
Denmark	755	24.78	16.12	−4.15	7.36	36	14.56
Finland	750	−0.00	16.46	−4.95	4.94	25	22.80
France	757	18.67	18.22	−5.08	8.05	125	4.60
Germany	758	12.19	22.11	−11.91	7.48	96	10.06
Hong Kong	744	15.37	24.85	−23.21	8.96	47	15.18
Ireland	758	11.55	21.38	−8.12	8.11	17	19.54
Italy	758	1.15	18.55	−5.18	7.65	97	14.39
Japan	749	−5.14	23.53	−8.19	10.76	455	6.67
Malaysia	748	20.58	18.99	−10.46	6.31	36	8.38
Mexico	691	52.42	24.35	−7.16	7.34	13	29.22
Netherlands	755	7.83	14.61	−5.35	4.48	41	20.56
New Zealand	751	−17.93	21.85	−9.21	7.59	20	26.87
Norway	754	15.67	20.95	−9.76	5.09	25	23.06
Singapore	749	18.95	18.97	−8.61	6.06	26	20.25
South Africa	731	18.75	30.29	−11.95	9.29	60	25.59
Spain	754	4.17	18.37	−5.36	9.73	42	21.94
Sweden	754	17.06	19.95	−6.68	8.16	34	10.28
Switzerland	752	5.66	19.45	−8.61	6.90	61	16.25
United Kingdom	758	8.62	16.30	−4.36	5.24	310	3.75
United States	743	12.27	14.37	−6.01	3.67	553	3.24
Cross-Country Mean	749	11.54	19.42	−7.79	6.93	100.2	15.37

*Annualization involves: for Means, Average Daily Return × $N/3$; for Standard Deviations, Daily Standard Deviation × $[N/3]^{1/2}$ where N is the number of daily returns available in the three-year period.

dollar-denominated daily returns[5] computed over the available daily observations from April 1988 through March 1991 inclusive. There were 770 calendar dates during this sample period that were trading days in at least some countries, but due to holidays the maximum number of observations for a given country was 758 (for Germany, Ireland, Italy, and the United Kingdom). The minimum was 691 (for Mexico).

Multiple day returns (for holidays and weekends) were included in calculating the means and volatilities of Table I. There is no essential difference in the results if such multiple day returns are excluded; the basic picture remains the same and the relative rankings of country volatilities are identical. Later, a Monday dummy variable will be included in the time series model to account for any potential difference in the *average* return during the weekend (which is included along with Monday's trading period in Monday's "daily" return.)

Large differences in volatilities of country index returns exist during the sample period. Canada had the lowest volatility, 9.97% standard deviation of dollar-denominated annualized rate of return, while South Africa had the highest, 30.3%, more than three times greater than Canada's. Mexico and Hong Kong are well known high volatility countries (annualized standard deviation above 24%). The Netherlands and the United States had lower volatilities (annualized standard deviation below 15%).[6]

In attempting to explain why volatilities differ so much among the countries, suspicion falls first on the compositions of the various indexes, for there

[5]The returns are actually daily index relatives; i.e., if $P_{j,t}$ is the local currency level of the price index in country j at the close of trading on day t, a "dollar-denominated daily return" is

$$R_{j,t} = [P_{j,t}X(\$/j)_t]/[P_{j,t-1}X(\$/j)_{t-1}] - 1,$$

where $X(\$/j)_t$ is the spot exchange rate (dollars per local currency) on day t. Dividends are not included in these indexes, but the virtual constancy of dividend yields, which are available, indicates that none of the results would be changed by their inclusion.

From the available daily returns from a given country, the standard deviation was computed over the entire sample period. Annualization of the daily standard deviation, S_d, to a percent per annum standard deviation, S_a, involves the approximation:

$$S_a = 100\{[NS_d^2]^{1/2}\},$$

where N is the total number of trading days in the sample (for the country) over a three-year calendar period. Note that an annualized standard deviation computed in this manner is not necessarily an unbiased estimate of annual volatility because, as shall be documented later in the paper, for some countries there is minor but significant serial dependence in returns, due perhaps to nonsynchronous trading.

[6]The extreme observations during the sample are also interesting as a gauge of market volatility. The single largest one-day returns, both positive and negative, are presented in Table I for each country. Across the 24 countries, the average of the largest positive single-day returns during the three sample years was 6.93% and the largest single-day return for any country was 10.8% (Japan). The average of the largest negative single-day returns was −7.79%, and the largest negative single-day return for a given country was −23.2% (Hong Kong). Nineteen of the 24 countries had single-day negative returns algebraically less than −5%, and 19 of the 24 had single-day positive returns in excess of +5%.

are wide disparities in the number of individual stocks included in each one. See the penultimate column of Table I. The FT Actuaries/Goldman Sachs indices are widely followed, but they generally include only the larger and more liquid individuals stocks. Thus, smaller markets simply have fewer constituent securities in their indices. Austria's, for instance, has only about eighteen and Mexico's only thirteen.[7] Finland, Ireland, New Zealand, Norway, and Singapore all have fewer than thirty. At the other extreme are countries such as the United States and Japan, with 553 and 455 stocks, respectively. Other countries with at least 100 stocks are Canada, France, and the United Kingdom. Germany and Italy have almost 100.

To ascertain whether the observed volatility of national market indexes could be due to the technical aspects of the index construction, a set of cross-country regressions were fit in the following form:

$$\log_e(S_j) = b_0 + b_1 C_j, \qquad j = 1, \cdots, 24 \tag{1}$$

where C_j is a measure of index concentration for country j at the beginning of the month and S_j is the calculated standard deviation of daily returns during the month. The standard deviation of returns was calculated using both local-currency- and dollar-denominated price indexes on each day during the month. This regression was repeated for each of the 36 months in the sample.

Several concentration measures were used. The first and the simplest was the number of individual stocks in the country's index. The second was a "Herfindahl" measure of industry concentration within the index.[8] This Herfindahl measure is based on *three-digit* industry codes provided along with the FT Actuaries/Goldman Sachs database. The three-digit codes and corresponding industries are listed in the Appendix.

If w_{ij} is the market value proportion of country j's index represented by stocks in three-digit industry i, the Herfindahl measure is given by

$$H_j = \Sigma_i (w_{ij})^2.$$

H_j possibly has a slightly different value at the beginning of each month because the relative market values of stocks in various industries change over time.[9] The last column of Table I presents the average Herfindahl index for each country (calculated in local currency units).

A third yardstick of concentration is a Herfindahl measure computed with the weights of *individual* stocks in the index, as opposed to the aggregate

[7]On average over the 36 months in the sample.

[8]For a general discussion of the Herfindahl measure of industry concentration, see Stigler (1968), chapter 4.

[9]The minimum value of H is $1/n$ where n is the total number of global industries (97). The maximum value of H is 1.0, which would imply that all firms in the country were concentrated in the same industry.

weights of all stocks within a given industry. The formula is identical to that shown above except that w_{ij} is the weight of *stock i* in the index of country *j*.

Separate regressions like model (1) were calculated each month, with the dependent variable (volatility) expressed in either dollars or in local currency units and with three different concentration measures; (1) $C_j = H_{jt}$, the Herfindahl industry concentration measure for country *j*'s index in month *t*, (2) $C_j = HS_{jt}$, the Herfindahl concentration measure calculated from individual stock weights in country *j*'s index in month *t*, and (3) $C_j = N_{jt}$, the number of stocks in country *j*'s index in month *t*.[10]

The mean value of b_j, the estimated slope coefficient, averaged over the 36 different regressions (one for each month in the sample), is presented in Table II along with its *T*-statistic obtained by computing a standard error of the mean coefficient from the 36 monthly regression estimates. The *T*-statistic's validity depends on the monthly regression estimation errors being independent across time (and normally distributed). If such an assumption

Table II

Summary for Monthly Cross-Country Regressions of Within-Month Volatility on Measures of National Stock Market Index Concentration (April 1988–March 1991)

During each of the 36 sample months, a cross-country bivariate regression was calculated between the standard deviation of returns during the month, the dependent variable, and three different measures of industry concentration at the end of the previous month. The three explanatory variables were (1) a Herfindahl measure based on aggregate industry weightings in the national equity market index, (2) a Herfindahl measure based on weightings of individual stocks, and (3) the number of stocks in the index. The first panel gives the average slope coefficient over the 36 sample months and an associated *T*-statistic computed from the standard deviation of the 36 coefficient estimates. The second panel presents the mean and standard deviation of the 36 slope coefficient *T*-statistics obtained from monthly regressions.

	Dollar-Denominated Returns			Local Currency Returns		
Concentration Measure (Explanatory Variable)	Herfindahl Industry Index	Herfindahl Individual Stocks	Number of Stocks	Herfindahl Industry Index	Herfindahl Individual Stocks	Number of Stocks
		Monthly Slope Coefficients				
Mean	1.540E-02	8.767E-03	−2.547E-04	9.382E-03	1.412E-02	−2.216E-04
T-Statistic of Mean	15.02	7.18	−3.56	8.18	8.78	−2.99
		Monthly *T*-Statistics				
Mean	1.776	0.817	−0.524	1.082	1.215	−0.392
Standard Deviation	0.693	0.674	0.914	0.836	0.828	0.805

[10]Lessard (1976) conducted a related test. He regressed international industry index volatility cross-industry against the number of individual firms in the industry (he says this explanatory variable is the number of "shares," but he must have meant the number of individual firms; see page 383) and against the proportion of the industry represented by the dominant country. Only the second variable was statistically significant.

seems acceptable, the results are highly significant and of the correct sign. More concentrated stock markets, whether concentration is measured either by Herfindahl indicia or simply by the number of constituent stocks, display significantly greater volatility.

Table II also presents the time series average of the individual month regression *T*-statistics for the slope coefficients. The theoretical standard deviation of the *T*-statistic from 36 independent observations (with 23 degrees of freedom) is slightly greater than 1.0 and thus the standard error of a *mean* *T*-statistic from 36 independent observations should be slightly greater than 1/6 = 0.167; thus, each of the average *T*-statistics is several standard errors away from zero.[11]

The results for the Herfindahl concentration measures are more statistically significant than the results using the number of stocks as a concentration measure. This encourages further examination of the possibility that industry composition can explain part of national equity market behavior. Although the Herfindahl measure gives an indication that industrial concentration in general is related to national market volatility, a more precise analysis would be based on which *particular* industries are represented in more than average proportions for a given country.

III. Constructing International Industry Indexes

Every stock in the database belongs to one of the three-digit industries listed in the Appendix. To construct an international industry index, one might simply average the returns of all stocks in each three-digit category, perhaps weighting by market capitalization. Unfortunately, this method is not feasible because individual stock returns are not available. Only the national *index* returns are provided by FT Actuaries/Goldman Sachs.

But the simple method of constructing indexes need not necessarily be the most informative. Since each stock is traded in its local currency, an important question is how best to combine stocks in the same industry but traded in different currencies. It would seem natural to convert all returns *first* to a common currency and then construct the industry index. Furthermore, there are 97 different three-digit industries used to categorize companies but surely there cannot be 97 different sufficiently *informative* fundamental industry factors. Some of these industries are closely related to each other. Moreover, even attempting to simultaneously comprehend 97 separate influences on national equity market returns would exhaust the mental agility of most of us.

This argument for sufficiently informative industry measurements suggests that the industries should be grouped into a relatively small number of broad categories. The categories employed here are simply the seven major

[11]The actual standard deviations of the *T*-statistics are given in the last line of Table II. Note that they are slightly less than 1.0.

sectors used by FT Actuaries/Goldman Sachs. These are:

1. Financial, Insurance, and Real Estate
2. Energy
3. Utilities
4. Transportation and Storage
5. Consumer Goods and Services
6. Capital Goods
7. Basic Industries

The components of each major sector are listed in the Appendix.

At the beginning of each month in the sample period, the market value proportion of a country's index represented by each major sector is available. Let W_{ij} be the proportion of country j's index represented by major sector i for a given month. $\sum_i W_{ij} = 1$. Then for each subsequent day t during the month, we can think of the national index return, R_{jt}, as being composed of a weighted average of *global* industry index returns, (I_{it}),

$$R_{jt} = I_{1t}W_{1j} + I_{2t}W_{2j} \cdots + I_{7t}W_{7t} + e_{jt}, \tag{2}$$

plus a country-specific disturbance, e_{jt}, which is assumed to be unrelated across countries. The industry returns, I's, should be regarded as *global* industry factors and expressed in some common currency (we'll use U.S. dollars here). Thus, the country's index return, R_{jt} must also be expressed in this numeraire currency.

Obtaining estimates of the seven I's is an indirect process that we accomplish in the following way: Estimates of each global industry factor return for a single day during a sample month can be obtained from a cross-country Fama/MacBeth (1973) type regression on *that* day of dollar-denominated country returns against industry weights. Thus, for day t, the regression is

$$R_{jt} = b_{1t}W_{1j} + \cdots + b_{7t}W_{7j} + e_{jt}, j = 1, \cdots, 24, \tag{3}$$

Knowing the W's and R_{jt}, (3) is identical in form to (2) and thus the coefficients (b's) from (3) can be interpreted as estimates of the global industry index returns (I's) in (2) on day t. Note that (3) is fitted for each day during a month and that the W's have the same values on each day *during that month only.* At the beginning of the next month, new values of W become available and are used in fitting (3) for the days in that month.

A minor complication in model (3) is that the industry weights, W, sum to unity for each country. This implies that the regressors in (3) are mutually linearly dependent, (perfect multicollinearity). However, this problem can be resolved easily by the simple expedient of eliminating one of the weights. Notice that (2) can be written equivalently as

$$R_{jt} = (I_{1t} - I_{7t})W_{1j} + (I_{2t} - I_{7t})W_{2j} + \cdots + (I_{6t} - I_{7t})W_{6j} + I_{7t} + e_{jt},$$

since $W_{7j} = 1 - W_{1j} - \cdots - W_{6j}$. This implies that a cross-country regression model *with an intercept term* of the following form,

$$R_{jt} = b_{1t}W_{1j} + \cdots + b_{6t}W_{6j} + b_{0t} + e_{jt}, \quad j = 1, \cdots, 24 \tag{4}$$

will not have a multicollinearity problem, and an estimate of each daily global industry factor return can be obtained by adding the corresponding slope coefficient to the intercept; i.e., using the b's from model (4), estimates of daily industry factor returns are simply,

$$I_{it} = b_{it} + b_{0t}, \quad i = 1, \cdots, 6$$

and

$$I_{7t} = b_{0t}.$$

Some sample statistics for the global industry factor returns derived in this manner, from a temporal set of cross-country regressions, are given in the first panel of Table III. Except for the Transportation Industry Index, the mean returns appear sensible.[12] The Finance and Energy sectors had negative mean daily returns over this period, (April 1988 to March 1991), but this seems to be consistent with the general malaise among financial institutions and with declining energy prices before the Kuwait crisis.

The correlations among the industry indexes also appear in most cases to conform with a priori intuition. For example, when the energy sector does well, utilities and transport do poorly; this might have been anticipated on the grounds that energy is a major cost of production for utilities and transportation companies. The Finance sector's returns are negatively correlated with the Utilities Sector returns; perhaps high interest rates are good for financial service companies and bad for utilities, who are usually large debtors. There are a few puzzling correlations in Table III, Panel A. For example, why should Consumer Goods be negatively correlated with Capital Goods? Why should Finance and Energy be positively correlated?

In addition to such puzzles, there are some other aspects of the results that are a bit disquieting. The large Transport mean return (relative to the returns in other sectors)[13] is disturbing and the pattern of standard deviations is not necessarily concordant with intuition. The Utilities Sector, for example, has one of the higher volatilities, yet utilities are often considered one of the most conservative (i.e., least volatile), sectors in the domestic U.S. economy.

[12] Actually, it is not really correct to call the Index numbers "returns" since they are weighted sums of individual country returns on a given day, *but* the weights do not necessarily sum to unity. In matrix notation, the Index "Returns" I are obtained from an equation of the form $\boldsymbol{I} = (\boldsymbol{W}'\boldsymbol{W})^{-1}\boldsymbol{W}'\boldsymbol{R}$, where $\boldsymbol{R}$ is the vector of country returns and $\boldsymbol{W}$ is the matrix of industry weights. Thus, I differs by a multiplicative scale factor from a true financial return to the extent that the implicit regression weightings $(\boldsymbol{W}'\boldsymbol{W})^{-1}\boldsymbol{W}'$ do not sum to unity.

[13] Remember that the actual values are not necessarily meaningful because the units of the Index returns differ from true financial returns by a scale factor. See footnote 12.

Table III

Sample Period Statistics for Global Industry Factors (April 1988–March 1991)

For each day in a sample month, a cross-country multiple regression was calculated between the dollar-denominated daily return on the national market index and the aggregate weights of the index in seven broad industry groupings at the beginning of the month. The coefficients of this regression represent the returns on global industry factors for the calendar day. The first panel gives descriptive statistics of the resulting time series of global industry factors: mean returns, standard deviations of returns, and correlations for OLS regressions which effectively weight each country equally. The second panel presents analogous descriptive statistics for weighted regressions where the weights are proportional to the aggregate market capitalization of stocks from each country at the beginning of the trading day.

Panel A. Countries are equally weighted

Industry	Correlation Coefficients of Industry Returns: Finance	Energy	Utilities	Transport	Consumer	Capital	Mean Return (% per Day)	Standard Deviation (% per Day)
Finance							−0.0753	1.663
Energy	0.222						−0.0605	1.740
Utilities	−0.226	−0.323					0.2528	2.679
Transport	−0.116	−0.175	0.152				0.4267	3.379
Consumer	0.024	0.146	−0.078	−0.323			0.1124	1.655
Capital	0.193	0.083	0.186	−0.009	−0.296		0.0302	2.545
Basic	−0.135	0.056	−0.277	0.280	−0.071	−0.151	0.0605	1.842

Panel B. Countries are weighted by aggregate market capitalization of index stocks

Industry	Correlation Coefficients of Industry Returns: Finance	Energy	Utilities	Transport	Consumer	Capital	Mean Return (% per Day)	Standard Deviation (% per Day)
Finance							−0.0831	3.099
Energy	0.027						0.0402	1.796
Utilities	−0.761	−0.133					0.0633	4.725
Transport	0.126	−0.544	−0.024				−0.1452	9.306
Consumer	−0.376	0.290	0.167	−0.559			0.1995	3.281
Capital	0.368	−0.297	−0.085	0.531	−0.796		−0.2056	6.272
Basic	0.003	0.054	−0.302	−0.037	0.064	−0.173	0.0467	1.964

These things might naturally arouse suspicion about the method used to construct the indexes. One arguable aspect of the method is that each country is weighted equally in the cross-country regression (4). Is it possible that some small country with high volatility happens to have a disproportionate influence on the results because its industry composition is atypical? For example, perhaps Norway has a very large transport sector relative to most countries and also a large average return during the sample period. Perhaps this caused something bizarre to be introduced into the Transport Sector Index.

To check this possibility, I re-estimated the Indexes using a *weighted* regression version of (4) where the weights of each observation (country) on a given day were the total market capitalization of the country on the close of trading the previous day. This puts enormous emphasis on Japan and the United States, which together make up approximately 75% of aggregate world market value during this particular sample period. Nonetheless, such a procedure should eliminate the possibility that a small country with an unusual industrial structure had a spurious influence on the behaviors of the indexes.

Table III, Panel B, presents sample statistics on these country-capitalization-weighted global industry indexes. The average return of the Transport sector is now small and negative but some of the puzzling correlations have become worse. For instance, the correlation is almost -0.8 for both the Finance/Utilities and the Consumer/Capital Goods pairs of sectors. The pattern of standard deviations across sectors is qualitatively similar but their absolute values have roughly doubled in size.

There is one other aspect of these two competing sets of industry indexes that makes me prefer the equally weighted set: the autocorrelation structure of the capitalization-weighted set displays marginally significant first-order serial dependence in four cases out of seven (results not shown). The equally weighted set has only one significant first-order autocorrelation coefficient out of seven. (Neither set of indexes is troubled with statistically significant higher order serial dependence.)

For these reasons, the Global Industry Index returns derived from cross-country regressions weighting every country *equally* will be used in most tests to follow.

Finally, a set of global industry factor returns was calculated *for each individual country separately* by excluding the subject country from the cross-sectional regression (4). For instance, if Australia were the subject country, regression (4) was fitted for each day in the sample period to the returns from the *other* 23 countries, equally weighted by country. The resulting global industry i return on day t, I_{it}, depends only on what happened to firms located outside of Australia. Results using these special foreign-domiciled industry factors for each country will be presented in the next section.[14]

[14]Table III contains results for global industry factors that include all 24 countries.

IV. Explaining the Time Series Behavior of National Stock Market Indices by Industry Structure and Exchange Rates

The item to be explained is the dollar-denominated daily return on a given country's national stock market. The explanatory variables are the local currency/dollar exchange rate's concurrent relative rate of change, a weekly seasonal, and concurrent returns in seven broad Global Industry Sectors derived as described in the previous section *and fitted using returns only from other countries.*

The only element that has not already been discussed is the seasonal, which takes a value of unity if the trading day is a Monday and a value of zero for other trading days in the week. The purpose of the seasonal is twofold. First, and most important, the Monday return is *always* a multiple day return and thus might have different characteristics than an ordinary 24-hour day; e.g., possibly greater volatility. Second, at least for U.S. data there is a well documented Monday "effect"; returns are significantly less on Mondays than on other days of the week.[15]

The basic time series regression model is

$$R_{jt} = b_{1j}I_{j1t} + \cdots + b_{7j}I_{j7t} + b_{8j}D_{Mt} + b_{9j}Z(j/\$)_t + e_{jt},\ t = 1,\cdots,T \quad (5)$$

where I_{jit} is the Industry Index return for sector i, D_{Mt} is the Monday seasonal dummy, $Z(j/\$)_t$ is the relative change in the exchange rate,[16] and T is the total number of trading days in the time series sample. Note that each of the I's has a subscript j which indicates that returns from country j are *not* used in I's calculation when R_{jt} is the dependent variable; i.e., R_{jt} is never regressed on itself, even partly.

To correct for a possible structural autocorrelation problem induced by asynchronous world market trading, one daily lead and one daily lag of each variable (except the Monday dummy variable), were introduced into the regression estimation along with the contemporaneous variable. A priori, both a lead and a lag were anticipated to be potentially relevant for the following reason: the global industry indices are derived from fitting data for all country returns on a particular *calendar* day. Thus, whenever news happens to arrive during the trading hours of one of the more westerly countries on the earth (i.e., westerly from the international date line in the mid-Pacific Ocean), it would be partially incorporated into the global industry factor on that calendar day. But it would not be reflected in the returns of more easterly countries which had already closed trading. Thus, there would be a lagged effect in regressions involving these more easterly countries; the industry index would lead the country return. On the next calendar day, the global industry indexes would again be affected by the original news because they would then incorporate the returns of these more easterly countries.

[15]Cf. French (1980).

[16]That is, if $X(j/\$)_t$ is the spot exchange rate of currency j per dollar at the close of trading on day t, $Z(j/\$)_t = [X(j/\$)_t/X(j/\$)_{t-1}] - 1$.

This would induce a spurious *lead* effect in regressions involving the global industry indices and returns from the more westerly countries (whose returns had already incorporated the news on the previous calendar day.)

In addition to this lead and lag structure induced solely by time zone differences in trading, the raw return indices for each country are affected by nonsynchronous trading of individual stocks on the local exchange. It seems conceivable that the combination of the two effects could even induce dependence beyond a single-day lead and lag. This possibility will be examined with various diagnostic tests in the sections to follow.

Table IV presents Adjusted R-Squares and F-Tests by country for various permutations of model (5). The most general model includes one daily lead and one daily lag in addition to the "contemporaneous" values of every variable except the Monday dummy; the adjusted R-squares for this version appear in the next-to-last column of the Table. Given that the data are *daily*, the explanatory power is reasonably good; the Adjusted R-Square is 0.482 on average. It exceeds 0.5 for 10 of 24 countries, and it is above 0.3 except in Hong Kong, Mexico, and the United States.[17]

For most countries, the contemporaneous variables are by far the most relevant; excluding all the leads and lags cuts the average Adjusted R-Square only slightly, to 0.456. See the rightmost column of Table IV.

A. The Relative Importance of Industry and Exchange Rate

The exchange rate variable is statistically significant for most of the countries. Is it a more or a less important explanatory variable than the global industry indices?

Table IV presents F-statistics that measure the statistical significance of all seven industry coefficients taken as a group, including lead and lag coefficients, along with F-statistics that measure the statistical significance of the exchange rate, including its lead and lag. There is not a single country for which the F-test for no industry relevance has a probability acceptance level that is other than minuscule; the 0.999 percentile of the F distribution for industries is approximately 2.27. Every F value exceeds this level by an order of magnitude.

In contrast, there are several countries with only moderately significant exchange rate effects: Malaysia and Sweden are not significant and Norway is significant at only the 5% level. For the exchange rate, the 0.999 percentile of the F distribution is approximately 5.5; four countries have lower F values.

These F-statistics are not very informative about the relative explanatory power of industry and exchange rate because they are not expressed in intuitive units. A more natural comparison is to recompute the regressions, excluding for one set of recomputations the exchange rate and excluding for a second set the industry index returns, and then to compare the adjusted R^2 from the two sets. Table IV also gives these results.

[17] The United States is the only country without the exchange rate change as an explanatory variable (because it is the numeraire country.)

In Table IV, the adjusted R^2 listed under "Industry Factors" is from model (5) with $Z(j/\$)$ excluded (but the Monday seasonal still *in*cluded). The adjusted R^2 listed under "Exchange Rate" is from model (5) with all the Industry Indices excluded (and again the Monday seasonal included). In both cases, the one-day lead and lag values are included. The results generally support the F-tests just described; industry has a higher adjusted R^2 in 17 of 23 countries. Over the 23 countries where the exchange rate is a possible explanatory factor (as the numeraire country, the U.S. is excluded), the average R-Square is 0.390 for the industry factors alone while it is 0.231 for the exchange rate alone.

B. The Empirical Significance of Industry in Explaining National Equity Returns

Table V reports estimated coefficients from the time series regressions (5) and corresponding T-statistics. Except for the Monday dummy variable, the T-statistics refer to the sum of three coefficients, lag + contemporaneous + lead.[18] The sum including leads and lags is intended to measure the total impact of a variable on a country's return giving account to time zone differences and nonsynchronous trading. Of course, if either a lead or lag is not really relevant, the resulting sum is noisier than the contemporaneous variable alone; but this merely lowers the T-statistic and makes the variable appear less significant than it really is.

Every country has a positive response to the global Financial industry sector and all but one (Canada) have T-statistics in excess of 2.0. Very large T-statistics, such as for Austria, Belgium, and Spain, indicate the importance of bank stocks in their national indexes. Remember too that the global finance industry index for each country is computed only from *other* countries' returns. Thus, these results imply a highly significant degree of global integration in the finance sector.

The T-statistics for the Energy sector are not as large for most countries, but there are some notable exceptions. Both the Netherlands and Norway, for example, have extremely significant energy coefficients; again, this accords with the fact that Dutch petroleum companies and North Sea oil companies comprise a relatively large fraction of the stock market indexes for these two countries. Other energy-sensitive countries, with T-statistics of at least +3.0, are Canada, France, Germany, Switzerland, the U.K., and the U.S. Hong Kong and Spain have negative (although insignificant) coefficients. This may indicate a reliance on imported energy; when oil firms do well, it helps the stock markets of countries such as the Netherlands and Norway, but it hurts stock prices in oil importing countries.

[18] I.e., if b_{ij}^- is the one-day lag coefficient for industry i and country j, and b_{ij}^0 and b_{ij}^+ are the corresponding contemporaneous and one-day lead coefficients, respectively, their sum $s_{ij} = b_{ij}^- + b_{ij}^0 + b_{ij}^+$ is computed. The standard error of this sum is computed using the estimated covariance matrix of the regression coefficients and then the T-statistic is computed as the ratio of the sum to the standard error of the sum.

Table IV

Statistics of Fit for Time Series Regressions of Country Index Returns (Dollar-Denominated) on Global Industry Factors and Exchange Rates, Daily (April 1988–March 1991)

For each country, a time series regression was calculated between the dollar-denominated daily index return for the country, the dependent variable, and 25 explanatory variables: seven global industry factor daily returns which were calculated only with stocks from foreign countries, the contemporaneous daily exchange rate change of local currency per dollar, and a Monday dummy variable. A one-day lag and a one-day lead for each explanatory variable, except the Monday dummy, were also used as regressors. The rightmost column reports adjusted R-squares for regressions using only the contemporaneous values of all variables. The F-statistics test the significance of groups of explanatory variables, either the industry factors, with leads and lags, or the exchange rate with its leads and lags. Adjusted R-squares listed under Industry Factors and Exchange Rates are from regressions which exclude Exchange Rates and Industry Factors, respectively. All regressions include the Monday dummy variable.

	One-Day Lead, One-Day Lag, Plus Contemporaneous					Contemporaneous Only
	Industry Factors		Exchange Rates			
Country	Adjusted R-Square	F-Statistic ($df1/df2$)	Adjusted R-Square	F-Statistic ($df1/df2$)	Industries and Exchange Rates Adjusted R-Square	Industries and Exchange Rates Adjusted R-Square
Australia	0.2946	16.04* (21/728)	0.3511	133.91* (3/728)	0.5435	0.5061
Austria	0.4509	21.77* (21/722)	0.1674	12.29* (3/722)	0.4754	0.4583
Belgium	0.5253	29.07* (21/714)	0.3755	89.41* (3/714)	0.6535	0.6345
Canada	0.2374	13.10* (21/730)	0.2425	85.87* (3/730)	0.4340	0.3715
Denmark	0.4633	15.94* (21/729)	0.3637	48.94* (3/729)	0.5514	0.5498
Finland	0.1890	5.30* (21/724)	0.2511	52.92* (3/724)	0.3321	0.3151
France	0.6144	36.81* (21/731)	0.2749	16.52* (3/731)	0.6374	0.6188
Germany	0.5981	38.19* (21/732)	0.1944	4.96** (3/732)	0.6045	0.6011
Hong Kong	0.1854	8.62* (21/718)	0.0330	6.97* (3/718)	0.2051	0.2059
Ireland	0.4199	17.48* (21/732)	0.2032	16.32* (3/732)	0.4541	0.4455
Italy	0.4319	18.39* (21/732)	0.2558	33.72* (3/732)	0.4988	0.4796
Japan	0.3146	10.35* (21/723)	0.3598	86.47* (3/723)	0.4935	0.4698
Malaysia	0.4770	32.38* (21/722)	0.0099	0.18 (3/722)	0.4753	0.4461
Mexico	0.0588	3.54* (21/665)	0.0912	26.88* (3/665)	0.1568	0.1058
Netherlands	0.6106	40.00* (21/729)	0.2112	8.98* (3/729)	0.6230	0.6202

Table IV-*Continued*

Country	One-Day Lead, One-Day Lag, Plus Contemporaneous: Industry Factors: Adjusted R-Square	One-Day Lead, One-Day Lag, Plus Contemporaneous: Industry Factors: F-Statistic ($df1/df2$)	One-Day Lead, One-Day Lag, Plus Contemporaneous: Exchange Rates: Adjusted R-Square	One-Day Lead, One-Day Lag, Plus Contemporaneous: Exchange Rates: F-Statistic ($df1/df2$)	One-Day Lead, One-Day Lag, Plus Contemporaneous: Industries and Exchange Rates Adjusted R-Square	Contemporaneous Only: Industries and Exchange Rates Adjusted R-Square
New Zealand	0.2350	10.45* (21/725)	0.1858	46.97* (3/725)	0.3568	0.3133
Norway	0.3273	12.98* (21/728)	0.1096	3.25*** (3/728)	0.3334	0.3225
Singapore	0.4697	32.16* (21/723)	0.0253	6.49* (3/723)	0.4814	0.4487
South Africa	0.0767	5.91* (21/705)	0.5956	380.47* (3/705)	0.6460	0.6340
Spain	0.5966	37.30* (21/728)	0.2754	31.02* (3/728)	0.6409	0.6330
Sweden	0.4971	27.66* (21/728)	0.1218	1.20 (3/728)	0.4975	0.4845
Switzerland	0.6193	44.15* (21/726)	0.2317	24.50* (3/726)	0.6528	0.6326
United Kingdom	0.4140	16.76* (21/732)	0.3760	87.23* (3/732)	0.5665	0.5568
United States	0.2626	13.66* (21/720)			0.2626	0.1008
Cross-Country Mean	0.3904	21.17 (21/723)	0.2307	52.41 (3/723)	0.4823	0.4564

*Significant at the 0.1% level.
**Significant at the 1.0% level.
***Significant at the 5.0% level.

Table V

Coefficients and T-Statistics from Time Series Regressions of Country Index Returns (Dollar-Denominated) on Global Industry Factors, Exchange Rates, and Monday Dummy Variable, Daily (April 1988–March 1991)

Estimated Coefficients are for One-day lag, Contemporaneous, and One-day Lead of seven industry factor returns, each calculated using data only from foreign countries, and for the local currency/Dollar daily change in the exchange rate. For the industry factors and the exchange rate, the T-Statistic is for the sum of lead, lag, and contemporaneous coefficients. For the Monday dummy, the T-Statistic is for the single coefficient.

		Finance	Energy	Utility	Transport	Consumer	Capital	Basic	Exchange	Monday
Australia	One-Day Lag	−0.0051	0.0417	0.0309	−0.0044	0.1069	0.0344	0.0133	0.1071	
	Contemporaneous	0.1500	0.0127	−0.0067	0.0443	0.1634	0.0173	0.1115	−0.9042	0.0020
	One-Day Lead	−0.0160	−0.0461	0.0162	−0.0123	−0.0177	−0.0230	0.0170	−0.0690	
	T-Statistic	4.1822	0.2726	1.8740	1.7058	7.6528	1.4010	5.0455	−11.0350	2.6665
Austria	One-Day Lag	0.0796	0.0315	0.0606	−0.0092	0.0576	0.0075	0.0592	0.0381	
	Contemporaneous	0.4028	0.0262	0.0841	0.0079	0.1784	0.1130	0.1767	−0.4143	0.0007
	One-Day Lead	0.0767	0.0007	0.0354	−0.0150	−0.0282	0.0095	−0.0159	0.0778	
	T-Statistic	12.2330	1.4072	6.3113	−0.7618	4.6823	4.6500	5.6370	−2.5222	0.6770
Belgium	One-Day Lag	0.0389	0.0126	0.0223	−0.0173	0.0549	0.0149	0.0339	0.1348	
	Contemporaneous	0.2305	0.0180	0.0320	0.0144	0.1073	0.0723	0.0873	−0.6097	−0.0001
	One-Day Lead	0.0451	−0.0113	0.0111	0.0087	−0.0015	−0.0110	0.0160	0.0152	
	T-Statistic	13.7490	0.8996	4.7997	0.4951	6.8383	5.1875	6.4030	−7.2197	−0.2248
Canada	One-Day lag	0.0130	−0.0026	−0.0042	−0.0001	0.0287	0.0104	0.0271	0.0288	
	Contemporaneous	−0.0133	0.0553	0.0139	0.0082	0.1014	0.0351	0.0126	−0.9881	−0.0001
	One-Day Lead	0.0354	0.0345	−0.0065	0.0303	0.0531	0.0034	0.0170	−0.0808	
	T-Statistic	1.8947	4.8852	0.2560	4.0535	9.2743	3.9290	3.3232	−9.7280	−0.2192
Denmark	One-Day Lag	0.0258	0.0147	0.0159	−0.0002	0.0334	0.0187	0.0039	0.1452	
	Contemporaneous	0.2057	0.0447	0.0496	0.0152	0.1160	0.0755	0.1164	−0.6170	−0.0012
	One-Day Lead	0.0075	−0.0072	0.0121	−0.0032	0.0110	0.0172	−0.0013	0.0419	
	T-Statistic	8.3166	1.9700	4.2325	1.9095	5.7534	6.0162	4.7102	−4.8005	−1.8306

Table V-*Continued*

		Finance	Energy	Utility	Transport	Consumer	Capital	Basic	Exchange	Monday
Finland	One-Day Lag	0.0394	0.0239	0.0104	0.0406	0.0131	0.0303	0.0027	0.0731	
	Contemporaneous	0.0908	−0.0118	0.0251	0.0337	0.0998	0.0317	0.0644	−0.8148	−0.0015
	One-Day Lead	−0.0065	−0.0044	0.0234	0.0026	0.0074	0.0032	0.0183	0.0022	
	T-Statistic	3.7881	0.2307	2.6059	4.4633	3.2808	2.9304	2.6879	−6.6430	−1.8345
France	One-Day Lag	−0.0473	−0.0440	−0.0296	−0.0088	−0.0221	−0.0088	−0.0061	−0.0975	
	Contemporaneous	0.2774	0.1505	0.0880	−0.0012	0.2203	0.1230	0.1193	−0.3374	−0.0027
	One-Day Lead	0.0818	−0.0139	0.0473	0.0034	−0.0344	−0.0190	0.0352	0.0397	
	T-Statistic	11.0400	3.4280	5.7225	−0.4692	5.8690	5.0934	5.7056	−4.8190	−4.1395
Germany	One-Day Lag	−0.0522	−0.0207	−0.0004	0.0020	0.0005	−0.0231	−0.0421	−0.0257	
	Contemporaneous	0.4100	0.1400	0.0576	0.0329	0.3455	0.1443	0.2233	−0.2171	0.0021
	One-Day Lead	0.0196	0.0025	0.0210	−0.0057	−0.0266	−0.0271	0.0048	−0.0688	
	T-Statistic	10.4370	3.6268	3.3291	1.6430	8.6790	4.0817	5.6918	−3.1518	2.6233
Hong Kong	One-Day Lag	−0.0530	0.0243	−0.0296	−0.0157	0.0332	0.0305	−0.0546	−1.5494	
	Contemporaneous	0.2768	−0.0196	−0.0180	0.1405	0.2534	0.0174	0.0219	−3.5566	−0.0014
	One-Day Lead	0.0238	−0.0290	0.0100	0.0075	0.0001	−0.0083	0.0121	0.0758	
	T-Statistic	4.8620	−0.4460	−1.0153	4.5190	3.7248	1.0243	−0.3921	−2.6704	−1.0701
Ireland	One-Day Lag	0.0552	−0.0594	0.0015	−0.0052	0.0100	0.0321	0.0046	0.1334	
	Contemporaneous	0.2822	0.1029	0.0280	0.0370	0.2691	0.1299	0.1392	−0.4779	0.0014
	One-Day Lead	−0.0301	0.0212	0.0147	0.0142	−0.0053	−0.0278	−0.0495	−0.0785	
	T-Statistic	7.6228	1.6437	1.6560	2.2925	6.4813	5.1393	2.6557	−3.6885	1.4907
Italy	One-Day Lag	0.0207	0.0371	−0.0013	0.0049	0.0652	0.0255	−0.0138	0.2900	
	Contemporaneous	0.2788	0.0229	0.0581	0.0170	0.1234	0.0764	0.1362	−0.5472	−0.0008
	One-Day Lead	0.0073	0.0042	0.0208	0.0120	−0.0226	−0.0166	−0.0035	−0.1173	
	T-Statistic	9.5602	1.9877	3.4928	2.0064	4.7480	3.7978	3.8223	−3.6683	−1.0583
Japan	One-Day Lag	0.0232	0.0221	0.0089	−0.0017	0.0578	0.0444	0.0094	−0.2564	
	Contemporaneous	0.2797	0.0175	0.0466	0.0536	0.1574	0.0370	0.0373	−1.0407	0.0015
	One-Day Lead	0.0007	−0.0339	0.0080	0.0005	−0.0236	−0.0229	0.0032	0.0075	
	T-Statistic	7.0569	0.1370	2.2233	2.3966	4.2566	2.0891	1.2618	−11.9270	1.5174

Table V-*Continued*

		Finance	Energy	Utility	Transport	Consumer	Capital	Basic	Exchange	Monday
Malaysia	One-Day Lag	0.0530	0.0444	0.0675	0.0148	0.0369	0.0019	0.0089	0.0266	
	Contemporaneous	0.3675	−0.0328	0.0238	0.1233	0.2306	0.0645	0.0681	0.1285	0.0005
	One-Day Lead	−0.0039	0.0394	0.0532	−0.0002	−0.0318	−0.0228	−0.0153	0.0492	
	T-Statistic	12.0950	1.5292	6.2339	7.3291	6.6328	1.8616	1.8764	0.6306	0.6520
Mexico	One-Day Lag	0.1841	−0.0003	0.0106	0.0196	0.1593	0.0435	0.0969	0.0758	
	Contemporaneous	0.0444	−0.0177	−0.0398	0.0119	−0.0050	0.0314	−0.0269	−0.9502	0.0020
	One-Day Lead	−0.0040	0.0257	0.0055	0.0010	−0.0453	−0.0058	0.0269	0.1292	
	T-Statistic	3.7565	0.1331	−0.5728	1.0221	1.6684	1.6905	1.7161	−2.6515	1.4108
Netherlands	One-Day Lag	−0.0146	−0.0106	0.0015	−0.0028	−0.0190	−0.0128	0.0021	−0.0142	
	Contemporaneous	0.1845	0.1103	0.0657	0.0021	0.2556	0.1179	0.1409	−0.1964	0.0001
	One-Day Lead	0.0021	−0.0046	0.0061	0.0137	−0.0282	−0.0158	−0.0110	−0.0374	
	T-Statistic	7.4253	6.0443	4.7277	1.1175	8.7792	5.9544	6.2129	−3.9005	0.2818
New Zealand	One-Day Lag	0.0187	0.0415	0.0588	−0.0059	0.0837	0.0425	0.0313	0.1412	
	Contemporaneous	0.1715	0.0185	0.0137	0.0708	0.1439	0.0539	0.1215	−0.7668	−0.0006
	One-Day Lead	−0.0230	−0.0046	0.0318	−0.0134	0.0132	−0.0794	−0.0183	−0.1541	
	T-Statistic	3.8803	1.3227	3.5254	2.3136	5.2118	0.5774	3.4758	−6.7521	−0.5797
Norway	One-Day Lag	0.0135	0.0876	0.0520	0.0247	0.0378	−0.0195	0.0080	−0.0068	
	Contemporaneous	0.1868	0.1432	0.0256	0.0559	0.3186	0.0917	0.1339	−0.2758	−0.0003
	One-Day Lead	−0.0698	−0.0109	−0.0185	−0.0131	−0.0150	0.0182	−0.0235	−0.0627	
	T-Statistic	3.0183	4.6266	1.9886	3.0854	7.8642	3.2123	2.9248	−2.3139	−0.2714
Singapore	One-Day Lag	0.0455	0.0344	0.0647	−0.0069	0.0860	0.0125	0.0198	0.2877	
	Contemporaneous	0.3341	−0.0060	0.0247	0.1166	0.2670	0.0469	0.0715	−0.0249	0.0004
	One-Day Lead	0.0141	0.0047	0.0215	0.0095	0.0214	−0.0005	−0.0066	0.5106	
	T-Statistic	11.6610	0.9933	4.8592	6.5372	10.2080	2.5415	2.6811	2.9987	0.5306
South Africa	One-Day Lag	0.0709	0.0214	0.0372	−0.0119	−0.0642	0.0176	0.0364	0.0268	
	Contemporaneous	0.1258	0.0582	−0.0371	0.0362	0.1079	0.0374	0.1140	−0.9233	−0.0008
	One-Day Lead	−0.0746	0.0349	0.0159	−0.0179	0.0114	0.0070	−0.0150	0.0833	
	T-Statistic	2.7050	2.5718	0.4992	0.2703	1.1042	2.0157	3.3972	−15.3340	−0.6880

Table V-*Continued*

		Finance	Energy	Utility	Transport	Consumer	Capital	Basic	Exchange	Monday
Spain	One-Day Lag	−0.0090	−0.0154	0.0090	0.0052	−0.0031	−0.0091	0.0035	0.0025	
	Contemporaneous	0.3326	0.0200	0.0460	0.0227	0.2645	0.1046	0.1353	−0.4362	0.0035
	One-Day Lead	0.0427	−0.0134	0.0348	−0.0040	−0.0129	−0.0087	0.0447	0.1237	
	T-Statistic	12.7200	−0.3302	5.4548	1.6891	9.3123	4.7630	6.9712	−3.8078	5.4761
Sweden	One-Day Lag	−0.0488	0.0354	−0.0085	0.0296	0.0197	0.0179	−0.0441	−0.0403	
	Contemporaneous	0.3803	0.0817	0.0621	0.0354	0.2405	0.1110	0.1528	−0.1388	−0.0007
	One-Day Lead	0.0724	−0.0642	0.0194	−0.0118	−0.0148	−0.0056	0.0137	0.0750	
	T-Statistic	11.4010	1.5047	3.0790	2.9397	6.5799	6.2941	3.6281	−0.7472	−0.8782
Switzerland	One-Day Lag	−0.0929	−0.0074	−0.0109	0.0013	−0.0246	−0.0277	−0.0062	−0.0621	
	Contemporaneous	0.3115	0.1159	0.0367	0.0182	0.2488	0.1609	0.1936	−0.3690	−0.003
	One-Day Lead	0.0400	−0.0139	0.0393	0.0058	−0.0224	−0.0089	0.0375	0.0257	
	T-Statistic	9.0162	3.4542	3.3673	1.6767	7.4685	6.3347	8.3589	−5.6131	−0.4714
United Kingdom	One-Day Lag	−0.0021	−0.0255	−0.0025	−0.0072	0.0047	0.0126	0.0138	−0.0640	
	Contemporaneous	0.0982	0.1293	0.0310	−0.0041	0.1589	0.0571	0.0647	−0.6998	−0.0013
	One-Day Lead	0.0526	−0.0141	0.0098	0.0256	0.0385	0.0113	0.0200	0.0077	
	T-Statistic	5.4701	3.4201	2.1061	1.0428	7.3839	4.4463	3.9089	−10.8060	−2.0499
United States	One-Day Lag	−0.0080	−0.0043	−0.0096	0.0026	−0.0065	−0.0017	−0.0170		
	Contemporaneous	0.0487	0.0802	0.0461	0.0023	0.0772	0.0066	0.0231		0.0002
	One-Day Lead	0.1394	0.0282	0.0211	0.0435	0.1588	0.0538	0.0609		
	T-Statistic	5.9030	3.4533	2.7251	3.0503	7.1805	2.9677	2.3070		0.2222

There are significant Utilities sector effects in many countries, with Austria, Belgium, Denmark, France, Malaysia, the Netherlands, Singapore, and Spain all exhibiting T-statistics greater than 4.0. Nine other countries have T-statistics greater than 2.0. Utilities stocks are traditionally interest-sensitive, so the pervasive nature of the global utilities sector might indicate a proxy for global interest rates. Otherwise, it would be hard to imagine why the prices of utilities stocks in other countries have such an impact on domestic utilities.

As one might have expected, the Transportation sector is quite variable across countries. Quite a few countries have stock market indexes which are insensitive to the transportation industry. Countries with highly significant transportation sectors are not too surprising: they are traditional maritime nations such as Hong Kong, Malaysia, Norway, and Singapore. Several other countries are also significant; these include Canada, Finland, and the U.S.

Only two countries in the world, Mexico and South Africa, have insignificant Consumer Goods coefficients. All other countries have consumer goods T-statistics in excess of 3.0 and most are much larger. This makes sense in that most countries produce and consume a lot of different consumer goods and services. Apparently, the consumer goods sector is well integrated globally; returns in foreign consumer goods firms are highly significant explanatory variables for each local stock market index.

There is quite a contrast between the Capital Goods sector and the Consumer Goods sector. Although many countries receive a statistically significant positive influence from the Capital Goods Index, most T-statistics are smaller than was the case for the Consumer Goods Index. The largest Capital Goods T-statistics, in declining order of magnitude, are for Switzerland, Sweden, Denmark, the Netherlands, Belgium, Ireland, and France, all greater than 5.0. Many others, such as Austria, Germany, Italy, Spain, and the U.K. still indicate strong statistical significance, but are smaller in magnitude.

There are five countries with insignificant Capital Goods influences: Australia, Hong Kong, Malaysia, Mexico, and New Zealand. These countries are indeed characterized by less than the average amount of capital goods production for a developed country, since their economies are more concentrated in Agriculture, Fisheries, Forestry, and Mining.

Fifteen of 24 countries have T-statistics larger than 3.0 for the Basic sector, which is composed of construction, chemicals, mining and metals, precious metals and minerals, forestry and paper, and fabricated metals. Belgium, the Netherlands, Spain, and Switzerland have T-statistics greater than 6.0. In this group, only Switzerland seems not to belong, but perhaps the Swiss economy has enough chemicals, construction, and fabricated metals firms to offset its lack of steel and mining.[19] Again Hong Kong has a *negative* coefficient perhaps because it imports most basic materials.

[19]For example, La Roche, Ciba-Geigy, Sandoz, and Alusuisse are significant components of Swiss market capitalization. I am indebted to the editor for this information.

C. More About Leads and Lags

The average absolute value of the *T*-statistic for the one-day **lagged** variables, over eight possible coefficients and 24 countries,[20] was 1.42. The average absolute value of the *T*-statistic for the corresponding one-day **lead** variables was 1.29. For the contemporaneous coefficient, in contrast, the average absolute value of the *T*-statistic was 6.04.

For a given variable, usually four to seven countries displayed *T*-statistics greater than 2.0 in absolute value for lead and lag coefficients. These were not the same countries for every variable. If we count the number of countries with *T*-statistics for a given variable greater than 2.0 in absolute value and then average over all variables, the mean number of lagged *T*-statistics greater than 2.0 was 6.9 (out of 24), the mean number of lead *T*-statistics greater than 2.0 was 4.4, and the mean number contemporaneous *T*-statistic's greater than 2.0 was 17.4.

There were certain countries, however, that displayed more consistently significant lead or lag effects. For the lead coefficients, the two most usually significant were Canada and the United States (average lead *T*-statistics of 2.41 and 4.41, respectively, over the seven global industry indices). This probably can be attributed to time zone location. Along with Mexico, Canada and the U.S. are the last countries on the planet to trade on a given calendar day. Any news that appears during their trading hours is likely to affect the returns of other countries on the subsequent calendar day. Such news would influence the global industry indices on the same calendar day as the Canadian, Mexican, and U.S. returns are included, but it would also influence the industry indices on the *next* calendar day, when returns from the other 21 countries are included. Thus, the Canadian, Mexican, or U.S. returns regressed on the industry indices might have been expected to display a significant lead effect.

The average *T*-statistic for the U.S. lead effect is the largest, lead or lag, for any country. This may reflect the dominating influence of U.S. news on the returns of other countries. Interestingly, Mexico's lead coefficients are not significant on average. This contrast with Canada reflects the fact the Mexico's index returns are considerably less correlated with the U.S. index returns than are Canada's.

As for lagged coefficients, the most often significant are observed for Mexico, Hong Kong, Malaysia, and Singapore, with Australia and New Zealand just behind. Again, except for Mexico, this is probably attributable to time zone locations.

There is frequently a sensible pattern across the industry factor. In the case of Australia, for instance, the largest *T*-statistics for lagged coefficients are for consumer goods and capital goods, 5.2 and 2.7, respectively. This probably reflects the importance of news about these industries emanating

[20]There were only seven one-day lag variables for the United States since the exchange rate was not included as a regressor.

from *other* countries whereas industries such as basic and transportation, which are more important within Australia, do not display significant lagged effects.

The Durbin-Watson statistics indicate that there is little reason to include leads or lags beyond one day. Only one country (Austria) had a Durbin-Watson d-statistic below 1.5 and no country had a d-statistic above 2.3. Austria's Durbin-Watson of 1.37 was the only one statistically significant at the 5% level, and, of course, at least this many could be found "significant" just by chance out of the 24 different values computed. Thus, the combined influences of time zone differences and nonsynchronous trading within local markets seems to be limited to a single day, at least in these regressions.

D. Interpreting the Exchange Rate Coefficient

Since R_{jt} is a dollar-denominated return, it is approximately equal to the local currency return on the national market *minus* the percentage change in the exchange rate, $Z(j/\$)_t$.[21] Dropping the excess notation, if $R_\$$ is the dollar-denominated return and R_L is the local currency-denominated return, then $R_\$ = R_L - Z$, where Z is the change in the exchange rate (local currency units per dollar). Suppose R_L is decomposed into two components as follows: $R_L = c_Z Z + c_r r$, where the c_r's are coefficients and r represents the real component of local returns, i.e., the component induced by global competitive market conditions and not influenced solely by local monetary policy and inflation. Substituting for R_L in the formula for dollar-denominated returns, we obtain $R_\$ = c_r r + (c_Z - 1)Z$. Thus, if r is measured satisfactorily by global industry index returns, the coefficient of Z in model (5) will be determined by the marginal influence of Z on R_L.

If the local currency country return were completely explained by global industry factors, c_Z would be zero (the exchange rate would have no influence on local returns), and the coefficient b_9 of the exchange rate change in equation (5) would be -1.0. The equity market behavior of such a country would be exchange rate neutral; i.e., real equity returns would be determined entirely by world conditions in various industries and the evolution over time in the equity index would be dictated by the country's industrial composition. Local *nominal* equity returns would simply be the real returns induced by industry structure plus whatever inflation rate happened to be produced by local and international monetary policies. There would be no perceptible empirical influence of inflation on local real returns.

At the other extreme, imagine a country that maintained a fixed exchange rate with the numeraire currency, in this case the U.S. dollar. The coefficient b_9 in (5) would necessarily be zero since there would be no intertemporal

[21] It would be exactly equal if the respective rates were continuously compounded. Daily discretely compounded returns are employed here, so there is a very small cross-product term which has been omitted in the following discussion.

variation in $Z(j/\$)$.[22] Such an exchange rate policy implies that the local real stock price movements are influenced by a combination of factors: the industrial structure of the local country, of the numeraire country, and of all other countries that maintain fixed exchange rates with the numeraire country. This exchange rate policy is completely *non*-neutral because it permits local *nominal* stock returns to be influenced by other countries' industrial structures and by their monetary policies and inflation rates.

Perhaps the most interesting case is when the exchange rate coefficient b_9 in (5) is significantly different from *both* zero and one. Such a finding implies that the country's exchange rates are neither entirely fixed nor entirely neutral. How are we to interpret such a result?

One possibility might be that occasional exogenous changes in exchange rates has a direct, immediate, and causative influence on local nominal equity prices; i.e., c_Z is not equal to zero because exchange rate shocks actually affect stock prices. Suppose, for instance, that labor productivity in the local economy increased relative to the rest of the world, thereby driving down the real relative price of locally produced goods. This could induce a reduction in the real value of the local currency relative to foreign currencies; i.e., a "real" exchange rate depreciation which would also induce a nominal exchange rate depreciation, and an increase in Z. But there would also be a corresponding increase in local equity prices to reflect the more favorable situation of local firms, to the extent that they would benefit from the increase in labor productivity. Therefore, an increase in Z would be associated with an increase in R_L, and the coefficient c_Z would be positive.

Another possibility is that a global industry shock, which affects local index returns through its influence on domestic members of the industry, induces a *subsequent* exchange market intervention by monetary authorities attempting to reverse the equity index movement. To the extent that monetary authorities engage frequently and systematically in such intervention and to the extent that investors realize this is happening, its impact should show up in equity prices *before the fact.* The intervention should be anticipated by rational market participants. Thus, there would be a correlation between local index returns and *concurrent* changes in the exchange rate (although the causative influence is reversed and actually flows from the index return *to* the exchange rate movement).

For example, consider a country with a particularly large financial sector. When there is an unanticipated *global* decline in the earnings of financial service companies, the country's *national* equity index will indicate a considerable economic slump; and because the financial sector is larger for this particular country than for most other countries, the balance of trade will likely tilt toward a deficit.

[22]This is a degenerate case econometrically since the estimate of $c_Z - 1$ from (5) would be zero even though the true value of c_Z could be something other than 1.0. It is not possible to estimate the true value of a coefficient if the regressor has no variation within the sample period.

The monetary authority might very well respond, quite probably with a lag, by intervening in the exchange market in an effort to reduce the trade deficit. But artificially reducing the value of local currency will make local stocks bargains for foreigners.[23] Since [lagged] intervention will be anticipated by rational traders, it will *immediately* induce a positive correlation between local currency returns and changes in exchange rates (as expressed by the variable $Z(j/\$)$ of regression model (5)).[24]

Of course, intervention will distort the world relative price of financial services and could conceivably distort relative prices in *all* industries. The overall impact on equity returns and exchange rates in both the intervening country and in other countries is complex because it would depend, inter alia, on the industrial structures of all countries and on their monetary policy responses.

Empirical results for the exchange rate coefficient are summarized in Table VI. The coefficient (b_9) is the sum of the one-day lag, "contemporaneous," and one-day leading change in the exchange rate[25] (previously reported in Table V). The two T-statistics test the deviation of the coefficient sum from zero and -1.0, respectively. Eighteen of 23 countries have exchange rate coefficient sums between zero and -1.0. Twenty-one countries have coefficients that differ significantly from zero (at probability levels of at least 0.01), and 19 countries have coefficients that differ significantly from -1.0. There are 15 countries whose coefficient is between zero and -1 and which differs significantly from *both*.[26]

[23]There is considerable controversy, however, over whether monetary authorities can actually affect real exchange rates. They may very well attempt to do so, but if they fail (and the market realizes that they will fail), the intervention explanation would not be valid. The literature on this subject including the dichotomy between "sterilized" and "nonsterilized" intervention, is happily beyond the scope of the present study.

[24]A related and interesting phenomenon is documented by Bailey (1990). He finds that surprises in the U.S. monetary (M1) stock induce responses in equity prices of non-U.S. Pacific rim countries, and he argues that the results are consistent with equity market participants anticipating reactions by the Federal Reserve to offset the observed surprise. This is very much in the spirit of the explanation here, that equity market participants anticipate later intervention by monetary authorities and that equity prices move to reflect these anticipations.

[25]Recall that for each explanatory variable in model (5) (except the Monday dummy variable), the regression included a one-day leading observation and a one-day lagging observation, plus the contemporaneous observation. This was intended to capture the impact of time zone differences and nonsynchronous trading. Thus, there were actually 25 separate explanatory variables in the regression: one lag, one lead, and one contemporaneous variable for each of the seven industry indexes and for the exchange rate, plus the Monday dummy.

[26]Hong Kong and Singapore appear to be anomalies. Actually, Hong Kong is easily explained. During this period, the Hong Kong dollar was virtually fixed to the U.S. dollar, approximately 7.8 HK$/US$, *except* for a single day, March 2, 1990. On that day, the Hong Kong dollar changed from 7.81 to 7.90 per U.S. dollar and it fell back to the same level on the next trading day, March 5. (At least this is the figure in my dataset.) Since every other day in the sample had an exchange rate change of almost zero, there is almost a singularity in the cross-product matrix of the explanatory variables. The one day in three years with a relatively large change was entirely responsible for the coefficient not degenerating to plus or minus infinity, rounded to within the computer's error. Singapore's *positive* and significant coefficient is much more puzzling. Its exchange rate was not fixed during the sample period.

Table VI

Coefficients of Exchange Rate and Tests of Significance

Significance of Exchange Rate daily change, Local currency/Dollar, in time series regressions of dollar-denominated daily index returns, the dependent variable, on global industry factors, exchange rates, and a Monday dummy variable. The T-Statistics here test the significance of the sum of three exchange rate coefficients, a one-day lead, a contemporaneous, and a one-day lag coefficient. Significance is measured from both zero and −1.0. The data period is April 1988–March 1991 inclusive.

Country	Coefficient Sum	T-Statistics for Sum	
		From Zero	From −1
Australia	−0.8662	−11.04	1.71
Austria	−0.2984	−2.52	5.93
Belgium	−0.4598	−7.22	8.48
Canada	−1.0401	−9.73	−0.38
Denmark	−0.4299	−4.80	6.37
Finland	−0.7395	−6.64	2.34
France	−0.3953	−4.82	7.37
Germany	−0.3116	−3.15	6.96
Hong Kong	−5.0302	−2.67	−2.14
Ireland	−0.4229	−3.69	5.03
Italy	−0.3745	−3.67	6.13
Japan	−1.2896	−11.93	−2.68
Malaysia	0.2044	0.63	3.72
Mexico	−0.7451	−2.65	0.91
Netherlands	−0.2479	−3.90	11.83
New Zealand	−0.7797	−6.75	1.91
Norway	−0.3453	−2.31	4.39
Singapore	0.7734	3.00	6.88
South Africa	−0.8132	−15.33	3.52
Spain	−0.3100	−3.81	8.48
Sweden	−0.1042	−0.75	6.43
Switzerland	−0.4054	−5.61	8.23
United Kingdom	−0.7561	−10.81	3.49

Thus, the majority of countries exhibit exchange rate behavior which is neither entirely non-neutral nor entirely neutral. There are a few countries (Malaysia is an example) which practice a very non-neutral monetary policy by linking their currency to the U.S. dollar. There are a few others (Canada is the best example) which seem to have had almost perfectly neutral policies. For Canada during this sample period, exchange rates had no measurable influence on local index returns. Perhaps its economy just happened to be structured industrially so that relative price changes that favored some of its industries were offset by changes that harmed other industries.

But since most countries have an exchange rate coefficient that is neither -1.0 nor zero, exchange rate changes were associated with real equity returns. Either exogeneous changes in exchange rates had a direct influence on local equity returns, an influence aside and apart from the global impact of industry events, or else fully anticipated exchange market intervention followed global shocks at least some of the time.

E. The Weekly Seasonal

A cross-country comparison of the statistical significance of the Monday dummy variable can be discerned in Table V. France and the U.K. have significant *negative* Monday seasonals (the established result, in a univariate model, for the U.S. market). The Monday (multivariate) coefficient for the U.S. was positive but *not* significant for this data sample. There were a few countries with significant *positive* Monday dummies: Australia, Germany, and Spain.[27]

If the existing literature is any indication,[28] the weekly seasonal remains an enigma and the present results are no different. There are too many significant Monday coefficients to be explained by chance but there is not a conspicuous pattern in their cross-country distribution that might have suggested an explanation.

F. Possible Specification Problems in the Time Series Regressions

Although most of the T-statistics reported above are so large that fine tuning of statistical inference seems almost beside the point, I nonetheless checked for possible econometric problems using diagnostics provided by the SHAZAM econometrics software.[29] As already mentioned above, there were virtually no autocorrelated residuals, but there was evidence of heteroscedasticity and of nonnormality. Chi-Square tests for heteroscedasticity of the

[27] Japan's and Spain's Monday dummies were significantly positive when country capitalization-weighted industry indexes were employed.

[28] Both Jaffe and Westerfield (1985) and Ziemba (1990) find that the strongest negative average return in Japan is on Tuesday, not on Monday as in the U.S. Also, Jaffe, Westerfield, and Ma (1989) show that the weekly seasonal is surprisingly complex; returns in the U.S. and in other countries are negative on Monday *only* after the market has declined during the previous week!

[29] See White, Wong, Whistler, and Haun (1990).

"ARCH" type indicated a significant problem for 19 of the 24 countries.[30] The coefficient of excess kurtosis was positive and more than two standard errors from zero for 23 of the 24 countries! Skewness was considerably less of a problem: the coefficient of excess skewness was more than two standard errors from zero in only nine of 24 countries.

Both heteroscedasticity and leptokurtosis can lead to incorrect inferences, because the estimated standard errors (used as denominators in computing T-statistics) can be both biased and inconsistent. Actually, the two problems are likely to be related. Heteroscedasticity involves nonstationarity in the variance of the disturbances of the regression model. Leptokurtotic non-normality (often observed with stock returns) can be induced if the data have been generated by mixtures of normal distributions where the elements of the mixture have differing variances.

In an attempt to solve both problems simultaneously, every time series model was re-estimated using a "GARCH (1,1)" process to model nonstationarity in the disturbance variance.[31] Twenty-two of 24 countries display a significant GARCH "alpha" parameter which measures the impact of immediate past squared regression disturbances on the variance of current regression disturbances. This is the simplest form of intertemporal heteroscedasticity and is equivalent to an ARCH process with a single lag. Additionally, 17 countries had a significant GARCH "beta" parameter which measures the impact of the past estimated disturbance *variance* on the current disturbance variance.

However, the GARCH results for coefficients, T-statistics, and explanatory power (adjusted R-Squares) were very similar to those obtained with ordinary least squares (OLS) and already reported in detail. The pattern of T-statistics across countries is virtually identical. Across the 24 countries, the average adjusted R-Square for the GARCH (1,1) version of model (5), including leads and lags, is 0.468. With simple OLS, the corresponding average was 0.482.[32]

In conclusion, although there were definite indications of both heteroscedasticity and nonnormality, correcting these problems by using the more general GARCH specification did not change the basic inference: global industry influences and exchange rates explain a large proportion of the daily movements in national stock price indexes.

V. The International Pattern of Return Correlations and the Influence of Industry Composition

Much has been written about the correlations of returns across countries. Correlation coefficients among countries are generally quite modest in

[30]The problem was "significant" if the Chi-Square test statistic exceeded two standard errors (under the null hypothesis of homoscedasticity).

[31]See Bollerslev (1986).

[32]To save space, the GARCH results will not be printed here but they are available from the author.

magnitude except between countries whose economies are very closely linked. For our sample period, the top panel of Table VII presents correlation coefficients computed from daily, dollar-denominated returns; i.e., from the same data used previously in the time series regressions.

The table confirms once again that intercountry correlations are surprisingly small. Only 50 of the 276 coefficients are above 0.5 and these are mainly among the western European countries and other regional trading partners: Australia/New Zealand, Canada/United States, and Malaysia/Singapore.

One possible reason for the low correlations among other countries would be time zone differences. Unexpected events during the trading day in the U.S., for example, could not possibly be reflected in far eastern markets until the next calendar day. Even greater suspicion about this possibility is the extremely low correlations across the three major time zone areas: Far East, Europe, and North America. The United States, as an example, has no correlation above 0.3 with any country in the world except Canada and its correlation exceeds 0.2 only with a few European countries. A similar remark could be made about Canada, although its correlation does just reach 0.3 with the Netherlands.

To test for the possibility that trading day time differences are reducing observed correlations,[33] a multiple regression of the following form was calculated with index returns (R) for each pair of countries, i and j:

$$R_{j,t} = g_0 + g_1 R_{i,t-1} + g_2 R_{i,t} + g_3 R_{i,t+1},$$

and the square root of the multiple coefficient of determination (adjusted for degrees of freedom) was taken as an indicator of the total correlation.[34] The second panel of Table VII presents the results.

A close examination of these numbers reveals that there is little difference between the simple correlations of daily returns (in the top panel) and the multiple regression analogs *for countries in the same time zone* such as the European countries. For example, Germany and Switzerland have the identical correlation of 0.72 whether or not a daily lead and lag is included in the calculation.

In contrast, there is a major improvement in the correlations among countries in different time zones. For example, the United States still has about the same correlation with Canada, but it now has 20 coefficients above 0.2 with other countries (it had only four using "contemporaneous" daily returns) and it even has a few above 0.4. Interestingly, the far eastern

[33]Bailey, Stulz, and Yen (1990) and Bailey and Stulz (1990) show that time zone differences play a significant role in daily correlation coefficients between Pacific Basin countries and the U.S. By allowing for lags, they find material increases in correlation.

[34]If the adjusted R-square was negative, a value of zero was assigned to the intercountry correlation. This occurred for only one pair, South Africa and the U.S.

countries do not show nearly as impressive an increase in their correlations with other countries. This may be attributable to the *causative* influence of the United States on other countries, an influence which does not seem to be reciprocated.[35]

Is the international pattern of return correlations merely a regional phenomenon or is it partly ascribable to the industrial structures of countries? In order to answer this question, portfolio returns were constructed for each country by weighting the global industry factors with the country's industry weights.[36] Then correlations were computed among the portfolio returns corresponding to each pair of countries. If industry composition is important in explaining the global pattern of correlations, there should be a relation between the correlations computed directly from the actual index returns of each country and the correlations computed from the country specific industry-weighted portfolios. Correlations for the industry-weighted portfolio returns are shown in the bottom panel of Table VII.

It is clear from a brief examination of the panels in Table VII that the correlations are generally larger when they are computed from industry-weighted portfolios rather than from the raw indexes (even after correcting for possible nonsynchronous daily trading). This is to be expected since industry factors explain only about 45% of the daily raw index volatility on average. The unexplained time series volatility serves to reduce measured correlations among countries.

But the absolute magnitude of the two correlations is of less interest than the comparative structure of the two correlation matrices. If correlations computed from raw index returns are related cross-sectionally to correlations computed from industry-weighted portfolios, we can conclude that a significant portion of the international pattern of correlations is due to the industrial structures of countries. To examine the extent of the similarity in the correlation matrices, two statistics have been computed for each of the 36 sample months and for the overall sample period. The first is simply the cross-sectional (Pearson) correlation of the 276 distinct sample correlation coefficients. The second is their rank correlation.

Table VIII presents a summary of the results. Within each sample month, two sets of 276 correlation coefficients were computed, one set from the raw country index returns (dollar-denominated) and a second set from the each country's industry-weighted portfolio of global industry factors. Then a cross-sectional correlation was computed between the two sets of correlations. The mean of this cross-sectional correlation over the 36 sample months was 0.344 (0.305) using a cross-sectional Pearson (Rank) correlation method. The stand-

[35]Canada shows significant correlation improvement too, but this might be induced by its strong link to the U.S.

[36]If W_{ij} is the weight of industry i in country j at the beginning of a month and f_{it} is the global industry i factor return for day t during the month, the portfolio return for country j on day t was calculated as $R_{pjt} = W_{1j}f_{1t} + \cdots + W_{7j}f_{7t}$.

Table VII

Correlation Coefficients of Daily Index Returns (April 1988–March 1991)

A bivariate correlation coefficient for each pair of countries is computed from dollar-denominated daily returns over three calendar years. Panel A reports the correlations computed from the FT Actuaries/Goldman Sachs country indexes. Panel B uses the same country indexes but allows for a one-day lead and a one-day lag in addition to the contemporaneous effect. Panel C reports correlations calculated from constructed portfolios for each country. The portfolio is actually a weighted average of global industry factors, each factor being based on returns from all countries. The weights are proportional to the country's stock index aggregate market capitalization in the industry at the beginning of each calendar month.

Panel A: FT Actuaries Index Returns

	Australia	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Hong Kong	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	New Zealand	Norway	Singapore	South Africa	Spain	Sweden	Switzerland	United Kingdom
Austria	0.24																						
Belgium	0.25	0.58																					
Canada	0.13	0.12	0.20																				
Denmark	0.26	0.47	0.60	0.16																			
Finland	0.15	0.33	0.38	0.06	0.40																		
France	0.24	0.49	0.59	0.25	0.55	0.31																	
Germany	0.32	0.62	0.57	0.19	0.54	0.28	0.68																
Hong Kong	0.24	0.24	0.20	0.09	0.19	0.08	0.19	0.24															
Ireland	0.26	0.43	0.52	0.20	0.49	0.32	0.54	0.56	0.19														
Italy	0.27	0.48	0.60	0.14	0.55	0.30	0.55	0.57	0.21	0.50													
Japan	0.29	0.32	0.45	0.15	0.36	0.24	0.39	0.37	0.26	0.36	0.39												
Malaysia	0.35	0.40	0.36	0.13	0.32	0.22	0.29	0.42	0.46	0.37	0.34	0.37											
Mexico	0.07	0.11	0.07	−0.02	0.10	0.15	0.07	0.04	0.01	0.03	0.10	0.06	0.13										
Netherlands	0.32	0.45	0.51	0.31	0.47	0.27	0.72	0.67	0.21	0.53	0.47	0.39	0.33	0.05									
New Zealand	0.54	0.29	0.25	0.11	0.25	0.12	0.17	0.30	0.21	0.25	0.27	0.27	0.34	0.10	0.26								
Norway	0.28	0.33	0.37	0.22	0.41	0.20	0.42	0.46	0.18	0.38	0.33	0.23	0.34	0.06	0.53	0.26							
Singapore	0.35	0.41	0.39	0.13	0.32	0.20	0.33	0.41	0.47	0.35	0.38	0.43	0.78	0.11	0.33	0.32	0.33						
South Africa	0.23	0.15	0.14	0.12	0.14	0.17	0.10	0.19	0.07	0.16	0.12	0.07	0.15	−0.04	0.16	0.16	0.18	0.13					
Spain	0.32	0.55	0.62	0.17	0.51	0.30	0.64	0.62	0.27	0.52	0.57	0.51	0.43	0.07	0.58	0.27	0.36	0.45	0.14				
Sweden	0.30	0.50	0.53	0.18	0.50	0.32	0.57	0.60	0.26	0.49	0.50	0.40	0.42	0.05	0.51	0.26	0.41	0.44	0.12	0.57			
Switzerland	0.35	0.49	0.55	0.18	0.52	0.34	0.69	0.72	0.22	0.53	0.55	0.39	0.39	0.01	0.68	0.27	0.46	0.39	0.20	0.65	0.61		
United Kingdom	0.25	0.31	0.41	0.29	0.36	0.30	0.55	0.44	0.18	0.46	0.36	0.36	0.21	0.02	0.62	0.22	0.38	0.25	0.11	0.45	0.41	0.49	
United States	0.02	0.14	0.15	0.62	0.13	0.07	0.25	0.16	0.11	0.12	0.08	0.13	0.16	−0.01	0.24	0.03	0.12	0.16	0.02	0.21	0.19	0.19	0.27

Panel B: Implied from Multiple Regressions with One (Daily) Lead and One (Daily) Lag

	Australia	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Hong Kong	Ireland	Italy	Japan	Malaysia
Austria	0.24												
Belgium	0.25	0.60											
Canada	0.29	0.17	0.24										
Denmark	0.26	0.49	0.61	0.19									
Finland	0.16	0.34	0.39	0.06	0.41								
France	0.25	0.53	0.63	0.26	0.55	0.33							
Germany	0.33	0.64	0.58	0.24	0.55	0.29	0.67						
Hong Kong	0.24	0.24	0.19	0.17	0.19	0.08	0.19	0.23					
Ireland	0.26	0.43	0.53	0.24	0.49	0.33	0.54	0.56	0.18				
Italy	0.26	0.50	0.61	0.20	0.55	0.32	0.56	0.58	0.20	0.50			
Japan	0.28	0.34	0.45	0.16	0.37	0.23	0.41	0.40	0.27	0.37	0.39		
Malaysia	0.35	0.39	0.37	0.30	0.32	0.23	0.33	0.44	0.48	0.37	0.34	0.38	

Table VII-*Continued*

														Mexico	Netherlands	New Zealand	Norway	Singapore	South Africa	Spain	Sweden	Switzerland	United Kingdom
Mexico	0.17	0.15	0.14	0.02	0.15	0.16	0.20	0.16	0.13	0.13	0.18	0.13	0.27										
Netherlands	0.34	0.48	0.53	0.33	0.47	0.28	0.72	0.67	0.21	0.53	0.48	0.40	0.35	0.14									
New Zealand	0.54	0.30	0.26	0.27	0.25	0.12	0.23	0.31	0.22	0.25	0.27	0.30	0.35	0.10	0.30								
Norway	0.29	0.33	0.37	0.30	0.41	0.24	0.42	0.46	0.17	0.38	0.33	0.23	0.34	0.06	0.54	0.26							
Singapore	0.35	0.41	0.39	0.29	0.31	0.22	0.38	0.43	0.49	0.35	0.38	0.43	0.79	0.21	0.37	0.32	0.33						
South Africa	0.22	0.14	0.16	0.13	0.13	0.15	0.10	0.20	0.07	0.16	0.12	0.03	0.15	0.07	0.16	0.16	0.17	0.12					
Spain	0.33	0.57	0.62	0.20	0.52	0.31	0.65	0.62	0.28	0.52	0.57	0.52	0.45	0.21	0.58	0.32	0.36	0.46	0.16				
Sweden	0.30	0.52	0.54	0.24	0.50	0.33	0.57	0.60	0.27	0.49	0.50	0.42	0.44	0.16	0.52	0.29	0.41	0.45	0.12	0.57			
Switzerland	0.36	0.54	0.56	0.23	0.53	0.36	0.69	0.72	0.22	0.53	0.56	0.42	0.42	0.17	0.68	0.30	0.47	0.42	0.21	0.66	0.62		
United Kingdom	0.31	0.33	0.43	0.29	0.36	0.31	0.55	0.45	0.20	0.47	0.37	0.38	0.27	0.10	0.62	0.28	0.39	0.30	0.12	0.46	0.42	0.50	
United States	0.38	0.29	0.28	0.63	0.24	0.10	0.34	0.39	0.28	0.31	0.31	0.25	0.46	0.21	0.44	0.40	0.31	0.43	0.00	0.34	0.40	0.34	0.30

Note: The row country is the dependent variable in the multiple regression and the column variable is the explanatory variable, which has a one-day lead and a one-day lag in addition to a contemporaneous return. The correlation reported is the square root of the adjusted R-square in the regression.

Panel C: Returns Constructed from Country-Weighted Global Industry Factors

	Australia	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Hong Kong	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	New Zealand	Norway	Singapore	South Africa	Spain	Sweden	Switzerland	United Kingdom
Austria	0.80																						
Belgium	0.53	0.80																					
Canada	0.75	0.74	0.85																				
Denmark	0.57	0.69	0.58	0.55																			
Finland	0.67	0.82	0.69	0.61	0.56																		
France	0.61	0.69	0.73	0.84	0.52	0.74																	
Germany	0.78	0.86	0.78	0.80	0.61	0.90	0.88																
Hong Kong	0.34	0.74	0.82	0.58	0.69	0.75	0.72	0.73															
Ireland	0.84	0.87	0.66	0.75	0.54	0.76	0.78	0.81	0.63														
Italy	0.47	0.80	0.81	0.64	0.57	0.88	0.84	0.86	0.93	0.75													
Japan	0.69	0.83	0.81	0.81	0.72	0.88	0.89	0.97	0.81	0.74	0.88												
Malaysia	0.59	0.75	0.70	0.70	0.79	0.68	0.82	0.77	0.84	0.79	0.82	0.82											
Mexico	0.20	0.22	0.46	0.50	0.20	−0.05	0.19	0.23	0.11	0.03	0.04	0.26	0.07										
Netherlands	0.46	0.46	0.56	0.70	0.35	0.54	0.78	0.57	0.46	0.60	0.59	0.59	0.63	−0.11									
New Zealand	0.93	0.79	0.50	0.72	0.46	0.62	0.62	0.71	0.37	0.92	0.49	0.61	0.60	0.12	0.48								
Norway	0.52	0.41	0.49	0.62	0.46	0.52	0.56	0.54	0.30	0.38	0.38	0.58	0.46	−0.02	0.80	0.36							
Singapore	0.48	0.76	0.72	0.58	0.79	0.82	0.77	0.79	0.95	0.69	0.92	0.86	0.92	−0.03	0.55	0.45	0.43						
South Africa	0.90	0.59	0.29	0.61	0.32	0.35	0.39	0.50	0.04	0.74	0.16	0.38	0.36	0.20	0.32	0.92	0.31	0.15					
Spain	0.39	0.74	0.96	0.73	0.54	0.70	0.67	0.75	0.86	0.54	0.83	0.79	0.64	0.44	0.42	0.35	0.36	0.74	0.10				
Sweden	0.51	0.50	0.50	0.59	0.40	0.74	0.80	0.83	0.49	0.47	0.67	0.83	0.54	0.16	0.54	0.37	0.55	0.61	0.20	0.51			
Switzerland	0.45	0.60	0.60	0.69	0.48	0.65	0.94	0.74	0.75	0.74	0.81	0.78	0.81	0.07	0.69	0.56	0.35	0.77	0.28	0.57	0.66		
United Kingdom	0.55	0.66	0.77	0.87	0.56	0.67	0.98	0.83	0.74	0.72	0.80	0.88	0.82	0.30	0.78	0.57	0.56	0.75	0.35	0.71	0.75	0.92	
United States	0.34	0.41	0.66	0.77	0.43	0.47	0.83	0.68	0.55	0.37	0.59	0.77	0.58	0.52	0.60	0.26	0.53	0.54	0.12	0.64	0.78	0.73	0.89

Table VIII

Correlation of Correlation Coefficients Summarized (April 1988–March 1991)

Bivariate correlations were computed between all pairs of countries using indicators of country returns. For the 24 countries, there are 276 different bivariate correlation coefficients. The indicators of returns are: (1) the dollar-denominated returns in each country for the FT Actuaries/Goldman Sachs index and (2) a constructed portfolio for the country. The constructed portfolio consists of global industry factors, each such factor using returns from all countries. The portfolio is determined by weighting each global industry factor by the actual industry weight in the subject country. For each of the 36 sample months, the two sets of bivariate correlations were calculated from returns during the month (the industry weightings were taken as of the beginning of the month). Then, a cross-sectional correlation was calculated between the two sets of 276 correlation coefficients. Both a Pearson and a Rank cross-correlation were calculated. Panel A summarizes these within-month correlations of correlation coefficients. The standard deviation over time of the within-month correlations allows the calculation of a T-Statistic based on the assumption that the months are independent. Also reported is the mean T-Statistic obtained within each month. Panel B reports the cross-sectional correlation between the two sets of 276 correlations when daily data from all sample months are used in their calculation. These sets of correlations are reported in Table VII, Panels A and C. Also given is a cross-sectional correlation for two sets of 276 bivariate correlations which take into account a one-day lead and a one-day lag between the returns of each pair of countries. These sets of correlation are in Table VII, Panels B and C.

	Type of Correlation	
	Pearson	Rank
Panel A: Within-Month Correlation of Correlation Coefficients		
Mean over 36 months	.344	.305
Standard Deviation, 36 months	.148	.125
T-Statistic	14.0	14.6
Within-Month T-Statistic, Mean over 36 months	6.43	5.48
Panel B: Correlation of Correlation Coefficients for All Months		
Correlation of Correlation Coefficients, All Months	.492	.451
T-Statistic	9.34	8.37
Correlation including Leads and Lags, All Months	.462	.408
T-Statistic	8.63	7.39

ard deviation across the 36 months was 0.148 (0.125) (see Table VIII). Under the assumption that the 36 months are independent, a T-statistic can be computed as the ratio of mean to standard error;[37] these T-statistics indicate a high level of statistical significance.

Table VIII also reports the mean of the T-statistics obtained within each month for the cross-sectional correlation. The within-month T-statistics were below 2.0 for only one month (December 1988), during the entire sample of 36 months, and they generally exceeded 4.0.

If the 276 correlations are computed from returns over the entire sample, the cross-sectional correlation of correlation coefficients is 0.49 using the standard Pearson correlation and 0.45 using the rank correlation method. The T-statistics are 9.3 and 8.4, respectively. When the raw index return correlations are calculated taking into account possible leads and lags (as in the second panel of Table VII), the cross-sectional correlation is just slightly lower but the statistical significance remains very large.

It therefore seems reasonable to conclude that a significant portion of the international structure of correlations among country returns can be ascribed to a very mundane fact: viz., it is induced by the industrial compositions of the country indexes. Two countries will be more highly correlated if their industrial makeups are similar. Industry structure is not the only explanation of the international pattern of correlations; regional affiliations seem also to play a large role, for instance, but industrial composition indeed seems to be a major explanatory element.

V. Summary and Conclusion

The comparative behavior of national equity markets has been a source of puzzlement. There are large differences in volatilities across markets, even after nominal and inflation differences are taken into account by converting returns into common currency units at prevailing exchange rates. Countries such as Canada and the Netherlands have low volatility. Countries such as Hong Kong and South Africa have high volatilities. This paper suggested a reason why.

The empirical evidence points to three explanatory influences. First, stock market indexes vary widely in the number of constituent individual common stocks and in their diversification. Second, national stock markets reflect the idiosyncracies of the country's industrial structure. Some countries are industry specialists and their stock market behavior merely reflects international perturbations of the industries in question. Third, the stock markets of most, but not all, countries are influenced by exchange rates.

[37] If the months are independent, the standard error is simply the standard deviation divided by the square root of the number of months.

Empirical evidence for the technical influence of index construction is that return volatility is related across countries inversely to the number of stocks in the index and positively to a "Herfindahl" measure of three-digit industry concentration within the index.[38] This finding is really nothing more than the "discovery" that an investment portfolio, the country's index, is more volatile when it is less well diversified. The novelty here is that inherent diversification can be empirically relevant when comparing countries.

Empirical evidence for the influence of industrial structure is that global industry indexes *computed strictly from returns in other countries* explain a sizeable part of the variations in a given country's national stock market. On average over countries, global industry indices of foreign returns plus exchange rates explain almost 50% of the volatility in a country's dollar-denominated *daily* stock returns, as measured by an adjusted R^2. Industries are more important than exchange rates for most countries; alone, they explain almost 40% of the volatility while exchange rates alone explain about 23%.[39]

The pattern of industry importance across countries makes intuitive sense. The consumer goods sector is extremely important for almost every country. The capital goods sector, in contrast, is more important for well known producers of capital equipment such as Germany. Basic goods, including mining, are important for such producers as South Africa and marginally negative for raw materials importers such as Hong Kong. Other sectors, Energy, Transportation, Utilities, and Finance also have widely differing impacts on national market returns and conform to the a priori anticipated pattern across countries.

For the majority of countries, exchange rates are neither perfectly neutral nor entirely non-neutral. Few countries follow a policy of fixed exchange rates, a perfectly non-neutralized regime that would link local stock prices to monetary shocks that occur in other countries. But the empirical evidence reveals also, for the majority of countries, that local currency returns are negatively correlated with changes in the value of the national currency. This is consistent with systematic exchange market intervention by monetary authorities in an effort to offset the impact of global shocks on local industries. Such intervention may occur with a lag, but to the extent it is anticipated by stock market participants, it can have an immediate effect.

The pattern of return correlations across countries has been the subject of considerable interest and investigation. We have found here that a significant part of the international structure of country correlations can be explained by the industry compositions of the national stock market indices. Regardless of region, countries with similar industries tend to be more correlated than countries with dissimilar industries.

[38]The Herfindahl measure turns out to be more sensitive than the number of stocks.

[39]These adjusted R-Squares are not additive, of course, since exchange rates are correlated with foreign industry indices.

Appendix: FT Actuaries/Goldman Sachs International Equity Indexes; Industry Codes by Industrial Sectors

Financial, Insurance & Real Estate Sector (Finance)[40]	
112:	Commercial Banks & Other Banks
121:	Financial Institutions
122:	Financial Services
181:	Investment Trusts
131:	Investment Companies
141:	Insurance—Life
142:	Insurance—Agents & Brokers
151:	Insurance—Multiline
152:	Insurance—Property & Casualty
161:	Real Estate
171:	Diversified Holding Companies
Energy Sector (Energy)	
212:	Oil—Internationals
213:	Oil—Crude Producers
214:	Petroleum Products & Refineries
201:	Non-Oil Energy Sources
202:	Energy Equipment & Services
Utilities Sector (Utilities)	
221:	Electric Utilities & Water Works Supply
222:	Natural Gas Utilities
223:	Telephone Companies
Transportation & Storage Sector (Transport)	
301:	Air Transport Carriers
302:	Freight Forwarders
303:	Sea Transport
304:	Rail & Road Transport
306:	Storage, Warehousing & Supporting Transport
Consumer Goods & Services Sector (Consumer)	
401:	Automobiles
402:	Household Durables & Appliances
406:	Diversified Consumer Goods & Services
411:	Apparel
412:	Textile Products
413:	Footwear
421:	Beverages—Brewers
422:	Beverages—Distillers
424:	Beverages—Soft Drinks

[40] Mnemonics used in the text to designate the seven major industry groupings are given in parentheses just below each sector name.

425:	Tobacco Manufacturers
431:	Health Care
432:	Cosmetics
433:	Drugs
434:	Hospital Supply & Management
451:	Food Processors
452:	Food—Sugar & Confectionery
453:	Soaps
454:	Agriculture & Fishing
461:	Entertainment & Leisure Time
462:	Toys
463:	Photography
464:	Restaurants & Hotels
471:	Printing
472:	Publishing
473:	Publishing—Newspapers
474:	Broadcasting Media
475:	Advertising
481:	Business Services
482:	Computer Software & Services
491:	Retail—Department Stores
492:	Retail—General Merchandise
493:	Retail—Grocery Chains
494:	Retail—Drug Chains
495:	Retail—Miscellaneous & Specialty
511:	Wholesale—Durables
512:	Wholesale—Nondurables
Capital Goods Sector (Capital)	
521:	Aerospace & Defense
522:	Defense Electronics
523:	Aircraft Manufacturers
531:	Computers
533:	Communications Equipment
534:	Office Equipment
541:	Electrical Equipment
551:	Electronics
552:	Instrumentation & Control Equipment
561:	Engineering Services & Pollution Control
562:	Machine Tools
563:	Machinery
564:	Machinery—Construction
565:	Machinery—Farm Equipment
566:	Machinery—Industrial & Specialty
571:	Auto Parts—Original Equipment
572:	Auto Parts—After Market
573:	Auto Trucks & Parts
574:	Tire & Rubber Goods
591:	Diversified Industrials
592:	Heavy Engineering & Shipbuilding
Basic Industries Sector (Basic)	
611:	Building Materials
612:	Ceramics

613:	Construction
614:	Homebuilding
621:	Chemicals, Fibers, Paints & Gases
622:	Chemicals (Diversified)
624:	Fertilizers
631:	Mining & Extractive Industries
632:	Metal Ore Mining
633:	Iron & Steel
634:	Nonferrous Metals
641:	Precious Metals & Minerals
651:	Forestry Products
652:	Paper & Paper Products
671:	Fabricated Metal Products
672:	Containers

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