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## MARKET CORRELATION: EFFECT OF HISTORICAL EVENTS ON THE WORLD'S LARGEST FINANCIAL CENTERS FROM 1983-2003

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### Abstract

*This paper studies the effect of various historical events on the market correlation among the three largest financial centers of the world: New York City, London, and Tokyo for the time period 1983-2003. The analysis focuses on those correlations associated with four historical events: the U.S. stock market crash of 1987, the London IRA Bombing of 1990, the Asian Currency Crisis of 1997 (particularly the day the Thai Baht fell), and the September 11<sup>th</sup>, 2001 terrorist attacks of 2001. The purpose of this study was to provide additional information that will provide the investment community with insights about maintaining market stability during periods of economic crises. With this information, investors may be able to avoid large losses and hedge their systemic risk of global events. Market data associated with each historical event were analyzed using correlational and statistical procedures. Results suggest that, during times of economic crises, the S&P 500 and the FTSE 100 tend to be more correlated with each other than with the Nikkei 225. At the end of the tested time period, the September 11th terrorist attack shows a similar correlation among the markets although the degree of correlation is slightly less. However, the fact that their correlations are very similar shows that there have not been significant changes in market correlation during economic crises over time.*

### Overview

The Dow Jones Industrial Average was down 251 points. That was the outcome on October 24, 2007 after Merrill Lynch announced third quarter earnings for 2007 with \$8 billion in write-downs associated with the subprime market. In addition, Citigroup had \$6.5 billion in write-offs. With days like this, it is clear that the subprime market in the United States is currently problematic. With this part of the U.S. economy in flux, the U.S. stock market has continued its downhill slide after closing at an all-time high of 14,000 on July 19<sup>th</sup> of 2007.

While the stock market serves as a leading indicator of economic health, it is important to determine how all the markets around the world are responding to this crisis. Current economic conditions in the United States, especially with the continuous slump of the housing market and the ongoing subprime market crisis, are leading to wealth deterioration, since the primary source of individual wealth is housing. But how is it affecting the international markets, especially since there has been an increase in globalization over the past decade (Reves, 2007)? This increased globalization makes it

particularly pertinent to examine the market correlations among the largest financial centers in the world: the markets of New York, London, and Tokyo. In establishing how these markets correlate with each other, it is possible to see which market was less volatile during times of economic crises, allowing investors to be better informed about investing options.

Prior research suggests that the financial markets of developed nations are highly correlated (Sarkar, 2002). However, the financial markets are not always in perfect synchronization at every moment in time. This raises the following question: are markets highly connected during times of economic crises? Economies of every country are forced to react to historical events that occur both domestically and abroad, but they are not forced to react in the same manner. In this study, the market correlations from 1983-2003 among the financial centers were determined at the time of several historical events, specifically the U.S. stock market crash of 1987, the London IRA Bombing of 1990, the Asian Currency Crisis of 1997 (particularly the decline of the Thai Baht), and the U.S. September 11 terrorist attack of 2001. The year 1983 is the benchmark year because it is the year when the United States stock market was entering a bull market and beginning a period of growth (Madrick, 2002). This is used as the foundation point in time since the great stock market crash did not occur until 1987. Following 1983, the historical events of interest are separated by a few years to control as much as possible for contagion effect of the crises. Contagion is simply a cross-market linkage of significant increases after some economic event in another market (Forbes, 2002).

Using these data, the study reported here was designed to determine which market is the most stable during times of economic crises and whether there is a relationship between the performance of markets at these times. Stock indices from each of three financial centers were analyzed, specifically, the S&P 500 (New York City), the FTSE 100 (London), and the Nikkei 225 (Tokyo). Using the market closes for each of the indices, the percentage change in value was calculated and used to determine how the markets relate among themselves. In order to understand the rationale for raising these research questions and for exploring market response to contagious events, it is first important to explore further the concept of market correlation and of contagious events.

*Correlation* simply characterizes the nature and degree of relationship between two variables. Market correlation studies the relationship between two different stock markets or indices. During times of downside moves, correlations among U.S.

stocks and the aggregate U.S. market are much greater, thus making the impact of negative historical events more powerful (Ang, 2002). Markets typically close in the same direction most of the time, whether up or down (Buttonwood, 2007). Most fund managers divide their portfolios into different regions and countries to allow international diversification (Kearney, 2004). However, investors need to understand the importance of market correlation because, in order to be well diversified, the securities need to have little or negative correlation. Further, there is evidence that suggests that stock correlations rise during negative returns, compounding the notion that diversification strategies do worse during bear markets (Kearney, 2004). However, previous research has not focused on bear markets or bull markets; instead, it has focused on shorter periods of historical events and their immediate impact on market correlation among the financial centers of New York City, London, and Tokyo.

When any type of historical event occurs, it is rare that the incident and its consequences remain isolated in a domestic region. Instead, there is research that suggests that *contagion effects* are phenomena that affect international markets. During times of an economic crisis, the stock markets tend to have increased volatility, placing more importance on a diversified portfolio. The contagion effect directly impacts one of the events in this study. After the Asian Currency Crisis, Henk Jager and others explored whether or not there was a contagion effect on the surrounding countries (Jager, 2006). They studied contagion using regression analysis, as opposed to the standard correlation coefficient analysis (Jager, 2006). In their study, contagion was actually shown in Thailand to spread to both Indonesia and Malaysia. The contagion effect is an important phenomenon that may affect some of the major historical events that have occurred since 1983.

In theory, knowledge about which markets are stable during times of economic crisis should allow investors to hedge their risks during times of uncertainty and potentially increase the diversification of their portfolios. Investors may find it useful to look at correlations among the markets and to invest in negatively correlated markets for greater diversification. This greater diversification can increase the benefit to any portfolio and, combined with low volatility, could potentially increase a portfolio's total return

### Hypothesis Development

This study was designed to test the theory of market correlation that compares the effect of historical events on the world's three largest financial centers controlling for the time period of each respective event. The independent variables are defined as each of the historical events measured in this study and the control variables are the time frame measured for each of the historical events.

Based on prior research, a set of hypotheses was developed for this study. This set of hypotheses describes market correlations and is designed to determine whether or not the correlations among the markets have changed over time. The primary research hypotheses are:

**H<sub>0</sub>:** There is no relationship among market correlations of the S&P 500, FTSE 100, and Nikkei 225 over the tested time periods for the historical events, or  $r = 0$

**H<sub>1</sub>:** There is a relationship among market correlations of the S&P 500, FTSE 100, and Nikkei 225 over the tested time periods for the historical events, or  $r \neq 0$

If any of the relationships among market correlations was significant, a subset of hypotheses was created to determine:

**H<sub>1</sub>:** The correlations among the S&P 500, FTSE 100, and Nikkei 225 have, in general, increased over time.

**H<sub>2</sub>:** The correlations among the S&P 500, FTSE 100, and Nikkei 225 have, in general, decreased over time.

**H<sub>3</sub>:** The correlations among the S&P 500, FTSE 100, and Nikkei have not changed over time.

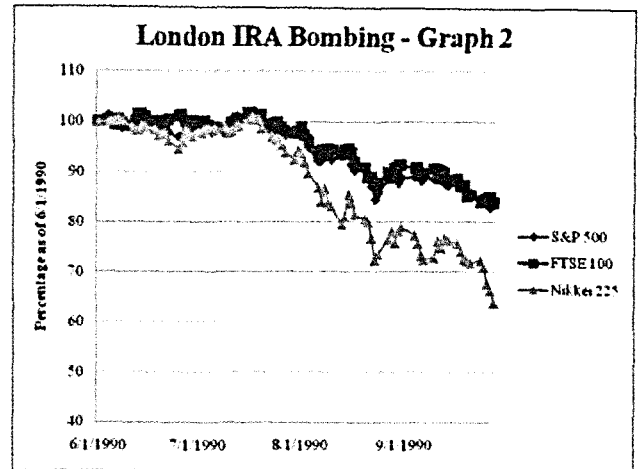
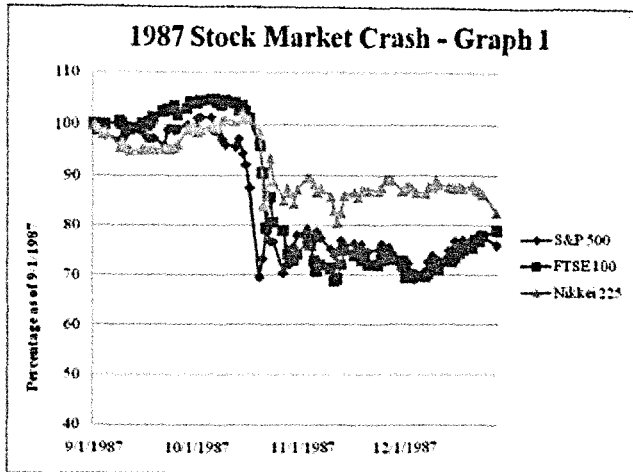
This subset of hypotheses was investigated by examining trends in the correlation data.

### Methodology

From 1983-2003, a variety of historical events have occurred that have had a profound impact on the world's economies. While it was difficult to select specific crises, events were chosen based upon economic impact and time frame. The market analysis begins in 1983, a time the U.S. market was beginning its period of growth (Madrack, 2002). After a few years of normal growth, the first economic crisis occurred in the form of the stock market crash of 1987. This event had a significant impact on the U.S. market, so future historical events test each respective market's resolve. The data were collected from Finance.Yahoo.com, a reliable website for daily market news. Because of the historical indices, Yahoo! Finance had daily market close data for the S&P 500, the FTSE 100, and the Nikkei 225. This source of data was extremely important because daily market closes were required to determine the correlation among the financial centers during the times of economic crises. The time frame for data collection was the month before the event until three months after the event to provide a sufficient number of observations.

Once the data were collected, the three financial centers' market closes were analyzed. Data for New York City, London, and Tokyo were measured both on a daily and a weekly basis. Daily data were computed using the beginning date as the benchmark, set at 100, with the rest of the data expressed as a percentage of the benchmark. Graph 1 displays market data for the 1987 U.S. Stock Market Crash after adjustment to set start dates at 100. In this example, it is clear that markets reacted differently throughout the four months tested, but that the S&P 500 and the FTSE 100 followed each other closely, while the Nikkei 225 displayed some disparity in the latter parts of the graph. The value of the markets on September 1<sup>st</sup>, 1987 was used as a benchmark and each subsequent market close was taken as a percentage of that value to provide data to measure market correlation.

As a robustness test, the weekly percentage changes in market closes were also used for comparable correlation



analyses. If the data were not adjusted for the percentage change in market close, and the magnitude of change was compared, then the S&P 500 would have a distinct disadvantage because the numerical value of its index is about one-fifth of the FTSE 100, while the Nikkei 225 is about one-hundred times larger than the S&P 500. Therefore, raw market data for the financial centers did not allow for proper comparison. The market closes had to be adjusted and measured as the percentage change in market close from one day to the next using the basic equation below.

$$\% \text{ Change in Market Closes} = (\text{Final market close} - \text{Initial market close}) / \text{Initial market close}$$

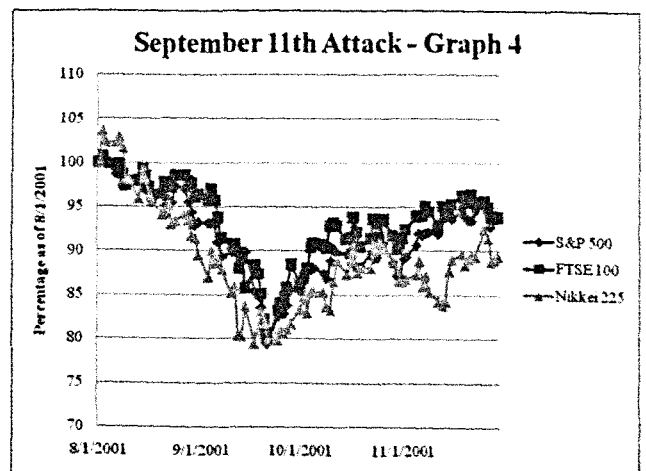
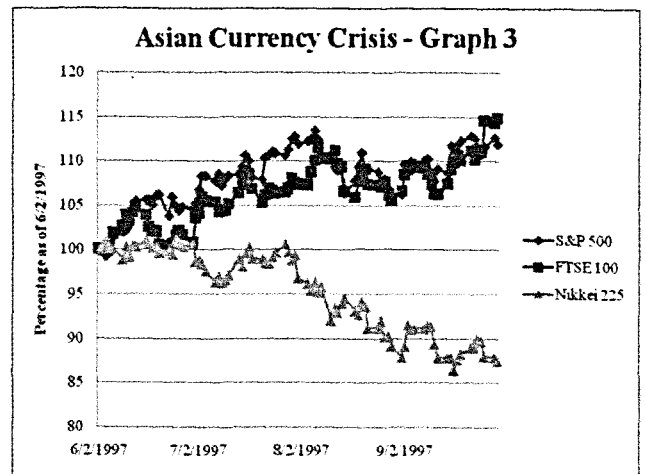
## Results and Discussion

### Primary Data Analyses

While it is well-known that economic crises create greater levels of uncertainty in the financial markets, the correlation among various financial markets is not clearly defined. Other studies have discussed the impact of historical events on the correlations of the stock market. However, most of the studies that conclude that market correlation increases during times of a financial crisis usually examine one historical event and compare volatility (Hameo, 1990).

Results of the current study examine market correlations across four historical events. Adjusted market close data for the four historical events examined in this study are shown in Graphs 1, 2, 3, and 4.

In general, based on visual inspection of the data, the market most closely linked to the historical event has the largest single day percentage decrease in market close. This is expected since these world markets are not completely dependent on any of each other. With the exception of the Asian Currency Crisis of 1997, the relationships between any two indices are relatively high, especially during the London IRA Bombing of 1990. A plausible explanation for the relatively low correlation between the Nikkei 225 and either the S&P 500 or FTSE 100 could be the fact that the Asian countries were hit the hardest during this economic crises.



Even though all of the markets may have been affected, the Nikkei 225 could have suffered from more of a contagion effect due to their close proximity to the Asian countries.

Pearson product moment correlations were calculated for the daily market closes of New York, London, and Tokyo for the time periods surrounding each of the historical moments selected in this study. Analyses used the adjusted market return data described above (see Table 1). Correlations measure the strength of relationships among variables. In this study, significance level was set at  $\alpha = .10$  for a two tailed test. Any correlation of 0.150 or higher was considered significant. All Pearson product moment correlations in this study were associated with probability levels below 0.10, and all null hypotheses were rejected. When data trends across the four historical events were examined, the basic pattern or relationship is similar for all markets.

<b>Table 1. Correlation matrices examining daily relationships among New York, London, and Tokyo stock markets for four historical events.</b>			
<b>1987 U.S. Stock Market Crash</b>			
	<i>S&amp;P 500</i>	<i>FTSE 100</i>	<i>Nikkei 225</i>
<i>S&amp;P 500</i>	1		
<i>FTSE 100</i>	0.936342166*	1	
<i>Nikkei 225</i>	0.860400585*	0.918773994*	1
<b>1990 London IRA Bombing</b>			
	<i>S&amp;P 500</i>	<i>FTSE 100</i>	<i>Nikkei 225</i>
<i>S&amp;P 500</i>	1		
<i>FTSE 100</i>	0.981574725*	1	
<i>Nikkei 225</i>	0.982187989*	0.975210072*	1
<b>1997 Asian Currency Crisis</b>			
	<i>S&amp;P 500</i>	<i>FTSE 100</i>	<i>Nikkei 225</i>
<i>S&amp;P 500</i>	1		
<i>FTSE 100</i>	0.845510039*	1	
<i>Nikkei 225</i>	-0.512928005*	-0.715090227*	1
<b>2001 September 11th Attack</b>			
	<i>S&amp;P 500</i>	<i>FTSE 100</i>	<i>Nikkei 225</i>
<i>S&amp;P 500</i>	1		
<i>FTSE 100</i>	0.949202634*	1	
<i>Nikkei 225</i>	0.861660848*	0.852065544*	1

\*Statistically significant Pearson product moment correlations at .01 level.

In this study, market correlation over this time period shows that the three markets measured have remained relatively constant. Because their correlations have remained similar, investors need to diversify their international holdings more carefully during times of economic crises. From visual inspection of the data and consideration of the size of the correlations, it is also clear that the financial markets of these developed nations are still subject to contagion, and degree of contagion will vary from market to market. During these times of an economic crisis, it is important for investors to properly diversify portfolios and have appropriate risk management

applied to the portfolio. In order to properly allocate securities, the investor needs to understand the basic relationship among financial markets, namely market correlation.

For example, if investors use this knowledge, they could invest in the FTSE 100 and hedge it with investments in the Nikkei 225, because of their lower correlation. However, this is only valid during times of economic crises. Thus investors should be able to decrease the amount of systemic risk in their portfolios and hopefully attain a more optimal return. This is especially relevant during this recent subprime crisis that the United States market is facing. The data also show that the correlation between S&P 500 and the Nikkei 225 has remained consistent over time, holding a 0.8604 correlation in the 1987 U.S. Stock Market Crash and a 0.8617 correlation in the 2001 September 11 Attack.

#### *Alternative Explanations/Sensitivity Analysis*

This study suggests that the market correlation among the world's three largest financial centers tend to remain consistent over time with respect to historical events. However, several factors may have influenced the correlations in each of the models. As a robustness test for the correlation data, the correlations among the financial centers were analyzed using daily and weekly data. The daily data were used to determine the correlations, as they would be the most accurate. Furthermore, daily data were measured as a percentage based on a benchmark date. In order to test the accuracy of the correlations, a separate correlation matrix was developed for each of the markets, comparing the weekly percentage change in market closes, as shown in Table 2.

<b>Table 2. Correlation matrices examining averaged weekly relationships among New York, London, and Tokyo stock markets for four historical events</b>			
<b>1987 U.S. Stock Market Crash</b>			
	<i>S&amp;P 500</i>	<i>FTSE 100</i>	<i>Nikkei 225</i>
<i>S&amp;P 500</i>	1		
<i>FTSE 100</i>	0.587782268*	1	
<i>Nikkei 225</i>	0.456410667*	0.766419154*	1
<b>1990 London IRA Bombing</b>			
	<i>S&amp;P 500</i>	<i>FTSE 100</i>	<i>Nikkei 225</i>
<i>S&amp;P 500</i>	1		
<i>FTSE 100</i>	0.819118245*	1	
<i>Nikkei 225</i>	0.550768894*	0.708344143*	1
<b>1997 Asian Currency Crisis</b>			
	<i>S&amp;P 500</i>	<i>FTSE 100</i>	<i>Nikkei 225</i>
<i>S&amp;P 500</i>	1		
<i>FTSE 100</i>	0.560489952*	1	
<i>Nikkei 225</i>	0.214382891*	0.372009271*	1
<b>2001 September 11th Attack</b>			
	<i>S&amp;P 500</i>	<i>FTSE 100</i>	<i>Nikkei 225</i>
<i>S&amp;P 500</i>	1		
<i>FTSE 100</i>	0.731072372*	1	
<i>Nikkei 225</i>	0.509313356*	0.617683684*	1

\*Statistically significant Pearson product moment correlations at .01 level.

The Pearson product moment correlations are lower for the weekly data, but the trend remains the same and all correlations remain significant. Thus, there is a relationship among the S&P 500, FTSE 100, and Nikkei 225 even using the daily measures for greater sensitivity.

Regulatory procedures affect sentiments among investors within a specific market. For example, the United States has the strictest type of regulations, most notably the Sarbanes-Oxley Act of 2002 (Gumbel, 2007). In contrast, London has more lenient regulations, which attract more business (Gumbel, 2007). In this study, regulation may serve as a confounding variable, as its influence cannot be directly observed. If the three markets adapted the same international accounting standards, then this confounding variable would practically cease, albeit the efficiency and correlation of the markets may or may not change (Grimes, 2007). This could help explain why the New York market was more strongly affected than the other markets. In this study, some of the errors presumed to exist in the models are beyond the scope of analysis. Future research should include additional variables that may influence market performance and interrelationships among major world markets.

## Conclusion

Based on this study, the market correlations among the S&P 500, FTSE 100, and the Nikkei 225 have not significantly changed over time. From the time period of 1983-2003, several historical events have occurred that have directly affected the financial markets. However, only a select few were chosen for this study. In the beginning of the time period, the correlation among any two markets was relatively high, especially between the S&P 500 and the FTSE 100 at 0.9363. As time progressed and other historical events were measured, market correlations remained relatively high and consistent, with evidence that these developed markets have continued to affect each other in the same manner. Therefore, contagion during times of economic crisis for one market may affect each of the other markets, as they may be more correlated. Even with the findings of this study, however, investors should still use caution when investing in order to properly hedge their risks.

These results have important implications.. The current economic conditions in the United States are challenging. The subprime crisis from the summer of 2007 has placed a sharp strain in the U.S. economy. This most recent economic crisis will no doubt be felt in other markets around the world, both developed and emerging. As a result, investors may need to reconsider their asset allocation during times of economic crises or anticipated times of economic crises.

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## Mentor Comments

Faculty mentor Robert Stapp provides an overview of the economic conditions that led Thomas Vo to pursue this examination of aspects of market volatility. Dr. Stapp identifies this work as highly relevant to understanding the impact of recent historical events in order help investors reduce risk.

*Stock market volatility generates uncertainty and leads to economic losses. Recent cataclysmic events such as the*

*Asian currency crisis and 9/11 generated capital losses to shareholders of the world that have rivaled the most renowned occurrences in history. Investors have therefore been seeking a 'safe haven' strategy to maintain their accumulated wealth. The major stock markets of the world, namely Tokyo, London and New York, along with their principle indexes were examined in this research in order to determine which market provides the greatest degree of stability during turbulent times. This is a*

*current subject of keen interest in financial economics. The dynamic relationship of the world's security markets are certainly in flux. The principle subject matter of Thomas Vo's research is perhaps one of the most relevant to this entire discussion as it provides an analysis of which market performs the best during unexpected shocks to the system. His research offers investors a strategy to reduce their risk in the face of uncertainty and thereby maximize their welfare.*