Sector Integration and the Benefits of Global Diversification

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One of the main reasons that investment advisors recommend international investments is that foreign stocks are not highly correlated with U.S. stocks. As world economies become increasingly interrelated, it may become more difficult for investors to achieve effective diversification. This research investigates international stock market correlation, and assesses whether global diversification on a sector basis is beneficial to U.S. investors. This analysis includes 38 developed and emerging stock markets from 1981-2000. In addition to demonstrating a potential loss of diversification benefits, this paper utilizes an optimal global asset allocation model to illustrate the effects of sector diversification on portfolio performance over time. The results indicate that although the correlation between most foreign sectors and U.S. sectors is increasing over time, there are still substantial international diversification benefits. Further, the inclusion of emerging market sectors may significantly enhance the return-to-risk performance of international portfolios (JEL: F21, F36, G11, G15).

Keywords: sectors, optimal portfolio, international diversification, co-movement.

I. Introduction

There is a growing concern among both individual and professional investors regarding the benefits of international portfolio diversification. Since the world stock market crash of October 1987, investors are acutely aware that markets are indeed interrelated. Global market

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correlations increase during periods of greater economic integration as is apparent during the late 19th and 20th centuries (Goetzmann et al. [2005]). Greater economic integration may be achieved through increased trade and cross-border investments. Trade has continued to rise dramatically due to the reduction of trade barriers and the proliferation of large trading blocs (e.g., the European Union [EU], and the North American Free Trade Agreement [NAFTA]). The fall of trade barriers began with the General Agreement on Tariffs and Trade (GATT), which later produced the World Trade Organization (WTO). These agreements have resulted in increases in economic integration, and the globalization of business enterprise. Economic policy coordination led to a single currency in the EU.

The linkage between international markets increases dramatically due to the acceleration of cross-border investments. Factors including global deregulation of the telecommunications, utility, and other industries increase competition. Industry consolidations and global merger-and-acquisition activity have all helped to strengthen ties between markets worldwide. It is not just the major stock market indexes (i.e., Dow, Nikkei, FTSE, etc.) that are linked, but also industries and individual firms that are closely tied together. The globalization of corporate revenues and expenses, and the growing proportion of intra-industry mergers and acquisitions have greatly influenced the relative importance of sector factors in explaining security returns.

Goetzmann et al. (2005) argue that diversification benefits change through time and are driven by either low correlations in the world markets or a large opportunity set. They believe that diversification benefits are currently lower than in previous periods during their 150-year sample. However, there have been other periods of low diversification benefits, such as in the late 19th century. They suggest that current diversification benefits are driven mostly by a larger and increasing opportunity set, because correlations are actually rising. They also attribute an important role to emerging stock markets as current diversification benefits are mostly derived from marginal markets. Meric et al. (2001) state that there is no diversification benefit to U.S. investors from investing solely in well-diversified country indexes in Latin America. They posit that investors would benefit the most from investing in selected industries or securities in these countries.

The purpose of this study is to examine the increase in correlation

that world markets experience from 1981–2000, and to assess any subsequent loss of global diversification benefits. The stock indexes of 38 developed and emerging countries are subdivided into 10 leading sector components (e.g., utilities, technology, etc.) to analyze the micro linkage between markets. Building on Goetzmann et al. (2005) and Meric et al. (2001), this study includes sector analysis to offer a broader array of investments. The apparent increase in international market integration is assessed using correlation and panel data analysis. Panel data asymmetry analysis is utilized to measure greater integration between markets and sectors during either upturns or downturns in U.S. markets. As correlation is a key factor in determining the benefits of portfolio diversification, a portfolio optimization model is applied to show the potential benefit of sector analysis in international diversification. The benefits of international diversification are investigated with particular focus on total market investment compared to sector-based investment in developed and emerging markets.

This paper provides evidence that international investing is beneficial to U.S. investors, even though this analysis documents that international stock market correlation has increased among the total stock market indexes of both developed and emerging markets. Micro-market analysis reveals that certain sectors do not experience a consistent increase in correlation over time, which allows for potentially greater diversification benefits. This paper presents evidence comparing international investment in total market indexes versus sector-based investment. Utilizing an ex post optimal portfolio model, it is shown that diversification among international markets using total market indexes could be superior to investing solely in the U.S. total market index. Further, that international sector-based diversification could be superior to simply holding a diversified portfolio of total market indexes. The results indicate that fundamental analysis of which countries and sectors to include in internationally diversified portfolios is potentially profitable. Additional findings support the inclusion of emerging market investments to achieve maximum portfolio diversification benefits.

II. Background and Literature Review

There is a considerable body of early empirical evidence documenting the benefits of international portfolio diversification including Levy and

Sarnat (1970) and Solnik (1974). However, recent studies indicate that correlations between the U.S. and most developed equity markets have risen (Meric and Meric [1998], Longin and Solnik [1995], Erb et al. [1994]), but stabilize after the 1987 crash period (Solnik et al. [1996]). Emerging markets exhibit very low correlations with developed markets (Divecha et al. [1992)], Harvey [1995]), but these correlations are increasing over time, and appear higher in times of greater international volatility (Erb et al. [1995], Aggarwal and Leal [1997], Bekaert and Harvey [1997], Meric et al. [2001]).

Several studies suggest that the opening of emerging financial markets reduces financial market segmentation (Bekaert and Harvey [1997], Bekaert [1995]). Market opening can be achieved through both economic and financial reforms. Trade liberalization is among the usual market opening economic reforms that have a positive impact on market valuations (Henry [2000]). Emerging markets may become more efficient with trade liberalization as returns show random walk properties, while financial liberalization does not seem to affect efficiency (Basu and Morey [2000] and Kawakatsu and Morey [1999]). Bekaert and Harvey (2000) find that emerging market correlation increases with the world market return after financial liberalization. The main attraction of emerging markets to investors is not only the greater potential returns that can be earned, but that they have low stock market correlations with developed markets. As emerging markets become increasingly linked with developed markets, the benefit of portfolio diversification may diminish.

Most of the prior studies cited focus on the relationship between the major stock market indexes of each country. Roll (1992) indicates that industry concentration is also a significant variable affecting equity market correlation. A number of studies investigate the relationship between capital market integration and security returns with some conflicting results. Beckers et al. (1996) examines country and industry factors, and does not find increasing global integration, except within the European Union. Heston and Rouwenhorst (1994) find that sectors accounted for less than 4% of the variation in stock return indexes of 12 European equity markets. Rouwenhorst (1999) finds that despite the formation of the European Union, individual country effects are still relevant.

More recently, Baca et al. (2000) conclude that industrial sector factors are increasingly important in explaining national equity returns in seven major industrial countries (including the U.S.). Serra (2000)

shows that although country effects are the most important factors explaining emerging market stock returns, investors should not ignore industry effects when they include emerging markets in their portfolios. Miller (2002) believes that both country and sector analysis are now equally important particularly due to technology. The author says that global sector effects may be confined to a few sectors and that others, such as consumer and industrial stocks, are traded locally. Miller adds that thinking in terms of country and sector effects is equivalent to thinking locally for some industries and globally for others.

III. Data

The sample consists of U.S. dollar-denominated total monthly index returns (including dividends) for 38 countries provided by Datastream from 1981–2000. There are 18 developed countries and 20 emerging countries. Emerging countries are identified as such by Morgan Stanley Capital International. Using U.S. dollar returns instead of local returns has the added benefit of accounting for disparate levels of inflation, particularly in some of the emerging countries. The developed sample begins in 1981, and the emerging sample in 1991 due to the data limitations of Datastream. Data collected for each country includes the total stock market index and 10 sectors within each of the markets. (In some countries, particularly emerging markets, 10 sectors may not exist. The total stock market index is created by Datastream as a consistent measure across all countries in the database.)

Datastream categorizes industries as defined by the Financial Times Actuaries Index into the following sectors: basic industries, cyclical consumer goods, cyclical services, financials, general industrials, information technology, nonclyclical consumer goods, nonclyclical services, resources, and utilities. The country indexes are weighted by market capitalization, contain the largest firms in each market, and represent close to 80% of each country's total market capitalization. There is no overlap between indexes, as foreign listings, including American Depositary Receipts, are excluded from each index.

All statistical tests are based on the perspective of a U.S. investor. The sample is divided into four 60-month investment horizons to assess changes over time-period I (January 1981–December 1985), period II (January 1986–December 1990), period III (January 1991–December

TABLE 1. Mean and Standard Deviation for Country Indexes. U.S. Dollar Monthly Returns (in %).

Series	Mean (1991–2000)	Std dev. (1991–2000)	Mean (1981–2000)	Std dev. (1981–2000)
Developed:				
Australia	0.63	5.27	0.56	6.31
Austria	0.28	4.90	0.76	6.83
Belgium	0.59	4.29	0.96	5.20
Canada	0.87	4.90	0.75	4.85
Denmark	0.84	4.59	1.10	5.35
Finland	2.19	9.16	1.88	7.85
France	0.96	4.97	0.99	6.16
Germany	0.68	4.45	0.94	5.32
Ireland	1.04	5.28	1.12	6.27
Italy	0.53	7.10	0.79	7.41
Japan	0.00	6.85	0.72	7.21
Netherlands	1.08	4.24	1.16	4.37
Norway	0.45	7.13	0.89	7.53
Spain	0.63	6.15	1.00	6.62
Sweden	1.00	6.20	1.30	6.18
Switzerland	1.28	4.62	1.17	4.91
U.K.	0.74	4.21	0.92	5.02
U.S.	1.23	3.71	1.11	3.85
Emerging:				
Argentina	1.46	12.10	n/a	n/a
Brazil	2.49	16.03	n/a	n/a
Chile	0.98	7.36	n/a	n/a
China	1.89	11.93	n/a	n/a
Greece	0.58	9.27	n/a	n/a
Hong Kong	1.27	8.52	n/a	n/a
India	0.32	11.36	n/a	n/a
Indonesia	–1.33	13.46	n/a	n/a
Korea	–0.30	12.40	n/a	n/a
Malaysia	0.13	11.36	n/a	n/a
Mexico	0.87	10.65	n/a	n/a
New Zealand	0.32	6.24	n/a	n/a
Philippines	0.53	10.27	n/a	n/a
Poland	–0.80	13.95	n/a	n/a
Portugal	0.53	6.03	n/a	n/a
S. Africa	0.21	7.82	n/a	n/a
Singapore	0.40	6.93	n/a	n/a
Taiwan	0.16	10.27	n/a	n/a
Thailand	–0.58	12.48	n/a	n/a
Turkey	0.31	18.25	n/a	n/a

Note: n/a = not available

1995), and period IV (January 1996–December 2000). Data from October 1987 are removed from the analysis.[1]

Statistics for the total stock market indexes of each country are presented in table 1. Monthly means and standard deviations demonstrate the relative risk-return tradeoff between developed and emerging markets. Although the developed sample spans from 1981–2000, the developed sample is also presented during the same time frame as the emerging sample (1991–2000) for comparison purposes. Among developed countries from 1991–2000, Finland (2.19%) has the highest monthly mean and Japan (0.00%) has the lowest. Standard deviation of returns is highest for Finland (9.16%) and lowest for the U.S. (3.71%). In the emerging countries, Brazil (2.49%) has the highest mean, while Indonesia, Korea, Poland, and Thailand experience negative monthly means. Turkey(18.25%) has the highest standard deviation and Portugal (6.03%) has the lowest. The standard deviations indicate that emerging markets have much greater volatility than do developed countries during that period of time.

Monthly means and standard deviations are provided for the sector returns in table 2. Since there are roughly 380 individual sector series, the data in table 2 report averages of sectors across countries. The sample is split between developed and emerging countries. Of the developed country sectors from 1991–2000, information technology (1.57%) has the highest mean return and resources (0.32%) has the lowest. The standard deviation is highest for information technology (10.43%) and lowest for utilities (5.91%). Among the emerging countries, information technology (1.64%) has the highest mean return, while cyclical goods (–0.11%) has the lowest. The standard deviation of information technology (19.35%) is also highest and nonclyclical goods (10.58%) has the lowest.

Again, the developed data is presented from 1991–2000 for comparison purposes with the emerging sample. The full sample(1981–2000) is also provided for the developed sample.

Some industries are dominated by only a few companies. Indeed,

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1. October 1987 is removed from the analysis as the inordinately high negative correlations during that month among stock markets worldwide would bias the findings. As indicated by Solnik, et. al. (1996), the shock of October 1987 over a multi-decade period of analysis is not exceptional. However, in this 5-year analysis, the October 1987 shock is pervasive. For example, the correlation in table 4 for the Total Market Index for 1986–1990 is reported as 0.35, which excludes October 1987. If October 1987 is included, the correlation increases to 0.50.

TABLE 2. Mean and Standard Deviation for Sector Indexes. U.S. Dollar Monthly Returns (in %).

Series	Mean (1991–2000)	Std dev. (1991–2000)	Mean (1981–2000)	Std dev. (1981–2000)
Developed countries:				
Basic industries	0.33	6.62	0.70	7.39
Cyclical goods	0.59	7.77	0.77	8.77
Cyclical services	0.70	6.37	0.95	7.70
General Industrials	0.60	6.88	0.76	7.36
Information Technology	1.57	10.43	1.26	10.16
Noncyclical goods	0.80	6.02	1.13	6.79
Noncyclical services	0.91	7.44	1.20	8.01
Resources	0.32	7.19	0.63	8.51
Financials	0.74	6.82	0.92	7.29
Utilities	0.48	5.91	0.75	7.01
Emerging countries:				
Basic industries	0.06	13.64	n/a	n/a
Cyclical goods	–0.11	13.49	n/a	n/a
Cyclical services	0.38	13.08	n/a	n/a
General Industrials	0.57	15.48	n/a	n/a
Information Technology	1.64	19.35	n/a	n/a
Noncyclical goods	0.47	10.58	n/a	n/a
Noncyclical services	1.03	12.47	n/a	n/a
Resources	0.40	14.97	n/a	n/a
Financials	0.31	12.80	n/a	n/a
Utilities	0.24	13.00	n/a	n/a

some country indexes can also be influenced by a major firm (e.g., Nokia in Finland during the late 1990's). To examine this issue in more detail, table 3 contains the number of firms in each sector, by country as of December 2000. The U.S., U.K. and Japan are the only countries with a substantial number of firms in virtually all sectors. Other developed market sectors contain a range of one firm to several dozen firms. In the emerging markets, most sectors have fewer than 12 firms. Many of the emerging sectors have only one-to-three firms. International investment, particularly in emerging markets, is subject to the realities of thinly traded markets, and markets dominated by a few large firms. Portfolio managers should be aware that many foreign sectors may not be adequately diversified. (The optimal portfolios formed in this analysis contain an 80% base investment in the U.S.,

which avoids the potential of holding a portfolio consisting of only a handful of equities.)

IV. Methodology and Results

A. Correlations over time

Low correlations between international markets is one of the prime reasons for international stock diversification. As the focus of this study is from the perspective of a U.S. investor, correlations are calculated between individual U.S. sectors and individual foreign country sectors on a country-by-country basis. Since there are close to 380 separate series (not including the total market series), sector correlations are averaged across countries. For example, U.S. basic industries are correlated against the average of the remaining industries (i.e., Australia basic, Austria basic, Belgium basic, ...). The average between-country sector correlations for four 60-month investment periods are given in table 4.

Several conclusions can be drawn from the results. The average correlation of the U.S. total market with other developed markets is steadily increasing from 0.31 in 1981–1985, to 0.59 in 1996–2000. On the surface, this dramatic increase in correlation may indicate a potential loss in diversification benefits. The sector correlations are not consistent over time. The information technology sector has stable correlations until the last period, while most other sectors show some variation between periods. However, the fourth period correlations are typically two or three times higher than those in the first period in eight of the ten sectors. The two notable exceptions are the resource sector with fairly stable correlations, and the utilities sector with very low correlations.

The trend in correlations between the U.S. and emerging markets are similar to the developed markets from 1991–2000. The correlation between the U.S. total market and the average emerging total market index increases from 0.20 (1991–1995) to 0.43 (1996–2000), which also indicates a potential overall loss of international diversification benefits relative to correlation. The sector correlations are generally highest in the fourth period, although certain industries demonstrate consistent correlations between the two periods (i.e., cyclical and nonclyclical goods, utilities).

In sum, the rising correlations indicate a potential loss in inter-

TABLE 3. Number of Firms in Each Sector, by Country, as of December 2000.

Series	Resource	Basic	General Ind.	Cyc. Goods	Noncycl .Goods	Cyc. Serv.	Nonycl. Serv.	Utilities	Info. Tech	Financials
Australia	17	17	7	2	19	36	4	5	2	51
Austria	1	10	8	3	4	2	1	2	1	18
Belgium	n/a	15	10	2	12	9	5	2	6	29
Canada	55	29	14	7	21	40	11	11	10	52
Denmark	n/a	7	7	2	13	9	1	1	1	9
Finland	1	11	11	2	6	8	4	1	2	4
France	7	17	25	20	40	63	13	1	27	36
Germany	1	27	43	27	24	32	9	14	22	49
Ireland	4	8	1	2	12	9	1	n/a	5	8
Italy	4	19	23	19	7	18	7	9	5	49
Japan	12	153	185	90	118	166	32	17	62	164
Netherlands	7	12	14	11	12	26	7	n/a	11	30
Norway	8	3	7	2	2	12	2	2	3	9
Spain	2	24	10	7	12	21	5	8	2	29
Sweden	n/a	11	18	2	7	6	5	1	2	18
Switzerland	n/a	18	26	4	23	14	3	6	1	54
U.K.	20	47	41	8	46	173	16	13	22	161
U.S.	50	58	71	49	152	178	28	64	105	243

(*Continued*)

TABLE 3. (Continued)

Series	Resource	Basic	General Ind.	Cyc. Goods	NonCyc .Goods	Cyc. Serv.	NonCyc. Serv.	Utilities	Info. Tech	Financials
Argentina	1	1	3	2	7	3	4	7	n/a	11
Brazil	7	20	8	4	7	1	24	16	n/a	13
Chile	1	9	6	n/a	8	6	2	9	n/a	9
China	5	10	4	8	2	11	n/a	6	2	2
Greece	3	11	n/a	1	5	9	3	2	3	13
Hong Kong	2	3	20	11	9	30	4	5	7	39
India	5	18	16	6	21	5	2	4	10	13
Indonesia	2	6	1	6	9	7	3	n/a	n/a	16
Korea	2	15	19	10	10	12	5	2	3	22
Malaysia	3	11	6	5	16	13	4	8	3	21
Mexico	1	16	10	1	19	23	9	n/a	1	10
N. Zealand	1	6	1	2	6	16	2	4	n/a	16
Philippines	1	1	3	n/a	7	7	5	4	n/a	22
Poland	1	7	2	3	9	4	2	1	4	19
Portugal	n/a	10	3	2	3	14	7	1	1	9
S. Africa	16	7	3	1	10	10	4	n/a	n/a	19
Singapore	2	5	20	2	13	24	2	1	5	26
Taiwan	n/a	5	5	4	1	4	3	n/a	32	16
Thailand	2	10	2	n/a	2	8	3	2	2	19
Turkey	3	7	7	11	2	5	2	4	n/a	9

TABLE 4. Average Correlation of U.S. Market/Sectors with Developed and Emerging Markets/Sectors.

	1981–1985	1986–1990	1991–1995	1996–2000
Developed Countries:				
Basic industries	0.28	0.35	0.35	0.51
Cyclical goods	0.12	0.29	0.26	0.32
Cyclical services	0.18	0.32	0.15	0.37
General Industrials	0.20	0.35	0.31	0.52
Information Technology	0.25	0.25	0.24	0.50
Noncyclical goods	0.25	0.30	0.25	0.36
Noncyclical services	0.04	0.25	0.14	0.42
Resources	0.48	0.31	0.42	0.43
Financials	0.23	0.20	0.24	0.48
Utilities	0.09	0.12	0.20	0.02
Total market index (developed countries)	0.31	0.35	0.41	0.59
Emerging Countries:				
Basic industries	n/a	n/a	0.17	0.32
Cyclical goods	n/a	n/a	0.13	0.16
Cyclical services	n/a	n/a	0.07	0.28
General Industrials	n/a	n/a	0.20	0.38
Information Technology	n/a	n/a	0.07	0.39
Noncyclical goods	n/a	n/a	0.16	0.20
Noncyclical services	n/a	n/a	0.05	0.30
Resources	n/a	n/a	0.16	0.27
Financials	n/a	n/a	0.03	0.29
Utilities	n/a	n/a	0.04	0.05
Total market index (emerging countries)	n/a	n/a	0.20	0.43

Note: For example, Basic industries (0.28) represents the average of the U.S. Basic industries with the Basic industries of each individual country during the first period.

national diversification benefits on a total market basis, but sector investing still may offer effective benefits due to consistent or low correlations. Further, while emerging market correlations are increasing over time, the level of correlation with the U.S. market remains lower for emerging markets compared to developed markets.[2]

2. We also examine the distribution of the correlation coefficients found in table 4, as the reported correlations are a function of the number and selection of the countries included in the study. For example, the reported total market index correlation is 0.59 for the 1996–2000 sub period. The range is from 0.45 to 0.79 when examining individual total market index correlations by country (results not reported here). The mean and median are both 0.59, indicating a symmetrical distribution of the data. The standard deviation of 0.09

B. Panel Data Analysis

To study the effects of time variability and to increase the efficiency of the parameter estimates, cross-sectional and time series data are pooled to form a panel data set. There are several advantages to using panel data. First, panel data allows the examination of the relationship between the U.S. sectors and all foreign sectors over time in a multi-country framework. Second, panel data provides additional data points that increase degrees of freedom. Third, utilizing both cross-section and time series data may reduce problems that can occur due to omitted-variables.

Panel data does introduce statistical difficulties in model specification as the error term may contain time series disturbances, cross-section disturbances, or both. The Durbin-Watson statistic for each regression is examined to test for time series disturbances (serial correlation). In addition, a random-effects model is utilized that allows for the error term to be correlated over time and across countries, which accounts for cross-sectional disturbances.

The basic framework for the panel data model is the generalized regression model:

$$\gamma_{it} = \beta_i \chi_{it} + \varepsilon_{it} \qquad (1)$$
$$\varepsilon_{i,t} = u_i + v_t + w_{i,t}$$

assuming that:

$u_i \sim N(0, \sigma_u^2)$	is the cross-section error component
$v_t \sim N(0, \sigma_v^2)$	is the time series error component
$w_{i,t} \sim N(0, \sigma_w^2)$	is the combined error component

Pooling is achieved by stacking *n*-time series so that:

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indicates a relatively tight dispersion. Thus, among developed markets, no country appears to bias the overall correlation structure. For the emerging total market sample, the mean (0.43) and median (0.45) are also fairly close together indicating a generally symmetrical distribution. The standard deviation is 0.13, indicating a somewhat larger variation than that of the developed sample, which is not unexpected. The details of the distributions of the 10 sectors for both the developed and emerging sample are not reported here, but indicate varying degrees of dispersion of correlation coefficients. To avoid unintentional data mining, all available sectors are included in the analysis.

TABLE 5. Generalized Least Squares (GLS) Estimates from Developed Foreign Markets/Sectors Panel Regressed on U.S. Markets/Sectors using a Random–Effects Model. Beta Coefficients and Adjusted R^2 Reported. (*t*–statistics are in Parentheses). Chow Test for Structural Stability between 1991–1995 and 1996–2000.

	1981–1985		1986–1990		1991–1995		1996–2000		Chow *F*–stat
Sector:	beta	adj.R^2	Beta	adj.R^2	beta	adj.R^2	beta	adj.R^2	
Basic industries	0.39***	0.06	0.45***	0.10	0.63***	0.10	0.54***	0.25	3.90***
	(8.10)		(10.36)		(11.16)		(18.67)		
Cyclical goods	0.21***	0.01	0.50***	0.09	0.43***	0.07	0.38***	0.09	3.87***
	(2.65)		(8.52)		(6.60)		(9.18)		
Cyclical services	0.27***	0.02	0.40***	0.08	0.26***	0.02	0.47***	0.13	6.85***
	(4.04)		(9.22)		(4.58)		(12.07)		
General Industrials	0.29***	0.04	0.50***	0.11	0.63***	0.08	0.74***	0.25	5.78***
	(5.92)		(10.99)		(9.62)		(18.56)		
Info. Technology	0.38***	0.05	0.30***	0.07	0.45***	0.06	0.64***	0.25	6.46***
	(3.75)		(5.67)		(6.15)		(15.20)		

(*Continued*)

TABLE 5. (Continued)

Sector:	1981–1985 beta	adj. R^2	1986–1990 Beta	adj. R^2	1991–1995 beta	adj. R^2	1996–2000 beta	adj. R^2	Chow *F*–stat
Noncyclical goods	0.45***	0.04	0.38***	0.07	0.36***	0.04	0.49***	0.10	3.02**
	(6.30)		(7.88)		(6.81)		(10.86)		
Noncyclical services	0.07	0.00	0.34***	0.03	0.28***	0.00	0.70***	0.16	6.86***
	(0.74)		(5.25)		(3.39)		(12.04)		
Resources	0.76***	0.17	0.41***	0.04	0.73***	0.12	0.56***	0.20	4.43***
	(10.23)		(6.18)		(11.11)		(13.13)		
Financials	0.29***	0.03	0.22***	0.02	0.40***	0.03	0.52***	0.22	6.39***
	(5.86)		(5.34)		(6.51)		(16.19)		
Utilities	0.11	0.00	0.24***	0.00	0.42***	0.03	0.02	0.00	9.08***
	(1.00)		(3.00)		(5.40)		(0.34)		
Total Market Index (developed countries)	0.54*** (10.28)	0.05	0.68*** (16.37)	0.09	0.74*** (13.93)	0.12	0.73*** (22.64)	0.33	5.01***

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_n \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}$$

The panel data model in the study is empirically estimated as a generalized least squares (GLS) regression:

$$FOR_{i,t} = \alpha_{i,t} + \beta_{i,t} US_{i,t} + \varepsilon_{i,t} \tag{2}$$

where *FOR* represents the foreign sector returns (in U.S. currency), and *US* represents the U.S. sector returns for individual sector *i* over time period *t*.

This procedure requires that the observations are weighted inversely to their variances. As the error component variances are unknown, a three-stage process is performed. The first stage pools together the entire sample based on ordinary least squares, where the residuals are decomposed into their random and individual components. Stage two computes the GLS covariance matrix to determine the precision of the overall estimates. In the final stage a matrix-weighted average of the individual estimates are used to calculate the grand coefficient matrix. (A detailed explanation is provided in Greene [1990]).

The regressions are performed on a sector-by-sector basis, and indicate the relationship between the U.S. sector and the cross-sectional comparable foreign sector over four 60-month investment periods. The sample is split between developed countries and emerging countries for two reasons. First, to maintain the continuity of the developed sample that begins 10 years earlier than the emerging sample. Second, to focus on the unique relationship between the U.S. and emerging markets. Beta coefficients, significance levels, and adjusted R^2 are reported.

Table 5 contains the results of the foreign sector returns panel-regressed on the U.S. sector returns for the developed countries only. Several observations are apparent from the results. First, the relationship between each U.S. sector and their corresponding foreign sectors are not similar within specific time periods. For example, the betas between sectors vary from a statistically insignificant 0.07 (noncyclical services) to a significant 0.76 (resource) during the 1981–1985 period. The relatively larger and more significant the beta coefficient, the closer is

the relationship between the individual U.S. sector and the corresponding foreign sectors. Second, sector betas are not necessarily consistent over time. That is, some sectors experience fairly stable betas across time periods such as noncyclical goods, while other sectors have much wider variation (information technology and cyclical services). Third, there is somewhat of an upward trend in the level of the beta coefficients over time, which is especially evident when comparing the period 1981–1985 with the 1996–2000 period.

The fourth observation is that the adjusted R^2 are noticeably larger in the last period (1996–2000) than in the prior periods for all sectors except the utilities sector. This demonstrates the rising percentage in variation of foreign sector returns explained by U.S. sector returns. In some cases, the percentage difference is small, such as the R^2 in cyclical goods between 1991–1995 (0.07) and 1996–2000 (0.09). For most sectors the difference in adjusted R^2 between the third and fourth periods is substantially larger as in non-cyclical services (0.00 [1991–1995] increases to 0.16 [1996–2000]). A Chow test is performed to detect a significant structural change in the model between the periods 1991–1995 and 1996–2000. The *F*-statistics reported in table 5 reject the null hypothesis that the models are statistically the same between periods. All of the *F*-statistics are significant at the 1% level, with the exception of noncyclical goods significant at the 5% level.

The last row of table 5 contains the results of the foreign total market indexes panel regressed on the U.S. total market index. The total stock market index is a rough proxy for a well-diversified equity investor. The index betas rise from 0.54 (1981–1985) to 0.73 (1996–2000). More telling is the rise in adjusted R^2 from 0.05 in the first period to 0.33 in the fourth period. That is, there is a significant rise in the explanatory power of the U.S. total market of foreign total markets during the sample period. Although the betas are similar in the third and fourth periods, a Chow test indicates a significant structural change in the 1996–2000 period.

The total market index betas and R^2 are larger in magnitude than those of the individual sectors. This may indicate potentially lower diversification benefits of international total market investment compared with individual sector investment. Sector selection must be carefully made, as some sectors have closer ties to the U.S. in certain periods. For example, the resource sector in the first period has an R^2 of 0.17, compared with the R^2 of the total market index of 0.05. However, even an R^2 of 0.33 for the total market index in the most recent period

TABLE 6. Generalized Least Squares (GLS) Estimates from Emerging Foreign Markets/Sectors Panel Regressed on U.S. Markets/Sectors using a Random–Effects Model. Beta Coefficients and Adjusted R^2 Reported. (*t*–statistics are in Parentheses). Chow Test for Structural Stability between 1991–1995 and 1996–2000.

	1991–1995		1996–2000		Chow *F*–stat
Sector:	beta	adj. R^2	beta	adj. R^2	
Basic industries	0.41***	0.00	0.66***	0.10	9.90***
	(3.54)		(11.47)		
Cyclical goods	0.25***	0.00	0.31***	0.01	3.05**
	(2.55)		(4.45)		
Cyclical services	0.06	0.00	0.65***	0.06	11.25***
	(0.49)		(6.65)		
General Industrials	0.44***	0.00	0.98***	0.07	7.68***
	(3.38)		(10.17)		
Info. Technology	0.30	0.03	0.78***	0.14	9.18***
	(1.53)		(9.41)		
Noncyclical goods	0.38***	0.01	0.44***	0.03	9.49***
	(4.11)		(6.61)		
Noncyclical services	0.09	0.00	0.73***	0.08	12.63***
	(0.66)		(9.39)		
Resources	0.06	0.00	0.61***	0.06	8.67***
	(0.36)		(8.18)		
Financials	0.16	0.00	0.53***	0.07	15.98***
	(1.57)		(9.41)		
Utilities	0.01	0.00	0.16	0.00	6.50***
	(0.02)		(1.53)		
Total market index	0.70***	0.03	0.98***	0.16	15.88***
(emerging countries)	(5.33)		(15.31)		

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

is still low enough to potentially offer international diversification benefits.

The relationship between the U.S. sectors and emerging market sectors is examined in table 6. The emerging market data is limited to two 60- month periods from 1991–2000. Compared with the developed sample during 1991–1995, the emerging sample beta coefficients are lower in magnitude and significance levels. Every sector beta in the developed sample is significant at the 1% level, while only four out of ten emerging market sector betas are significant during the same period. However, during 1996–2000, all of the emerging beta coefficients are

significant at the 1% level except for the utilities sector. Likewise, the adjusted R^2 are all close to zero during 1991–1995, but rise to more measurable levels during 1996–2000 in most cases. The Chow test indicates a significant structural change in the model between the two time periods.

The emerging total stock market indexes panel regressed on the U.S. total market index indicate a rise in the explanatory power of the U.S. total market over time. The R^2 increases from 0.03 (1991–1995) to 0.16 (1996–2000). A Chow test confirms a significant structural change. Similar to the developed markets, the emerging R^2 in the last period (1996–2000) is higher than the individual sectors. Thus, the potential benefits of emerging market investments are likely higher on a sector basis rather than a country basis, which is consistent with the predictions by Meric et al. (2001) and Serra (2000). One exception is the information technology sector, which has similar R^2 statistics compared with the total market index over time.

In sum, the panel regressions measure the cross-sectional and time series relationship of the U.S. markets' explanatory power of foreign markets. From the perspective of a U.S. investor, the more that U.S. sectors explain movements of foreign sectors, the less value the foreign sectors provide in diversification benefits. While there is some variability in the developed sample beta coefficients during the four investment periods, the adjusted R^2 and *t*-statistics are generally highest in the most recent investment period. The low beta coefficients and R^2 during 1991–1995 in the emerging sample illustrate a potentially large portfolio diversification benefit. The rising magnitudes, significance levels, and R^2 in the emerging sample indicate that the diversification benefits of emerging market investment may diminish over time. Although the U.S. sectors appear closer to the foreign sectors in many cases in the most recent period, the betas and R^2 are still low enough to potentially provide international diversification benefits.

C. Asymmetry Analysis

One shortcoming of the prior tests is that the estimated coefficients do not depend on the sign of the coefficients, i.e., changes in U.S. stock returns are assumed to have symmetrical effects on foreign stock returns. Erb et al. (1995) demonstrate that correlation and volatility between major stock indexes is higher in U.S. down markets. In order to detect asymmetrical relationships among international sectors, define

TABLE 7. Asymmetry Analysis. Generalized Least Squares (GLS) Estimates from Developed Foreign Markets/Sectors Panel Regressed on Positive and Negative Movements of U.S. Markets/Sectors using a Random–Effects Model. *POS* & *NEG* Coefficients, and *F*–Statistics for Equality Tests (*POS*=*NEG*) reported.

	1981–1985			1986–1990		
Sector:	*POS*	*NEG*	*POS*=*NEG*	*POS*	*NEG*	*POS*=*NEG*
Basic industries	0.43***	0.33***	0.33	0.10	0.95***	31.42***
Cyclical goods	0.13	0.37*	0.69	0.04	0.99***	20.63***
Cyclical services	0.49***	0.21	6.35***	0.17***	0.66***	11.17***
General Ind.	0.40***	0.15	1.89	0.14	0.88***	23.45***
Info. Technology	0.38**	0.37	0.00	0.17*	0.44***	2.40
Noncycl. goods	0.61***	0.16	2.72*	0.35***	0.44***	0.36
Noncycl. .services	0.01*	0.17	0.22	0.10	0.56***	4.90**
Resources	0.84***	0.68***	0.40	0.28***	0.63***	3.16*
Financials	0.37***	0.12	1.89	0.05	0.42***	6.54***
Utilities	0.96***	–1.05***	27.45***	0.46***	–0.02	3.33*
Total market index (developed countries)	0.42***	0.65***	1.36	0.34***	0.66***	4.29**

(*Continued*)

TABLE 7. (Continued)

	1991–1995			1996–2000		
Sector:	*POS*	*NEG*	*POS=NEG*	*POS*	*NEG*	*POS=NEG*
Basic industries	0.62***	0.65***	0.02	0.39***	0.74***	15.88***
Cyclical goods	0.21*	0.79***	6.03***	0.36***	0.39***	0.81
Cyclical services	0.25***	0.29**	0.04	0.45***	0.49***	0.07
Gen. Industrials	0.64***	0.61***	0.02	0.56***	1.08***	13.89***
Info. Technology	0.45***	0.43**	0.00	0.52***	0.77***	2.91*
Noncycl. goods	0.44***	0.16	2.07	0.67***	0.26***	7.18***
Noncycl. services	0.18	0.41**	0.66	0.66***	0.74***	0.14
Resources	0.74***	0.72***	0.01	0.57***	0.54***	0.04
Financials	0.24**	0.66***	3.76**	0.43***	0.62***	3.75**
Utilities	0.50***	0.33**	0.47	–0.01	0.07	0.21
Total market index (developed countries)	0.76***	0.98***	0.86	0.57***	0.94***	9.99***

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

two series (POS and NEG) that contain only positive and negative changes in U.S. stock sector returns (USSTK), respectively:

$$POS = \begin{Bmatrix} POS....if\ (USSTK > 0) \\ 0.....if\ (USSTK \leq 0) \end{Bmatrix}$$

$$NEG = \begin{Bmatrix} NEG....if\ (USSTK < 0) \\ 0.....if\ (USSTK \geq 0) \end{Bmatrix}$$

Asymmetry tests are then conducted using a GLS panel regression on the following model:

$$FOR_{i,t} = \alpha_{i,t} + \beta_{i,t} POS_{i,t} + \gamma_{i,t} NEG_{i,t} + \varepsilon_{i,t} \qquad (3)$$

POS and *NEG* coefficients, equality tests, and significance levels for the developed country sample are provided in table 7. The equality tests provide an *F*-statistic which tests the null hypothesis that the coefficients are symmetrical, H_0: $POS = NEG$. The coefficients vary greatly across sectors and over time, but are generally within the range of 0.00 to 1.00. The larger the relative magnitude and significance levels of the coefficients, the closer the relationship between the U.S. and foreign sectors. As this relationship becomes closer, the benefits of international diversification may diminish. Out of the 40 equations estimated (10 industries × 4 periods), 18 equations demonstrate statistically significant asymmetry.

The asymmetrical effects between the U.S. total market index and the foreign total market indexes within the developed sample are provided in the last row of table 7. All of the positive and negative coefficients are significant during each period, but the relative magnitude of the negative coefficients is consistently higher. The equality tests only indicate a significant difference between the positive and negative coefficients during 1986–1990 and 1996–2000. In sum, it appears that the correlation between the U.S. and foreign markets is generally higher during downturns in the U.S. market. However, many sectors (noncyclical services and resources) provide little or no evidence of asymmetry. Depending on the time period, it may be possible to

minimize higher overall correlations between international stock returns due to downturns in the U.S. market by investing on a sector basis. It should be noted that severe downturns (e.g. 1987 crash) are not tested, which are probably unavoidable in all markets and sectors.

Asymmetry analysis for the emerging market sectors is presented in table 8. While several of the *POS* and *NEG* coefficients are significant during 1991–1995, the equality tests indicate that asymmetry exists in only two sectors. The noncyclical services and financials sectors demonstrate a significant response to downturns in the corresponding U.S. sectors. The correlation between U.S. sectors and most emerging sectors does not appear to increase in either up or down movements in U.S. sectors during this time period. The most recent time period (1996–2000) indicates a substantial increase in the magnitude and significance levels of most *POS* and *NEG* coefficients. Of the four cases of significant equality tests (*POS*=*NEG*), the correlation between U.S. and emerging sectors is always higher during downturns in the U.S. sectors than upturns.

The emerging total market indexes are panel regressed on the U.S. total market index to test for asymmetry. The findings in the last row of table 8 show that emerging total market indexes are significantly related to the U.S. total market during both downturns and upturns in the U.S. market. Equality tests indicate that the correlation between emerging markets and the U.S. is higher during downturns in the U.S. market relative to that during upturns. The emerging market results are consistent with the developed market results; correlations between U.S. and foreign sectors are generally higher in the most recent period (1996–2000) during downturns in the U.S. market. Compared to the developed markets, the emerging sample contains more sectors that do not have an asymmetrical effect. That is, there are potentially greater international diversification benefits among emerging sectors that are less correlated with U.S. sectors during downturns in the U.S. However, based on the limited emerging sample period (1991–2000), the correlations between emerging and U.S. sectors appear to be increasing over time.

D. Optimal Sector Allocation

It is possible that arbitrarily selecting foreign sectors or country indexes may offer some diversification benefits. Even a random selection of stocks will reduce portfolio risk. Of course, professional investors do

TABLE 8. Asymmetry Analysis. Generalized Least Squares (GLS) Estimates from Emerging Foreign Markets/Sectors Panel Regressed on Positive and Negative Movements of U.S. Markets/Sectors Using a Random–Effects Model. *POS* & *NEG* Coefficients, and *F*–Statistics for Equality Tests (*POS*=*NEG*) reported.

	1991–1995			1996–2000		
Sector:	*POS*	*NEG*	*POS=NEG*	*POS*	*NEG*	*POS=NEG*
Basic industries	0.31	0.58**	0.43	0.53***	0.85***	3.10*
Cyclical goods	0.26	–0.05	0.40	0.18	0.23	0.01
Cyclical services	–0.03	0.22	0.28	0.66***	0.64***	0.00
Gen. Industrials	0.32	0.70**	0.65	0.68***	1.51***	5.92***
Info. Technology	0.67**	–0.42	2.08	0.57***	1.03***	2.56
Noncycl. goods	0.53***	0.07	1.67	0.36***	0.54***	0.63
Noncycl. services	–0.34	0.61**	4.34**	0.45***	1.03***	4.60**
Resources	0.19	–0.11	0.28	0.75***	0.40**	1.80
Financials	–0.07	0.57**	2.93*	0.25***	0.86***	10.10***
Utilities	0.33	–0.41	1.30	0.18	0.12	0.03
Total market index (emerging countries)	0.42***	1.26***	2.83*	0.55***	1.50***	17.19***

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

not select stocks at random. To demonstrate the potential benefit of fundamental analysis for international sector allocation, optimal efficient portfolios are formed over four 60-month investment periods from 1981–2000. As this procedure is performed on an ex post basis, the selected assets are not recommendations for future investment. The purpose of this procedure is to illustrate the benefits of international sector investments relative to U.S. sector investments and country index investments over time.

Markowitz mean-variance (MV) optimization is used to obtain the optimal portfolios. The model for portfolio optimization is based on the following:

$$MAX\,\Theta = \frac{E\left(r_p\right)}{\sigma_p} \tag{4}$$

subject to:

$$E\left(r_p\right) = \sum_{i=1}^{N} x_i E\left(r_i\right)$$

$$\sum_{i=1}^{N} x_i = 1$$

and

$$x_i \geq 0, i = 1, \ldots N$$

where $E(r_p)$ represents the expected return of the portfolio, σ_p is the portfolio standard deviation, x^T is the transpose of a vector of risky assets weights, and S is the sample variance-covariance matrix. The portfolio is MV efficient for a given level of portfolio expected return. The model does not allow for short sales or risk free investments. As a result, the efficient portfolio weights are further constrained to sum to 1.0 and to have nonnegative values. The efficient frontier is computed using 500 efficient portfolios. The investments that maximize the portfolio return-to-risk ratio ($MAX\,\Theta$) are reported.

The results for six variations of optimized portfolios are presented in table 9. Four of the variations are constrained to invest 80% in the U.S. market to mimic the allocation of an average U.S. pension fund. Restricting the portfolio to invest 80% in the U.S. ensures that sufficient diversification is maintained (as noted in data section, numerous foreign

TABLE 9. Summary Statistics for Markowitz Mean–Variance Efficient Portfolio Optimization. Comparison of Market and Sector–Based Investment Strategies in Developed and Emerging Markets. Emerging Market data is unavailable prior to 1991 (n/a).

	PORTFOLIO COMPOSITION					
Portfolio Attributes (all in %)	Total Market Index (U.S. only)	Total Market Indexes (Developed)	Total Market Indexes (Developed & Emerging)	Sectors (U.S. only)	Sectors (U.S. & Developed)	Sectors (U.S., (Developed & Emerging)
1996–2000						
Mean	1.30	1.63	1.50	1.37	1.75	1.91
Standard deviation	4.63	4.97	3.97	3.43	3.24	2.70
Maximum return/risk ratio	28.08	32.70	37.83	39.81	54.09	70.85
% invested in U.S.	100.00	80.00	80.00	100.00	80.00	80.00
% in Developed		20.00	1.03		20.00	1.20
% in Emerging			18.97			
1991–1995						
Mean	1.16	1.26	1.40	1.50	1.85	1.68
Standard deviation	2.51	2.43	2.50	2.88	2.69	1.88
Maximum return/risk ratio	46.22	52.08	56.05	52.19	68.81	89.16
% invested in U.S.	100.00	80.00	80.00	100.00	80.00	80.00
% in developed		20.00	6.57		20.00	1.46
% in Emerging			13.43			18.54

(*Continued*)

TABLE 9. (Continued)

	PORTFOLIO COMPOSITION					
Portfolio Attributes (all in %)	Total Market Index (U.S. only)	Total Market Indexes (Developed)	Total Market Indexes (Developed & Emerging)	Sectors (U.S. only)	Sectors (U.S. & Developed)	Sectors (U.S., (Developed & Emerging)
1986–1990						
Mean	0.72	0.96	n/a	1.57	1.81	n/a
Standard deviation	5.43	4.84	n/a	5.67	5.00	n/a
Maximum return/risk ratio	13.26	19.78	n/a	27.68	36.10	n/a
% invested in U.S.	100.00	80.00		100.00	80.00	
% in Developed		20.00			20.00	
1981–1985						
Mean	0.83	0.96	n/a	1.17	1.67	n/a
Standard deviation	3.60	3.33	n/a	2.88	2.53	n/a
Maximum return/risk ratio	23.05	28.84	n/a	40.63	66.17	n/a
% invested in U.S.	100.00	80.00		100.00	80.00	
% in Developed		20.00			20.00	

sectors may contain a limited number of equities). The remaining two variations invest 100% in the U.S.,and are provided for comparison purposes only.

Referring to the most recent period (1996–2000), it is clear that the return/risk ratios are increasing across variations of the model. For comparison purposes, the first column on the left-hand side provides the return/risk profile for a 100% investment in the U.S. total market index. The mean (1.30%) and standard deviation (4.63%) produce a return/risk ratio of 28.08%. The second variation allows for 80% investment in the U.S. total market index, and 20% in other developed total market indexes.(There are 17 remaining developed market indexes that may be included in the 20% asset allocation). The return/risk ratio is 32.70%, which is an improvement in performance from the 100% U.S. total market index portfolio.

The third variation constrains 80% investment in the U.S. total market index, but allows 20% in foreign total market indexes selected from 17 developed and 20 emerging market indexes. The return/risk ratio increases to 37.83%. The fourth variation is an optimized portfolio allocated among 10 U.S. sectors only, and is also provided for comparison purposes. The return/risk ratio (39.81%) is higher than in the previous three variations of the model that invests in only total market indexes. The fifth variation expands sector investments into 80% U.S. sectors and 20% selected from approximately 170 developed market sectors. The return/risk ratio (54.09%) is a substantial improvement over the U.S. sectors only portfolio (39.81%). The final variation constrains 80% in U.S. sectors, and 20% selected from approximately 170 developed market sectors and 200 emerging market sectors. There is another large increase in the return/risk ratio to 70.85%. It is worthwhile to note that the 20% invested in foreign sectors is comprised of 18.80% emerging sectors, and 1.20% developed sectors as determined by the optimal asset allocation model.

Table 10 contains the composition of the market and sector based optimized portfolios for the 1996–2000 sub period. Again, the first model variation is invested 100% in the U.S. total index provided for comparison purposes only. The second variation is restricted to invest 80% in the U.S. total market index, while the model selects the total market indexes of Denmark (6.41%), Finland (2.00%), France (6.59%), and Italy (5.00%) to represent the remaining 20% of the portfolio among a choice of 17 developed equity markets. When the total market index model is open to all countries, the optimal portfolio consists of

investments in U.S. (80%) and Finland (1.03%), with the remaining 18.97% allocated among Chile (2%), Greece (4%), Hong Kong (0.18%), India (4%), Poland (1.72%), Portugal (4%), and Turkey (3.07%).

When sector investment is allowed, the U.S. only model selects general industrials (23%), noncyclical goods (32%), utilities (33%), and information technology (12%) as the optimal investment sectors. When all developed market sectors are allowed, eight sectors from Denmark, France, Ireland, Italy, and the U.K. are included in addition to four U.S. sectors. When all sectors (developed and emerging) are available for investment, the model selects 24 developed market sectors (excluding the U.S.), four U.S. sectors, and 17 emerging sectors. The emerging sectors represent 18.8% of the portfolio. As some emerging sectors may either be thinly traded or dominated by only a few firms, portfolio managers must be cautious in making investment decisions to ensure adequate diversification.

Depending on the sample size, it appears that some sectors are more important than other sectors. In the U.S. only sector selection, only four sectors are included as noted above. When the sample is expanded to all developed markets, seven of the 10 sector groups are chosen. When all developed and emerging sectors are available, all 10 sectors are included in the model. With the widest possible selection of sectors available for investment, the model selects the widest variety of sectors producing the maximum return/risk ratio.

A similar pattern is observed in earlier periods as in the most recent period. In sum, the findings demonstrate that sector investments across countries are superior to investing in a total market index across countries regardless of the time horizon selected.(The U.S. only sector portfolio does not outperform the total market index portfolio that includes developed and emerging markets in the 1991–1995 period, but does surpass the U.S. total market index portfolio in that period.) A U.S. investor in total market indexes or sectors will achieve greater performance by including foreign investments, particularly emerging markets. The earliest two periods (1981–1985 and 1986–1990) do not include emerging market investments due to data limitations. However, sector based investment between developed markets produces substantially higher return/risk ratios than total market index investment.

Once again, this evidence is consistent with the prediction of greater diversification benefits from investing in sectors across countries rather than solely in well diversified country index portfolios as posited by

TABLE 10. Markowitz Mean-Variance Efficient Portfolio Optimization. Composition of Market And Sector-Based Investment Strategies in Developed And Emerging Markets For The Subperiod 1996–2000.

Total Market Indexes (Developed)	Total Market Indexes (Developed & Emerging)	Sectors (U.S. only)
80% U.S.	80% U.S.	23% Gen. Ind.
6.41% Denmark	1.03% Finland	32% Non-cycl. gds
2.00% Finland	2.00% Chile	33% Utilities
6.59% France	4.00% Greece	12% Info. Tech.
5.00% Italy	0.18% H. Kng	
	4.00% India	
	1.72% Poland	
	4.00% Portugal	
	3.07% Turkey	

(*Continued*)

Serra (2000) and Meric et al. (2001). Ex post portfolio optimization includes assets that stochastically dominate other assets historically. Unfortunately, ex ante knowledge of superior performing countries and sectors is unknown. The goal here is not to forecast which countries and sectors to invest in, but to simply show that sector investment is the potentially dominant strategy of well diversified portfolios.

V. Conclusions

This paper examines the changes in international equity sector and country index correlations from 1981–2000, and assesses the impact on portfolio diversification benefits over time from the perspective of a U.S. investor. The correlation and panel data analyses demonstrate that total market index integration is rising over time. Foreign sectors are also more highly integrated with U.S. sectors when comparing the first sub period (1981–1985) with the last sub period (1996–2000). Panel data tests confirm the existence of asymmetry in certain sectors, which generally react more to downturns in U.S. markets than upturns.

Why are some foreign sectors more highly correlated with U.S. sectors than others? There are at least two main factors to explain this. First, the level of integration between international economies accounts for the increase in sector and total market indexes. This is evidenced as

TABLE 10. (Continued)

Sectors (U.S. & Developed)	Sectors (U.S., Developed & Emerging)	
18.40% Gen. Ind. (U.S.)	0.03% ncycl. gds (Belgium)	15.25% gen. ind. (U.S.)
25.6% Non-cycl. Goods (U.S.)	0.02% cycl. srv (Belgium)	34.06%ncycl. gds (U.S.)
26.40% Utilities (U.S.)	0.05% ncycl. srv. (Canada)	20.59% utilities (U.S.)
9.60% Info. Tech. (U.S.)	0.07% financials (Canada)	10.10% info. tech. (U.S.)
5.00% Gen. Ind. (Denmark)	0.06% basic ind. (Denmark)	0.34% basic (Greece)
1.38% Non-cycl. Gds (Denmark)	0.08% cycl. gds (Denmark)	3.95% cycl. srv (Greece)
0.21% Financials (Denmark)	0.07% ncycl. srv. (Dnmrk)	1.19%info.tech. (Greece)
0.14% Non-cycl. Gds (France)	0.06% basic ind. (France)	0.38%financials (Greece)
0.32% Non-cycl. Srvcs (France)	0.03% gen. ind. (France)	0.60% resource (H. K.)
4.14% Cycl.-Srvcs (Ireland)	0.10% info. tech (France	2.00% utilities (H. Kong)
3.81% Non-cycl. Srvcs (Italy)	0.01% financials (France)	0.60% info. tech. (H. K.)
5.00% Info. Tech. (U.K.)	0.07% basic ind.(Germany)	0.22% basic ind. (India)
	0.09% gen. ind.(Germany)	0.45% ncycl. gds (India)
	0.05% cycl. srv. (Germany)	0.20% cycl. srv (India)
	0.05% basic ind. (Ireland)	0.80% utilities (India)
	0.05% cycl. gds. (Ireland)	2.72% info. Tech. (India)
	0.01% cycl. gds. (Italy)	0.10% financials (India)
	0.10%resource(Nethlnd)	0.60%resource(N.Z.)
	0.06% cycl. gds. (Nethlnd)	0.62% gen. ind. (N. Z.)
	0.01% financials (Norway)	0.43% cycl. gds. (N. Z.)
	0.02% basic ind. (Norway)	3.60%cycl. srv. (Taiwan)
	0.02% basic ind. (Swtzerlnd)	
	0.05% financials (Swtzerlnd)	
	0.05% resource (UK)	

the U.S. is more highly correlated with developed markets compared with emerging markets. The dramatic increase in correlations between U.S. and emerging markets during the 1990's also reflects the increase in trade and investments between these entities. Second, some sectors are impacted more from local rather than global factors. For example, information technology firms tend to trade in line with each other both nationally and internationally according to global demand for their products. Utilities, for the most part, depend more on domestic factors such as local consumption and government policy. Decisions on public expenditure, employment policies, and tax systems all continue to segment markets to an extent.

Since the level of correlation is a significant determinant of the benefits of international diversification, a portfolio optimization model

is utilized to demonstrate the value of fundamental sector analysis in foreign investment to U.S. investors. The model assumes the position of a typical U.S. pension fund that invests 80% in the U.S. and 20% internationally. Several variations of the model are tested that specifically include or exclude total market indexes, sector only investments, investments in developed markets, and investments in emerging markets.

The results clearly indicate on an ex post basis the superiority of asset allocation strategies that utilize sector based investing across countries compared with total market index investments. Also, portfolios that include investment in emerging markets provide superior return/risk ratios than portfolios that only invest in developed markets.

Although correlations between U.S. and most other markets and sectors have increased dramatically over the past 20 years, careful sector or total market index investment may provide significant international diversification benefits to a U.S. investor's portfolio. As this procedure is performed on an ex post basis, it is not appropriate to use these portfolio weights in future investments. Dahlquist and Harvey (2001) provide a strategy for a forward-based portfolio model.

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