The Effects of the 2007-2009 Financial Crisis on the Cointegration Relationship between Stock Markets

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ABSTRACT

This study examines the cointegration relationship between the S&P 500 and other major stock market indices before, during and after the 2007-2009 financial crisis. This paper examines the S&P 500 and its cointegration relationship with the following indices: Hang Seng, FTSE 100, DAX, Nikkei 225, CAC 40, IPC, TSX 60 and Merval Buenos Aires. The augmented Dickey-Fuller test (ADF) is used to test the cointegration between the major stock market indices. It is found that the majority of the indices were cointegrated with the S&P 500 before and during the crisis and were not cointegrated after the crisis.

INTRODUCTION

This study will look into how the U.S. financial market influenced other countries' stock market performance following the 2007-2009 financial crisis. The cointegration relationship between the U.S stock market index and the stock market indices of other countries will be examined. Financial markets around the world are interdependent with each other and every movement in one of their economies has the potential to affect another market in a different country. This paper will focus on the effect that the recent 2007-2009 U.S. financial market crash had on the stock market performance of different countries around the world and how this influenced the relationship between the countries' stock markets. This relationship is important because global financial interdependence is a strong factor in the economy and it can be very beneficial but it also can have its negative aspects.

The housing bubble burst in 2007 and led to a large decrease in the prices of securities related to U.S. real estate pricing. There were many causes of the 2007-2009 U.S. financial crisis including sub-prime borrowers having easy access to loans, the overvaluation of bundled sub-prime mortgages, banks and insurance companies having a shortage of sufficient capital holdings to back up their financial commitments, and problematic trading methods of buyers and sellers. The crisis led to credit tightening, a decline in international trade and a rise in unemployment. Unemployment started to significantly increase in September 2008 and reached its peak of ten percent in October of 2009 ("Financial Crisis of 2007-2008", 2014).

According to the National Bureau of Economic Research the recent financial crisis began in December 2007 and lasted until June 2009 ("U.S. Business Cycle Expansions and Contractions" 2013). This crisis had many negative effects on the United States. Between 2007 and 2009 American

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employment decreased by about 8.8 million people, U.S. GDP fell by more than five percent, and the Standard and Poor's 500 decreased by about 57 percent. As a result of the crisis many banks filed for bankruptcy while many other banks were bailed-out, acquired or taken over (Rodrigo, 2013).

One indicator to examine this more in depth is to look at the weekly adjusted close prices, adjusted for dividends and splits, of major stock indices around the world from January 2003 to February 2013. The stock indices studied are the S&P 500 in the U.S., the Hang Seng in Hong Kong, the FTSE 100 in England, the DAX in Germany, the Nikkei 225 in Japan, the CAC 40 in France, the IPC in Mexico, the TSX 60 in Canada and the Merval Buenos Aires in Latin America. Europe should be studied because it was so largely influenced by the crisis. The financial crisis in the United States helped contribute to the European sovereign-debt crisis; an ongoing crisis in Europe where countries had trouble repaying their government debt without assistance. The crisis also led to bank failures in Europe ("Financial Crisis of 2997-2008", 2014). The Asian region is included in the study because it contains two of the world's largest economies, The People's Republic of China and Japan. The Latin American region is of interest because of its past financial troubles in the 1980s and 1990s that made it better prepared to withstand the recent financial crisis. There was an external debt crisis in Latin America in the early 1980s. That crisis led the Latin American governments to enact reforms that helped strengthen the region's financial sector and better prepare it for future financial instability (Griffin, 2010). Mexico and Canada were chosen because of their close proximity to the U.S.

This study is different than many previous studies because it uses cointegration rather than correlation measures. Another distinction of this study is that the augmented Dickey-Fuller test will be used to measure the cointegration relationship, unlike many previous studies which use other forms of cointegration measures.

LITERATURE REVIEW

There have been many studies that have tried to measure the amount of linkage between countries following a financial crisis in one country. Some studies focus on contagion or correlation while other studies use cointegration to examine the relationship between two countries. Financial contagion occurs when shocks in one country's economy spread to other financial institutions and economies in other countries. The correlation coefficient can be used to measure the strength of the linkage between two countries (King and Wadwani, 2013). King and Wadwani (1990) studied the correlation of stock markets in different countries following the stock market crash of October 1987. They found that the impact from the contagion increases as volatility increases. Hamao, Masulis, and Ng (1991) examined stock market returns on the New York Stock Exchange, the Tokyo Stock Exchange and the London Stock exchange from 1985-1990 to study the impact of the stock market crash in October 1987. They believe there is an increased awareness of the interdependence of financial markets due to the increased volatility spillover effects originating in Japan. They found that before the crash there was weak correlation in returns

among international stock markets but during the crash there were much stronger correlations. They found that spillover effects do not occur evenly around the world.

While many researchers use correlation to measure the relationship between stock market returns some use cointegration measures instead. This study is going to use cointegration measures because cointegration attempts to measure common trends in prices over the long run while correlation is only a short term measure of interdependence. Cointegration occurs when two or more times series have a common stochastic trend. This means that they have the same trend component because over the long run the times series drift together. The concept of cointegration was first formalized by Engle and Granger (1987). Kasa (1992) studied the cointegration relationship among the stock indices of five developed countries from 1974 to 1990 using Johansen's (1991) likelihood ratio. Kasa found that among the five markets there was only one common stochastic trend (Fu and Pagani, 2010).

Forbes and Rigobon (2002) discuss how correlation coefficients have a bias because they depend on market stability. They define contagion as a considerable rise in cross-market co-movements after a shock occurs in one country. They say that interdependence occurs when a high level of market correlation implies a link between two countries, but a significant increase in co-movements does not occur. Forbes and Rigobon believe that there is a bias in the correlation coefficient due to heteroskedasticity. They manipulate the equation for the correlation coefficient to adjust for heteroskedasticity bias. Heteroskedasticity in markets can cause an upward bias of cross-market correlation coefficient estimates. The adjusted equation assumes that there are no omitted variables or endogeneity between markets. This adjustment of the equation helps solve the problem of the difference between the conditional and unconditional correlation coefficients. They examined the contagion during the 1987 U.S. stock market crash. To do this they define the turmoil period and the stable period and they focused on the ten largest stock markets. Forbes and Rigobon found that there wasn't much evidence of a significant increase in cross-market correlation coefficients during the 1987 U.S. stock market crash.

There are many factors that may contribute to the degree to which stock markets are related. Walti (2005) studied 15 countries from 1973 to 1997 and examined the co-movements between their stock market returns and how they were influenced by macroeconomic variables. He studied the process of synchronization between the markets, which is measured by a correlation coefficient. He found that synchronization of stock markets is affected by the intensity of trade relations, the degree of financial integration, and the nature of the exchange rate regime. Other factors that influence the synchronization of stock markets are: informational asymmetries, similarity of economic structure across countries, and a common language (Walti, 2005).

Countries' synchronization can be affected by a common disturbance such as a change in the world interest rate level, changes in the level of price and volatility of oil, political uncertainty or similar characteristics. These common disturbances tend to make comovements between countries stronger. Shocks that are related to specific countries that pass through economic linkages such as trade can have an effect on comovements (Walti, 2005).

Michael Dooley and Michael Hutchison (2009) examine the spreading of the U.S financial crisis to emerging markets. In their studies they examine fourteen emerging markets around the world to study how countries with emerging financial markets respond to U.S. news through the stages of a financial crisis. Fu and Pagani (2010) wanted to test if there was bias affecting Kasa's cointegration studies; to do this they use the Johansen's small sample correction factor. They find that there is still a cointegration relationship between the indices studied by Kasa by the evidence supporting this is weaker. They believe Kasa's findings are probably due to size distortion in extremely long lag vector auto regression (VAR) models.

Khan (2011) looks at the United States and twenty two other countries and studies their convergence in the long-run. He finds that by 2010 stock markets for most countries have become cointegrated. To examine the stock markets he uses the Johansen (1988) and the Gregory and Hansen (1996) tests.

Rim and Setaputra (2012) examined the impact of the U.S. financial crisis on different financial markets in Asia and Europe by using the daily return of stock market indexes between January 2005 and February 2010. Using a GARCH model to look at the U.S. financial crisis and its impact on other markets, they found that before the crisis the U.S financial market had a strong impact on markets in Hong Kong, UK and France. They also found that during the U.S financial crisis the U.S. became more integrated with Asian markets and less integrated with financial markets in Europe but the influence from the U.S remained strong in Asia and Europe throughout the crisis. They found that before the crisis the average correlation coefficient between the U.S. and Asia was 0.0884 and during the crisis it increased to 0.2437. Between U.S. and European markets, before the crisis the average correlation coefficient was 0.1128 and during the crisis it decreased to -0.0566.

Asongu (2012) studied the markets of emerging countries and their vulnerability during the 2007-2008 U.S financial crisis. They found that Asian markets were hit the worst and Latin American countries were the least affected. Latin America was probably the least affected area based on shifts in conditional correlation coefficients because it was the most prepared due to its history of financial crises.

DATA

This study will use the weekly adjusted close prices gathered from Yahoo Finance from January 2003 to February 2013 for the following indices: S&P 500, Hang Seng, FTSE 100, DAX, Nikkei 225, CAC 40, IPC, TSX 60 and Merval Buenos Aires ("Historical Prices" 2013). Each index was compared to the S&P to measure if there is cointegration with the U.S. market before, during and after the 2007-2009 financial crisis. The period before the crisis is from January 2003 to November 2007. The crisis was from December 2007 to June 2009. The period after the crisis goes from July 2009 to February 2013. For the Nikkei stock index three dates are missing from the data set due to exchange holidays in Japan; these dates are January 2, 2003, December 31st, 2007, and December 31st, 2012 ("Market Holidays," 2014).

METHODOLOGY

The augmented Dickey-Fuller test (ADF) was used to test the cointegration between the stock market indexes of different countries. This model tests for a unit root in a time series sample ("Augmented Dickey-Fuller Test" 2013). First one variable needs to be regressed on another using least squares. Then the residuals are tested for nonstationary using the Dickey-Fuller test. If the Dickey-Fuller test statistic turns out to be statistically significant then the two series are cointegrated. If the null hypothesis, that the residuals are nonstationary, is rejected then it is concluded that the residuals are stationary and that the two series are Cointegrated ("Cointegration and the ECM" 2013).

RESULTS

As table 1 shows that there are some common patterns of cointegration between the different countries before, during and after the crisis.

Table 1: Summary of cointegration Tests

	Before Crisis	During Crisis	After Crisis
S&P - DAX	Cointegrated	Cointegrated	Not Cointegrated
S&P - Hang Seng	Not Cointegrated	Cointegrated	Not Cointegrated
S&P - FTSE 100	Cointegrated	Cointegrated	Not Cointegrated
S&P - CAC 40	Cointegrated	Cointegrated	Not Cointegrated
S&P - IPC	Cointegrated	Cointegrated	Cointegrated
S&P - Merval	Cointegrated	Not Cointegrated	Not Cointegrated
S&P - Nikkei 225	Not Cointegrated	Cointegrated	Not Cointegrated
S&P- TSX 60	Cointegrated	Cointegrated	Not Cointegrated

Table 2 shows the cointegration relationship between the indices before the crisis. Table 3 shows the cointegration relationship between the indices during the crisis. Table 4 shows the cointegration relationship between the indices after the crisis. These relationships were computed through Stata: data analysis and statistical software using the augmented Dickey-Fuller test. Before the crisis, the S&P and the DAX have a Dickey-Fuller test statistic of -3.101 and a p-value of 0.0264, which causes us to reject the null hypothesis at the five percent level and conclude that they are stationary and cointegrated. During the crisis, the S&P and the DAX are found to be stationary and cointegrated because the test statistic of -2.679 and the p-value of 0.0778 cause us to reject the null hypothesis at the ten percent level. After the crisis, with a test statistic of -1.802 and a p-value of 0.3795 we fail to reject the null hypothesis and find

that the S&P and the DAX are not cointegrated. Before the crisis, the S&P and Hang Seng have a test statistic of -0.322 and a p-value of 0.9223 so we fail to reject the null hypothesis and find that they are cointegrated. During the crisis, we find that the S&P and Hang Seng are stationary and cointegrated because the null hypothesis was rejected at the five percent level with a test statistic of -3.217 and a p-value of 0.0190. After the crisis, the S&P and the Hang Seng have a test statistic of -1.490 and a p-value of 0.5385 so we fail to reject the null hypothesis and find that they are not cointegrated.

We reject the null hypothesis at the ten percent level and find that before the crisis, the S&P and FTSE 100 are stationary and cointegrated with a test statistic of -2.633 and a p-value of 0.0864. For the S&P and FTSE 100 during the crisis we reject the null hypothesis at the one percent level and find they are cointegrated and stationary with a test statistic of -3.550 and a p-value of 0.0068. After the crisis, the S&P and FTSE 100 are found not to be cointegrated because we fail to reject the null hypothesis with a test statistic of -1.503 and a p-value of 0.5321. For the S&P and CAC 40 before the crisis we reject the null hypothesis at the ten percent level and find they are stationary and cointegrated with a test statistic of -2.835 and a p-value of 0.0535. During the crisis, we reject the null hypothesis at the five percent level for the S&P and CAC 40 with a test statistic of -3.035 and a p-value of 0.0318 to find that they are stationary and cointegrated. After the crisis, the S&P and CAC 40 were found not to be cointegrated with a test statistic of -1.962 and a p-value of 0.3033 which causes us to fail to reject the null hypothesis.

Before the crisis, the S&P and IPC had a test statistic of -3.966 and a p-value of 0.0016 so we rejected the null hypothesis at the one percent level and found they were stationary and cointegrated. During the crisis, the S&P and IPC we rejected the null hypothesis at the one percent level and found they were stationary and cointegrated with a test statistic of -3.814 and a p-value of 0.0028. The S&P and IPC after the crisis were stationary and cointegrated because we rejected the null hypothesis at the one percent level with a test statistic of -5.906 and a p-value of 0. Before the crisis, S&P and the Merval Buenos Aires had a test statistic of -3.935 and a p-value of 0.0018 so we reject the null hypothesis at the one percent level and find that they are stationary and cointegrated. For S&P and Merval during the crisis we fail to reject to the null hypothesis with a test statistic of -1.738 and a p-value of 0.4117 and found they are not cointegrated. After the crisis we found that S&P and Merval were not cointegrated because we fail to reject the null hypothesis with a test statistic of -1.253 and a p-value of 0.6504.

Before the crisis, S&P and Nikkei 225 had a test statistic of -1.994 and a p-value of 0.289 so we fail to reject the null hypothesis and find they were not cointegrated. During the crisis, S&P and Nikkei 225 had a test statistic of -3.72 and a p-value of 0.0038 so we reject the null hypothesis at the one percent level and find they are cointegrated. After the crisis, for S&P and Nikkei 225 we fail to reject the null hypothesis and find they were not cointegrated with a test statistic of -1.814 and a p-value of 0.3736. Before the crisis, the S&P and TSX 60 we reject the null hypothesis at the one percent level and find that they are stationary and cointegrated with a test statistic of -4.280 and a p-value of 0.0005. For the S&P and TSX 60 during the crisis we reject the null hypothesis at the ten percent level and find they are cointegrated and stationary with a test statistic of -2.622 and a p-value of 0.0885. After the crisis, the S&P and TSX 60

are found not to be cointegrated because we fail to reject the null hypothesis with a test statistic of -1.949 and a p-value of 0.3094.

Table 2: Summary of cointegration tests before crisis

Before Crisis			
	Dicky-Fuller Test	**p-Value**	**Note**
S&P - DAX	-3.101	0.0264	Cointegrated
S&P - Hang Seng	-0.322	0.9223	Not Cointegrated
S&P - FTSE 100	-2.633	0.0864	Cointegrated
S&P - CAC 40	-2.835	0.0535	Cointegrated
S&P - IPC	-3.966	0.0016	Cointegrated
S&P - Merval	-3.935	0.0018	Cointegrated
S&P - Nikkei 225	-1.994	0.289	Not Cointegrated
S&P- TSX 60	-4.280	0.0005	Cointegrated

Table 3: Summary of cointegration tests during crisis

During Crisis			
	Dicky-Fuller Test	**p-Value**	**Note**
S&P - DAX	-2.679	0.0778	Cointegrated
S&P - Hang Seng	-3.217	0.019	Cointegrated
S&P - FTSE 100	-3.55	0.0068	Cointegrated
S&P - CAC 40	-3.035	0.0318	Cointegrated
S&P - IPC	-3.814	0.0028	Cointegrated
S&P - Merval	-1.738	0.4117	Not Cointegrated
S&P - Nikkei 225	-3.72	0.0038	Cointegrated
S&P- TSX 60	-2.622	0.0885	Cointegrated

Table 4: Summary of cointegration tests after crisis

After Crisis			
	Dicky-Fuller Test	**p-Value**	**Note**
S&P – DAX	-1.802	0.3795	Not Cointegrated
S&P – Hang Seng	-1.49	0.5385	Not Cointegrated
S&P – FTSE 100	-1.503	0.5321	Not Cointegrated
S&P – CAC 40	-1.962	0.3033	Not cointegrated
S&P – IPC	-5.906	0.0000	Cointegrated
S&P – Merval	-1.253	0.6504	Not Cointegrated
S&P – Nikkei 225	-1.814	0.3736	Not Cointegrated
S&P- TSX 60	-1.949	0.3094	Not Cointegrated

CONCLUSIONS

Based on the research a common pattern of cointegration between the stock indices and the S&P 500 were found in the before and during crisis periods but not in the after crisis period. It was found that all of the indices studied were cointegrated with the S&P 500 before the crisis except the Hang Seng and the Nikkei 225. During the crisis all indices were cointegrated with the S&P 500 except the Merval Buenos Aires. After the crisis the results show that all of the indices were not cointegrated with the S&P 500 except for IPC.

Some of the outliers in the data can be explained through the global effects discussed earlier in the paper. The Hang Seng and the Nikkei 225 are outliers in the before crisis period, this may be due to their large market power. The past financial troubles in Latin America could have caused the Merval Buenos Aires index to be an outlier since the country was better prepared for a crisis. The close proximity of the United States and Mexico could effect the IPC being an outlier in the after crisis period.

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