INTERNATIONAL INVESTMENT DIVERSIFICATION BEFORE AND AFTER THE 2008 FINANCIAL CRISIS

Steven V. Le, Department of Finance, California State University, Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840-8505, 562-985-1608, svle@csulb.edu

ABSTRACT

This paper compares the change in correlation between the New York Stock Exchange (NYSE) and international markets before and after a major change in U.S. economic climate. The Lehman Brothers Bankruptcy announcement on September 15th, 2008 is used as a starting point for the change in economic conditions. Empirical evidence shows that the correlation between the U.S. and international markets significantly increases *after* the event. The change in correlation may decrease diversification benefits, which in turn may be sufficient cause to redistribute international portfolio allocations in order to bring the Capital Asset Line (CAL) back in line with the optimal portfolio (p*) on the efficient frontier.

INTRODUCTION

The focus of this project contains two elements. The first is to determine if correlation between the US stock market and each international market separately increases after the news event over a two year time period (one year before and one year after the news). The second element is to determine the optimal portfolio along the Capital Asset Line or p* where the CAL is tangent to the efficient frontier of a two asset portfolio consisting of the United States and the international market observed again, for a one year period both before and after the event. Based on June 30, 2010 domestic capitalization, the five largest country specific markets from developed countries and the five largest emerging markets were chosen. Since part of the focus of this paper is to determine correlation between the U.S. and foreign markets, only one exchange per country is used. Short Term U.S. Treasury Bills are used as the Risk Free Rate over the two year time frame. International markets are widely used today to maximize the risk reward relation through the benefits of portfolio diversification. If economic turmoil, as defined by a major news event in the United States, increases correlation between the U.S. and international markets then this benefit may be diminished. The purpose of this paper is to both verify if an increase in correlation has occurred and thereby present an argument for an immediate adjustment to portfolio allocations. Optimal portfolio allocations for each two asset portfolio consisting of the U.S. and each country individually that will maximize the risk/reward relationship, as defined by the tangent of the Capital Asset Line to the efficient frontier (p*), are calculated using a one year period both before and after the event.

Previous Studies

A study was published in the Journal of Asia-Pacific Business that covered the correlation between international markets in September of 2004. This study (Using ETF's) determined that there was a significant interdependence between markets but that portfolio diversification was still possible, and in this case investors were able to diversify risk if investing in both the U.S. and Japanese markets. (Yavas,

Rezayat, & Bilici, 2004). Another study, completed in 2005, determined that correlation between stock markets is unstable over time. This study used intra-national market volatilities, international market volatilities, and other factors to determine market correlation. Their conclusion was that time varying relationship was primarily dependent on national and international market volatility. In addition, some weaker evidence showed that some association was driven by market downturns. (Knif, Kolari, & Pynnönen, 2005). In 2002 a study was completed by Dr. Burhan F. Yavas, which determined that there was a high correlation between the U.S., Japan and German stock markets, noting the stock markets moved in tandem 30% of the time. The United States and German markets moved the same 47.4% of the time, while the German and Japanese markets moved together 43.3% of the time. The U.S. and Japanese market moved together 54.2% of the time. (Burhan, 2002). Another study was completed regarding the causality of co-integration among stock markets from the U.S., Japan and China, where they determined that no co-integration existed among the three countries' markets. In addition they showed that changes in the U.S. markets can be used to predict future changes in the Taiwan and Hong Kong market the following day. (Huang, Yang, & Hu, 2000). A study of International Investment Diversification - Before and After the October 1987 Stock Market Crisis completed in 1991 (Le, 1991). Another study was completed in 1998 that showed short and long term correlation among six different international stock markets. They determined that substantial efficiency can be obtained by diversifying internationally as opposed to a more traditional, national only approach. (Chou & Ng, 1998). A further study was completed in 2009 that examined co-movement of international stock returns of country industry and country style portfolios. It was determined that an upward trend in returns did not exist. They also determined that industry factors relative to country factors were short lived phenomenon. (Bekaert, Hodrick, & Zhang, 2008).

Hypothesis

The correlation between the United States and international stock markets significantly increases after a major news announcement in the United States. Hypothesis - H_0: ρ_{12} (pre news) < ρ_{12} (post news), Ha: ρ_{12} (pre news) ≥ ρ_{12} (post news) where ρ is the correlation coefficient between the two markets. This adjustment in correlation causes a change in the risk/reward relationship, which results in a suboptimal portfolio.

DATA AND METHODOLOGY

Data

Yahoo Finance was used to obtain weekly index data from each country's exchange from February 16th 2007 (30 weeks before the initial one year period were obtained to calculate a rolling 30 week correlation) to September 11th 2009. The five largest exchanges in developed countries that were selected and compared to the NYSE, in order of domestic capitalization size in dollars as of June 30, 2010, are: The Tokyo Stock Exchange in Japan (TSE - $3.277B), the London Stock Exchange in England (LSE - $2.407B), the Toronto Stock Exchange in Canada (TSX - $1.634B), Germany's Frankfurt Stock Exchange run by Deutsche Börse Group (FWB - $1.106B) and the Australian Securities Exchange (ASX - $1.058B). The five largest exchanges in emerging countries are: The Shanghai Stock Exchange in China (SSE - $2.050B), The Bombay Stock Exchange in India (BSE - $1.376B), The Brazilian Securities, Commodities and Futures Exchange in Brazil (BM&FBOVESPA - $1.151B), The Bolsas y Mercados Españoles group of exchanges in Spain (BME - $1.018B) and South Korea's stock exchange in Busan (KRX - $836M). (World-Federation-of-Exchanges, 2010) Not only were country

specific markets chosen but if a country has more than one exchange, then only one was selected to eliminate duplication. For this reason, the NASDAQ, Euronex, the Hong Kong Exchanges and the National Stock Exchange of India were not included in the analysis. An index that is intended to represent the country market was then chosen for correlation calculations. An exchange traded fund (ETF) for each market was also selected to obtain current dividend data as well as projections from the international monetary fund for nominal gross domestic product growth (nominal) for each country for use in expected return calculations.

Methodology

The "Pearson Product Moment Correlation Coefficient" formula for a sample of a population was used for correlation calculations. A value between -1 and 1 was calculated, where a value of -1 represents the two variables are perfectly negatively correlated and a value of 1 means they are perfectly correlated. A value at or near zero means there is little or no correlation between the two variables. The formula for $\rho_{US,Int}$ = correlation coefficient of a sample population is:

$$\rho_{US,Int} = \sigma_{US,Int}/\sigma_{US}\,\sigma_{Int} = \frac{\sum_{i=1}^{n}(US_i - \overline{US})(Int_i - \overline{Int})}{(n-1)s_{US}s_{Int}}$$

$$\sigma_{US,Int} = Covariance_{US,Int} = \rho_{US,Int}\sigma_{US}\sigma_{Int}$$

Where n is the number of observations of US and International market return variables, s_{US} and s_{Int} are the sample standard deviations, and $\overline{US}$ and $\overline{Int}$ are the sample means of the United States (US) Market return and the International (Int) Market return. In addition, the coefficient of determination (or R^2) is observed using regression analysis to determine the proportion of total variation in the dependent variable "Int" (the international market) that is explained by the variation in the independent variable "US" (the U.S. market). $\rho_{US,Int}$ is the correlation coefficient and $\sigma_{US,Int}$ is the covariance of the US and International markets. $\boldsymbol{\sigma}$ represents the standard deviation of the return on each market. Sample sizes of thirty were used given that most statisticians consider this a large enough sample to employ the central limit theorem, which means a sampling distribution is close to normal and can be used as a close indicator to population data. (Lind, Marchal, & Wathen, 2008)

The percentage movement in each market was used to normalize the data by taking the current closing price, subtracting the previous week's closing price and then dividing by the previous week's closing price:

$$Percentage\ Change = \frac{P_1 - P_0}{P_0}$$

P_1 represents the closing price on the week observed and P_0 is the closing price from the previous week's trading session. (Lind, Marchal, & Wathen, 2008)

The optimal portfolio (p*) or the tangent on the Capital Asset Line (CAL) to the efficient frontier of a two asset portfolio (See exhibit 12 for an example of the efficient frontier and the CAL) consisting of the U.S. market and each international market was individually determined. The formula for the weight of each country's allocation in p* is:

$$W_{\boldsymbol{Int}} = \frac{[\mathrm{E}(\mathrm{r_{Int}}) - \mathrm{r_f}]\sigma_{\mathrm{US}}^2 - [\mathrm{E}(\mathrm{r_{US}}) - \mathrm{r_f}]\sigma_{\mathrm{Int,US}}}{[\mathrm{E}(\mathrm{r_{Int}}) - \mathrm{r_f}]\sigma_{\mathrm{US}}^2 + [\mathrm{E}(\mathrm{r_{US}}) - \mathrm{r_f}]\sigma_{\mathrm{Int}}^2 - [\mathrm{E}(\mathrm{r_{Int}}) - \mathrm{r_f} + \mathrm{E}(\mathrm{r_{US}}) - \mathrm{r_f}]\sigma_{\mathrm{Int,US}}}$$

$$W_{US} = 1 - W_{Int}$$

$$E(r_{p^*}) = w_{US}E(r_{US}) + w_{Int}E(r_{Int})$$

$$\boldsymbol{\sigma_{p^*}^2} = w_{Int}^2\sigma_{Int}^2 + w_{US}^2\sigma_{US}^2 + 2w_{Int}w_{US}\sigma_{Int,US} \,..and\,..\boldsymbol{\sigma_{p^*}} = \sqrt{\sigma_{p^*}^2}$$

W_{us} represents the weight of the portfolio in the United States and W_{Int} is the weight of the portfolio in the respective international market. $E(r_{US})$ = Expected return in the United States and $E(r_{Int})$ is the expected return in the international market observed. σ^2 is the variance and $\boldsymbol{\sigma}$ is the standard deviation. $\sigma_{US,Int}$ represents the covariance between the United States and the International Market and r_f is the risk free rate. (Viswanath, 2000)
The variance ($\boldsymbol{\sigma}^2$) and standard deviation ($\boldsymbol{\sigma}$) were calculated using the standard formula as follows:

$$\sigma^2 = p_1[r_1 - E(r)]^2 + p_2[r_2 - E(r)]^2 + \cdots + p_n[r_n - E(r)]^2 \; and \; \sigma = \sqrt{\sigma^2}$$

Where p represents the weight of each observation and n is the number of observations. r is the actual return on the asset and E(r) the expected or average return for the period.
Regression analysis was run (as mentioned above) using the least some of the squares principle to determine the coefficient of determination or R^2. This method minimizes the sum of the squares of the vertical distance between the actual values of Y and the expected values of Y. The equations are:

$$Linear\ Regression\ Line\ Equation \rightarrow \hat{Y} = a + bX$$

$$Slope\ of\ the\ line \rightarrow b = r\frac{S_y}{S_x}$$

$$Y\ intercept \rightarrow a = \bar{Y} - b\bar{X}$$

Y hat represents the expected value of Y for a specified value of X and "a" is the Y axis intercept. r is the correlation coefficient and S is the standard deviation of both variables as denoted by Y and X. Y hat and X hat are the means of the dependent and independent variables respectively. (Lind, Marchal, & Wathen, 2008)
Expected market return for each country was determined using the Dividend Growth Pricing Method sometimes referred to as Gordon's Model (Bujang & Nassir, 2007).

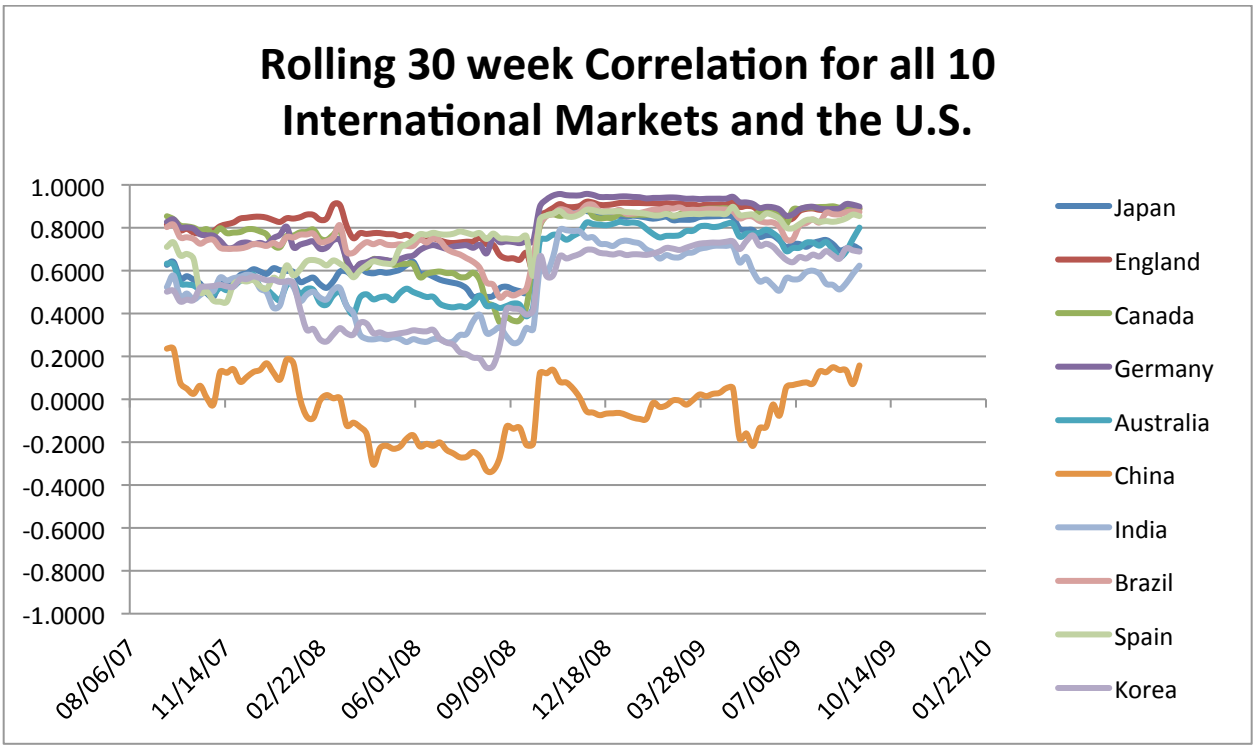
$$K_e = \frac{D^0 * (1+g)}{P_0} + g = Current\ Dividend\ Yield * g = D_1 + g$$

Where K_e is the expected return, D_0 is the previous year's dividend, P_0 is the price and g is the growth. D_1 (the current dividend yield of the index) was added to the 10 year projected Nominal GDP (Exhibit 14) for each country (the growth variable) and used as expected return.

RESULTS

10 market comparison – Comparing all 10 markets to the U.S. together (Exhibit 1) gives a good picture of how closely the markets are linked to the Lehman Brothers Bankruptcy news event. U.S. correlation with all 10 markets sharply increases right after the event and remains abnormally highly correlated until around May of 2009 with the exception of China, which is still a little higher than it was till about the same time. At that time the markets seem to drop back into their normal correlation rhythm, which would suggest new optimal portfolio allocation changes once again. Exhibit 12 shows a graph of the efficient frontier and Capital Asset Line (CAL) for a portfolio comprised of the United States and China prior to the announcement. The point at which the CAL is tangent to the efficient frontier is called the optimal portfolio or p*. The Y intercept of the CAL is the risk free rate and an investor can select a portfolio using the risk free rate and the optimal portfolio to obtain the maximum return per unit of risk that is acceptable for their level of risk tolerance. Exhibit 13 shows the allocation changes for each two asset portfolio individually assuming an investor balances their portfolio annually before and after the event. The interesting thing about this analysis is that the model recommends some two asset portfolios increase the U.S. allocation after the event, while others recommend a decrease. It should also be noted that the model for every two asset portfolio recommends a change in allocation of some kind, which makes sense since an investor would probably want to move their money to the highest expected return country when markets become highly correlated. The results of the project also present a strong argument that, for an investor to properly manger risk, they should closely monitor portfolio allocations or use an investment manager that will. It also suggests that individual investors may wish to use institutional management to help lower transaction costs related to continual portfolio reallocations since transaction costs can take a significant portion of portfolio return if economies of scale are not used.

Exhibit 1 – U.S. & all 10 markets



CONCLUSIONS

The study provides evidence of major changes in correlation shortly after the start of economic turmoil as defined by a major news event in the United States. Major changes in correlation may call for asset portfolio allocation changes that will maximize the risk/reward relationship. If a change in economic climate can be accurately detected then it would be beneficial to the investor or portfolio manager to proactively adjust allocations to reduce risk or increase reward. The strategy does not suggest exiting or timing the market, which may cause an investor to miss potential rebounds, but instead recommends allocation rebalancing. The rolling correlation data present a strong argument in favor of using a portfolio manager in order to continually rebalance investments to the optimal portfolio on the efficient frontier or p*. By using a manager an individual investor will be able to reduce transaction costs associated with constant allocation changes as well as provide a professional to continually check asset relationships. An important note regarding this project is that different assumptions for expected returns for each market as well as the risk free rate can significantly impact optimal portfolio allocations.