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Link between S&P 500 and FTSE 100 and the Comparison of that Link Before and After the S&P 500 Peak in October 2007

Michael Joseph SILK

Abstract

The paper reviews the correlation between the S&P 500 and the FTSE 100 before and during the 2008 global financial crisis. It found that The S&P 500 has a strong causation effect on the FTSE 100, both before and since the financial crisis. This link seems to have increased after the October 2007 peak in the S&P 500. Since the crisis, the FTSE 100 appears to have a weak causation effect on the S&P 500. Before the crisis there was no apparent impact on the S&P 500's movements from movements in the FTSE 100.

1. Introduction

With the seeming interdependence of the global economic system it would be logical to assume that international financial market indices are similarly linked. The intent of this paper is to compare the correlation between the S&P 500 and the FTSE 100 during the five years prior to and during the financial crisis. We will review the correlation of these indices from October 2003 to October 2007 and compare these results to their correlation from November 2007 to November 2011. The reason for using October 2007 as the cut off between the two periods is that the S&P 500 peaked during October 2007. Also, this paper seeks to examine whether the correlations between markets are visibly different before and after major market events, like the global financial crisis.

2. Review of Previous Literature

Previous studies have reviewed linkages between the US and foreign stock market indices. Arshanapalli and Doukas (2002), examined the link between the US and major Western European stock market indices. Their paper specifically examined the period before and after the October 1987 stock market crash. Their research displayed a lack of interdependence between the indices before the crash. However, a strong link was developed after the crash. This link resulted in the US indices having a strong impact on the indices in France, Germany, and the UK. An exception in their study was the apparent lack of interdependence of the Japanese equity market and the other sampled indices².

Yang et al. (2006) examined the interdependence between the US indices and the emerging markets of Eastern Europe. Their study examined the period preceding and following the 1998 Russian financial crisis. This study revealed a link between the US and the Eastern European indices. The US indices were found to have a strong corollary effect on the emerging market indices. Moreover, during the course of their research they found that this link was amplified during and after the 1998 Russian financial crisis. Their results found that “the impact of the 1997–1998 global emerging market crisis on emerging stock market integration, the finding of strengthened stock market linkages (both in the long run and the short run).”³

3. Framework

1. Hypotheses

H₀: The S&P 500 exerted a greater influence on the FTSE 100 after its peak in October 2007.

H_A: The S&P 500 exerted the same or less influence on the FTSE 100 after its peak in October 2007.

² Arshanapalli, Bala and Doukas, John. (1993) “International stock market linkages: Evidence from the pre- and post-October 1987 period,” *Journal of Banking & Finance* 17 (February 1993): 193-208

³ Yang, Jian; Hsiao, Cheng; Li, Qi; Wang, Zijun. (2006) “The emerging markets crisis and stock market linkages: further evidence,” *Journal of Applied Econometrics* 21 (Sept/Oct 2006) 727-744.

2. Testing Method

The primary methods of testing our hypotheses will be the Granger causality test and variance decomposition. By utilizing the Granger causality test we will be able to determine the significance level of the probability that the S&P 500 influences the FTSE 100. Variance decomposition allows us to determine to what extent changes in the FTSE 100 are the result of changes in the S&P 500. Both of these testing methods are in line with our intention of utilizing the VAR model.

4. Data Description

SP500_old: The close of the S&P500 from 1 October, 2003 to 31 October, 2007 adjusted for dividends and splits.

lnSP500_old: The log of the close of the S&P500 from 1 October, 2003 to 31 October, 2007 adjusted for dividends and splits.

dlnSP500_old: The log difference of the close of the S&P500 from 1 October, 2003 to 31 October, 2007 adjusted for dividends and splits.

FTSE_old: The close of the FTSE 100 from 1 October, 2003 to 31 October, 2007 adjusted for dividends and splits.

lnFTSE_old: The log of the close of the FTSE 100 from 1 October, 2003 to 31 October, 2007 adjusted for dividends and splits.

dlnftse_old: The log difference of the close of the FTSE 100 from 1 October, 2003 to 31 October, 2007 adjusted for dividends and splits.

SP500_new: The close of the S&P500 from 1 November, 2007 to 30 November, 2011 adjusted for dividends and splits.

lnSP500_new: The log close of the S&P500 from 1 November, 2007 to 30 November, 2011 adjusted for dividends and splits.

dlnSP500_new: The log difference close of the S&P500 from 1 November, 2007 to 30 November, 2011 adjusted for dividends and splits.

FTSE_new: The close of the FTSE 100 from 1 November, 2007 to 30 November, 2011 adjusted for dividends and splits.

lnFTSE_new: The log close of the FTSE 100 from 1 November, 2007 to 30 November, 2011 adjusted for dividends and splits.

dlnftse_new: The close of the FTSE 100 from 1 November, 2007 to 30 November, 2011 adjusted for dividends and splits.

All data was downloaded from Yahoo! Finance. Figures 1.1 and 1.2 reveal the movements of the S&P 500 and FTSE 100 together over the two different times periods: 1) 1 October, 2003 to 31 October, 2007 and 2) 1 November, 2007 to 30 November, 2011. For the purposes of the paper, all data sets ending in “old” are for the time period 1 October, 2003 to 31 October, 2007. All data sets ending in “new” are for the time period 1 November, 2007 to 30 November, 2011.

The adjusted close for the FTSE 100 was collected over the sample period and the S&P 500 was matched for the correlated period. Days when one or both markets were closed were not included in the sample. Days when one or both of the markets were open for only half-days were included due to the cost to benefit of excluding them. It is assumed that these minor time differences do not significantly affect the overall results of the paper.

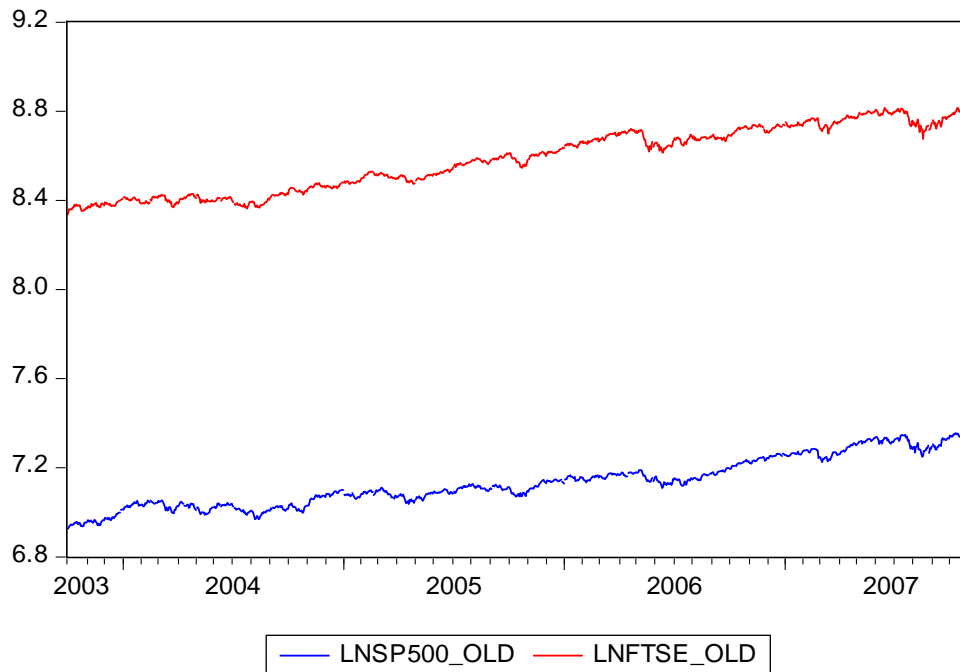


Figure 1.1

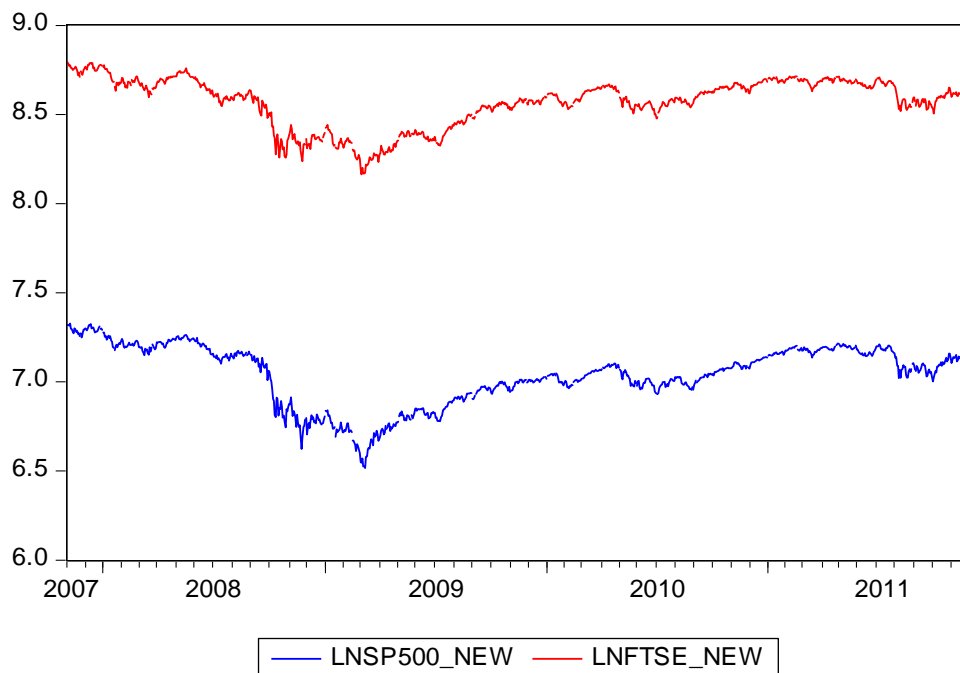


Figure 1.2

5. Specification of the Model

1. Basic Model

Due to the goal of the paper and the format of the data we will seek to find the correlation of the S&P 500 and FTSE 100 from 5 years up until the S&P 500's peak in October 2007 and the 5 years since that peak. The VAR model will be utilized to find these correlations.

2. Unit root and cointegration test

The variables are all time series. Thus, the unit root test must be conducted. The unit root test will reveal whether or not the time series are stationary and the existence of a unit root in the residual will reveal that we must utilize the VAR model.

From the below table we can see that neither the S&P 500 nor the FTSE 100 from 2003 to 2007 have unit roots and thus are non-stationary series. Since the S&P 500 and FTSE 100 have no unit roots a test for cointegration of the residual is unnecessary. You can see from the graph that the indices were fairly uniformly increasing and therefore were not stationary.

Variable	ADF-test	5%--CV	Conclusion
ln(SP500_old)	-3.867214	-3.414269	I(0)
ln(ftse_old)	-3.668086	-3.414273	I(0)

Table 1.1

In table 1.2 below we see that both the S&P 500 and FTSE 100 have one unit root in their movements since October 2007, which indicates that they are stationary series.

Variable	ADF-test	5%--CV	Conclusion
ln(SP500_new)	-1.980669	-3.414282	I(1)
Δ ln(sp500_new)	-25.96323	-2.864199	I(0)
ln(ftse_new)	-2.476288	-3.414273	I(1)
Δ ln(ftse_new)	-24.75911	-2.864199	I(0)

Table 1.2

When testing the residual of the two series we see that there is one unit root. The existence of this unit root shows that the series are not cointegrated, meaning that we must utilize the VAR model.

Variable	ADF-test	5%--CV	Conclusion
resid02_new	-2.861548	-3.414287	I(1)

Table 1.3

3. VAR model Optimal Lag Selection

The first thing to consider when utilizing the VAR model is selecting the optimal lag order criteria. The optimal lag is the lag that generates the lowest AIC score. From the table below we see that lag 2 is the optimal lag for the data from 2003 to 2007. Lag 2 generates an AIC score of -14.34471.

Lag	FPE	AIC
0	2.46e-09	-14.14681
1	2.03e-09	-14.34081
2	2.02e-09*	-14.34471*
3	2.02e-09	-14.34204
4	2.03e-09	-14.33847
5	2.03e-09	-14.33834
Lag	FPE	AIC
6	2.04e-09	-14.33657

Lag	FPE	AIC
7	2.05e-09	-14.33188
8	2.06e-09	-14.32642

Table 2.1

The optimal lag for the data during the crisis, from 2007 to 2011, is lag 7. It generates an AIC score of -11.47958.

Lag	FPE	AIC
0	5.58e-08	-11.02641
1	3.83e-08	-11.40330
2	3.65e-08	-11.44930
3	3.60e-08	-11.46429
4	3.60e-08	-11.46303
5	3.57e-08	-11.47322
6	3.56e-08	-11.47564
7	3.54e-08*	-11.47958*
8	3.56e-08	-11.47435

Table 2.2

It is interesting to note the difference in the optimal lags in the two data sets. This difference is most likely the result of both the S&P 500 and the FTSE 100 being non-stationary series.

4. Granger causality tests

For each respective time period, we must first update the VAR models for their respective optimal lag lengths. This will allow us to conduct the Granger causality test. This test aids us in determining whether the S&P 500 movement causes the FTSE 100 movement and vice versa.

From the results shown in table 3.1 we see that the S&P 500 was not caused by the FTSE 100 during the sample time period. This result is in contrast to the result showing that the movements in the FTSE 100 were caused by the movements in the S&P 500. Note the extremely low probability, which indicates that the S&P 500 is statistically significant to the FTSE 100, meeting our 5% significance threshold.

VAR Granger Causality/Block Exogeneity Wald Tests

Date: 12/08/11 Time: 13:49

Sample: 10/01/2003 10/31/2007

Included observations: 1008

Dependent variable: DLNSP500_OLD

Excluded	Chi-sq	df	Prob.
DFTSE_OLD	1.204498	2	0.5476
All	1.204498	2	0.5476

Dependent variable: DFTSE_OLD

Excluded	Chi-sq	df	Prob.
DLNSP500_OL D	131.6368	2	0.0000
All	131.6368	2	0.0000

Table 3.1

The above results are contrasted against table 3.2 below. An interesting difference is how closely related that the S&P 500's movements are to the FTSE 100's movements. Although, the S&P 500 is not caused by the movements in the FTSE 100's movements at the 5% significance level, as a dependent variable it is much more closely related to the FTSE 100 after the October 2007 peak. A similarity between the two time periods is that probability in regards to the FTSE 100 as the dependent variable. This indicates that the FTSE 100 still appears to be affected by the S&P 500 movements.

VAR Granger Causality/Block Exogeneity Wald Tests

Date: 12/08/11 Time: 15:53

Sample: 11/01/2007 11/30/2011

Included observations: 1002

Dependent variable: DLNSP500_NEW

Excluded	Chi-sq	df	Prob.
DFTSE_NEW	12.84602	7	0.0760
All	12.84602	7	0.0760

Dependent variable: DFTSE_NEW

Excluded	Chi-sq	df	Prob.
DLNSP500_NE W	182.0544	7	0.0000
All	182.0544	7	0.0000

Table 3.2

5. Impulse Response

The goal of conducting the impulse response is to see the reaction of the market to various shocks. In the figure 2.1 below, we see the response of the S&P to shocks in the index (top left graph). From the graph we can see that the market quickly processes information, might go slightly negative for a short period before resettling at its new equilibrium. In the top right graph, we see the reaction of the S&P to shocks in the FTSE 100. It is clear that the S&P 500 has very little reaction to shocks in the FTSE 100.

It is interesting to note the FTSE 100's reaction to shocks in the S&P 500 (bottom left). From the graph, we see that the FTSE 100 drops about half as much as the S&P 500 but takes the same amount of time for the market to process the information. The FTSE 100 has a much more significant reaction to shocks in itself (bottom right). It might be vulnerable to more panic than the S&P 500. The FTSE 100 appears to drop falls into the negative when reacting to shocks before it slightly over-corrects and then resettles at its new equilibrium.

Response to Cholesky One S.D. Innovations ?2 S.E.

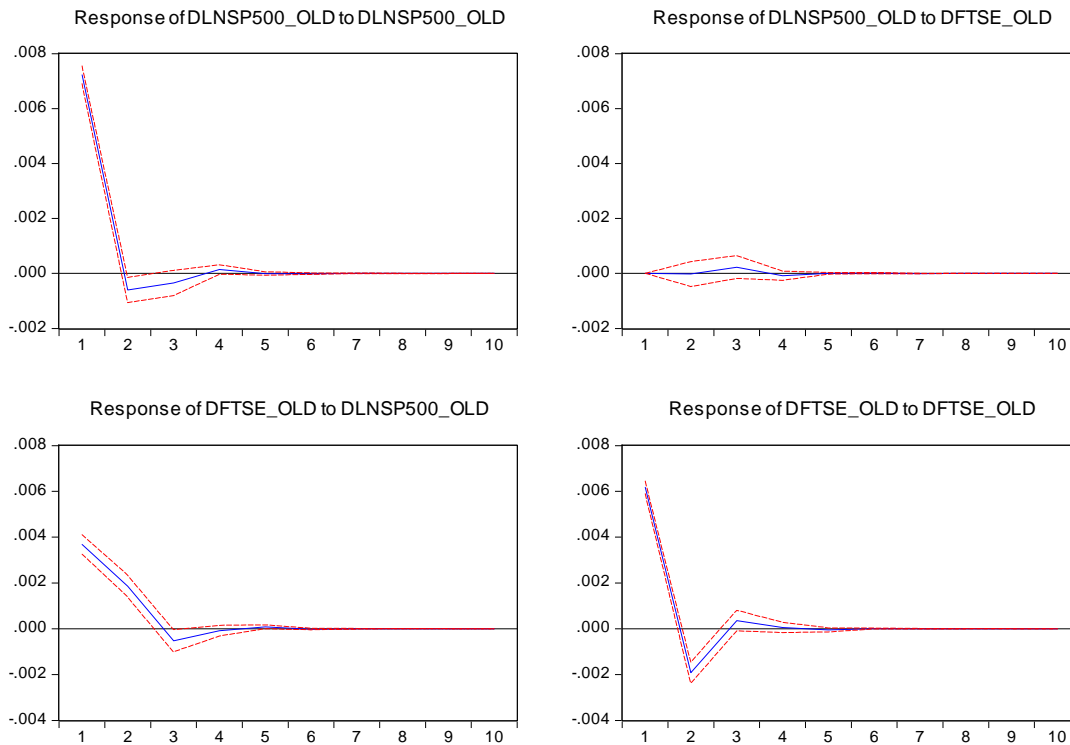


Figure 2.1

In figure 2.2 we see the two indices reactions to shocks since the financial crisis. It appears that there is a stronger cyclical effect on the S&P 500 when it is processing shocks since October 2007. After the peak, the S&P 500 drops by over twice as much as it did before the crisis, meaning that investors in the market react more strongly to shocks. This is coupled by a longer series of peaks and valleys as the market seems to correct and re-correct, not settling on an equilibrium point. Since the crisis, the S&P 500 also has a slightly larger reaction to shocks in the FTSE 100 and it also takes a longer time to process the shock (top right graph). This activity can be tied to the S&P 500's reaction to its own shocks in that investors are generally unsure of how to react in the longer term, even if they efficiently process most of the effect of the shock very quickly.

Since the crisis, the FTSE 100 reacts more strongly to shocks in the S&P 500 (bottom left). However, this is coupled with the shock also being processed more slowly. Investors in the FTSE 100 are having similar reactions to these shocks as investors in the S&P 500; they seem unable to quickly settle the marketplace into a new equilibrium point. A surprising issue is that although the FTSE 100 has been taking longer to process shocks in the S&P 500 it appears able to quickly and more strongly respond to shocks in the FTSE 100 itself (bottom right). This willingness to quickly and strongly respond to shocks in the FTSE 100 is producing an even

stronger uncertainty once the shock has been introduced into the system. Before the crisis, the FTSE 100 reacted to shocks and quickly returned to its equilibrium. Since the crisis, the FTSE 100 reacts more strongly but then is unable to return to equilibrium.

Response to Cholesky One S.D. Innovations ?2 S.E.

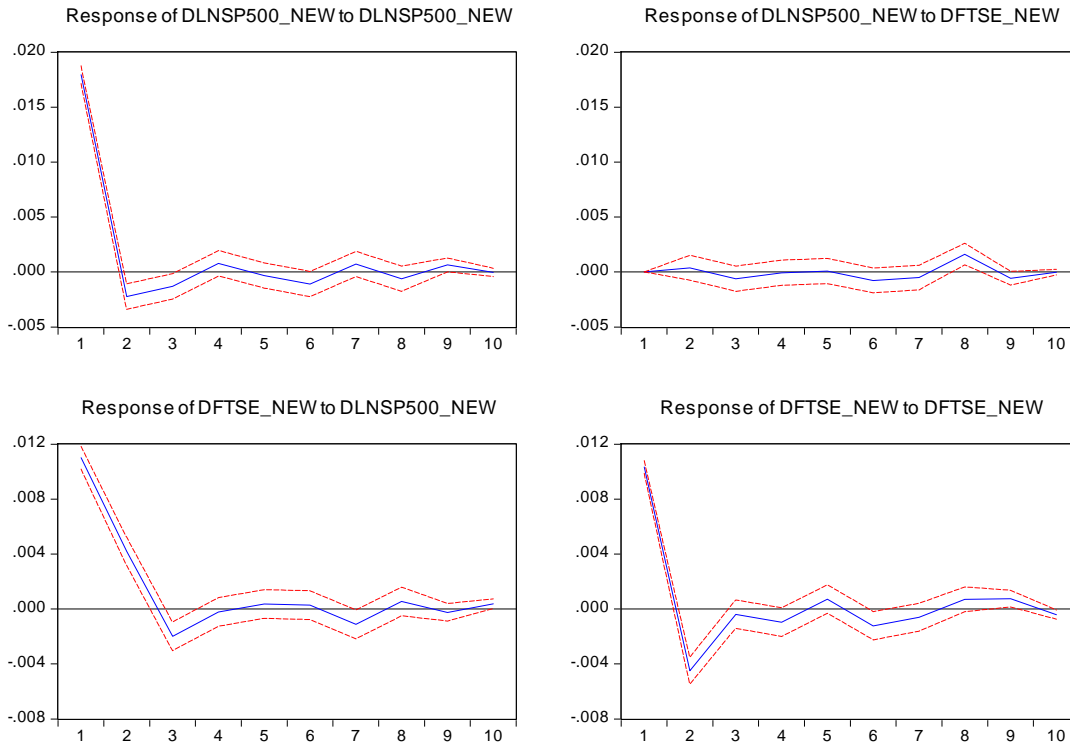


Figure 2.2

6. Variance Decomposition

Table 4.1 below shows us that the FTSE 100 has a very strong effect on the movements of the S&P 500. On day 1, we see that the FTSE 100 has no impact on the S&P 500, that is the S&P is 100% independent. After day 2 we see a slight impact on the S&P's movements from the FTSE 100. The FTSE 100's impact on the S&P 500 peaks at day 7 and remains constant thereafter at a level of causing 0.113870% of the movements in the S&P 500. This level of impact is so small as to be insignificant.

In contrast, we see that the S&P 500 initially has a relatively large impact on the movements in the FTSE 100. From day 1 we see that movements in the FTSE 100 are 26.22055% caused by the movements in the S&P 500. We see this effect increase until it peaks at day 7 where it causes 29.17873% of the movements in the FTSE 100. This impact is significantly greater than the force that the FTSE 100 exerts on the S&P 500.

Variance Decomposition of DLNSP500_OLD			
Period	S.E.	DLNSP500_OLD	DFTSE_OLD
1	0.007228	100.0000	0.000000
2	0.007253	99.99893	0.001074
3	0.007265	99.90032	0.099684

Variance Decomposition of DLNSP500_OLD			
Period	S.E.	DLNSP500_OLD	DFTSE_OLD
4	0.007267	99.88629	0.113715
5	0.007267	99.88627	0.113731
6	0.007267	99.88614	0.113855
7	0.007267	99.88613	0.113870
8	0.007267	99.88613	0.113870
9	0.007267	99.88613	0.113870
10	0.007267	99.88613	0.113870

Variance Decomposition of DFTSE_OLD:			
Period	S.E.	DLNSP500_OLD	DFTSE_OLD
1	0.007186	26.22055	73.77945
2	0.007665	28.89172	71.10828
3	0.007691	29.16399	70.83601
4	0.007692	29.17147	70.82853
5	0.007693	29.17845	70.82155
6	0.007693	29.17871	70.82129
7	0.007693	29.17873	70.82127
8	0.007693	29.17873	70.82127
9	0.007693	29.17873	70.82127
10	0.007693	29.17873	70.82127

Table 4.1

The variance decomposition in table 4.2 below reveals fairly similar results for the S&P 500 after the crisis. Initially, at day 1, we see that the S&P 500's movements are 100% independent of the FTSE 100. However, starting on day 2, the movements in the S&P 500 are slightly the result of the FTSE 100. We see that the FTSE's influence grows over the ten day span. This influence peaks at day 10 where the FTSE 100 causes 1.300421% of the movements in the S&P 500.

Variance Decomposition of DLNSP500_NEW:			
Period	S.E.	DLNSP500_NEW	DFTSE_NEW
1	0.017957	100.0000	0.000000
2	0.018100	99.95613	0.043867
3	0.018157	99.83832	0.161681
4	0.018175	99.83722	0.162776
5	0.018178	99.83515	0.164847
6	0.018227	99.65518	0.344818
7	0.018249	99.57943	0.420573
8	0.018332	98.79413	1.205869
9	0.018352	98.69962	1.300379
10	0.018352	98.69958	1.300421

Variance Decomposition of DFTSE_NEW:			
Period	S.E.	DLNSP500_NEW	DFTSE_NEW
1	0.015101	53.18750	46.81250
2	0.016306	52.24894	47.75106
3	0.016431	52.91806	47.08194
4	0.016461	52.74527	47.25473
5	0.016480	52.66604	47.33396
6	0.016528	52.38827	47.61173
7	0.016578	52.53850	47.46150
8	0.016601	52.49465	47.50535
9	0.016620	52.40015	47.59985
10	0.016629	52.39274	47.60726

Table 4.2

Table 4.2 above, also reveals a surprising fact. Thus far, both of the indices begin with their largest impact on their movements and the other index slowly grows before plateauing in its influence on the opposing index. Since the crisis, we see the opposite effect occurring on the FTSE 100. At day 1, a majority of the movements in the FTSE 100 are actually the result of movements in the S&P 500. The S&P 500's influence peaks at 53.1875% at day 1 and slowly decreases over the following days. Its lowest impact on the FTSE 100 occurs on day 10 at 52.39274%. This means that although the S&P 500's influence slowly declines over the course of the observed period it remains the major influence on the FTSE 100.

6. Results

1. Hypotheses results: S&P 500's influence on the FTSE 100

H_0 : The S&P 500 exerted a greater influence on the FTSE 100 after its peak in October 2007.

H_A : The S&P 500 exerted the same or less influence on the FTSE 100 after its peak in October 2007.

The Granger causality test indicated that the S&P 500 had a high significance level in regards to its influence on the FTSE 100 both before and after the October 2007 peak of the S&P 500. The S&P 500 met both a 1% and 5% threshold and thus it can be concluded that the S&P 500's influence is and has been significant on the FTSE 100. Since the results of the Granger causality indicated an identical significance level it is difficult to utilize it in the assessment of the growth in the S&P 500's influence on the FTSE 100. These results force us to rely on the variance decomposition to evaluate our hypotheses.

In table 4.1 we saw the percentage of the FTSE 100's movements, up to the peak in October 2007, that were a result of the S&P 500's influence. Over the 10 day observed period the S&P 500's influence peaked at 29.17873%. This means that up until its peak in October 2007 the S&P 500 caused almost 30% of the movement in the FTSE 100. Table 4.2 revealed the impact the S&P 500 had on the FTSE 100 after the peak. This revealed to us that the impact of the S&P 500 has in fact, increased

since its peak in October 2007. Since the peak, the S&P 500 has caused up to 53.1875% of the movements in the FTSE 100. That means that a majority of the movements in the FTSE 100 are a direct result of movements in the S&P 500.

Based on these results we can accept the null hypothesis and reject the alternative hypothesis. The S&P 500's impact on the FTSE 100 has dramatically increased since its peak in October 2007.

2. Secondary Results: FTSE 100 Influence on the S&P 500

Our observed tests indicated that the FTSE 100 had very little impact on the S&P 500 before the crisis. The Granger causality test did not show any significant influence on the S&P 500 from the FTSE 100. Graphing the impulse response of the S&P 500 to the FTSE 100 appeared to confirm these results. The results of the variance decomposition suggested that the FTSE 100 was a minor influence on the S&P 500. It stated that the FTSE's influence on the S&P 500 peaked at causing 0.11387% of the movements in the S&P 500. From these results, we can conclude that the FTSE 100 had almost no influence on the S&P 500 before its peak in October 2007.

After the peak of October 2007, the Granger causality test showed that the FTSE 100's influence may have increased but it still did not meet our 5% threshold. Thus, its influence has remained statistically insignificant. The impulse response followed this point by indicating there might have been some force exerted on the S&P 500, albeit minor. In table 4.2 we saw that the influence on the S&P 500 by the FTSE 100 had increased. Based on the results of the variance decomposition we saw the FTSE's influence over the S&P increase to 1.300421%.

7. Limitations

Due to insufficient time, the paper was not as in depth as originally planned. Originally, it was the researcher's intention to compare more US indices across a larger variety of global indices. It is believed that with more time, a global perspective could have been attained in order to achieve a more complete picture of the interconnectivity of equity indices. This will be a subject matter that the researcher will return to so that he may gain a better perspective on the linkage between international financial markets.

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