Using Forecasts to Trigger Portfolios Rebalancing: Can Forecasts Reduce the Gap Between Expected and Actual Returns?

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Abstract

This research finds considerable support for the notion that "buy and hold" investor's will attain superior performance if they select portfolios using forecasted returns within the traditional mean variance approach. Portfolios comprised of the U.S. and five foreign i-Shares were generated using both historical and forecasted returns. Over the course of five holding periods, the portfolios generated using forecasted returns consistently outperformed those generated using the traditional mean-variance approach as well as the U.S. only, "home biased" portfolio. This suggests that buy and hold investors can attain the benefits of international diversification without the constant monitoring and rebalancing necessary to attain the expected performance of portfolios generated using historical returns.

I. Introduction

This research seeks to determine whether the application of forecasting techniques offer a mechanism which will allow American investors to pursue a buy and hold strategy while reaping the gains available from international portfolio diversification. In doing so it addresses explanations that attribute the observed lack of international portfolio diversification to the need for constant monitoring and rebalancing of international portfolios (Jorion 1985; Kopp 2004).

While a significant body of research has suggested that American investors have not internationally diversified despite opportunities for significant gains (Lewis 1999), the root cause has not been identified. Supporting the notion that this lack of diversification is irrational, Solnik (1995) demonstrated that the returns of internationally diversified portfolios exhibited one-tenth the variation of domestically diversified portfolios. Other research has suggested that diversified portfolios comprised of the equities of U.S. international companies do not achieve the same effect as international portfolio diversification (Russell 1998). Despite this and similar research, a significant home bias in portfolio allocation continues to exist. In the past, this was attributed to tax policies, exchange regulation and capital flow regulation. As capital flow liberalization has largely removed such barriers, some research has suggested that the gains from international diversification have significantly diminished (Errunza, Hogan & Hung 1999). Investors may also perceive that such barriers continue to exist; inhibiting international portfolio diversification (Russell 1998) or the cause may be a mispricing of foreign equities (Pastor 2000).

To explain this apparent bias against international diversification, research by Bekaert and Urias (1996), and DeSantis and Gerard (1997) focused on the size of available gains. They found that the gains available from international diversification were not statistically significant. In addition, Jorion (1985) demonstrated that there are barriers to the practical application of the mean-variance approach of optimal portfolio selection while Gorman and Jorgensen (2002) concluded "that observed portfolio allocation weights were not significantly different than an optimal allocation."

This suggests that the tendency of U.S. investors to hold portfolios dominated by U.S. equities may be rational. However, work by Sarkar and Li (2002) continue to find significant

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diversification benefits for international investors. Building on Jorion (1985), Kopp (2004) determined that the performance of international equity portfolios that comprise the efficient investment frontier degraded rapidly over time. This suggests that accessible international equity portfolios do not offer an advantage to investors who pursue a buy and hold strategy since they must continually attempt the difficult task of timing the market (Butler, Domian, and Simonds 1995). Therefore, for such investors domestic portfolios may be rational unless a viable method to select international diversified portfolios that maintain their effectiveness over time is available. Development of such a method is the focus of this research.

II. The Data

This research uses the five MSCI Barra (2007) stock market gross indexes (pre-tax returns with dividends) for foreign equity markets for which investment iShares are traded and MSCI Barra's United States equity market iShare. Originally created by Morgan Stanley, these indexes and their associated iShares are essentially exchange-traded index funds that track price fluctuations in the underlying markets. Of the eighteen indexes which existed for the entire span of this study, the five foreign iShares identified by Kopp (2004) are used. That work identified those five foreign iShares and the U.S. iShare as significant components of the iShare efficient frontier for the 1970's. The finding that efficient portfolios can be constructed with only six funds is consistent with O'Neil (1997), Fant and O'Neil (1999) and Louton and Hakan (2006). They found that well diversified portfolios could be constructed with six mutual funds. Therefore, limiting this research to six iShares is expected to reduce the transactions cost and the forecasting effort required to implement the strategies identified without harming performance. This makes construction of the portfolios of exchange traded funds identified within this research easily accessible to U.S. investors.

The iShares and their associated equity markets in this study are those of Austria, Hong Kong, Japan, Sweden, United Kingdom, and the United States. This study uses the monthly gross indexes from December 1969- December 2004, to calculate the corresponding monthly return series for January 1970-December 2004. This resulted in five, five year holding periods as described in Table I below.

III. The Model

Traditionally, it is assumed that most investors are risk averse. Therefore, investors will only consider portfolios which maximize expected return for a given level of risk. This research identifies the combination of equity indices that if purchased by investors are expected to yield the maximum return per unit of risk. Expected return (ER) of any portfolio (p) is expressed as:

$$\text{ER (p)} = \sum_{i=1}^{n} w_i ER(i)$$

where n represents the total number of equity indices included in the portfolio and i represents a particular equity index, and w_i represents the proportion of the total portfolio made up of index i.

Portfolio risk (σ_p) is quantified using the standard deviation of recent index returns (σ_i), the weights of the indices in the portfolio (w_i), and the correlation coefficient ($\rho_{i,j}$) between pairs of the individual markets. It can be expressed as:

$$\sigma_p = \sqrt{\sum_{i=1}^{n} w_i^2 \sigma_j^2 + 2\sum_{i=1}^{n-1} \sum_{j=i+1}^{n} w_i w_j \rho_{i,j} \sigma_i \sigma_j}$$

Using linear programming, the portfolio which maximized the ratio of return to risk is identified under the constraints that the weights sum to 1, and that they are individually greater than or equal to zero (no short selling). The calculation of portfolios and an evaluation of their performance will be conducted through a sequential procedure. The returns, standard deviations and correlations of the historic data for period one will be used to calculate the portfolio which is expected to maximize the return per unit of risk (ER(p)/σ_p). Then the performance of this portfolio will be evaluated over the five year holding period as indicated in the right hand column of Table I. The performance of this portfolio over the five-year holding period is evaluated using actual returns, standard deviations and correlations for that period. At the end of this period, a new portfolio, which will be held for five years, is calculated using the prior ten years of data (period 2's historical data). This portfolio's performance over the next five years will then be evaluated as the process continues through the five holding periods.

Table I: Time periods used	
Data to Identify Portfolios & as Input in Forecasting	**5 Year Portfolios Holding Period**
Period 1 January 1970-December 1979	January 1980-December 1984
Period 2 January 1975-December 1984	January 1985-December 1989
Period 3 January 1980-December 1989	January 1990-December 1994
Period 4 January 1985-December 1994	January 1995-December 1999
Period 5 January 1990-December 1999	January 2001-December 2004

In addition to using the traditional mean-variance approach to identifying portfolios that maximize return per unit risk the, this research uses the underlying gross indexes for each of the ten year historic periods to forecast the index's performance for the next five year holding period. Those forecasts are then used to calculate a forecasted monthly return series. Those series of returns and their correlations are then used, to identify portfolios which are expected to maximize return per unit of risk. The performance of this portfolio over the five-year holding period is then evaluated using actual returns, standard deviations and correlations for that period. As suggested by in Table I, this process results in the identification of ten portfolios, five resulting from the standard application of the mean-variance approach using ten years of historic data and five using forecasts based upon those same ten-year historic series within the mean variance approach.

Mean-Variance Portfolios –The Traditional Approach

Using monthly returns sequentially for each of the five periods identified in column 1 of Table I, five portfolios were identified using the traditional mean variance approach. Each of these portfolios, presented in Table II, is expected to maximize expected return per unit of risk in the period which it will be held (column 2 of Table I). As noted in prior research (Kopp 2004) the composition of these portfolios varies significantly over time. For example using period one data, the portfolio that is expected to maximize return per unit of risk is heavily weighted towards the Austrian index. However, using period two data, that weight is zero, and is only non-zero when period four data is used to identify portfolio composition for holding period four. While this tells us nothing about the performance of these portfolios during the holding period, it does support the notion that optimal portfolio allocation requires continual monitoring when this approach is utilized.

Mean-Variance Portfolios Using Forecasted data

The next phase of this research required each stock index be forecasted for the holding period. Using the gross indices for the data periods identified in Table I, each of the underlying stock indices were forecasted using Crystal Ball Predictor (Oracle Crystal Ball Global Business Unit, 2007). Returns generated from those forecasts and their correlations were then used within the traditional mean-variance portfolio selection model to identify the portfolio that will be held.

The forecasting techniques used within Crystal Ball are called exponential smoothing techniques (Chatfield 1978 & 2001). They attempt to smooth out random and other variation present in the data to identify the patterns hidden within. The data is smoothed by taking weighted averages of: the data itself to remove randomness, sequential estimates of its trend, and sequential estimates of its seasonal behavior. (Assuming all three characteristics exist within the data.) While the sizes of the weights vary, larger weight is always given to the most recent data, since it is assumed most relevant to future events. The sizes of the weights are determined by the smoothing parameters (alpha for the data, beta for trend and gamma for season). The techniques are called "exponential" since the weights diminish exponentially over time. For example a beta close to 1 would mean that recent estimates of trend are given a very high weight, and those weights diminish quickly, so that earlier estimates will receive almost no weight. Conversely, a very low beta indicates that the weights while still favoring the most recent estimates of trend diminish much more slowly. Thus many of the more historic estimates of trend are used in creating the weighted average forecast.

Using data from the historic periods identified in Table I, each technique uses different weighted average combinations of the data, as well as estimates of its trend and season to duplicate the patterns found within the historic period. Once those patterns are identified, Crystal Ball selects the technique whose forecasts for the historic period were the most accurate. Then, using only the historic data, the weights that had been identified are used to predict values of the data for the forecast period. Crystal ball has eight forecasting techniques to select from. Table III identifies the forecasting technique automatically selected by the software to make each forecast, as well as the associated smoothing parameters. In general, techniques which are based upon weighted averages of both trend and season dominate the list. This is consistent with the behavior of the data which generally exhibited strong trend during these time periods.

Having forecasted each of the gross index time series, those forecasts were used to generate the corresponding monthly return series for each holding period. Their mean return and their correlations were then used to generate the portfolios which are expected to yield the highest return per unit of risk for each period. Those portfolios as well as expected portfolio return and risk for each period are also presented in Table II. (It should be noted that since forecasting techniques generate relatively constant variation, the standard deviation of the historic series was used as estimates of each series' risk.)

IV. Comparison of Performance

Having identified portfolios based upon traditional application of the mean-variance approach and by using forecasts of expected performance for the period we now turn to evaluating the performance of each portfolio. To do this, each portfolio's actual performance was ascertained by entering the actual returns, standard deviations and correlations that occurred during the period that the portfolios were held. These performance characteristics are included in Table II and are summarized in Table IV. As these Tables demonstrate, the traditional mean variance approach identified portfolios whose return was lower than expected in four of the five periods, and whose risk was higher than expected in three of the five periods. This caused their return per unit of risk to be lower than expected in four out of the five periods. In comparison, when portfolios were generated using forecasts of expected returns, actual portfolio returns were higher than expected during four of the five periods. In addition, risk was also higher than expected in four of the five periods resulting in return per unit of risk being lower than expected in three of the five periods.

When comparing the relative performance of each technique's portfolios, we see that forecasting provided superior results. Those portfolios exhibited superior actual returns in all five periods. The return per unit of risk of the forecasted portfolios was higher than portfolios selected through the traditional mean variance approach in all periods except period two, when they were essentially the same. Thus the use of forecasting offers investors significant opportunities to improve the performance of portfolios that will be held over time. However, to demonstrate that international portfolio allocation based forecasts provides a superior alternative to domestic non-internationally diversified portfolios we need to compare performance to the U.S. only portfolio. Table V presents the returns and return per unit of risk for the U.S. only iShare portfolio versus those portfolios identified within this research.

As we can see, the U.S. only portfolios outperformed the traditionally derived mean variance portfolios in all but one period. This result suggests that investors who only periodically wish to reallocate their portfolios will benefit from "home bias" when using traditional portfolio allocation techniques. However, the clear superior performance of portfolios derived by using forecasted returns indicates that there is a viable alternative for these investors. Forecast based portfolios outperformed the U.S. only portfolio on a risk adjusted basis in all but the first period and in general offered higher returns. This suggests the benefits of international diversification can be attained without the constant portfolio reallocation.

V. Conclusion

This research finds considerable support for the notion that "buy and hold" investor's will attain superior performance if they select portfolios using forecasted returns within the traditional mean variance approach. Investors who do not wish to constantly monitor their portfolios for reallocation will be able to attain the benefits of international diversification with such a procedure. Rather than attempt to "time the market" through reallocation of their portfolio as conditions change, the use of forecasted returns yields portfolios whose performance persists over time. Therefore, buy and hold investors can avoid the effort and cost associated maintaining the returns of internationally diversified portfolios without resorting to "home bias". Instead, they can construct forecast based portfolios that achieve the superior performance available from international diversification, while pursuing a buy and hold strategy.

Table II: Optimal Portfolios and Performance

Period 1: Portfolio to be held January 1980 to December 1984					
Traditional Mean Variance			**Forecasted Mean Variance**		
Index Allocation	**Expected Performance**	**Actual Performance**	**Index Allocation**	**Expected Performance**	**Actual Performance**
U.S.=8.80%			U.S.=22.24%		
U.K.=1.08%	Return=.0128	Return=-.0034	U.K.=0.00%	Return=0.0045	Return=0.0280
Sweden=2.59%	Risk=.0378	Risk=.0382	Sweden=0.00%	Risk=0.0334	Risk=0.1419
Austria=78.84%	Re/Rsk=.3378	Re/Rsk=-.088	Austria=77.76%	Re/Rsk=0.1351	Re/Rsk=0.1271
Japan=0.00%			Japan=0.00%		
H. K.=8.69%			H.K.=0.00%		
Period 2: Portfolio to be held January 1985 to December1989					
Traditional Mean Variance			**Forecasted Mean Variance**		
Index Allocation	**Expected Performance**	**Actual Performance**	**Index Allocation**	**Expected Performance**	**Actual Performance**
U.S.=36.20%			U.S.=25.31%		
U.K.=6.28%	Return=01367	Return=0.0253	U.K.=0.00%	Return=0.0026	Return=0.0311
Sweden=18.28%	Risk=.0373	Risk=0.0428	SW=0.00%	Risk=0.0008	Risk=0.0520
Austria=0.00%	Re/Rsk=.3666	Re/Rsk=0.5922	AS=47.92%	Re/Rsk=3.0857	Re/Rsk=0.5976
Japan=39.24%			JAP=26.76%		
H. K.=0.00%			H.K.=0.00%		
Period 3: Portfolio to be held January 1990 to December 1994					
Traditional Mean Variance			**Forecasted Mean Variance**		
Index Allocation	**Expected Performance**	**Actual Performance**	**Index Allocation**	**Expected Performance**	**Actual Performance**
U.S.=17.55%			U.S.=50.06%		
U.K.=0.00%	Return=0.0220	Return=0.0045	U.K.=0.00%	Return=0.0056	Return=0.0064
SW=38.89%	Risk=0.0426	Risk=0.0510	SW=19.13%	Risk=0.0215	Risk=0.0223
AS=0.00%	Re/Rsk=.5165	Re/Rsk=0.0880	AS=30.80%	Re/Rsk=0.2603	Re/Rsk=0.2880
JAP=43.56%			Jap=0.00%		
H. K.=0.00%			H.K.=0.00%		
Period 4: Portfolio to be held January 1995 to December 1999					
Traditional Mean Variance			**Forecasted Mean Variance**		
Index Allocation	**Expected Performance**	**Actual Performance**	**Index Allocation**	**Expected Performance**	**Actual Performance**
U.S=.18.10%			U.S.=35.54%		
U.K.=0.00%	Return=0.0194	Return=0.0182	U.K.=0.00%	Return=0.0057	Return=0.0388
SW=34.07%	Risk=0.0484	Risk=0.0489	SW=0.00%	Risk=0.0167	Risk=0.0561
AS=16.59%	Re/Rsk=0.4020	Re/Rsk=0.3723	AS=28.50%	Re/Rsk=0.3436	Re/Rsk=0.6926
JAP=0.00%			JAP=35.96%		
H. K.=31.24%			H.K.=0.00%		

Table II: Optimal Portfolios and Performance (cont'd)					
Period 5: Portfolio to be held January 2000 to December 2004					
Traditional Mean Variance			Forecasted Mean Variance		
Index Allocation	Expected Performance	Actual Performance	Index Allocation	Expected Performance	Actual Performance
U.S.=80.05%			U.S.=1.00%		
U.K.=7.47%	Return=0.0154	Return=-0.0009	U.K.=5.27%	Return=0.0092	Return=0.0084
SW=7.32%	Risk=0.0383	Risk=0.0479	SW=35.29%	Risk=0.0006	Risk=0.0496
AS=0.00%	Re/Rsk=0.4029	Re/Rsk=-0.0185	AS=40.21%	Re/Rsk=16.26	Re/Rsk=0.1685
JAP=0.00%			JAP=2.53%		
H.K.=5.17%			H.K.=15.71%		

Table III: Forecast Techniques and Parameters for each Period

Index	Forecast Techniques	Alpha	Beta	Gamma
Period 1 January 1970-December 1979 to Forecast January 1980 to December 1984				
Index	**Forecast Techniques**	**Alpha**	**Beta**	**Gamma**
US	Holt-Winters' Multiplicative	0.999	0.001	0.001
UK	Holt-Winters' Additive	0.999	0.001	0.001
Sweden	Holt-Winters' Additive	0.852	0.001	0.001
Austria	Holt-Winters' Multiplicative	0.989	0.001	0.001
Japan	Holt-Winters' Additive	0.999	0.001	0.001
HK	Holt-Winters' Multiplicative	0.999	0.001	0.001
Period 2 January 1975-December 1984 to Forecast January 1985 to December 89				
Index	**Forecast Techniques**	**Alpha**	**Beta**	**Gamma**
US	Holt-Winters' Multiplicative	0.999	0.001	0.001
UK	Holt-Winters' Additive	0.959	0.001	0.001
Sweden	Holt-Winters' Multiplicative	0.753	0.311	0.096
Austria	Holt-Winters' Multiplicative	0.999	0.001	0.001
Japan	Holt-Winters' Multiplicative	0.999	0.001	0.001
HK	Holt-Winters' Multiplicative	0.999	0.001	0.001
Period 3 January 1980-December 1989 to Forecast January 1990 to December 1994				
Index	**Forecast Techniques**	**Alpha**	**Beta**	**Gamma**
US	Holt-Winters' Multiplicative	0.999	0.001	0.001
UK	Holt-Winters' Multiplicative	0.865	0.001	0.001
Sweden	Double Exponential Smoothing	0.999	0.039	NA
Austria	Seasonal Multiplicative	0.992	NA	0.999
Japan	Double Exponential Smoothing	0.979	0.028	NA
HK	Holt-Winters' Additive	0.986	0.001	0.001
Period 4 January 1985-December 1994 to Forecast January 1995 to December 1999				
Index	**Forecast Techniques**	**Alpha**	**Beta**	**Gamma**
US	Holt-Winters' Additive	0.884	0.001	0.001
UK	Holt-Winters' Multiplicative	0.858	0.001	0.001
Sweden	Holt-Winters' Multiplicative	0.999	0.001	0.001
Austria	Holt-Winters' Additive	0.999	0.001	0.001
Japan	Holt-Winters' Multiplicative	0.999	0.001	0.001
HK	Holt-Winters' Additive	0.999	0.001	0.001
Period 5 January 1990-December 1999 to Forecast January 2000 to December 2004				
Index	**Forecast Techniques**	**Alpha**	**Beta**	**Gamma**
US	Double Exponential Smoothing	0.907	0.045	NA
UK	Holt-Winters' Multiplicative	0.999	0.001	0.001
Sweden	Holt-Winters' Multiplicative	0.999	0.202	0.001
Austria	Holt-Winters' Multiplicative	0.769	0.001	0.001
Japan	Seasonal Multiplicative	0.985	NA	0.001
HK	Holt-Winters' Additive	0.999	0.001	0.001

Table IV: Comparisons of Performance of Portfolios for Each Data Period

	Traditional Portfolio Actuals Relative to Expected	Forecasted Portfolio Actuals Relative to Expected	Forecasted Portfolios Actual Returns Compared to Traditional Portfolios Actual
Period 1 held January 1980 to December 1984	Return lower Risk same Re/Rsk=lower	Return higher Risk higher Re/Rsk lower	Return higher Risk higher Re/Rsk higher
Period 2 held January 1985 to December1989	Return higher Risk higher Re/Rsk higher	Return higher Risk higher Re/Rsk lower	Return higher Risk higher Re/Rsk same
Period 3 held January 1990 to December 1994	Return lower Risk higher Re/Rsk lower	Return higher Risk same Re/Rsk higher	Return higher Risk lower Re/Rsk higher
Period 4 held January 1995 to December 1999	Return lower Risk same Re/Rsk lower	Return higher Risk higher Re/Rsk higher	Return higher Risk higher Re/Rsk higher
Period 5 held January 2000 to December 2004	Return lower Risk higher Re/Rsk lower	Return lower Risk higher Re/Rsk lower	Return higher Risk same Re/Rsk higher

Table V: U.S. Domestic versus Internationally Diversified Portfolios

	Domestic U.S. Only Index Performance	Standard Mean Variance Performance	Forecasted Portfolio Performance
Period 1 held January 1980 to December 1984	Return .0123 Re/Rsk=.2906	Return=-.0034 Re/Rsk=-.088	Return=0.0280 Re/Rsk=0.1271
Period 2 held January 1985 to December1989	Return .0165 Re/Rsk .3235	Return=0.0253 Re/Rsk=0.5922	Return=0.0311 Re/Rsk=0.5976
Period 3 held January 1990 to December 1994	Return .0080 Re/Rsk .2230	Return=0.0045 Re/Rsk=0.0880	Return=0.0064 Re/Rsk=0.2880
Period 4 held January 1995 to December 1999	Return .0228 Re/Rsk .5625	Return=0.0182 Re/Rsk=0.3723	Return=0.0388 Re/Rsk=0.6926
Period 5 held January 2000 to December 2004	Return -.0016 Re/Rsk -.0016	Return=-0.0009 Re/Rsk=-0.0185	Return=0.0084 Re/Rsk=0.1685

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