Efficacy of Portfolio Performance Measures: An Evaluation

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Using Sharpe and Treynor's two moment and Prakash and Bear's and Stephens and Proffitt's higher moment performance measures, this paper presents empirical evidence that various measures provide vastly different performance rankings of 14 international stock markets, albeit in the same direction. The choice of different investment horizons (i.e., the intervaling) also affects these rankings.

INTRODUCTION

There is ample empirical evidence (Bailey and Stulz, 1990; Cumby and Glen, 1990; etc.) that internationally diversified portfolios provide a greater degree of diversification in comparison to domestically diversified portfolios. This greater reduction in risk usually is obtained because the movements in stock prices in different countries typically have correlation coefficients of less than one. These less than perfectly positive correlations between the returns of world stock markets allow an investor to increase expected rate of return for any given level of risk.

Several studies have attempted to evaluate the performance of international bond and/or common stock portfolios. In determining the performance of portfolios, problems arise as to which performance measure should be selected. Traditionally, performance has been evaluated using the two moment capital asset pricing model (CAPM). The selection of performance measures based on the two moment CAPM is subject to criticism, however, especially when the return distributions of portfolios are not symmetrical. Hence, it seems that performance measures that incorporate higher moments are appropriate because they utilize a more complete description of the underlying return generating process.

This paper evaluates the performance of a sample of 14 selected international stock markets using two types of performance measures:

- The two moment performance measures of Sharpe (1966) and Treynor (1965); and
- The more recently developed higher moment performance measures of Prakash and Bear (1986) and Stephens and Proffitt (1991).

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We also investigate the effect of intervaling, i.e., the selection of the period (length) between consecutive data observations (investment horizon), on portfolio performance. Previous studies (Levy, 1972; Brown and Warner, 1985; and Parhizgari, Dandapani, and Prakash, 1993) have demonstrated that empirical results are affected by the length of the assumed investment horizons.

LITERATURE REVIEW

Since the pioneering works of Sharpe (1964) and Lintner (1965), investment performance usually has been evaluated using the performance measures based on two moment CAPM. The mean variance composite performance measures include Treynor's reward-to-volatility index (1965), Sharpe's reward-to-variability index (1966), and Jensen's alpha measure (1968). Ang and Chua (1979) use all of these measures to evaluate the performance of mutual funds in the United States during the years 1955 to 1974. Cumby and Glen (1990) utilize the Jensen measure to evaluate the performance of a sample of 15 U.S.-based internationally diversified mutual funds between 1982 and 1988.[1]

Arditti (1967, 1971) argues that two moment performance measures may not be adequate if return distributions are asymmetrical and investors value skewness. To alleviate the problem that may be associated with nonsymmetric rates of return, several researchers develop other performance measures based on higher moments. For example, Ang and Chua (1979) construct an excess return index using the three moment CAPM developed by Kraus and Litzenberger (1976). This index incorporates investors' preference for positive skewness of returns. Prakash and Bear (1986) develop a composite performance measure incorporating skewness based on the Kraus and Litzenberger skewness preference model. The Prakash and Bear measure has the desirable property of reducing to Treynor's reward-to-volatility index in the absence of skewness.

Stephens and Proffitt (1991) generalize the Prakash and Bear performance measure to account for any number of moments. The Stephens and Proffitt methodology is essentially the same as that of the Prakash and Bear except the Stephens and Proffitt measure is developed from Rubinstein's (1973) n parameter pricing model rather than from Kraus and Litzenberger's three moment CAPM. The Stephens and Proffitt measure reduces to the Prakash and Bear measure in the absence of moments beyond the third and reduces to the Treynor measure in the two moment case. Stephens and Proffitt (1991) utilize the Prakash and Bear measure to evaluate the performance of 27 internationally diversified mutual funds. They note that the higher moment performance measure seems to be appropriate for evaluating the international mutual fund portfolios, as they empirically find that the rate of return distributions are not symmetrical.

EMPIRICAL APPLICATIONS

THE HIGHER MOMENT PERFORMANCE MEASURE

Stephens and Proffitt (1991) restate the Rubinstein (1973) n moment CAPM as:

[1] Cumby and Glen (1990), however, point out that the Jensen measure is subject to some limitations. The most important is the possibility that errors in performance measures may arise when the fund manager possesses and utilizes superior timing information.

$$(1)\ E(R_j) = R_f + \lambda_n \eta_n \sum_{i=2}^{n} \frac{1}{\eta_i} \sigma_{mi} (R_m, R_j)$$

where λ_n is the n moment performance measure given by

$$(2)\ \lambda_n = \frac{E(R_j) - R_f}{\eta_n \sum_{i=2}^{n} \frac{1}{\eta_i} \sigma_{mi} (R_m, R_j)}$$

where:

$E(R_j)$	=	Expected rate of return on asset j;
R_f	=	The risk free rate of return;
η	=	Constant whose value depends on the type of underlying utility function of the investor;[2]
$\sigma_{mi} (R_m, R_j)$	=	Joint central moment of order i between the market and portfolio rates of return; and
n	=	2, 3, 4 for covariance, coskewness, and cokurtosis, respectively.

The derivation of λ_n can be found in Stephens and Proffitt (1991).

For different values of n (= 2, 3, 4), λ_n becomes the Treynor, Prakash and Bear, and Stephens and Proffitt performance measures as follows:

For n = 2, λ_2 simplifies to the Treynor measure as:

$$(3)\ \lambda_2 = \frac{E(R_j) - R_f}{\eta_2 \frac{1}{\eta_2} \sigma_{m2} (R_m, R_j)}$$

For n = 3, λ_3 simplifies to the Prakash and Bear measure as:

$$(4)\ \lambda_3 = \frac{E(R_j) - R_f}{\eta_3 \frac{1}{\eta_2} \sigma_{m2} (R_m, R_j) + \eta_3 \frac{1}{\eta_3} \sigma_{m3} (R_m, R_j)}$$

For n = 4, λ_4 simplifies to the Stephens and Proffitt measure as:

$$(5)\ \lambda_4 = \frac{E(R_j) - R_f}{\eta_4 \frac{1}{\eta_2} \sigma_{m2} (R_m, R_j) + \eta_4 \frac{1}{\eta_3} \sigma_{m3} (R_m, R_j) + \eta_4 \frac{1}{\eta_4} \sigma_{m4} (R_m, R_j)}$$

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[2] See Prakash and Bear (1986) and Stephens and Proffitt (1991) for values of η for various utility functions of hyperbolic absolute risk aversion class.

For empirical investigations, equation (1) can be written in *ex post* form as:

$$(6)\ R_{jt} = \theta_1 + \sum_{i=2}^{n} \theta_i Z_{jit} + \varepsilon_{jt}$$

where:

θ = Regression coefficient whose value for different values of n will proxy η_n/η_i ($i = 2, 3, \ldots, n$);

R_{jt} = The rate of return of asset j at time t;

$Z_{jit} = \frac{1}{N}\sum_{t=1}^{N} [(R_{jt} - \bar{R}_j)(R_{mt} - \bar{R}_m)^{i-1}] = \sigma_{mi}(R_m, R_j)$;

t = The number of observations;

R_{mt} = The market rate of return at time t;

i = 2, 3, 4 for covariance, coskewness, and cokurtosis, respectively.

The parameters θ's can be estimated using the ordinary least squares method. Thus,

θ_2 = OLS coefficient for the covariance term;

θ_3 = OLS coefficient for the coskewness term; and

θ_4 = OLS coefficient for the cokurtosis term.

Then, the relationship of parameters θ's and η's can be written as follows:

$$(7)\ \frac{\theta_3}{\theta_2} = \frac{\eta_3}{\eta_2} = \mu_1$$

$$(8)\ \frac{\theta_4}{\theta_2} = \frac{\eta_4}{\eta_2} = \mu_2$$

$$(9)\ \frac{\theta_4}{\theta_3} = \frac{\eta_4}{\eta_3} = \mu_3$$

Substituting μ's for (η_n/η_i)'s in equations (3), (4), (5),we have

$$(10)\ \text{Treynor} = \frac{\bar{R}_j - R_f}{\bar{Z}_{j2}}$$

$$(11)\ \text{Prakash and Bear} = \frac{\bar{R}_j - R_f}{(\mu_1 \bar{Z}_{j2} + \bar{Z}_{j3})}$$

$$(12)\ \text{Stephens and Proffitt} = \frac{\bar{R}_j - R_f}{(\mu_1 \bar{Z}_{j2} + \mu_3 \bar{Z}_{j3} + \bar{Z}_{j4})}$$

where:

$$\bar{R}_j = \frac{1}{N}\sum_{t=1}^{N} R_{jt};$$

$$\bar{Z}_{ji} = \frac{1}{N}\sum_{t=1}^{N} Z_{jt};\ \text{and}$$

i = 2, 3, 4, for covariance, coskewness, and cokurtosis, respectively.

THE METHODOLOGY

The methodology of this study can be summarized in three parts. First, using the ordinary least squares regression, the regression parameters θ of equation (6) are estimated. Separate runs are made for weekly and monthly observations. These estimated coefficients are used to construct various performance measures.

Next, international stock market indexes are evaluated and ranked using the Prakash and Bear and the Stephens and Proffitt measures (equations (11) and (12)), the two moment performance measures of Treynor (equation (10)) and the Sharpe measure given by:

$$(13)\ \frac{\bar{R}_j - R_f}{\sigma_j}$$

Finally, the coefficients of correlation between fund rankings across performance measures are obtained using Spearman's rho to see whether the various performance measures rank the stock markets differently. To investigate the effects of intervaling on performance rankings, coefficients of correlation of stock market rankings between weekly and monthly observations (using the same measure) also are obtained.

THE DATA

The sample data consists of weekly and monthly rates of return of 14 international stock market indexes from January 1987 to December 1990. The data for constructing the return series which includes the stock indexes and the exchange rates of a country are collected from *Barron's*. To minimize any intracountry risk, only well-diversified indexes are chosen to represent the portfolio of each country. A list of the selected markets in the sample is given in Table 1. The index prices are converted to dollar prices using their respective exchange rates. Holding period returns for each country index (j) are calculated as follows:

$$(14)\quad R_{jt} = \frac{I_{jt}\,X_{jt} - I_{jt-1}\,X_{jt-1}}{I_{jt-1}\,X_{jt-1}}$$

where:

I_{jt} = The stock market index in foreign country j at time t;

X_{jt} = Country j exchange rate at time t, expressed in U.S dollars;

R_{jt} = The exchange-rate-adjusted rate of return from investment in country j's stock at time t.

Following Cumby and Glen (1990), the market's rate of return series (R_{mt}) is constructed using the Morgan Stanley world capital international index, obtained from various issues of *Barron's*. These market returns are used to compute the covariance, coskewness, and cokurtosis for each of the international stock markets.

EMPIRICAL RESULTS

THE BENEFITS OF INTERNATIONAL DIVERSIFICATION

The simplest way to measure the benefit of diversification is to estimate the reduction in the variance (risk) of the portfolio for a given (desired) rate of return. The extent to which the variance of the portfolio can be reduced depends on the coefficients of correlation (r) between the assets in the portfolio.

Tables 1 and 2 present the intercountry coefficients of correlation, respectively for weekly and monthly rates of return. A test of significance (using the t-statistic given by

$$(15)\quad t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

Table 1—Correlation Coefficients of Weekly Returns in Major Stock Market Indexes*

	Australia	Belgium	Canada	France	Hong Kong	Italy	Japan	Nether lands	Singa--pore	Sweden	Switzer-land	U.K.	U.S.
Belgium	0.419												
Canada	0.241	-0.047											
France	0.412	0.435	0.098										
Hong Kong	0.350	0.423	-0.104	0.304									
Italy	0.125	0.245	-0.008	0.152	0.153								
Japan	0.414	0.227	0.318	0.143	0.167	0.174							
Netherlands	0.245	0.274	0.066	0.177	0.178	0.157	0.227						
Singapore	0.402	0.583	-0.210	0.299	0.676	0.116	0.120	0.220					
Sweden	0.504	0.487	0.156	0.326	0.399	0.291	0.322	0.293	0.471				
Switzerland	0.630	0.547	0.215	0.504	0.280	0.312	0.386	0.298	0.394	0.606			
U.K.	0.364	0.103	0.185	0.155	0.126	0.080	0.339	0.166	0.205	0.322	0.405		
U.S.	0.304	0.199	0.363	0.311	0.140	0.157	0.346	0.144	0.093	0.364	0.412	0.297	
West Germany	0.366	0.420	0.195	0.326	0.159	0.258	0.242	0.149	0.257	0.454	0.579	0.210	0.334

* As computed by footnote 3, the correlation coefficient whose value is greater than 0.2836 is significant at 5 percent significance level.

Table 2—Correlation Coefficients of Monthly Returns in Major Stock Market Indexes*

	Australia	Belgium	Canada	France	Hong Kong	Italy	Japan	Nether lands	Singa-- pore	Sweden	Switzer- land	U.K.	U.S.
Belgium	0.593												
Canada	0.390	0.394											
France	0.493	0.696	0.378										
Hong Kong	0.736	0.506	0.377	0.388									
Italy	0.108	0.396	-0.172	-0.018	0.136								
Japan	0.509	0.555	0.288	0.467	0.584	0.081							
Netherlands	0.531	0.561	0.372	0.346	0.522	0.247	0.424						
Singapore	0.835	0.636	0.418	0.457	0.792	0.205	0.635	0.498					
Sweden	0.646	0.566	0.314	0.294	0.562	0.537	0.410	0.446	0.644				
Switzerland	0.663	0.746	0.452	0.656	0.608	0.313	0.463	0.486	0.648	0.623			
U.K	0.552	0.384	0.446	0.421	0.587	-0.022	0.379	0.307	0.628	0.504	0.387		
U.S	0.743	0.738	0.575	0.568	0.748	0.293	0.561	0.546	0.850	0.653	0.783	0.684	
West Germany	0.524	0.695	0.415	0.551	0.452	0.345	0.469	0.489	0.545	0.558	0.734	0.296	0.687

* As computed by footnote 3, the correlation coefficient whose value is greater than 0.2836 is significant at 5 percent significance level.

to test the null hypothesis that each of these 91 coefficients of correlation is zero against the alternative hypothesis that it is not) reveals that there are 46 insignificant (at the 5 percent level of significance) coefficients of correlation for weekly rates of return, but only eight for the monthly rates of return.[3] These empirical findings show that during the period under study the weekly investment horizon provided a larger reduction in risk than did their monthly counterparts. Thus, intervaling (that is, the investment horizon) did affect the diversification opportunities.[4] Furthermore, inclusion of Canada and Italy's stock indexes in the worldwide stock index portfolio would have provided larger diversification opportunities because intercountry coefficients of correlation with Canada (as well as to a lesser extent with Italy) provide, in general, smaller correlations with rest of the other countries. On the other hand, Japan, Belgium, the Netherlands, Singapore, and Sweden seem to provide the least diversification opportunities due to higher and significant correlations. These findings are consistent with the Bailey and Stulz (1990) study on the diversification of Pacific Basin stock markets. They find that the longer the measurement interval, the higher the correlation coefficients, i.e., the more closely the stock markets move together. Also, the coefficients of correlation reported in Tables 1 and 2 are different than the usual correlations obtained from any two well-diversified portfolios of domestic stocks. Roll (1988) notes that in a domestic stock portfolio, the interstock coefficients of correlation between rates of return are usually 0.9 or above.

Table 3 lists the means, variances, and coefficients of variation of the indexes' rates of return. A look at the fourth column reveals that Japan ranks at the top of the list (providing the least risk per unit of return), whereas Italy ranks last. Table 4 provides the covariance, coskewness, and cokurtosis with the market rates of return computed using the Morgan Stanley world capital international index.

THE PERFORMANCE OF INTERNATIONAL STOCK MARKETS

To obtain the regression coefficients of covariance (Z_{j2}), coskewness (Z_{j3}), and cokurtosis (Z_{j4}), least squares regressions of the model specified in equation (6) are per-

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[3] The easiest way to check the significance of the t-statistics in our case is to realize that for 12 (which is 14-2) degrees of freedom, the obtained value of t using the statistic in equation (15) should be greater than 2.14 at the 5 percent level of significance. This corresponds to a value of 0.2836 for the obtained sample correlation coefficient. For

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

or

$$2.14 = \frac{r\sqrt{12}}{\sqrt{1-r^2}}$$

then
$r = 0.2836$.

[4] Intervaling and investment horizons are one and the same because of the way the rates of return are computed in most empirical research in finance. Period by period computations of the rates of return implicitly assume buy at t and sell at t+1 for the t^{th} period's ($t = 1, 2, \ldots, n$) rate of return. (See, for example, Levy, 1972; Levhari and Levy, 1977; Levy, 1981; and Parhizgari, Dandapani, and Prakash, 1993; etc.).

Table 3—Summary Statistics of Stock Market Indexes

	Mean Return*		Variance*		CV**		Rank of CV	
	Week	Month	Week	Month	Week	Month	Week	Month
Australia	0.31	1.56	18.69	110.04	13.95	6.72	9	9
Belgium	0.42	1.82	6.68	35.41	6.15	3.27	3	2
Canada	0.37	1.40	19.31	37.01	11.88	4.35	7	5
France	0.33	1.52	10.37	58.50	9.76	5.03	5	7
Hong Kong	0.22	0.88	25.95	93.61	23.16	10.99	11	11
Italy	-0.06	-0.03	41.37	135.75	107.20	388.37	14	14
Japan	0.56	2.47	10.94	35.34	5.91	2.41	1	1
Netherlands	0.10	-0.04	39.70	76.70	63.01	218.95	13	13
Singapore	0.56	2.28	22.20	75.71	8.41	3.82	4	4
Sweden	0.45	1.99	7.13	42.55	5.93	3.28	2	2
Switzerland	0.14	0.56	7.09	29.37	19.02	9.68	10	10
U.K.	0.41	1.59	20.10	62.95	10.93	4.99	6	6
U.S.	0.19	0.85	6.31	26.76	13.22	6.09	8	8
West Germany	0.09	0.35	14.77	63.98	42.70	22.85	12	12

* Mean returns and variances are indicated in percent per holding period

** CV represents the coefficients of variation = $(\sigma/\bar{x})$

Table 4—Summary of Co-moments Between Stock Market Indexes and World Equity Index

	Covariance*		Coskewness*		Cokurtosis*	
	Week	Month	Week	Month	Week	Month
				$x10^2$	$x10^2$	$x10^3$
Australia	6.09	40.86	-63.79	-8.99	8.52	19.79
Belgium	2.62	23.47	-12.88	-3.72	1.34	7.85
Canada	2.74	13.25	-29.09	-2.36	3.97	4.55
France	3.57	28.14	-22.23	-3.97	2.74	8.35
Hong Kong	3.87	32.56	-15.24	-7.56	1.26	16.85
Italy	1.89	-7.22	-14.13	0.01	2.63	1.23
Japan	3.22	8.57	-24.18	-0.24	3.23	-0.31
Netherlands	4.33	21.59	-30.82	-3.77	4.01	7.93
Singapore	3.89	37.76	-17.38	-7.86	1.23	16.79
Sweden	2.69	14.48	-24.99	-3.60	3.28	8.12
Switzerland	3.22	18.37	-32.33	-3.47	4.39	7.63
U.K.	4.55	23.63	-47.62	-4.61	6.66	9.84
U.S.	2.74	18.74	-22.51	-4.07	3.30	8.92
West Germany	2.84	18.27	-22.23	-3.22	2.90	7.03

*Covariance, coskewness and cokurtosis are indicated in percent per holding period

formed on both weekly and monthly rates of return. The results of the regressions of R_{jt} on Z_{j2}, Z_{j3}, and Z_{j4} are presented in Table 5. Unlike Stephens and Proffitt who did not find any statistical significance for the coefficient of the fourth moment (cokurtosis) in their empirical study, we find that the regression coefficients on cokurtosis are statistically significant for both weekly and monthly rates of return,. This may be attributed to the different time periods selected in the two studies.

The estimated coefficients for the third moment (Z_{j3}) are statistically significant at the 1 percent level of significance for both weekly and monthly rates of return. The signs

Table 5—OLS Regression Results

$R_{jt} = \theta_1 + \theta_2 Z_{j2t} + \theta_3 Z_{j3t} + \theta_4 Z_{j4t} + \varepsilon_{jt}$

Observations	θ_1	θ_2	θ_3	θ_4
Weekly**	0.6884 (4.0440)*	0.1283 (1.2468)	0.1074 (3.0781)	0.0059 (2.8252)
Monthly***	2.9231 (5.8682)	0.1158 (1.5491)	0.0610 (3.1712)	0.0024 (3.0534)

* The numbers in the parentheses are the values of t-statistics for the regression coefficients
** Regression of 2,198 observations
*** Regression of 504 observations

of the skewness coefficients are positive, as hypothesized by Kraus and Litzenberger (1976) and Prakash and Bear (1986). Therefore, an equilibrium pricing model incorporating the higher moments seems to be more appropriate for evaluating the performance of international stock markets.

Using the regression coefficients obtained from Table 5 and the mean values from Tables 3 and 4, the performance of international stock markets are ranked by the Sharpe, Treynor, Prakash and Bear, and Stephens and Proffitt measures. As presented in Table 6, Japan consistently is ranked first across all performance measures for monthly investment horizons. For weekly investment horizons, the ranking for Japan ranges from first to third. The superior performance of the Japanese market also is documented by Cumby and Glen (1990), who examine the efficiency of 13 international stock markets with the world equity index in October 1987. Italy is ranked last for each of the performance measures for weekly as well as monthly distributions except one (the exception being Sharpe's measure for monthly data). Furthermore, the ranking of seven stock markets (Singapore, Sweden, Belgium, Canada, France, Hong Kong, and U.K.) changes when higher moment measures are used.

We obtain the coefficients of correlation between the stock market rankings using Spearman's rho to see whether the performance rankings presented in Table 6 are consistent across the various performance measures. As reported in Table 7, all correlation coefficients are significant at the 1 percent level of significance. The coefficients of correlation between Sharpe and Treynor's measures (ρ_{12}) and the Prakash and Bear and the Stephens and Proffitt measures (ρ_{34}) have the highest values for both weekly and monthly intervals. Furthermore, as one intuitively would expect, the coefficients of correlation (ρ_{34} which is between the Prakash and Bear and the Stephens and Proffitt measures) for both weekly and monthly intervals are high, as both of these rankings are based on higher (than two) moments. The magnitudes of the coefficients of correlation between Sharpe and Treynor's measures (ρ_{12}) are lower than the correlation coefficients between the Prakash and Bear and the Stephens and Proffitt measures (ρ_{34}). Thus, it seems that even though Sharpe and Treynor's measures provide similar rankings, the closeness (in ranking) is tighter between the performance measures based on higher moments.

Table 6—International Stock Market Rankings

Ranking Method	Sharpe Week	Sharpe Month	Treynor Week	Treynor Month	Prakash & Bear Week	Prakash & Bear Month	Stephens & Proffitt Week	Stephens & Proffitt Month
Australia	8	9	8	8	9	8	9	8
Belgium	2	2	4	4	2	4	2	4
Canada	7	5	5	3	6	3	7	2
France	5	7	7	7	5	5	5	5
Hong Kong	10	10	9	10	8	9	6	10
Italy	14	13	14	14	14	14	14	14
Japan	3	1	1	1	3	1	3	1
Netherlands	12	14	12	13	12	13	12	13
Singapore	4	4	3	5	1	7	1	7
Sweden	1	3	2	2	4	2	4	3
Switzerland	11	11	11	11	11	11	11	11
U.K.	6	6	6	6	7	6	8	6
U.S.	9	8	10	9	10	10	10	9
West Germany	13	12	13	12	13	12	13	12

Table 7—Correlations of Stock Market Rankings Between Two Performance Measures

Ranking Method	ρ_{12} Week	ρ_{12} Month	ρ_{13} Week	ρ_{13} Month	ρ_{14} Week	ρ_{14} Month	ρ_{23} Week	ρ_{23} Month	ρ_{24} Week	ρ_{24} Month	ρ_{34} Week	ρ_{34} Month
Spearman's Rho	.9560 (.0001)	.9692 *(.0001)	.9429 (.0001)	.9341 (.0001)	.9121 (.0001)	.9341 (.0001)	.9473 (.0001)	.9780 (.0001)	.9165 (.0001)	.9780 (.0001)	.9868 (.0001)	.9912 (.0001)

1 = Sharpe measure
2 = Treynor measure
3 = Prakash and Bear measure
4 = Stephens and Proffitt measure
*Numbers in parentheses represent the significance levels of the correlation coefficients

To investigate the effect of intervaling, we also obtain the coefficients of correlation between the rankings based on weekly and monthly distributions to see whether the rankings are consistent within the same performance measure. As reported in Table 8, all correlation coefficients obtained by Spearman's rho are positive and significant at the 1 percent level of significance. The rankings obtained with the Sharpe and Treynor measures are highly positively correlated, while those obtained with the Prakash and Bear and Stephens and Proffitt measures are positively correlated, but with smaller magnitudes than the Sharpe and Treynor measures. This evidence indicates that intervaling affects the consistency of rankings and that the effects are more obvious on the higher moment performance measures. This confirms Levy's (1972) suggestion that more attention needs be paid to the selection of investment horizons in evaluating the performance of portfolios.

CONCLUSIONS

This paper obtains statistically significant coefficients for coskewness and cokurtosis for the indexes of 14 major stock markets of the world. This evidence indicates that the higher moment performance measures should be appropriate to evaluate the relative

Table 8—Correlations of Stock Market Rankings Between Weekly and Monthly Investment Horizons

Ranking Method	Sharpe ρ_{12}	Treynor ρ_{12}	Prakash & Bear ρ_{12}	Stephens & Proffitt ρ_{12}
Spearman's Rho	0.9473 (0.0001)*	0.9736 (0.0001)	0.8637 (0.0002)	0.7934 (0.0007)

1 = Ranking under weekly investment horizon
2 = Ranking under monthly investment horizon
* The numbers in the parentheses represent the significance levels of the correlation coefficients

performances of the various stock markets. For comparison purposes, we also obtain the rankings using the Sharpe and Treynor performance measures. We find that the rankings of seven stock markets change when higher moment measures are used.

The magnitude of coefficients of correlation between the rankings by the Stephens and Proffitt and the Prakash and Bear measures are higher than those obtained by Sharpe and Treynor's measures, which suggests that the measures based on higher moments rank the portfolios closer than those based on two moments in the presence of asymmetric return distributions. Also, of 14 markets utilized in this study, the U.S. ranks between eighth and tenth by all of the performance measures. This evidence confirms that investors may benefit from investing in the internationally diversified stock markets.

The empirical findings also suggest that intervaling does affect the choice of performance measures. The coefficients of correlation obtained between the rankings for weekly and monthly data by the Prakash and Bear and the Stephens and Proffitt measures are consistently lower than their counterparts obtained using Sharpe and Treynor's measures. This suggests that the effect of intervaling is more pronounced in the performance measures based on higher moments.

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