CAUSALITY AMONG NEW YORK, LONDON, TOKYO AND HONG KONG STOCK MARKETS

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ABSTRACT

Investors tend to look into the possibility of broadening their investment activities across countries in order to diversify portfolio risk. This requires an understanding of regional and global linkages of stock markets. *In this study, I examine the co-movements* in *worlds' largest equity* markets*. I used the daily data of S&P 500, Nikkey 225, Hang Seng and FTSE100 for the period Jan-Nov 2009 in order to examine causality between the markets. Granger causality results show that eastern markets are affected by both S&P 500 and FTSE100, but do not affect western markets. Estimating the rate of change of each index as a function of its lags and of the lags of indexes that were found to granger-cause it, I find a very low predictability for S&P 500, Hang Seng and FTSE100 ,while the Nikkey 225 is pretty highly predictable*.

Keywords: *causality; predictability; S&P 500; Hang Seng; FTSE100; Nikkey 225*

INTRODUCTION

Research for industrialized countries has confirmed that macroeconomic variables influence stock prices (see Mukherjee & Naka (1995), Fifield et al. (2000), Lovatt & Ashok (2000), Nasseh & Strauss (2000), Hondroyiannis & Papapetrou (2001), and Merikas & Merika (2006)). Using annual data covering the years 1960-2000 Kim (2003) found that the S&P 500 stock price is positively related to industrial production, but negatively related to the real exchange rate, interest rate, and inflation. However, the removal of barriers to the free flow of financial capital increased the relationships between equity markets around the world. Fluctuations that occur in one stock market may affect other countries' stock markets, especially in the short run.

The relationships between equity markets in various countries have been extensively examined in previous empirical studies. Arshanapalli, Doukas and Lang (1987) noted an increase in stock market interdependence after the 1987 crisis for the emerging markets of Malaysia, the Philippines, Thailand, and the developed markets of Hong Kong, Singapore, the US and Japan for the period 1986–1992. King and Wadhwani (1990) found that the US market leads other developed markets. Becker et al. (1990) and Hamao et al. (1990) have examined the international linkage between the United States and Japan. They found a high correlation between the two markets with an asymmetric spillover effect from the United States to the Japanese markets. Smith et al. (1993) and Aggerwal and Park (1994), however, found that U.S. equity prices did not lead Japanese equity prices.

Relevant empirical studies have employed a variety of methodologies and have analyzed data from a great number of countries. The identified interdependence was mainly due to the influence which is exerted from the dominant markets. My contribution is to explore the direction of causality across stock markets in 2009 and to examine the predictability of major stock market indexes as a vector auto regression of self and other major stock market indexes.

LITERATURE REVIEW

In the last years, the wide range of technological innovations and internet applications has enabled the instantaneous realization of investors' decisions from the one side of the planet to the other. As a result, stock exchanges experience higher fluctuations in the price levels and the volume of transactions and their links are made even stronger, enhancing their interdependence. The interdependence among the world stock markets has intensively been studied.

Najand (1996) detected stronger interactions among the stock markets of Japan, Hong Kong, and Singapore after the 1987 stock market crash. Malliaris and Urrutia (1992) analyzed the impact of the 1987 crash on the relationships for six stock market indices and found no lead-lag relationships for the period before and after the market crash, but there were feedback relationships and unidirectional causality during the month of crash.

Narayan et al. (2004) found that stock prices in Bangladesh, India and Sri Lanka Granger-caused stock prices in Pakistan for the period 1995–2001. European countries have also been examined for interdependencies between stock exchange markets. Malliaris and Urrutia (1994) and Gerrits and Yuce (1999) used the concept of Granger causality to analyze the linkage and dynamic interactions among stock prices.

Gklezakou and Mylonakis (2009) examined the relationships among the developing markets of South Eastern Europe before and during the current economic crisis. Their findings suggest that their rather low and vague interdependence has been enhanced.

Mahesh (2005) examined whether there was long-run financial integration between the developed markets of the US, Canada and UK and the emerging markets of India, Malaysia and Singapore. According to his findings, only the pairs Malaysia-Singapore and the US-Canada stock markets exhibited long-run relationships.

Kim (2005) examined the stock market linkages in the advanced Asia-Pacific stock markets of Australia, Japan, Hong Kong and Singapore with the US stock markets. Using the Granger Causality Test on whether the US and Japanese market returns and trading volume Granger caused the market returns of the other markets, he found that the US returns Granger caused returns of each of the stock markets in the region. The Japanese returns, on the other hand, appeared to have a less significant effect.

Rivas et al. (2006) investigated the responses of the stock markets of some Latin American countries, namely, Brazil, Chile and Mexico, to movements in the stock markets in Spain, Italy, Germany, France, UK and the US. The returns of Mexico were significantly influenced by the US market, but returns of Brazil and Chile were affected neither by the US nor the European stock markets.

In this paper, I will examine the causality relations among four major stock markets in 2009 and after detecting the causual direction, I will estimate an adequate Var and will calculate the level of predictability as represented by R^2 . The examination will not only give us an idea regarding the causality direction, but will also provide information regarding the possiblility of using previous market information in order to predict future stock martkets returns.

RESEARCH METHODOLOGY

Granger Causality Tests

Correlation does not necessarily imply causation in any meaningful sense of the word. The econometric graveyard is full of magnificent correlations, which are simply spurious and/or meaningless. An interesting example includes a positive correlation between teachers' salaries and the consumption of alcohol. The Granger (1969) approach to the question of whether there is causality is to see how much of the current Y can be explained by past values of Y and then to see whether adding lagged values of X can improve the explanation. Y is said to be Granger-caused by X, if X helps in the prediction of Y, or equivalently, if the coefficients on the lagged X's are statistically significant. Since we use time series, we should use only stationary series in order to avoid "spurious" results.

Stationarity

I used the daily rate of change data of S&P 500, Nikkey 225, Hang Seng and FTSE100 for the period Jan 5 – Nov 25, 2009. All series were found to be stationary as can be seen in table 1 below and in tables 4-7 in **appendix 1**,

Table 1 Augmented Dickey-Fuller Test Results

Null Hypothesis: variable has a unit root	Augmented Dickey-Fuller test statistic	Prob.*	Test critical values: 1% level	Test critical values: 5% level
PSP500 (SP500 rate of change)	-14.97971	0.0000	-3.466377	-2.877274
PN225 (Nikkey225 rate of change)	-15.11418	0.0000	-3.466377	-2.877274
PHGSE (Hang Seng rate of change)	-13.45405	0.0000	-3.466377	-2.877274
PFTSE100 (Ftse100 rate of change)	-13.90526	0.0000	-3.466377	-2.877274

*MacKinnon (1996) one-sided p-values

Number of Lags in the Var

In general, it is better to use more rather than fewer lags, since the theory is couched in terms of the relevance of all past information. I used two alternatives for the lag length, a granger test with three lags and another test with seven lags. These lag lengths correspond to my reasonable belief about the longest time over which one of the variables could help predict the other.

Table 2 summarizes granger exogeneity test results (see **appendix 2**, tables 8-9 for detailed results):

Table 2 Granger Exogeneity Test Results

		Affected			
		SP500	HGSE	FTSE100	N225
causing	SP500		+	+ (**)	+
	HGSE	X		X	+
	FTSE100	+ (*)	+		+
	N225	X	X	X	

(+) column variable causes effected variable (line variable).
(X) column variable does not cause effected variable (line variable).
(*) FTSE100 was found not to be a granger cause of SP500 when using 3 lags, but was found to be a granger cause when using 7 lags.
(**)SP500 was found not to be a granger cause of FTSE100 when using 7 lags, but was found to be a granger cause when using 3 lags.

The results in table 2 show that eastern markets (HGSE and N225) are affected by western markets (S&P 500 and FTSE100) ,but do not affect the western markets, which also effect each other.

The Nikkey 225 is affected by western markets and by the Hang Seng, but does not affect any other market.

It is important to note that the statement "X Granger causes Y" does not imply that Y is the effect or the result of X. Granger causality measures precedence and information content, but does not by itself indicate causality in the more common use of the term.

Vector Auto Regression

Using exogeneity test results, I estimated each of the stock indexes rate of change as a function of 7 lags of the causal variables. After non-significant variables were removed, Tables 3 presents the R^2 for each estimated equation, number of self lags and the number of other variables lags (see **appendix 3**, tables 10-13 for detailed results).

Table 3 R^2 and Number of Self Lags and Other Variables' Lags

Dependent Variable	R^2	Number of self lags	Number of other variables lags	Number of significant lag variables
PSP500	0.078653	2	2	4
PHGSE	0.176977	4	2	6
PFTSE100	0.056948	2	1	3
PN225	0.466408	3	7	10

As can be seen in table 3, the eastern markets have a higher predictability according to the higher R^2 and they are affected by more lag variables in comparison to the western markets. These results are especially true for the Japanese stock market.

SUMMARY

In this paper, I examined causality relations in 2009, according to "Granger" between S&P 500, FTSE, Hang Seng and Nikkei 225. The findings show that eastern markets (Nikkey225 and Hang Seng indexes) are Granger caused by western markets (S&P500 and Ftse100), while western markets affect each other, but are not affected by eastern markets. The Nikkey 225 is affected by all other markets, while it does not affect any other market.

The Granger causality test only measures precedence and information content, but does not indicate the predictability of a dependent variable. The fact that S&P "Granger cause" FTSE100 does not mean that past values of S&P 500 returns can determine future FTSE100 returns, but only that past S&P 500 returns contain information that has a certain affect over FTSE100. In order to determine the predictability level, I estimated each of the four indexes as a function of lags of variables that "Granger cause" it. The estimation results show that R^2 is very low for S&P 500 and FTSE100 as dependent variables, which means a very low ability to predict future returns, given past returns of variables that granger cause these indexes. For eastern markets, R^2 is much higher and is equal to 0.176 for the Hang Seng and 0.47 for the Nikey225 as dependent variables. The R^2 is especially high for the Nikey225 which was also found to be "Granger caused" by all other market indexes.

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Appendix 1

Table 4 Unit root test for S&P 500
Null Hypothesis: PSP500 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=13)

Prob.*	t-Statistic		
0.0000	-14.97971	Augmented Dickey-Fuller test statistic	
	-3.466377	1% level	Test critical values:
	-2.877274	5% level	
	-2.575236	10% level	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PSP500)
Method: Least Squares
Sample(adjusted): 1/06/2009 9/16/2009
Included observations: 182 after adjusting endpoints

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0000	-14.97971	0.074069	-1.109532	PSP500(-1)
0.3820	0.876412	0.001443	0.001265	C

-1.82E-05	Mean dependent var	0.554887	R-squared
0.029049	S.D. dependent var	0.552414	Adjusted R-squared
-5.032649	Akaike info criterion	0.019434	S.E. of regression
-4.997440	Schwarz criterion	0.067983	Sum squared resid
224.3916	F-statistic	459.9711	Log likelihood
0.000000	Prob(F-statistic)	1.968030	Durbin-Watson stat

Table 5 Unit root test for PN225
Null Hypothesis: PN225 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=13)

Prob.*	t-Statistic		
0.0000	-15.11418	Augmented Dickey-Fuller test statistic	
	-3.466377	1% level	Test critical values:
	-2.877274	5% level	
	-2.575236	10% level	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PN225)
Method: Least Squares
Sample(adjusted): 1/06/2009 9/16/2009
Included observations: 182 after adjusting endpoints

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0000	-15.11418	0.074010	-1.118599	PN225(-1)
0.7549	0.312619	0.001443	0.000451	C

4.94E-07	Mean dependent var	0.559297	R-squared
0.029238	S.D. dependent var	0.556849	Adjusted R-squared
-5.029624	Akaike info criterion	0.019463	S.E. of regression
-4.994416	Schwarz criterion	0.068189	Sum squared resid
228.4385	F-statistic	459.6958	Log likelihood
0.000000	Prob(F-statistic)	1.977020	Durbin-Watson stat

Table 6 Unit root test for PHGSE
Null Hypothesis: PHGSE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=13)

Prob.*	t-Statistic		
0.0000	-13.45405	Augmented Dickey-Fuller test statistic	
	-3.466377	1% level	Test critical values:
	-2.877274	5% level	
	-2.575236	10% level	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PHGSE)
Method: Least Squares
Sample(adjusted): 1/06/2009 9/16/2009
Included observations: 182 after adjusting endpoints

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0000	-13.45405	0.074536	-1.002817	PHKSE(-1)
0.1953	1.300017	0.001826	0.002374	C

6.52E-05	Mean dependent var	0.501401	R-squared
0.034643	S.D. dependent var	0.498631	Adjusted R-squared
-4.566951	Akaike info criterion	0.024530	S.E. of regression
-4.531742	Schwarz criterion	0.108306	Sum squared resid
181.0114	F-statistic	417.5925	Log likelihood
0.000000	Prob(F-statistic)	1.991737	Durbin-Watson stat

Table 7 Unit root test for PFTSE100
Null Hypothesis: PFTSE100 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=13)

Prob.*	t-Statistic		
0.0000	-13.90526	Augmented Dickey-Fuller test statistic	
	-3.466377	1% level	Test critical values:
	-2.877274	5% level	
	-2.575236	10% level	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PFTSE100)
Method: Least Squares
Sample(adjusted): 1/06/2009 9/16/2009
Included observations: 182 after adjusting endpoints

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0000	-13.90526	0.074419	-1.034810	PFTSE100(-1)
0.4375	0.778203	0.001252	0.000974	C

-2.90E-05	Mean dependent var	0.517887	R-squared
0.024215	S.D. dependent var	0.515208	Adjusted R-squared
-5.316765	Akaike info criterion	0.016860	S.E. of regression
-5.281556	Schwarz criterion	0.051169	Sum squared resid
193.3562	F-statistic	485.8256	Log likelihood
0.000000	Prob(F-statistic)	1.974125	Durbin-Watson stat

Appendix 2

Table 8 Granger exogeneity test with 3 lags
Pairwise Granger Causality Tests
Sample: 1/05/2009 11/25/2009
Lags: 3

Probability	F-Statistic	Obs	Null Hypothesis:
0.00000	37.9059	180	PSP500 does not Granger Cause PN225
0.71215	0.45778		PN225 does not Granger Cause PSP500
0.01519	3.57591	180	PHGSE does not Granger Cause PN225
0.49638	0.79829		PN225 does not Granger Cause PHGSE
5.5E-13	23.8859	180	PFTSE100 does not Granger Cause PN225
0.20654	1.53755		PN225 does not Granger Cause PFTSE100
0.37008	1.05423	180	PHGSE does not Granger Cause PSP500
6.1E-14	26.0162		PSP500 does not Granger Cause PHGSE
0.11222	2.02483	180	PFTSE100 does not Granger Cause PSP500
0.05938	2.52326		PSP500 does not Granger Cause PFTSE100
2.0E-07	12.4578	180	PFTSE100 does not Granger Cause PHGSE
0.57115	0.67063		PHGSE does not Granger Cause PFTSE100

Table 9 Granger exogeneity test with 7 lags
Pairwise Granger Causality Tests
Sample: 1/05/2009 11/25/2009
Lags: 7

Probability	F-Statistic	Obs	Null Hypothesis:
2.1E-15	15.4690	176	PSP500 does not Granger Cause PN225
0.49801	0.91293		PN225 does not Granger Cause PSP500
0.02603	2.34985	176	PHGSE does not Granger Cause PN225
0.89814	0.40510		PN225 does not Granger Cause PHGSE
3.9E-10	9.78558	176	PFTSE100 does not Granger Cause PN225
0.17980	1.47448		PN225 does not Granger Cause PFTSE100
0.36943	1.09410	176	PHGSE does not Granger Cause PSP500
3.2E-11	10.8957		PSP500 does not Granger Cause PHGSE
0.04584	2.10508	176	PFTSE100 does not Granger Cause PSP500
0.11568	1.68658		PSP500 does not Granger Cause PFTSE100
3.6E-05	5.02462	176	PFTSE100 does not Granger Cause PHGSE
0.32224	1.17107		PHGSE does not Granger Cause PFTSE100

Appendix 3
Table 10 Vector auto-regression of PSP500 over lagged causal variables.
Dependent Variable: PSP500
Method: Least Squares
Sample(adjusted): 1/12/2009 9/16/2009
Included observations: 178 after adjusting endpoints

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0996	-1.655862	0.072939	-0.120777	PSP500(-1)
0.0048	2.859424	0.104073	0.297590	PSP500(-5)
0.0235	2.285812	0.084528	0.193216	PFTSE100(-3)
0.0220	-2.311408	0.120845	-0.279322	PFTSE100(-5)
0.001550	Mean dependent var		0.078653	R-squared
0.019429	S.D. dependent var		0.062768	Adjusted R-squared
-5.086686	Akaike info criterion		0.018810	S.E. of regression
-5.015185	Schwarz criterion		0.061561	Sum squared resid
1.949862	Durbin-Watson stat		456.7150	Log likelihood

Table 11 Vector auto-regression of PHGSE over lagged causal variables.
Dependent Variable: PHGSE
Method: Least Squares
Sample(adjusted): 1/14/2009 9/16/2009
Included observations: 176 after adjusting endpoints

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0589	1.901688	0.001725	0.003281	C
0.0129	-2.511807	0.079746	-0.200307	PHGSE(-1)
0.0597	-1.895503	0.073807	-0.139900	PHGSE(-2)
0.0404	-2.065133	0.079792	-0.164782	PHGSE(-3)
0.0719	1.811106	0.067760	0.122720	PHGSE(-7)
0.0000	4.598681	0.117744	0.541465	PFTSE100(-1)
0.0009	3.371711	0.120706	0.406986	PFTSE100(-3)
0.003328	Mean dependent var		0.176977	R-squared
0.024048	S.D. dependent var		0.147757	Adjusted R-squared
-4.738424	Akaike info criterion		0.022201	S.E. of regression
-4.612325	Schwarz criterion		0.083295	Sum squared resid
6.056743	F-statistic		423.9813	Log likelihood

0.000009	Prob(F-statistic)	2.088810	Durbin-Watson stat

Table 12 Vector auto-regression of PFTSE100 over lagged causal variables.
Dependent Variable: PFTSE100
Method: Least Squares
Sample(adjusted): 1/14/2009 9/16/2009
Included observations: 176 after adjusting endpoints

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0082	-2.674470	0.104948	-0.280679	PFTSE100(-1)
0.0654	1.854237	0.071236	0.132089	PFTSE100(-7)
0.0033	2.982677	0.089288	0.266316	PSP500(-1)

0.001634	Mean dependent var	0.056948	R-squared
0.016417	S.D. dependent var	0.046046	Adjusted R-squared
-5.411197	Akaike info criterion	0.016035	S.E. of regression
-5.357154	Schwarz criterion	0.044482	Sum squared resid
2.023893	Durbin-Watson stat	479.1853	Log likelihood

Table 13: Vector auto-regression of PN225 over lagged causal variables.
Dependent Variable: PN225
Vector Auto-regression Estimates
Sample(adjusted): 1/14/2009 9/16/2009
Included observations: 176 after adjusting endpoints
Standard errors in ( ) & t-statistics in [ ]

PN225	
-0.245927 (0.07323) [-3.35814]	PN225(-1)
-0.174143 (0.07248) [-2.40272]	PN225(-3)
-0.145266 (0.07906) [-1.83731]	PN225(-7)
0.616651 (0.05930) [10.3988]	PSP500(-1)
0.122408 (0.07728) [1.58387]	PSP500(-2)
0.213467 (0.07003) [3.04811]	PSP500(-3)
0.162425 (0.07089) [2.29107]	PSP500(-4)
-0.125227 (0.05679) [-2.20503]	PHGSE(-2)
0.206532 (0.06182) [3.34083]	PHGSE(-7)

-0.130989 (0.06489) [-2.01855]	PFTSE100(-6)
0.466408	R-squared
0.437479	Adj. R-squared
0.033292	Sum sq. resids
0.014162	S.E. equation
16.12214	F-statistic
504.6834	Log likelihood
-5.621402	Akaike AIC
-5.441261	Schwarz SC
0.001101	Mean dependent
0.018882	S.D. dependent