not be appropriate to compute the returns of these portfolios, and the profit reported here may be overstated.

Widely held stocks such as those of large firms are not candidates for this kind of price pressure. Institutional investors who manage a large amount of money are likely to hold large-firm stocks and thus may not gain much from this simulation. On the other hand, individual investors may be able to make use of the results reported here if they believe the pattern will persist into the future.

CONCLUDING REMARKS

Results of this examination of anomalous stock price movements in the Japanese market indicate that the Tokyo market may have changed drastically since 1980. While the trading strategies employed here may be attractive to a certain type of investor, we cannot be sure that past patterns will persist into the future. As the Tokyo stock market has risen continuously over the last two decades, the enormous profit to be made by these trading strategies may simply be a result of the long bull market.

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[1] Some of the results in this section are based on Kato [1988a, 1988b] and daily return data provided by the Yamaichi Research Institute.

[2] Keim [1983] provides substantial evidence for the existence of this anomalous effect in the U.S. market. Similar results were obtained by other researchers such as Reinganum [1983], Roll [1983], and Givoly and Ovadia [1983].

[3] The June anomaly is observed during the non-trading period. The January effect is observed in both periods.

[4] I am grateful to M. Hotchi and M. Hokao at the Daiwa Securities Co. for helpful comments regarding this effect.

[5] K. Watanabe at Daiwa Securities provided helpful suggestions for this research.

[6] Because 1,000 shares is the minimum unit to be purchased for most Japanese stocks, it is assumed that average daily trading volume must be greater than 100,000 shares in order to avoid significant market impact.

Benefits of international diversification: The case of Pacific Basin stock markets

The benefits are substantial.

Warren Bailey and Rene M. Stulz

Recent international diversification literature uses monthly data from foreign stock markets to make the point that American investors should hold foreign stocks to reduce the variance of a portfolio of domestic stocks without reducing its expected return.[1] While this claim is the source of some debate, it has come to be believed that a well-managed equity portfolio should include positions in foreign stocks.

At the same time, little research has been produced that investigates the benefits of diversifying into the markets of the Pacific Basin. This article estimates these benefits using daily dollar returns for indexes from these markets. We also discuss the problems that arise in using daily returns to estimate the benefits from international diversification.

The issue of diversifying into Pacific Basin markets is interesting for a number of reasons. As a group these markets have a capitalization that exceeds the capitalization of the European markets and is not too different from the capitalization of the United States markets.[2] Although not all of these markets are equally open to foreign investors, they are rapidly becoming more accessible. The economies of most of the Pacific Basin countries generally have been healthy even when Western economies were in cyclical downturns. All this suggests that diversifying into the economies of these countries is likely to improve portfolio performance. Our analysis finds that these benefits are indeed substantial.

A superficial study of Pacific Basin markets could lead to an overly optimistic assessment of the diversification gains they provide. First, the benefits of international diversification are much lower if one compares Pacific Basin indexes to previous-day U.S. returns, instead of comparing same-day returns for both U.S. and Pacific Basin indexes. This is because U.S. returns typically lead rather than lag Pacific Basin returns.[3] With same-day returns, part of the U.S. return accrues after the Pacific Basin markets close; with U.S. returns lagged one day, part of the Pacific Basin return accrues after the U.S. markets close. Whether one uses same day U.S. returns or lagged U.S. returns, the measurement intervals for the returns overlap by a similar number of hours, so that there is no good reason to prefer one approach instead of the other on theoretical grounds.

Second, because Pacific Basin stock returns do not follow a random walk, it turns out that the benefits of international diversification decrease as the returns are computed over a longer holding period.[4] This is because U.S. and Pacific Basin stock price movements are more closely related if one uses weekly or monthly data rather than daily data.

Finally, many of the Pacific Basin markets have turnover taxes, limited liquidity, and barriers to international investment that cause the observed re-

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turns to exceed the returns available to U.S. investors.

PACIFIC BASIN INDEXES

Our study uses daily U.S. dollar returns for nine Pacific Basin stock market indexes and the U.S. S&P 500 index from the beginning of January 1977 to the end of December 1985. For each Pacific Basin country, we use a major broad-based index published in that country and use daily exchange rates to compute returns in U.S. currency.[5] The indexes are:

1. The Australian All-Ordinaries Share Price Index. This is a capitalization-weighted index of a sample of companies (between 250 and 300 for our sample period) covering nearly 90% of the market's capitalization.[6]
2. The Hong Kong Hang Seng Index, a capitalization-weighted index of thirty-three major companies. It represents 70% of total market capitalization.
3. The Japan Nikkei Dow 225 Index. This index is an unweighted average of the prices of 225 stocks listed on the Tokyo Stock Exchange.
4. The Malaysia Industrials and Commercials Index, which is an index of selected stocks. We have been unable to find a precise description of how it is computed.
5. The Philippines Manila Mining Index, a weighted average of the last daily transaction prices for nine mining shares. The weights are determined by the par values of the shares.
6. The Singapore All-Share Index. This is a capitalization-weighted index of virtually all shares traded on the exchange. At the end of our sample period, about 275 shares were trading on the exchange.
7. The South Korea Composite Index. Until the beginning of 1983, the index is an unweighted average of prices of stocks listed on the Korean stock market. Starting with 1983, the index is a capitalization-weighted index of all common stocks listed on the exchange.
8. The Taiwan Weighted Index, which is a value-weighted index of virtually all shares traded. One hundred forty-one companies were listed on the Taiwan stock exchange at the end of 1987.
9. The Thailand Bangkok Book Club Index. This is a value-weighted index of all listed securities. At the end of 1987, 102 shares were traded on the stock exchange.

In 1985, the capitalization of the Tokyo stock exchange was in excess of a trillion U.S. dollars. Except for Australia, with a capitalization of about 80 billion U.S. dollars, the other Pacific Basin markets had a capitalization smaller than 50 billion dollars each.

Many of these markets have explicit restrictions on stock purchases by foreign investors; some have no restriction on stock purchases but do have restrictions on foreign exchange transactions. Investors can avoid these barriers to international investment by taking positions in country funds traded in the U.S. for many, but not all, of these countries.

The Hong Kong market is, however, fully open to foreign investors. The markets of Australia, Japan, Malaysia, and Singapore are almost as open as the Hong Kong market; they have been reducing restrictions on foreign investment over the last few years, and what restrictions remain are generally not binding.[7]

Both the Philippines and Thailand have serious restrictions for foreign investors. Over our sample period, foreign investors were able to buy stocks from the Philippines but at times found it difficult to repatriate the proceeds from sales of stocks. Finally, investments in individual stocks in Korea and Taiwan are typically prohibited for foreigners, but country funds traded in the U.S. are available for both countries.

Table 1 presents summary statistics on the dollar returns from these markets. A dollar return can be low even if the index increased dramatically in local currency if that currency depreciated relative to the dollar. The first column provides annualized average returns; the returns do not depend on the measurement interval, so that they are the same whether measured daily, weekly or monthly.

Not surprisingly, Japan performed the best among these markets. Its annualized average dollar return over the sample period is almost twice that of the S&P 500. The Philippines index is the worst performer, with a dramatic −27.40% annualized average return and a standard deviation of return that is almost twice the standard deviation of the return of the S&P 500. Australia, Malaysia, Korea, and Thailand also performed poorly in dollars, compared individually with the U.S.; each had a lower average return and a higher volatility than the S&P 500.

TABLE 1

Mean Percentage Returns, Standard Deviations, and First Order Autocorrelations for the Pacific Basin Indexes and the S&P 500

Index	Mean	Standard Deviation Daily	Weekly	Monthly	ρ
U.S. S&P 500	7.58	13.34	14.29	13.00	0.106*
Australia All-Ordinaries	6.95	16.17	18.73	22.02	0.163*
Hong Kong Hang Seng	10.55	30.60	32.72	37.18	0.038
Japan Nikkei	13.30	18.37	18.30	18.68	−0.003
Malaysia Industrials and Commercials	5.88	20.92	21.90	26.72	0.056
Philippines Manila Mining	−27.40	25.10	29.70	31.68	0.158*
Singapore All-Share	16.27	20.89	16.27	22.11	−0.196*
South Korea Composite	6.23	18.51	19.75	17.32	0.085*
Taiwan Weighted Index	10.28	16.06	20.43	21.99	0.003
Thailand Bangkok Book Club	1.25	16.06	18.93	20.29	0.241*

Note: Returns are computed in dollars from the first trading day in January 1977 through the last trading day in December 1985. Mean returns are annualized. The standard deviations are computed using daily, weekly, and monthly data. The first order autocorrelation (ρ) is computed using daily data.

A * denotes that a first order autocorrelation coefficient exceeds two standard deviations.

For each index, we provide standard deviations computed using daily, weekly, and monthly returns. The S&P 500 is the index with the smallest standard deviation. Standard deviations should be the same regardless of the measurement interval if the indexes follow a random walk. The fact that standard deviations differ depending on the measurement interval indicates that the random walk hypothesis often does not hold for the indexes in our sample. For some, the largest standard deviation is the one computed using monthly returns, while for others it is the one computed with weekly returns.

The relation among the three standard deviations for an index depends on the nature of the departure of returns from the random walk hypothesis.[8] For instance, negative autocorrelations in daily returns would produce a lower estimate of the annualized standard deviation computed with monthly returns than with daily returns. This is because one day's unexpected return is partly offset by returns on subsequent days.

The last column of Table 1 provides the first order daily autocorrelation for each index. This autocorrelation measures how today's return is related to yesterday's return. If the random walk hypothesis holds, yesterday's return should not be helpful in predicting today's return. The autocorrelations with an asterisk are those that are larger in absolute value than one would expect if the random walk hypothesis holds. Some countries have significant positive first order autocorrelations; others do not. For six of the nine Pacific Basin markets, however, the random walk hypothesis does not hold.[9]

THE GAIN FROM DIVERSIFICATION

The simplest way to measure the benefit of international diversification is to estimate how much international diversification can reduce the variance of a U.S. portfolio without changing its mean. For an investor forming a portfolio, the measure of interest is the expected benefit from international diversification over the holding period.

The extent to which the variance can be reduced depends on the variance of the foreign indexes, on their correlation with the U.S. index, and on their mean returns. If foreign indexes have similar variances and mean returns as the S&P 500, the benefits of international diversification obviously are greatest if these indexes have a low correlation with the S&P 500. If stock indexes do not move together, one index is more likely to do well while another one does poorly; as a result, the variance of the diversified portfolio is smaller.

Table 2 gives correlations of the dollar returns of Pacific Basin stock markets with the return on the S&P 500 index. We compute these correlations in four ways. First, we compute the correlations using same-calendar day returns for all indexes. That is, a Tuesday return for Japan is matched to a Tuesday return for the U.S. A Tuesday return is computed from the close of trading on Monday to the close of trading on Tuesday. As a result of time differences across markets, the Tuesday return for Japan is known before the U.S. stock market opens on Tuesday.

Second, we compute the correlations using the U.S. return lagged one day. Consequently, a Tuesday return in Japan is matched with a Monday return in the U.S. In this way, the U.S. return is known when the Japanese markets open.

Third, we compute the correlations using weekly returns, and fourth, with monthly returns. Obviously, for weekly and monthly returns the time differences between the markets are not important. For daily returns, however, there is no way to match exactly the calendar times over which returns are measured, and both ways of matching daily returns imply that the Pacific Basin returns measurement period overlaps the S&P 500 returns measurement period for about twelve hours on average.

In Table 2, it is clear that for daily returns the correlations are dramatically different if one uses same-day or lagged U.S. returns. The explanation for this result is straightforward. Recent work shows that the American markets lead the Pacific Basin markets. This means that knowledge of changes in U.S. indexes is useful to predict returns on Pacific Basin markets, but not vice versa. Previous-day U.S. returns

TABLE 2

Correlation of Pacific Basin Index Returns with the Return of the S&P 500

Index	Correlation Daily	Daily′	Weekly	Monthly
Australia All-Ordinaries	0.085*	0.292*	0.300*	0.368*
Hong Kong Hang Seng	0.110*	0.184*	0.251*	0.156*
Japan Nikkei	0.086*	0.179*	0.256*	0.263*
Malaysia Industrials and Commercials	0.044	0.185*	0.180*	0.229*
Philippines Manila Mining	0.037	0.102*	0.216*	0.258
Singapore All-Share	0.046	0.118*	0.196*	0.292*
South Korea Composite	−0.031	−0.018	−0.076	0.080
Taiwan Weighted Index	0.050*	0.064*	0.184*	0.278*
Thailand Bangkok Book Club	−0.004	0.001	−0.120	−0.128

Note: Returns are computed in dollars from the first trading day in January 1977 through the last trading day in December 1985. The correlations are computed using daily, daily with U.S. return lagged one day (daily′), weekly, and monthly data.

A * denotes a correlation coefficient that is significantly different from zero at the 0.05 level.

contain information about next-day Pacific Basin returns, which are, consequently, more highly correlated with these returns than with same-day U.S. returns.

Consider, however, that investors are interested in the long-run performance of their portfolio. Using same-day returns to compute how much markets move together understates the comovement of markets from a long-run perspective because the next-day Pacific Basin stock movements will be related to today's U.S. stock movements.

Table 2 indicates that the longer the measurement interval, the more closely the Pacific Basin stocks move with the U.S. stocks. There are at least two explanations for this phenomenon.

First, the returns for the various markets are not truly contemporaneous; our measurement understates the true correlations because the returns are observed at different calendar times and hence contain different information. For instance, using same-day correlations, the Japanese return accrues before the opening of the market in the U.S. for that day, and hence the U.S. return incorporates information that is not incorporated in the Pacific Basin stock returns used to compute the correlations.

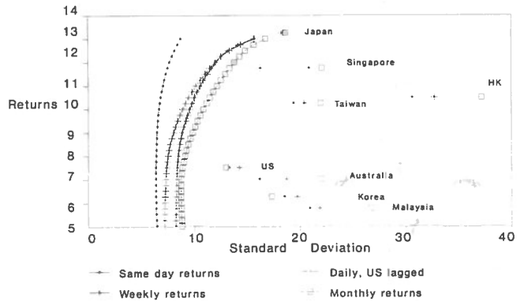
Second, differing autocorrelation patterns across countries make it difficult to estimate how stock price movements are related across countries. To compute the true relation between stock price changes across countries, one should subtract from a day's return the return that can be predicted based on past price changes. If one does not proceed in this way, estimates of comovements in stock returns are based on unexpected returns measured with noise and are biased toward zero. Typically, the random walk hypothesis holds better for weekly and monthly returns than it does for daily returns. This means that it is easier to estimate comovements in stock prices by focusing on weekly and monthly returns.

The Figure provides four different estimates of the ex post efficient frontier (theoretically) available to investors holding long positions in the Pacific Basin indexes as well as the S&P 500.[10] No matter how the frontier is computed, it is striking that the S&P 500 is well within the frontier. This means that an investor who holds the S&P 500 can substantially reduce portfolio volatility by reducing S&P 500 holdings and investing more in the Pacific Basin stock markets. The efficient frontier estimated with same-day returns shows that a U.S. investor invested in the S&P 500 portfolio could have decreased the standard deviation of wealth from about 13% to about 6% without changing mean return by diversifying into the Pacific Basin countries over the sample period.

The extent of the benefit depends to a great

FIGURE

EFFICIENT FRONTIER FROM 1977 TO 1985



Note: These are estimates of the efficient frontier for portfolios consisting of long positions in the S&P 500 and Pacific Basin indexes. The returns are in dollars and are annualized. The efficient frontier is computed in four ways. The leftmost frontier uses same-day returns for all indexes; the second left frontier uses U.S. returns lagged one day; the third frontier uses weekly returns. The rightmost frontier uses monthly returns. (The Philippines and Thailand are not shown here because their average returns are too low to fit in the Figure.)

extent on how the efficient frontier is computed. If the benefit from international diversification for the U.S. investor is measured using monthly returns, the standard deviation falls from about 13% to about 9%, which is substantially less dramatic. Depending on the measurement interval, we can conclude that the standard deviation is reduced by 50% or by 30%. These results mean that the benefits of international diversification are substantially larger for a holding period of one day than they are for a holding period of one month or longer.

The reason behind the shrinking of the benefits of international diversification as a longer measurement interval is used is the same as the reason for the increase in the correlations across markets as the measurement interval becomes longer. Using a short time interval to compute returns, one uses returns that are noisy. This noise makes the markets look more independent than they truly are. Yet for most investors, the appropriate measure of the benefits to international diversification is the one that applies for long horizons, and a monthly holding period is more likely to provide a measure of the long-term benefits of diversification than a daily holding period.

Studies that examine the benefits of international diversification for a particular sample period are of interest mainly because it is reasonable to believe that such studies have some validity beyond the sample period. That is, an ex post efficient frontier can be viewed as an ex ante efficient frontier for a subsequent period. For estimates derived from monthly data to be reliable, however, a sample period of several years is required. If the distribution of index returns changes over time, the use of daily returns makes it possible to obtain reliable estimates with a shorter sample period.

Our study shows that an efficient frontier estimated with lagged daily U.S. returns is closer to an efficient frontier estimated with monthly data over the same sample period than one estimated with same-day returns for all markets.

CONCLUSION

We have used daily dollar returns on Pacific Basin market indexes to investigate the benefits to U.S. investors of diversifying into these markets. Our analysis shows that benefits are substantial and yet that they are easily overestimated, for two statistical reasons.

With monthly data, we show that a U.S. investor holding the S&P 500 index could have reduced the standard deviation of a portfolio by a third by also investing in Pacific Basin stocks. While the risk reduction provided by diversifying into Pacific Basin stocks is substantial, it could be considerably overstated using daily data.

With daily data, the same U.S. investor could have reduced the standard deviation by 50%. The results using same-day returns for both the U.S. and Pacific Basin markets offer a poor estimate of the gains from international diversification for investors with holding periods longer than one day.

Estimates of monthly return gain appear to be more appropriate than simple estimates that use daily or weekly returns. If, however, one has to use daily returns because one believes that the correlations between markets have changed, one should lag the U.S. returns by one day.

Further research should investigate whether adjustments to daily returns that exploit their time series properties provide more efficient estimates of the benefits from international diversification than would monthly returns. We have concentrated on diversification benefits for an investor holding the S&P 500 portfolio. Additional work should investigate the benefits from diversifying into Pacific Basin markets for an investor who holds European stocks.

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[1] See Grubel [1968], Levy and Sarnat [1970], Lessard [1970], and Solnik [1974] for the classic papers on the benefits of international diversification. Solnik [1988] provides an up-to-date review of the literature.

[2] See Solnik [1988] for a summary of capitalization data.

[3] See Hamao and Masulis [1988], for instance.

[4] See Bailey, Stulz, and Yen [1990] for empirical evidence on the serial correlation in the daily returns for Pacific Basin stock market indexes.

[5] Exchange rates are obtained from the *Wall Street Journal*. The U.S. S&P 500 index is obtained from the CRSP Daily Stock Index File. The indexes for Australia, Hong Kong, Japan, the Philippines, and Thailand are collected from the *Far Eastern Economic Review*. Publications of the Singapore Stock Exchange are the source for the data on the Singapore and Malaysia indexes. Finally, the Center for Pacific-Basin Capital Markets Research provided us with quotes for the Korean and Taiwanese indexes.

[6] Prior to January 1981, we use the Sydney All-Shares Index. We do not use the return spanning 12/31/80–1/2/81 because the two indexes have a different basis.

[7] Malaysia monitors large foreign investments, while Japan has significant restrictions on the total foreign shareholdings for a number of corporations.

[8] See Lo and McKinlay [1988] for a discussion of how serial correlation in stock returns and variance estimates obtained with different holding periods are related.

[9] Bailey, Stulz, and Yen [1990] provide local currency autocorrelations for Pacific Basin indexes up to ten lags. Typically, some of the higher order autocorrelations are significant, which differs from the U.S. Various hypotheses could explain these results. Infrequent trading of securities in an index typically will induce positive serial correlation in the index.

[10] We exclude short sales because they would be too costly for most of the indexes included in the sample. A frontier with short sales could be computed and would lead to similar conclusions; the Manila index would have to be excluded from the computation, however, because of its large negative average return. To compute the frontier, we computed points by minimizing portfolio variance subject to a return constraint using the NCONF subroutine of the IMSL library.