Design of Portfolio using Multivariate Analysis

B. Lohith Kumar

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Abstract

Stock markets are considered a barometer of the respective country’s economy around the world. Modern portfolio theory advocates diversification for risk management, which helps maintain returns as long as indices around the world are not perfectly correlated. The relationship exists across markets; as a result, co-movement has drawn the attention of individual investors and portfolio managers for the construction of their portfolios to maximize returns for a given level of risk. The study of co-movements provides inputs for portfolio construction and facilitates the identification of markets where indices may move in the same direction or the opposite direction and the country’s stock markets that are not correlated. A review of the literature revealed that statistical tools like Correlation, Factor analysis, and Granger causality test, etc., are some of the tools that can be used to understand co-movements of markets. Alan Harper et al. (2012) study used principle component analysis and inferred that Indian stock returns are aligned with its trading partners and concluded that maximizing the investors’ returns by reducing the risk. Tak Kee Hui concluded that factor analysis provides inputs for selecting foreign markets for risk diversification. This study examines the potential for diversification using 22 world stock market indices using multivariate analysis.

Index terms — diversification, co-movements, factor analysis, portfolio.

1 I. Introduction

Stock markets worldwide are the most researched topic by different people like portfolio managers, investors, researchers, policymakers and academicians, etc. One of the barometers for measuring the economy is the stock market index. Among the many techniques for risk management, diversification is the one. It can be done by mixing the variety of assets, including stocks and indices which are non-perfectly correlated into a portfolio. Harry Markowitz, a Nobel prize winner, has laid the foundation for Modern Portfolio Theory in 1952. Thereon investment community started focusing on portfolio risks, expected returns, and diversification and its advantages. Many researchers attempted to understand the stock markets’ co-movement of various markets across the globe and selected markets over time. Presently, the topic has become the most popular topic in finance for research. In a globalized economy, the integration of financial markets provides an opportunity to investors, i.e., institutional as well as individual, to generate returns and at the same time manage risk. It gives a platform to strike a balance between risk and return. The integration of various world economies and their liberal policies has provided an opportunity for investors if they wish to diversify. The intention behind the international diversification across countries that are not perfectly correlated is to minimize the variability in the returns on portfolios. Optional risk-reward is also one of the objectives of international diversification as it offers many benefits to all investors around the world. Mansourfar, et.al, 2010). Stock markets worldwide do not move in the same direction as the country’s economic indicators, viz., industrial growth, monetary and fiscal conditions, political scenario, and taxation are unique and specific to the respective country, and returns offered by the markets also vary. Co-movements of the market’s information guide the investors on investment alternatives. A high level of co-movement of stock markets does not benefit from diversification across markets and countries, whereas Low levels of co-movement of stock prices offer investors the benefit of diversifying their holdings across the markets.
Diversification strategies can be designed based on acumen of various market comovements, which affect the risk-return relationship or the expected return from investing in a portfolio of markets. Economists and Capitalists are interested in understanding co-movements of needs. The former is interested in capital movements among countries, and the latter is keen on the effects of co-movements on equity segmentation. (Panton, Lessig, and Joy 1976). For an international investor co-movement of the world, markets are critical for developing a diversification strategy. Many countries have encouraged inflows of capital by having liberal economic policies that result in capital account surplus. Capital market reforms create suitable conditions for investors to take care of riskreturn profiles. The present work emphasizes examining an opportunity to investors, both retail and institutional, for diversification by considering 22 world stock indices using multivariate analysis. Alan Harper and Zhennu Jin (2012) concluded that investors could diversify their portfolios to increase their returns while managing the risk, which has been adopted for the present study.

II. Review of Literature

The inter-relationship between national stock markets has been the subject of several papers in the general area of investment management and international finance research. Apart from exploring and presenting the relationship between national stock markets, these papers have helped develop essential tools necessary for the statistical analysis of correlation structure. Numerous studies have been conducted to explore the linkages among various financial markets around the world. Integration of world markets has provided many opportunities to the investors to look for different investments options across world markets to manage risk and returns. Diversification is a strategy to manage the risk that investors can use by understanding other stock markets globally. As risk diversification is the primary concern for most investors, they tend to look into the possibility of widening their investment choices across the countries or creating a region-based investment strategy. This requires the understanding of regional and global linkages of stock markets. Abbas Valadkhani et al. (2008) investigated the relationship among the selected 13 stock markets returns. To understand the co-movements, the authors deployed principle components analysis and maximum likelihood methods on the monthly data from 1987 to 2007. The authors found that stock markets in the Asian countries are correlated highly, and factor analysis proved a well-defined common factor, and both the methods like ML and PC have provided similar results. Alan Harper and Zhennu Jin (2012) study was conducted to find the linkage between Indian stock market returns with its eleven major trading partners. Monthly stock data for 11 years, i.e., 2000 to 2010, was used for analysis and found that investors can enhance their returns by managing the risks in India’s trading partners’ country’s stock markets. Principle component analysis has been used and inferred that Indian stock returns are aligned with its trading partners. Hence, investors can diversify their investments by choosing the country’s stock indices to improve their returns and minimize risk. Maran Marimuthu (2010) has examined the comovements of the Asian markets with developed markets by considering Malaysian, Indian, Chinese, the US, and the UK equity markets using Statistical models like Johansen multivariate cointegration, Vector Error Correction Model, and Granger causality test. The author found that there is a long-run relationship among the regional markets. Malaysia and India Granger cause each other. There is no role of China in the regional market. In addition, shocks in one country seem to affect other countries briefly in the Asian context. Maran has concluded that the US market is still the main influential factor in the Asian markets. Wen-Chung Guoa and Hsiu-Ting Shihb (2008) investigated the comovement of stock prices and its association with herd behavior during a period of high-tech mania using daily equity returns for each stock. The analysis consists of return dispersion, volatility dispersion, and the directional co-movement of stock prices for a sample of 443 stocks from January 1996 to December 2000, covering industries like electronics, the Internet, communication, etc., semiconductors. The authors found that both return dispersion and volatility dispersion correlate with extreme market movements for high-tech stocks. It was found that herding, measured by directional co-movement, is more prevalent in high-tech industries than traditional economic industries. It also found an asymmetric result that herding has tremendous significance during extreme up markets. Tak-Kee Hui (2005) studied the possibility of Singaporean investors diversifying into US and Asia Pacific markets. Factor analysis was performed on weekly data for the ten stock market indices, covering the period January 1990 to June 2001 to investigate the systematic covariation of the stock market returns to select markets for a Singaporean investor to invest in. Tak suggested that Singaporean investors or portfolio managers select relatively large and well-developed markets for risk diversification and invest in the USA, Australia, and Japan markets. In addition to that, there would not be any significant risk reduction by investing in the Hong Kong, Philippines, South Korea, Thailand, and Singapore markets simultaneously. Therefore, a Singaporean investor can invest in the USA, Australia, Japan, and Taiwan. Kivlicim Metin and Gulnur Muradoglu (2001) focus is forecasting stock returns in emerging markets using their interrelations to significant world stock exchanges and regional counterparts by using international co-movements for weekly stock prices by employing the Engle-Granger (1987) two-step cointegration technique. Kivlicim et al. found that unconditional variances were much higher for emerging markets than their mature counterparts. All national markets are cointegrated with the world leaders and other emerging markets according to their geographical proximity. Jorg Bley (2007) focused on determining the contemporary interactions of the stock markets of Bahrain, Egypt, Israel, Jordan, Kuwait, Lebanon, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Tunisia, Turkey, and the United Arab Emirates by using daily historical prices for a period ranging from 1/2000 to 12/2004. The data
series is divided into two sub-periods, the first period includes 130 weekly observations, and the second period covers the subsequent 128 weeks. The author found that changing stock market dynamics within the Middle East and North African (MENA) countries region still yield substantial intraregional diversification benefits and suggest the inclusion of regional equity in a global portfolio. In addition, Jorg opined that Gulf Cooperation Council (GCC) stock markets are likely to achieve the highest level of homogeneity within the MENA region, as its economies are increasingly synchronized in preparation for an economic union and may lead to a greater level of self-sufficiency of the regional economies which could translate into the manifestation of the currently low external stock market dependency.

Kedarnath Mukharjee and RK Mishra (2007) studied how Indian equity markets responded to the world markets movements and tried to examine the interdependencies of markets worldwide by considering daily closing prices of all the major equity indices for a period of 16 years starting from 1990 to 2005. Twenty-three countries are taken for the study to find comovements of prices among the markets using Geweke measures of feedback. The annual feedback measures indicated that a significant same day relationship among the stock markets in India with that of almost all other foreign countries considered in the study and also found that there is a degree of integration among the markets over some time, resulting in a higher co-movement of prices among markets and therefore higher market efficiency at the international market scenario. Shaista Wasiuzaman and Lim Ai Li (2009) examined whether co-movements between stock markets exist for four stock markets included in this study: Malaysia, Singapore, the US, and Japan. The indices used are Kuala Lumpur Composite Index (KLCI), Straits Times Index (STI), Standard and Poor’s 500 (S&P 500), and Nikkei 225 for Malaysia, Singapore, the US, and Japan, respectively. The sample has been considered based on the liquidity criterion measured by a stock’s average daily traded value. The period of investigation spans January 2000-December 2006. The observations consist of the daily returns of each stock market. Daily returns are used instead of weekly or monthly returns because daily returns are more capable of capturing all possible interactions. The study used three methods to examine the linkages or comovements, namely, correlation analysis, cointegration analysis, and Granger causality test. The results of the correlation analysis suggest that financial market linkages are weak among the four countries undertaken in this study. Cointegration tests reveal that there is a long-run relationship as there is at most a single cointegrating vector. Finally, the Granger causality test shows that most stock markets influence the other stock markets. Overall, the four stock markets seem to have financial market linkages or comovements.

Preeti Sharma (2011) studied the issue of comovement between Asian emerging stock markets and developed economies using cointegration and correlations in the index returns using Six years’ weekly data of 8 Asian Stock Markets and United States of America for the period of six years, spans from January 2002 to December 2007. The author found that among the selected Asian markets, the highest positive correlation is found between Singapore and the Philippines, followed by Singapore and Malaysia and the Philippines and Malaysia. This signifies that Singapore, the Philippines, and Malaysia are the economies whose stock markets usually move in tandem. Japan and China, followed by the United States of America and China, have the most minor correlation among the sample. But as the economies are undergoing different reforms and fundamentals keep on changing, the author cautioned that due care should be taken while making investment decisions.

Shearat Ali et al. (2011) study investigated the co-movement of Pakistan’s Equity Market with the markets of India, China, Indonesia, Singapore, Taiwan, Malaysia, Japan, USA, and the UK by using a cointegration test on monthly stock prices from the period of July 1998 to June 2008. The results disclosed that there is no co-movement of Pakistan’s equity market with the UK, USA, Taiwan, Malaysia, and Singapore markets. In contrast, the stock prices of the Pakistan equity market move together with the stock prices of India, China, Japan, and Indonesia; hence there is no scope of risk minimization for investors through diversification of international markets in these countries. Furthermore, the authors found that the role of the stock exchange structure is not found in the co-movement of the Pakistan stock market with the selected stock markets.

Razan Salem et al. (2011) focused on examining significant portfolio benefits diversification internationally, especially for middle east investors. The authors considered developed markets like USA, Germany, and Japan and a few developing markets, including Oman, for the study by taking daily data from 2008 to 2010. By using statistical tools like correlation and partial correlation, it was found that investors in the middle east can enjoy the benefits of international portfolio diversification despite regional political uncertainties and uncertainties at the global level, including financial. The authors recommended that middle-east investors consider including Brazil, Jordan, Japan, and Oman markets as part of constructing an international portfolio.

Rajesh Chakrabarti examined the nature of regional inter-dependence among selected Asian stock markets and that among selected European markets before and during the Asian crisis while looking at both the "spillover" angle of stock market interrelationship as well as the evolution of the correlation structure over time. The data consists of daily close-to-close returns for eight East Asian developing countries and eight West European developed countries. The East Asian countries are Hong Kong, Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand. In contrast, the European countries are France, Germany, Italy, the Netherlands, Portugal, Spain, Switzerland, and the United Kingdom. This gives us two groups of equal size for comparison purposes. Because we use groups of neighboring countries and the time zone difference within either group does not exceed 2, issues of lead-lag structure for studying volatility spillovers and covariance are not critical for us, and current data can be used for this study. The data covers five years from 12/31/93 to 12/31/98. Thus, we have 1305 data points in our sample. We consider 7/2/97 to be the beginning of the Asian
crisis. In our study, we look at the correlation structure of the eight Asian countries and compare it with the correlation structure among the European countries.

Salim M Darbar and Partha Deb (1997) investigated the co-movements of equity returns for indices of four major equity markets, namely Toronto 300 share index, Topix, the financial times stock exchange 100 shares, and S&P 500 index for a period of 1 Jan 1989 to 31 Dec 1992 by using Multivariate GARCH framework. The authors found that the US and Japan have transitory correlations, but there is no evidence of permanent correlation, and conditional correlations can change considerably in reaction to the news. Portfolios can be adjusted based on the variations shown in correlations. Michel Beine and Bertrand Candelon (2007) examined the impact of trade and financial liberalization on the degree of stock market comovement among emerging economies using a sample of 25 developing countries observed over 15 years. The authors estimate the impact of reforms that aim at opening these countries to trade and financial channels to the rest of the world. Estimating time-varying cross-country correlations allows the econometric investigation to be performed using a panel data framework, raising the quality of the statistical inference. Our results offer strong support in favour of a positive impact of trade and financial liberalization reforms on the degree of cross-country stock market linkages.

Ritesh Patel (2017) found that various investors like Foreign institutional investors, High net worth individuals, institutional investors, retail investors derive an advantage in diversifying the fourteen stock markets that the author considered in the study. The author used the Johansen cointegration test to find the relationship among the selected stock markets and found a long-term relationship among the selected stock markets. The Granger causality test proved that BSE returns are affected by BVSP, FTSE-100, and MXX. The author suggested that investors take their portfolio investment decision by observing the long-and short-term markets integration Indian market.

3 III. Rationale for the Study

The literature review revealed that many studies had been carried out to understand the co-movements and integration of the various stock markets. The studies focused more on American, European, Asia, and Asia Specific markets, but limited work has been done covering Asia Pacific, Europe, American, and Middle East markets. Hence, the present study included middle east markets apart from the other world markets. The study’s findings can be used by the retail and institutional investors, especially the Indian investors, for designing their portfolio and those who are seeking other than their markets for risk minimization. This study has been carried out to investigate the potential for diversification into various stock indices by using the concept of cointegration and co-movement among world stock markets. One of the well-known multivariate analysis techniques, like factor analysis, has been used in the study to understand the relationship among the latent variables. It obtains a reduced set of uncorrelated latent variables using a set of linear combinations of the original variables to maximize the variance of these components, and few studies have been conducted using the Principle Component analysis and Maximum Likely hood methods (Abbas Valadkhani et al. 2008). Factor analysis is used to determine the co-movements among the 22 selected world markets covering major continents like Asia, Asia Pacific, Europe, North America, America, Belgium, etc. Alan Harper and Zhenhu Jin’s (2012) approach has been adopted for the present study.

4 IV. Methodology of the Study

Monthly indices data for the period from 1 Jan 2000 to 31 Dec 2018 are used in the present study. Twenty-two stock markets indices were considered for the study. They are ASX 200 (Australia), Nikkei 225 (Japan), KOSPI (South Korea), Hang Seng (Hong Kong), Jakarta Composite Index (Indonesia), SSE Composite Index (China), Taiwan Capitalization Weighted Stock Index, Sensex (India), Amman SE General (Jordan), BLOM (Lebanon), QE General (Qatar), MSM 30 (Oman), Tadawul (Saudi Arabia), Tel Aviv (Israel), CAC 40 (France), DAX 30 (Germany), BEL 20 (Belgium), Euronext 100, DJIA (United States), TSE (Canada), BOVESPA (Brazil) and BMV (Mexico). The monthly returns have been calculated and tested their stationary by using ADF and PP tests. Factor analysis conceptually helps identify the variables that have similar patterns associated with the latent factor or variable. Factor analysis traditionally assumes that there is no unit root in time series data. This model is well known multivariate analysis model ??Hair et al., 1998; ??abachnick and Fidell, 2001; ??say, 2002). Similarly, the same concept can be used to identify the markets which are associated and not associated. This information is vital for the design portfolio. The linear combination of stock market returns accounts for the variance in the data as a whole Alan Harper and Zhenhu Jin (2012).

5 V. Empirical Results

In this section, quantitative results obtained from the statistical analysis have been presented in the below tables. Various tests conducted are: correlations test, KMO test, component matrix test, communalities test, and rotated component matrix test. 1 depicts stock market returns correlation with all the sample countries in the study. Sensex is correlated among the sample ranging from weak to highly correlated. Further, it can be inferred that Sensex has a weak correlation with few indices like Tadawul (Saudi Arabia, Amman SE General (Jordan), BLOM (Lebanon), and MSM (Oman). A geographical and economic association is one of the critical drivers for having such a relation. From the results depicted in Table 1, China, Jordan, Lebanon, Qatar, and Saudi Arabia
are weakly correlated with other countries except with the countries geographically associated similarly France, Germany, Belgium, US, Canada, and Mexico are highly the rest having moderately correlated. For measuring the sample adequacy, the Kaiser-Meyer-Olkin (KMO) statistical method can be used, which measures the proportion of variance in the data variables that underlying factors might cause.

Values close to 1 generally indicate that the factor analysis is helpful for the present study data. As the KMO measure of sampling, adequacy was as high as the measure of .940, which is excellent as per the review of the literature, and it is an indication that the study can proceed with Principle Component Analysis and the Bartlett test of sphericity.

6 Source: Authors calculations

The co-movements of stock market returns can be examined using the Principle Component analysis, a multivariate technique that helps in reducing the number of variables. Precisely it reduces the number of factors through observed correlations among the variables or factors. The above table 3 shows variance explained in each of the factor(s). It can be observed from the above-stated results that four factors have an Eigenvalue greater than one. The cumulative percentage of the summation of percentage variance for factor 1 is 42.206, for factor 2 is 49.811, for factor 3 is 56.181, and for factor 4 is 60.822. This analysis helped to find out an optimal number of factors, i.e., four.

- Saudi Arabia, Oman, and Jordan, and the last factor has only two countries like Lebanon and Qatar. Hence, it can be inferred that constructing a portfolio using countries under each of the factors will not benefit the portfolio. Hence, while designing the portfolio, investors and institutions should include a country stock index from all four factors to diversify. For example, a portfolio could have indices like DJIA, SSE Composite Index, MSM 30, and BLOM. The factors also have geographical diversification, which helps in deriving the advantage.

7 VI. Conclusion

The correlation values in the study find that Sensex has a weak relationship with few indices and strong relationships with other stock market indices. Sensex has a weak correlation with few indices like Tadawul (Saudi Arabia), Amman SE General (Jordan), BLOM (Lebanon), and MSM (Oman). Rotated component matrix results concur with it because these markets indices have fallen in a different factor. Hence investors, including institutions in India, can use this grouping of the indices while constructing their portfolios. For instance, an investor designed a portfolio using indices like ASX 200 (Australia), Nikkei 225 (Japan), CAC 40 (France), DAX 30 (Germany), BEL 20 (Belgium), Euronext 100, DJIA (United States), etc., the benefits of diversification are minimal. Though the number of indices is included, their correlations are high and fall in the same factor. Hence, investors need to design portfolios by considering factor 1, factor 2, factor 3, and factor 4 to have wide diversity. As these countries are geographically and economically spread out, the investor can enjoy the risk and return portfolio benefits.
KMO and Bartlett’s Test
Kaiser-Meyer-Olkin Measure of Sampling Adequacy: .940
Bartlett’s Test of Sphericity Approx. Chi-Square 15311.880
Df 231
Sig. .000
Source: Authors calculations
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Extraction Method: Principal Component Analysis.

Figure 4: Table 3:
.1 Source: Authors calculations

The component matrix results in Table ?? above; many of the stock markets results are highly correlated with factor 1 followed by factor 2, factor 3, and factor 4.

In factor 1, Indian stock market returns are correlated with many world stock market returns covering South Asia and European countries.

.2 Source: Authors calculations

Table ?? shows communalities which can be between 0 to 1, and the values reported in the above table indicate that all initial communalities have a value of 1; hence it can be inferred that the common factors explain all of the variances in the stock market returns among the sample markets Alan Harper and Zhenhu Jin (2012).

.3 Source: Author calculations

The rotated component matrix results are depicted in Table ?? above, and the findings show that the first factor has large weights for France, Germany, Belgium, Euronext, US, Canada, Mexico, which can be concluded that these stock market returns are highly correlated and designing a portfolio using these markets indices will not help to derive the diversification benefits. The second factor extracted countries like India, Taiwan, China, Japan, South Korea, Hong Kong, and Indonesia are correlated. The third factor extracted countries like


VI. CONCLUSION


