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Sector Integration and the Benefits of Global Diversification[1]

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One of the main reasons that financial analysts 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 significantly enhances the return-to-risk performance of international portfolios.

1 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 correlations increase during periods of greater economic integration as is apparent during the late 19th and 20th centuries (Goetzmann et al., 2001). 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

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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 boom in 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 indices (i.e., Dow, Nikkei, FTSE, etc.) that are linked, but industries and individual firms are also 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.

The purpose of this study is to examine the increase in correlation that world markets experienced from 1981 – 2000 and to assess any subsequent loss of global diversification benefits. Goetzmann et al. (2001) 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 most from investing in selected industries or securities in these countries.

This study examines the proposition that sector investing is potentially more beneficial than market index investing. 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. The goal of this paper is to demonstrate to what extent the increase in international market/sector correlation has affected the benefits of portfolio diversification. This article adds to the existing literature by analyzing international portfolio diversification using a sector-based approach and an optimal global asset allocation strategy to demonstrate the benefits of foreign investing to U.S. investors.

2 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 stabilized 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 they also have low stock market correlation 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 conflicting results. Beckers et al. (1996) examine country and industry factors, but do 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.

3 DATA

The sample consists of U.S. dollar-denominated total monthly returns for 38 countries available in the *Datastream* database 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*. In addition to each country's total stock market index, 10 industrial sectors within each of the markets are included (in some countries, particularly emerging markets, 10 industrial sectors may not exist).

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, non-cyclical consumer goods, non-cyclical 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 Depository 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 1995), and Period IV (January 1996 – December 2000). Data from October 1987 are removed from the analysis.

Statistics for the total stock market indexes of each country are presented in table 1. Monthly means, standard deviations, minimum and maximum returns demonstrate the relative risk-return tradeoff between developed and emerging markets. Among developed countries Finland (1.88%) has the highest monthly mean and Australia (.56%) has the lowest. Standard deviation of returns is highest for Finland (7.85%) and lowest for the U.S. (3.85%). 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. It is not appropriate to

directly compare the developed sample descriptive statistics with the emerging sample because the developed countries data range from 1981 – 2000, while the emerging sample is from 1991 – 2000.

Monthly means, standard deviations, minimum and maximum returns 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, information technology (1.26%) has the highest mean return and resources (.63%) has the lowest. The standard deviation is highest for information technology (10.16%) and lowest for non-cyclical goods (6.79%). Among the emerging sectors, information technology (1.64%) has the highest mean return, while cyclical goods (-.11%) has the lowest. The standard deviation of information technology (19.35%) is also highest and non-cyclical goods (10.58%) has the lowest. Again, as the developed data begin in 1981 and the emerging data in 1991, it is inappropriate to directly compare the two samples in this table. Subperiod analysis is provided in later sections to allow for direct comparisons.

4 METHODOLOGY AND RESULTS

4.1 Correlations Over Time

Low correlation 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 county-by-country basis. Since there are close to 380 separate series (not including the total market series), sector correlations are averaged across countries. The average between-country sector correlations for four 60-month investment periods are given in table 3.

Several conclusions can be drawn from the results. The average correlation of the U.S. total market with other developed markets steadily increasing from 0.31 in 1981-1985 to .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 volatility between periods. However, the fourth period correlations are typically two or three times higher than the first period in eight of

the ten sectors. The two notable exceptions are the resources sector with fairly consistent correlations, and the utilities sector with very low correlations.

The trend in correlation between the U.S. and emerging markets is 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 .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 non-cyclical goods, utilities).

In sum, the rising correlations indicate a potential loss in international 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 have been increasing over time, the level of correlation with the U.S. market has remained lower for emerging markets compared to developed markets.

4.2 *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 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-section disturbances.

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

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

assuming that: $u_i \sim N(0,\sigma_u^2)$ = cross-section error component

$v_t \sim N(0,\sigma_v^2)$ = time series error component

$w_{i,t} \sim N(0,\sigma_w^2)$ = combined error component

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

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

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

$$FOR_{i,t} = \alpha_{i,t} + \beta_{i,t} US_{i,t} + \varepsilon_{i,t} \qquad (2)$$

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 is 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 4 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 is not similar within specific time periods. For example, the betas between sectors vary

from a statistically insignificant .07 (non-cyclical services) to a significant .76 (resources) during the 1981-1985 period. The relatively larger and more significant the beta coefficient, the closer 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, such as non-cyclical goods, experience fairly equivalent betas across time periods, while other sectors have a 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 (.07) and 1996-2000 (.09). For most sectors the difference in adjusted R^2 between the third and fourth periods is substantially larger as in non-cyclical services [.00 (1991-1995) which increases to .16 (1996-2000)]. A Chow test is performed detecting a significant structural change in the model between the periods 1991-1995 and 1996-2000. The F-statistics reported in table 4 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 non-cyclical goods significant at the 5% level.

The last row of table 4 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 .54 (1981-1985) to .73 (1996-2000). More telling is the rise in adjusted R^2 from .05 in the first period to .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 resources sector in the first period has an R^2 of .17 compared with the R^2 of the total market index of .05. However, even an R^2 of .33 for the total market index in the most recent period 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 5. 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. 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 indicates a rise in the explanatory power of the U.S. total market over time. The R^2 increases from .03 (1991-1995) to .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 on a country basis, 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.

4.3 *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 two series (*USPOS* and *USNEG)* that contain only positive and negative changes in U.S. stock sector returns, respectively:

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

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

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

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

POS and *NEG* coefficients, equality tests, and significance levels for the developed country sample are provided in table 6. The equality tests provide an F-statistic which tests the null hypothesis that the coefficients are symmetrical, H_o: POS=NEG. The coefficients vary greatly across sectors and over time, but are generally within the range of 0.00 to $\pm$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 X 4 periods), 17 demonstrate statistically significant asymmetry. Of these 17 cases, 76% indicate that sectors are more highly related during negative changes in U.S. sectors compared to positive changes.

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 6. 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 (non-cyclical 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. the 1987 crash), which are probably unavoidable in all markets and sectors, are not tested.

Asymmetry analysis for the emerging market sectors is presented in table 7. 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 non-cyclical 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 during 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 7 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 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.

4.4 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. In reality, however, professional investors do not select stocks at random because to do so ignores the risk characteristics of the underlying securities. To demonstrate the potential benefit of 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:

$$MAX\Theta = \frac{E(r_p)}{\sigma_p} \qquad (4)$$

subject to: $\sum_{i=1}^{N} x_i = 1$ and $x_i \geq 0, i = 1,...N$

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

$$\sigma_p = \sqrt{x^T S x}$$

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, and Sx is the 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 up to 1.0 and to have nonnegative values. The efficient frontier is computed using 500 portfolios. The investments that maximized the portfolio return-to-risk ratio ($MAX\Theta$) are reported.

The results for six variations of optimized portfolios are presented in table 8. 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. The remaining two variations invest 100% in the U.S. and are provided for comparison purposes only. While each variation of the model provide specific asset allocation weights (among roughly 380 sectors in some cases), only summary statistics are provided here. (Detailed asset allocation weights are available upon request).

Referring to the most recent period (1996-2000), it is clear that the return/risk ratios increase 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%) produces 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 investment to 80% 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 the previous three variations of the model that invest only in 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 investment to 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.

A similar pattern is observed in earlier periods as in the most recent period. In sum, sector investments are superior to total market index investments regardless of the time horizon selected. (The U.S. sector only 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 industries rather than solely in well-diversified country index portfolios as posited by Serra (2000) and Meric et al. (2001).

5 CONCLUSIONS

This paper examines the changes in international equity sector and country index correlations from 1981-2000, and assesses the impact of 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 subperiod (1981-1985) with the last subperiod (1996-2000). Panel data tests do confirm the existence of

asymmetry in certain sectors, which generally react more to downturns in U.S. markets than to 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 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 1990s 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.

Since the level correlation is a significant determinant of benefits of international diversification, a portfolio optimization model is utilized to demonstrate the value of 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 the superiority of asset allocation strategies that utilize sector-based investing 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. Lastly, 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 still provides significant international diversification benefits to a U.S. portfolio.

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Table 1 - Descriptive statistics for country indexes. U.S. dollar monthly returns (in %). Developed countries (1981 – 2000). Emerging countries (1991 – 2000).

	Series	Mean	Std dev.	Min.	Max.
Developed:	Australia	0.56	6.31	-18.05	17.11
	Austria	0.76	6.83	-19.79	29.60
	Belgium	0.96	5.20	-18.61	21.79
	Canada	0.75	4.85	-22.90	14.69
	Denmark	1.10	5.35	-14.30	19.80
	Finland	1.88	7.85	-24.19	32.69
	France	0.99	6.16	-30.28	17.02
	Germany	0.94	5.32	-14.78	17.00
	Ireland	1.12	6.27	-20.91	23.75
	Italy	0.79	7.41	-25.69	24.75
	Japan	0.72	7.21	-25.90	22.33
	Netherlands	1.16	4.37	-11.96	12.01
	Norway	0.89	7.53	-33.00	21.70
	Spain	1.00	6.62	-20.70	27.04
	Sweden	1.30	6.18	-18.27	16.60
	Switzerland	1.17	4.91	-16.12	19.33
	U.K.	0.92	5.02	-17.25	14.33
	U.S.	1.11	3.85	-11.79	13.26
Emerging:	Argentina	1.46	12.10	-28.08	70.55
	Brazil	2.49	16.03	-49.49	45.53
	Chile	0.98	7.36	-25.87	16.81
	China	1.89	11.93	-20.71	64.76
	Greece	0.58	9.27	-26.88	30.16
	Hong Kong	1.27	8.52	-28.15	26.02
	India	0.32	11.36	-40.18	43.81
	Indonesia	-1.33	13.46	-48.58	44.23
	Korea	-0.30	12.40	-38.47	49.15
	Malaysia	0.13	11.36	-39.01	37.12
	Mexico	0.87	10.65	-41.94	20.92
	New Zealand	0.32	6.24	-19.69	19.81
	Philippines	0.53	10.27	-31.16	42.08
	Poland	-0.80	13.95	-43.44	32.39
	Portugal	0.53	6.03	-18.46	25.69
	S. Africa	0.21	7.82	-41.63	27.83
	Singapore	0.40	6.93	-21.77	26.19
	Taiwan	0.16	10.27	-22.89	41.91
	Thailand	-0.58	12.48	-39.67	41.29
	Turkey	0.31	18.25	-54.77	50.82

Table 2 -Descriptive statistics for sector indexes. U.S. dollar monthly returns (in %). Developed countries (1981 – 2000). Emerging countries (1991 – 2000).

Series	Mean	Std dev.	Min.	Max.
Developed countries:				
Basic industries	0.70	7.39	-40.49	30.91
Cyclical goods	0.77	8.77	-62.21	47.85
Cyclical services	0.95	7.70	-79.25	117.00
General Industrials	0.76	7.36	-48.45	39.99
Information Technology	1.26	10.16	-57.64	47.77
Non-cyclical goods	1.13	6.79	-46.73	41.52
Non-cyclical services	1.20	8.01	-30.75	54.90
Resources	0.63	8.51	-77.86	76.75
Financials	0.92	7.29	-37.67	45.78
Utilities	0.75	7.01	-36.87	41.76
Emerging countries:				
Basic industries	0.06	13.64	-109.86	100.80
Cyclical goods	-0.11	13.49	-81.85	80.06
Cyclical services	0.38	13.08	-75.44	119.24
General Industrials	0.57	15.48	-197.29	304.36
Information Technology	1.64	19.35	-81.09	241.92
Non-cyclical goods	0.47	10.58	-69.31	73.15
Non-cyclical services	1.03	12.47	-71.40	68.26
Resources	0.40	14.97	-135.10	148.71
Financials	0.31	12.80	-80.93	96.64
Utilities	0.24	13.00	-81.09	60.61

Table 3 - 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
Non-cyclical goods	0.25	0.30	0.25	0.36
Non-cyclical 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
Non-cyclical goods	N/A	N/A	0.16	0.20
Non-cyclical 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 (.28) represents the average of the U.S. Basic industries with the Basic industries of each individual country during the first period.

Table 4 - 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	.39*** (8.10)	.06	.45*** (10.36)	.10	.63*** (11.16)	.10	.54*** (18.67)	.25	3.90***
Cyclical goods	.21*** (2.65)	.01	.50*** (8.52)	.09	.43*** (6.60)	.07	.38*** (9.18)	.09	3.87***
Cyclical services	.27*** (4.04)	.02	.40*** (9.22)	.08	.26*** (4.58)	.02	.47*** (12.07)	.13	6.85***
General Industrials	.29*** (5.92)	.04	.50*** (10.99)	.11	.63*** (9.62)	.08	.74*** (18.56)	.25	5.78***
Infor. Technology	.38*** (3.75)	.05	.30*** (5.67)	.07	.45*** (6.15)	.06	.64*** (15.20)	.25	6.46***
Non-cyclical goods	.45*** (6.30)	.04	.38*** (7.88)	.07	.36*** (6.81)	.04	.49*** (10.86)	.10	3.02**
Non-cyclical services	.07 (.74)	.00	.34*** (5.25)	.03	.28*** (3.39)	.00	.70*** (12.04)	.16	6.86***
Resources	.76*** (10.23)	.17	.41*** (6.18)	.04	.73*** (11.11)	.12	.56*** (13.13)	.20	4.43***
Financials	.29*** (5.86)	.03	.22*** (5.34)	.02	.40*** (6.51)	.03	.52*** (16.19)	.22	6.39***
Utilities	.11 (1.00)	.00	.24*** (3.00)	.00	.42*** (5.40)	.03	.02 (.34)	.00	9.08***
Total market index(developed countries)	.54*** (10.28)	.05	.68*** (16.37)	.09	.74*** (13.93)	.12	.73*** (22.64)	.33	5.01***

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

Table 5 - 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		
Sector:	beta	adj. R^2	beta	adj. R^2	Chow F-stat
Basic industries	.41*** (3.54)	.00	.66*** (11.47)	.10	9.90***
Cyclical goods	.25*** (2.55)	.00	.31*** (4.45)	.01	3.05**
Cyclical services	.06 (.49)	.00	.65*** (6.65)	.06	11.25***
General Industrials	.44*** (3.38)	.00	.98*** (10.17)	.07	7.68***
Infor. Technology	.30 (1.53)	.03	.78*** (9.41)	.14	9.18***
Non-cyclical goods	.38*** (4.11)	.01	.44*** (6.61)	.03	9.49***
Non-cyclical services	.09 (.66)	.00	.73*** (9.39)	.08	12.63***
Resources	.06 (.36)	.00	.61*** (8.18)	.06	8.67***
Financials	.16 (1.57)	.00	.53*** (9.41)	.07	15.98***
Utilities	.01 (.02)	.00	.16 (1.53)	.00	6.50***
Total market index (emerging countries)	.70*** (5.33)	.03	.98*** (15.31)	.16	15.88***

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

Table 6 - 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			1991-1995			1996-2000		
Sector:	POS	NEG	POS=NEG	POS	NEG	POS=NEG	POS	NEG	POS=NEG	POS	NEG	POS=NEG
Basic industries	.43***	.33***	.33	.10	.95***	31.42***	.62***	.65***	.02	.39***	.74***	15.88***
Cyclical goods	.13	.37*	.69	.04	.99***	20.63***	.21*	.79***	6.03***	.36***	.39***	.81
Cyclical services	.49***	.21	6.35***	.17***	.66***	11.17***	.25***	.29**	.04	.45***	.49***	.07
Gen. Industrials	.40***	.15	1.89	.14	.88***	23.45***	.64***	.61***	.02	.56***	1.08***	13.89***
Infor. Technology	.38**	.37	.00	.17*	.44***	2.40	.45***	.43**	.00	.52***	.77***	2.91*
Non-cycl. goods	.61***	.16	2.72*	.35***	.44***	.36	.44***	.16	2.07	.67***	.26***	7.18***
Non-cycl. services	.01*	.17	.22	.10	.56***	4.90**	.18	.41**	.66	.66***	.74***	.14
Resources	.84***	.68***	.40	.28***	.63***	3.16*	.74***	.72***	.01	.57***	.54***	.04
Financials	.37***	.12	1.89	.05	.42***	6.54***	.24**	.66***	3.76**	.43***	.62***	3.75**
Utilities	.96***	-1.05***	27.45***	.46***	-.02	3.33*	.50***	.33**	.47	-.01	.07	.21
Total market index (developed countries)	.42***	.65***	1.36	.34***	.66***	4.29**	.76***	.98***	.86	.57***	.94***	9.99***

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

Table 7 - 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	.31	.58**	.43	.53***	.85***	3.10*
Cyclical goods	.26	-.05	.40	.18	.23	.01
Cyclical services	-.03	.22	.28	.66***	.64***	.00
Gen. Industrials	.32	.70**	.65	.68***	1.51***	5.92***
Infor. Technology	.67**	-.42	2.08	.57***	1.03***	2.56
Non-cycl. goods	.53***	.07	1.67	.36***	.54***	.63
Non-cycl. services	-.34	.61**	4.34**	.45***	1.03***	4.60**
Resources	.19	-.11	.28	.75***	.40**	1.80
Financials	-.07	.57**	2.93*	.25***	.86***	10.10***
Utilities	.33	-.41	1.30	.18	.12	.03
Total market index (emerging countries)	.42***	1.26***	2.83*	.55***	1.50***	17.19***

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

Table 8 - 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
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*			*18.80*
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
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*
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
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
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*	