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4. **Topic of research** : Impact of Extreme Events on Diversification and Co-Integration: A Study of Selected World Indices

### **ABSTRACT**

The effects that global extreme events have on stock prices listed on various exchanges in the world have conspired financial economists for decades. Such catastrophic events impact the economies in short as well as long run. It has become imperative to understand the consequences arising out of the occurrence of these disastrous events and the possible strategies to minimize the loss from the perspective of an investor. The awful news of the occurrence of such extreme event travels swiftly from the country of origin to the other nations carrying with it the negative vibes, thus, resulting in significant impact on the financial markets. The countries which are financially interlinked in the long term get affected at a greater scale in comparison to the other unrelated nations. This is well understood in terms of the level of cointegration amongst the countries. The stock indices of Germany, Hong Kong, India and Russia actively participated in the error correction process for the one year period prior to the happening of both U.S. subprime crisis and Euro zone debt crisis. Hence, these countries do not offer any diversification gains. Hong Kong and Russia continued to be strongly integrated and did the error correction for post one year period of both the crises included in the study. In addition, Israel and Japan also got involved in the error correction process thereby becoming irrelevant for diversification. Hang Seng appeared to be strongly integrated in all the extreme events for the pre one year event period. It continued to do the error correction in response to the occurrence of extreme events in eight out of twelve events. The main stock market index of South Africa stayed neutral in ten out of twelve extreme events and did not participate in the error correction process prior to the incidence of catastrophic events and therefore it serves as a good candidate for international diversification. Russia's stock index did not participate in the co-movements of the other countries for the out-of-sample period and was not impacted due to the happening of catastrophic events except the US subprime crisis, Euro zone debt crisis and Japan earthquake and tsunami.

The empirical analysis of impact of twelve extreme events on selected major stock market indices of the world for the period spanning from 1<sup>st</sup> January 2001 to 31<sup>st</sup> October 2013 revealed that terrorist attacks have impacted the level of cointegration among the stock markets world over. For example, the blast in Bali Island, terrorist attacks in London, explosion in Madrid and trains attack in Mumbai significantly increased the number of cointegrating equations, thereby resulting in higher levels of co-movements amongst the nations. Surprisingly, events of greater dimension like US subprime crisis, Euro Zone debt crisis and September 11 terrorist attack resulted in a decrease in the level of financial linkage among the selected countries. Out of the two hurricanes, Hurricane Sandy has been completely neutral in impacting the financial markets. The earthquake and tsunami in Japan emerged as an important cataclysmic event resulting in noticeable increase in the number of countries participating in the error correction mechanism whereas the tsunami in South East Asia and the earthquake in China have decreased the inter linkage amongst the selected countries. It can be summed up that extreme events contribute towards varying the level of cointegration of the national stock indices of the various financial markets of the world.

The study revolves around three popular portfolio diversification methods, namely Naive 1/N portfolio construction technique, Markowitz Modern Portfolio Theory of diversification and last but not the least, cointegration-based portfolio construction method. Events like blast in Bali Island, Madrid bombing, tsunami in South-East Asia, terrorist attacks in England, hurricane Katrina in US, US subprime crisis, China Earthquake and Japan earthquake & tsunami, the Sharpe's ratio was maximum for the portfolios based on cointegration analysis. However, Markowitz based portfolios delivered better results as per Sharpe's ratio for events such as Mumbai train attacks, Euro zone debt crisis, and U.S. hurricane Sandy. Astonishingly, the naive portfolio performed comparatively better for the period when US twin towers were attacked by terrorists. The results indicate that equally-weighted all market portfolio performs the worst in all but one extreme event and therefore cannot be considered as an effective portfolio selection technique. Similarly, optimum portfolios created on the basis of Markowitz method have also not performed for a significant number of events. Their performance excelled only in the case of Euro zone debt crisis, Japan earthquake & tsunami and US hurricane Sandy. Portfolios created on the basis of the analysis of cointegration among the selected stock indices are likely to benefit an investor who wants a shield against the losses occurring due to an extreme event. This cointegration-based portfolio creation results in maximum international diversification.