In Search of Market Index Leaders: Evidence from Asian Markets

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Abstract

This paper investigates the presence of Granger-causality amongst market indices in six Asian stock markets: Malaysia, India, China, Pakistan, the Philippine and Japan, from April 7th 1992 to July 23rd 2008. Using daily market returns I performed a Granger-causality test, based on the Vector Autoregressive (VAR) model, in order to detect the causalities amongst indices. Different sub-samples were considered, which take into account the distinction between bearish and bullish phases of the markets. Results show that there is not Granger-causality amongst stock returns for the overall sample, but that there is Granger-causality amongst some indices during bearish and bullish phases. In particular, I found that market index leaders does exist both in up and down trends, even though these market leaders are not necessarily the same in the two phases.

Keywords: Granger-causality, Asian stock markets, market indices, VAR.

1 Introduction

Is there a market index which reacts faster than others to market events and whose reactions are followed by other indices? In other words, is there a market index leader? This question has always been of remarkable interest amongst market traders, investors and portfolio managers, who aim to detect market trends to increase their trade's gains.

Finance journalism has always implicitly recognise the existence of a linkage amongst the performances of world stock markets and believes that some stock exchange (e.g. Wall Street) are more influencing than others in tracing the market trends[1]. But in spite of this common feeling regarding the existence of a linkage amongst indexes, the empirical evidence in this field of research is still very poor. One of the obstructing motivations which generates this scarcity is due to the difficulty in defining a causality model. Of course, the pioneering

[1] Just to mention two examples, one may read "Asian shares follow Wall Street lower", from the Financial Times' web site, 22nd October 2008; "Nikkei's 6.8% Fall Leads Asia Lower", from the Wall Street Journal's web site, 22nd October 2008.

works by Granger (1969), Engle & Granger (1987), and Granger & Hallman (1991) represent the base on which establishing a research programme on this topic. Nevertheless, the concept of "Granger-causality"[2] has not been fully understood yet, and it is often a source of misunderstandings.

Granger himself wrote that the G-causality (and the statistic test which measures it) does not capture a true causality amongst series (e.g.

series x_t is the cause of series y_t) but it measures the ability of a series to predict another series (e.g. series x_t predicts series y_t). Furthermore, Granger supposed that if x_t is the Granger-cause of y_t, then x_t must come before y_t (Hamilton, 1994), as causes happen before effects. Of course, this definition of causality from a temporal point of view seems to be very helpful to answer our initial questions, since we are looking for an approach which enables us to understand what happens to an index when another one moves in a certain direction, regardless of why this happens. Therefore, the problem is even more simple than that addressed in other disciplines (i.e. Labour Econometrics) where the goal is to fully understand why things happen. Investors can be totally outside the economic theories, but they simply desire to predict the future of their invested money.

In this paper I introduce the definition of market index leader, defining it as that index which Granger-causes other indices but it is not Granger-caused by any other index. I perform a time-series analysis to detect the existence of possible market index leaders in Asian financial markets. Many authors have already studied the interdependence amongst Asian stock markets (Chang et al. 1992, Pan et al. 1999, Manning 2002) and Granger-causality in financial markets was studied in a few empirical researches (Gu & Annala 2005, Herwany & Febrian 2008) but, to the best of my knowledge, an integration of these two field of research has never been considered. This study aims to investigate the Granger-causality under different market conditions in order to detect whether this type of causality always exist or if it is more related to certain conditions. Furthermore I aim to discover if market leaders does and if they are the same in all the quartiles analysed.

2 Methodology and Data

The candidate indexes used in the analysis are the following:

1. The **Kuala Lumpur Stock Exchange Composite Index** is a broad-based capitalization-weighted index of 100 stocks designed to measure the performance of the Kuala Lumpur Stock Exchange. The index has a base value of 100 as of January 2,1977.

[2] Sometimes the term "Granger-causality" is substituted by the term "Granger-Wiener causality", since it is based on the concept of causality expressed by the mathematician Norbert Wiener (1956).

2. The **Bombay Stock Exchange Sensitive Index (Sensex)** is a cap-weighted index. The selection of the index members has been made on the basis of liquidity, depth, and floating-stock-adjustment depth and industry representation. Sensex has a base date and value of 100 in 1978-1979. The index uses free float.

3. The **Hang Seng Comm/Indu Index** is a capitalization-weighted index of all the stocks designed to measure the performance of the comm/indu sector of the Stock Exchange of Hong Kong. The parent index is HSI.

4. The **Karachi Stock Exchange KSE100 Index** comprises the top company from each of the 34 sectors on the KSE, in terms of market capitalization. The rest of the companies are picked on market cap ranking, without any consideration for the sector to make a sample of 100 common stocks with base value 1,000.

5. The **Philippine Stock Exchange PSEi Index** is a capitalization-weighted index composed of stocks representative of the Industrial, Properties, Services, Holding Firms, Financial and Mining & Oil Sectors of the PSE. The index has a base value of 2922.21 as of September 30, 1994. Free-float adjusted as of 4/3/06*New industry classification effective 1/2/2006. Formerly named PSE Composite.

6. The **Nikkei-225 Stock Average** is a price-weighted average of 225 top-rated Japanese companies listed in the First Section of the Tokyo Stock Exchange. The Nikkei Stock Average was first published on May 16, 1949, where the average price was ¥176.21 with a divisor of 225.

Performance of the stocks were measured by cumulative returns, calculated as

$$CR = \ln(P_{it}) - \ln(P_{it-1})$$

$i = 1, ..., n$

where P_{it} represents the trading day's closing price of index i.

The time period runs from April 7th, 1992, to July 23rd, 2008. Data source is Bloomberg database.

I divided the entire sample into four quantiles, in order to have a distinction between bullish and bearish markets. The first two quartiles represt the bearish phase of the market, whilst the third and the fourth the bullish. I want to test the hypothesis that there exists a leader index amongst Asian financial markets.

2.1 Leader Indexes

I define an index as a *leader index* if it causes another index and it is not caused by any other index. For example, let us take two indexes, say M and N. Index

M is said to be a leader index if it Granger-causes (and it is not Granger-caused by) index N. The term "leader" should be read as a synonimous of "first mover", whose trend is followed by the other indexes. This definition respects the true meaning of Granger causality, which should not be read as "M causes N" but as "if M occurs, then also does N, regardless of whether M is the actual cause of N".

More formally, let us write the two time series $M = \{m_t, t, \text{real}\}$ and $N = \{n_t, t, \text{real}\}$; furthermore, let us introduce a "break-up" time, say t, and $M_t = \{m_{t-s}, s \geq 0\}$, $N_t = \{n_{t-s}, s \geq 0\}$ the two entire series up to the break-up time. Denote also Γ_t the information set accumulated at t and suppose that

$$M_s \subseteq \Gamma_t \Longleftrightarrow s \leq t$$

$$N_s \subseteq \Gamma_t \Longleftrightarrow s \leq t$$

If we are better able to predict m_t, using Γ_t than we are using $\Gamma_{t-1} \not/ N_{t-1}$, then N causes M. If we are better able to "predict" m_t, using $\Gamma_{t-1} \cup n_t$ than we are using Γ_{t-1}, then N causes M instantaneously. Appendix 1 illustrates more in details the concept of causality.

3 Results

Tables 1-5 show overall statistics for the first differences of the natural logarithms of prices for the overall sample and for the quartiles. It is interesting to note that, in table 1, means are around zero for every index but that the level of risk, roughly measured by the standard deviation is slightly higher for the Kuala Lumpur Stock Exchange Composite Index. Table 1 shows that the return mean values on the overall sample are positive, except for Nikkei Index, i.e. -0.003%. Hang Seng shows the highest return (0.039%) and the highest risk level (the largest return standard deviation), i.e. 2.25%. Kse Index also shows high level of returns and risk levels (0.028% and 2.1% respectively), while Philippine index reveals to be high risky but low profitable (0.006% and 2.11% respectively).

Results of the Granger-causality tests are reported in tables 5-10. Table 5 reveals that, during the overall period, there is no conintegration between indexes and therefore, we have to reject the hypothesis about the existence of a market index leader.

3.1 Leaders in Bearish Markets

Table 2 shows the mean values for the first quartile. Hang Seng is still the more risky index (standard deviation equal to 2.24%) and this is confirmed by the lowest return (-1.6%). Otherwise, Nikkei is the less risky (standard deviation equal to 1.79%) and the best performer (returns equal to -1.1%). Table 3 shows the mean values for the second quartile. There KSE reveals to be both the more risky and the most rewarding index (standard deviation equal to 1.59% and mean return equal to –0.1%).

Cointegration does exist in both the first and second quartile. I summarise the main results in the following scheme:

- Nikkei G-causes Hang Seng at the 10% of the confidence interval in the first quartile and at the 5% in the second quartile, and G-causes KSE at the 1% in the second;
- Hang Seng G-causes BSE SENSEX 30 at the 5% of the confidence interval in the first quartile;
- BSE G-causes KSE at the 1% of the confidence interval in the first quartile and Hang Seng at the 5% of the confidence interval in the second;
- KSE G-causes Philippine at the 10% of the confidence interval in the first quartile;
- Philippine G-causes Nikkei at the 10% of the confidence interval in the first quartile and KSI at the 1% in the second.

Apparently, in the first quartile a market index leader does not seem to exist; it is true that Kuala Lumpur is not G-caused by any other index, but it neither causes other indexes. Nevertheless ad Chart 1 shows, BSE seems to represent a suitable candidate, since it directly G-causes KSE and Hang Seng and indirectly Philippine (via KSE), Nikkei (via Philippine) which G-causes Hang Seng. Instead, in the second quartile BSE, Philippine and Nikkei are not caused by any other index and causes other indexes. These three indexes are suitable candidates to be an index leader.

3.2 Leaders in Bullish Markets

Table 4 shows the mean values for the third quartile. The most risky / best performer indexes are KSE and BSE with a standard deviation of 1.42% for BSE and 1.57% for KSE and a mean return equal to 0.36% for the BSE and 0.26% for KSE..

Finally, table 5 shows the mean values for the fourth quartile. Hang Seng reveals to have the highest mean return, i.e. 1.7% and a medium standard deviation, i.e. 2.33%, whilst the Kuala Lumpur index is the most risky (standard deviation equal to 2.8%). Cointegration does exist in both the third and fourth quartile.

- Nikkei G-causes Hang Seng and BSE at the 10% of the confidence interval and the Philippine at the 5% in the third quartile, and Hang Seng at the 10% and BSE at the 5% in the fourth;
- Hang Seng G-causes Kuala Lumpur at the 5% of the confidence interval in the third quartile and BSE at the 1% in the fourth;

- KSE G-causes Kuala Lumpur at the 1% of the confidence interval and BSE and Nikkei at the 10% in the third quartile, and Nikkei at the 5% in the fourth;
- Philippine G-causes BSE at the 5% of the confidence interval and Nikkei at the 1% in the third quartile, and Kuala Lumpur at the 5% in the fourth;
- Kuala Lumpur G-causes Hang Seng at the 5% of the confidence interval in the third quartile, and Nikkei at the 5% in the fourth.

KSE emerges as a true market leader in the third quartile, since it is not G-caused by any other index and G-causes both BSE and Nikkei, which in turn G-causes Hang Seng. Otherwise, Philippine and KSE are the market leaders in the fourth quartile since the former G-causes Kuala Lumpur, which in turn G-causes Nikkei , Hang Seng and BS, but it is not G-caused by any other index, whilst KSE directly G-causes Nikkei and indirectly Hang Seng (via Nikkei) and BS (via Hang Seng).

4 Conclusions

In this paper I performed a time series analysis whose goal was to find market index leaders, those which lead other indices in different phases of the market. I found that BSE, Philippine and Nikkei can represent suitable candidates to be index leaders during bearish markets, whilst Philippine and KSE are the market leaders in the bullish trends. The quest of market leaders can be easily extended to any security: equities, bonds, futures, derivatives. I hope these suggestions could find a place in future works.

5 Appendix 1

Suppose to have a space of possible outcomes $\complement$ and two sets of restrictions $M, N \subset \complement$ on these outcomes, with $(M \cap N) \subset \complement$. x and y map $\complement$ by probabilistic function $\Pr_x$ and $\Pr_y$. We write the set of the following 5 axioms which represents the steps to define the concept of causality.

- Axiom of *Causal Ordering from x to y*

$$C1 := \left(\Pr_y (M) = M\right) \cap \left(\Pr_x (M \cap N) = \Pr_x (M)\right) \Rightarrow (M, N) \subset \complement x \circlearrowright y$$

- Axiom of *Acceptance of inputs by N*

$$\begin{aligned} C2 \quad &: \quad = \left(\overset{-1}{\underset{x}{\Pr}} \left(\underset{x}{\Pr}(M) \right) = M, \forall M \subset \complement \right) \\ &\Longrightarrow \quad \left(\left(\underset{y}{\Pr}(M) = M \right) \cap \left(\underset{x}{\Pr}(M \cap N) = \underset{x}{\Pr}(M) \right) \Rightarrow (M, N) \subset \complement x \circlearrowright y \right) \end{aligned}$$

- Axiom of *Realilzability of N with M as input*

$$C3 := C2 \cap \left(\begin{array}{c} \Pr_{x_t}(M_1) = \Pr_{x_t}(M_2) \\ \Rightarrow \Pr_{y_s}\left(\Pr_{x_t}(M_1 \cap N) = \Pr_{x_t}(M_2 \cap N)\right), \\ \forall M_1, M_2 \subset \complement, \forall t \geq s \end{array} \right)$$

- Axiom of *Structurality of N with x as input*

$$C4 := C3 \cap \left(\begin{array}{c} \textit{any implemented } C \subseteq \complement \\ \Rightarrow \Pr_y \left(\Pr_x^{-1}(C) \cap B \right) = True \end{array} \right)$$

- Axiom of *Causality*

$$C5 := C3 \Rightarrow C4$$

6 Appendix 2

The standard multi-variate Granger causality test adopts an OLS approach of the following system of equations

$$\begin{aligned} Y_t &= \mu_0 + \mu_1 Y_{t-1} + ... + \mu_k Y_{t-k} + \\ &\quad + \sum_{p=1}^{P} \left(\gamma_1^p X_{t-1}^p + ... + \gamma_k^p X_{t-k}^p \right) + u_t \\ X_t^1 &= \mu_0 + \mu_1 X_{t-1}^1 + ... + \mu_k X_{t-k}^1 + \gamma_1^1 Y_{t-1}^1 + ... + \gamma_k^1 Y_{t-k}^1 + \\ &\quad + \sum_{p=2}^{P} \left(\gamma_1^p X_{t-1}^p + ... + \gamma_k^p X_{t-k}^p \right) + u_t \\ &\quad \vdots \\ X_t^p &= \mu_0 + \mu_1 X_{t-1}^p + ... + \mu_k X_{t-k}^p + \gamma_1^1 Y_{t-1}^1 + ... + \gamma_k^1 Y_{t-k}^1 + \\ &\quad + \sum_{p=1}^{P-1} \left(\gamma_1^p X_{t-1}^p + ... + \gamma_k^p X_{t-k}^p \right) + u_t \end{aligned}$$

under the joint hypothesis

$$H_0 : \gamma_1^1 = ... = \gamma_{t-p}^1 \wedge ... \wedge \gamma_1^P = ... = \gamma_{t-p}^P = 0$$

which is tested by the meaning of a Wald test that the coefficients on the lags of the "excluded" variables are zero in the equation for the (assumed) dependent variable. Selection criteria, such as the Bayesian Information Criteria (BIC, Schwartz, 1978)) or the Akaike Information Criteria (AIC, (Akaike, 1974)), can be used to determine the appropriate number of lags.

The multivariate case of the Granger causality test produces more reliable results than repeated pairwise analyses. Let us take the example 1 in Figure 1; a pairwise analysis would not be able to disambiguate the two connectivity patterns between the yellow, the blue and the red circle. A multivariate approach is able to detect the causality nexus where the red circle is both caused by the blue and the yellow circles. The example 2 of the same figure shows another danger which a multivariate test is able to avoid. Suppose that the blue circle drives two outputs (red and yellow) with different time delays. Pairwise analyses would falsely infer a causal connection from the red circle to the yellow circle, whilst a multivariate Granger test would not detect this result.

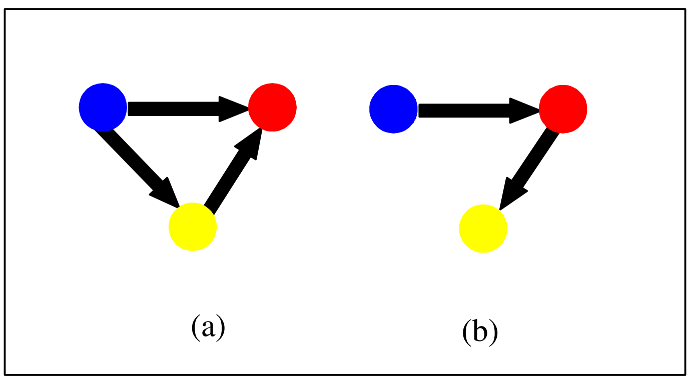

Figure 1: Two relations which cannot be disentangled by a pairwise analysis.

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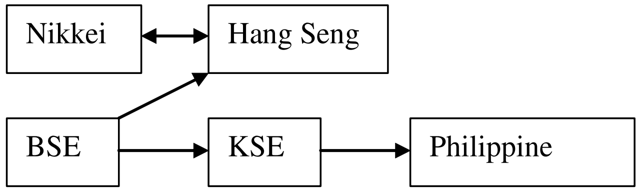

Chart 1: G-causal relations among indexes - First Quartile

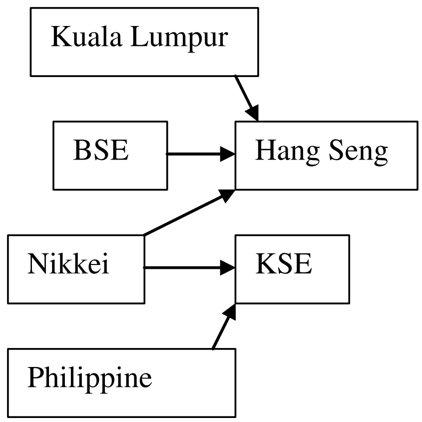

Chart 2: G-causal relations among indexes - First Quartile

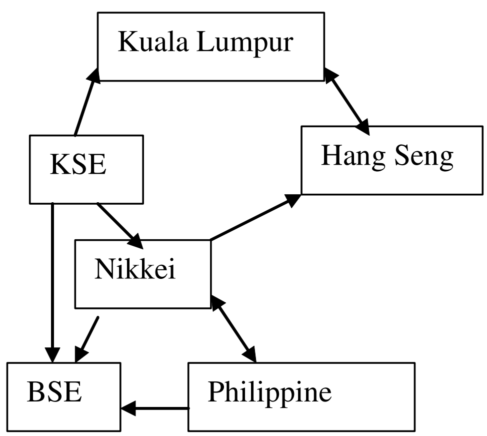

Chart 3: G-causal relations among indexes - First Quartile

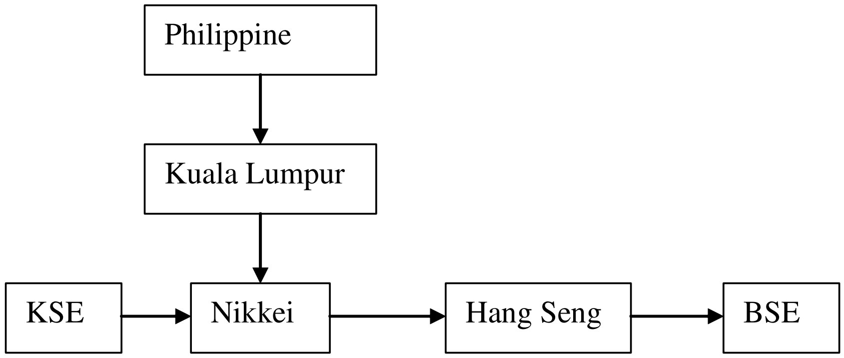

Chart 4: G-causal relations among indexes - First Quartile

	Obs	Mean	Std. Dev.	Min	Max
Hang Seng	3000	0.00039	0.02251	-0.13410	0.18646
Kuala Lumpur	3000	0.00015	0.02096	-0.24193	0.36126
BSE SENSEX 30	3000	0.00028	0.02037	-0.15095	0.11161
Kse	3000	0.00037	0.02104	-0.13214	0.13010
PSEi - Philippine SE	3000	0.00006	0.02110	-0.13806	0.29555
Nikkei	3000	-0.00003	0.01835	-0.10022	0.15485
All	3000	0.00020	0.01109	-0.05608	0.15324

Table 1 – Summary Statistics for the Indexes' Return in Natural Logs – Entire Sample *Source*: Processed data

	Obs	Mean	Std. Dev.	Min	Max
Hang Seng	750	-0.01606	0.02240	-0.13410	0.07758
Kuala Lumpur	750	-0.01130	0.02138	-0.13076	0.04737
BSE SENSEX 30	750	-0.01182	0.02161	-0.15095	0.07056
Kse	750	-0.01128	0.02213	-0.13214	0.09221
PSEi - Philippine SE	750	-0.01356	0.02010	-0.13806	0.05016
Nikkei	750	-0.01104	0.01792	-0.10022	0.07676
All	750	-0.01251	0.00817	-0.05608	-0.0050

Table 2 – Summary Statistics for the Indexes' Return in Natural Logs – First Quartile *Source*: Processed data

	Obs	Mean	Std. Dev.	Min	Max
Hang Seng	750	-0.00301	0.01524	-0.10026	0.08085
Kuala Lumpur	750	-0.00124	0.01185	-0.06800	0.08425
BSE SENSEX 30	750	-0.00149	0.01539	-0.06625	0.06070
Kse	750	-0.00101	0.01599	-0.08911	0.05312
PSEi - Philippine SE	750	-0.00272	0.01303	-0.05104	0.07507
Nikkei	750	-0.00326	0.01365	-0.055	0.06384
All	750	-0.00212	0.00149	-0.00498	0.00034

Table 3 – Summary Statistics for the Indexes' Return in Natural Logs – Second Quartile *Source*: Processed data

	Obs	Mean	Std. Dev.	Min	Max
Hang Seng	750	0.00356	0.01339	-0.03788	0.08780
Kuala Lumpur	750	0.00200	0.01072	-0.07933	0.05926
BSE SENSEX 30	750	0.00361	0.01423	-0.08674	0.08030
Kse	750	0.00268	0.01573	-0.07909	0.09345
PSEi - Philippine SE	750	0.00213	0.01221	-0.04720	0.04653
Nikkei	750	0.00248	0.01317	-0.04346	0.06593
All	750	0.00274	0.00148	0.00036	0.00547

Table 4 – Summary Statistics for the Indexes' Return in Natural Logs – Third Quartile *Source*: Processed data

	Obs	Mean	Std. Dev.	Min	Max
Hang Seng	750	0.01708	0.02333	-0.06005	0.18646
Kuala Lumpur	750	0.01112	0.02808	-0.24193	0.36126
BSE SENSEX 30	750	0.01083	0.02197	-0.14009	0.11161
Kse	750	0.01108	0.02285	-0.09131	0.13010
PSEi - Philippine SE	750	0.01440	0.02561	-0.04292	0.29555
Nikkei	750	0.01171	0.01975	-0.07141	0.15485
All	750	0.01270	0.00955	0.00548	0.15324

Table 5 – Summary Statistics for the Indexes' Return in Natural Logs – Fourth Quartile *Source*: Processed data

Equation	Excluded	chi2	df	Prob>chi2
Hang Seng	Kuala Lumpur	21.541	21	0.426
	BSE SENSEX 30	16.107	21	0.764
	Kse	13.287	21	0.898
	PSEi - Philippine SE	15.285	21	0.808
	Nikkei	25.791	21	0.215
	All	96.023	105	0.723
Kuala Lumpur	Hang Seng	25.381	21	0.231
	BSE SENSEX 30	25.882	21	0.211
	Kse	16.152	21	0.761
	PSEi - Philippine SE	14.864	21	0.83
	Nikkei	24.439	21	0.272
	All	107.76	105	0.407
BSE SENSEX 30	Hang Seng	20.011	21	0.521
	Kuala Lumpur	9.7529	21	0.982
	Kse	23.34	21	0.326
	PSEi - Philippine SE	18.395	21	0.624
	Nikkei	23.652	21	0.31
	All	103.1	105	0.534
Kse	Hang Seng	21.892	21	0.406
	Kuala Lumpur	18.155	21	0.639
	BSE SENSEX 30	26.539	21	0.187
	PSEi - Philippine SE	18.893	21	0.592
	Nikkei	23.727	21	0.306
	All	104.08	105	0.507
PSEi - Philippine SE	Hang Seng	20.586	21	0.484
	Kuala Lumpur	10.273	21	0.975
	BSE SENSEX 30	8.2117	21	0.994
	Kse	22.68	21	0.361
	Nikkei	14.272	21	0.858
	All	71.797	105	0.995
Nikkei	Hang Seng	19.152	21	0.575
	Kuala Lumpur	19.472	21	0.555
	BSE SENSEX 30	25.193	21	0.239
	Kse	21.759	21	0.413
	PSEi - Philippine SE	14.162	21	0.863
	All	108.71	105	0.383

Table 6 – Granger causality Wald tests, Entire Sample (*) significant at the 1% of the C.I.; (**) significant at the 5% of the C.I.; (***) significant at the 10% of the C.I.

Equation	Excluded	chi2	df	Prob>chi2
Hang Seng	Kuala Lumpur	21.541	21	0.426
	BSE SENSEX 30	16.107	21	0.764
	Kse	13.287	21	0.898
	PSEi - Philippine SE	15.285	21	0.808
	Nikkei	25.791	21	0.215
	All	96.023	105	0.723
Kuala Lumpur	Hang Seng	25.381	21	0.231
	BSE SENSEX 30	25.882	21	0.211
	Kse	16.152	21	0.761
	PSEi - Philippine SE	14.864	21	0.83
	Nikkei	24.439	21	0.272
	All	107.76	105	0.407
BSE SENSEX 30	Hang Seng	20.011	21	0.521
	Kuala Lumpur	9.7529	21	0.982
	Kse	23.34	21	0.326
	PSEi - Philippine SE	18.395	21	0.624
	Nikkei	23.652	21	0.31
	All	103.1	105	0.534
Kse	Hang Seng	21.892	21	0.406
	Kuala Lumpur	18.155	21	0.639
	BSE SENSEX 30	26.539	21	0.187
	PSEi - Philippine SE	18.893	21	0.592
	Nikkei	23.727	21	0.306
	All	104.08	105	0.507
PSEi - Philippine SE	Hang Seng	20.586	21	0.484
	Kuala Lumpur	10.273	21	0.975
	BSE SENSEX 30	8.2117	21	0.994
	Kse	22.68	21	0.361
	Nikkei	14.272	21	0.858
	All	71.797	105	0.995
Nikkei	Hang Seng	19.152	21	0.575
	Kuala Lumpur	19.472	21	0.555
	BSE SENSEX 30	25.193	21	0.239
	Kse	21.759	21	0.413
	PSEi - Philippine SE	14.162	21	0.863
	All	108.71	105	0.383

Table 7 – Granger causality Wald tests, First Quartile (*) significant at the 1% of the C.I.; (**) significant at the 5% of the C.I.; (***) significant at the 10% of the C.I.

Equation	Excluded	chi2	df	Prob>chi2
Hang Seng	**Kuala Lumpur**	**40.789**	**21**	**0.006(*)**
	BSE SENSEX 30	**32.854**	**21**	**0.048(**)**
	Kse	20.161	21	0.511
	PSEi - Philippine SE	25.697	21	0.218
	Nikkei	**34.251**	**21**	**0.034(**)**
	All	154.02	105	0.001(*)
Kuala Lumpur	Hang Seng	29.592	21	0.101
	BSE SENSEX 30	18.899	21	0.592
	Kse	18.088	21	0.643
	PSEi - Philippine SE	25.574	21	0.223
	Nikkei	27.823	21	0.145
	All	128.39	105	0.06(***)
BSE SENSEX 30	Hang Seng	8.9839	21	0.989
	Kuala Lumpur	20.517	21	0.489
	Kse	21.699	21	0.417
	PSEi - Philippine SE	18.815	21	0.597
	Nikkei	28.645	21	0.123
	All	102.98	105	0.537
Kse	Hang Seng	24.528	21	0.268
	Kuala Lumpur	25.561	21	0.224
	BSE SENSEX 30	17.427	21	0.685
	PSEi - Philippine SE	**45.225**	**21**	**0.002(*)**
	Nikkei	**40.953**	**21**	**0.006(*)**
	All	168.56	105	0(*)
PSEi - Philippine SE	Hang Seng	20.486	21	0.491
	Kuala Lumpur	21.724	21	0.416
	BSE SENSEX 30	14.174	21	0.862
	Kse	16.055	21	0.767
	Nikkei	8.9283	21	0.99
	All	92.158	105	0.81
Nikkei	Hang Seng	28.542	21	0.125
	Kuala Lumpur	15.844	21	0.778
	BSE SENSEX 30	26.959	21	0.172
	Kse	13.267	21	0.899
	PSEi - Philippine SE	19.712	21	0.54
	All	107.77	105	0.407

Table 8 – Granger causality Wald tests, Second Quartile (*) significant at the 1% of the C.I.; (**) significant at the 5% of the C.I.; (***) significant at the 10% of the C.I.

Equation	Excluded	chi2	df	Prob>chi2
Hang Seng	**Kuala Lumpur**	**36.439**	**21**	**0.02(**)**
	BSE SENSEX 30	13.524	21	0.889
	Kse	23.725	21	0.307
	PSEi - Philippine SE	24.168	21	0.285
	Nikkei	**30.584**	**21**	**0.081(***)**
	All	135.83	105	0.023(**)
Kuala Lumpur	**Hang Seng**	**33.674**	**21**	**0.039(**)**
	BSE SENSEX 30	25.68	21	0.219
	Kse	**43.209**	**21**	**0.003(*)**
	PSEi - Philippine SE	27.58	21	0.152
	Nikkei	29.373	21	0.105
	All	156.84	105	0.001(*)
BSE SENSEX 30	Hang Seng	25.128	21	0.242
	Kuala Lumpur	21.635	21	0.421
	Kse	**32.426**	**21**	**0.053(***)**
	PSEi - Philippine SE	**33.203**	**21**	**0.044(**)**
	Nikkei	**32.284**	**21**	**0.055(***)**
	All	151.68	105	0.002(*)
Kse	Hang Seng	23.27	21	0.33
	Kuala Lumpur	21.964	21	0.402
	BSE SENSEX 30	19.726	21	0.539
	PSEi - Philippine SE	21.606	21	0.423
	Nikkei	26.582	21	0.185
	All	97.418	105	0.688
PSEi - Philippine SE	Hang Seng	29.438	21	0.104
	Kuala Lumpur	28.708	21	0.121
	BSE SENSEX 30	28.811	21	0.119
	Kse	23.401	21	0.323
	Nikkei	**32.884**	**21**	**0.048(**)**
	All	131.54	105	0.041(**)
Nikkei	Hang Seng	13.873	21	0.875
	Kuala Lumpur	21.485	21	0.43
	BSE SENSEX 30	21.061	21	0.455
	Kse	**30.69**	**21**	**0.079(***)**
	PSEi - Philippine SE	**40.352**	**21**	**0.007(*)**
	All	135	105	0.026(**)

Table 9 – Granger causality Wald tests, Third Quartile (*) significant at the 1% of the C.I.; (**) significant at the 5% of the C.I.; (***) significant at the 10% of the C.I.

Equation	Excluded	chi2	df	Prob>chi2
Hang Seng	Kuala Lumpur	25.023	21	0.246
	BSE SENSEX 30	22.681	21	0.361
	Kse	22.381	21	0.378
	PSEi - Philippine SE	22.289	21	0.383
	Nikkei	**30.794**	**21**	**0.077(***)**
	All	129.78	105	0.051(***)
Kuala Lumpur Comp	Hang Seng	11.702	21	0.947
	BSE SENSEX 30	27.957	21	0.141
	Kse	24.358	21	0.276
	PSEi - Philippine SE	**30.76**	**21**	**0.078(***)**
	Nikkei	21.291	21	0.441
	All	114.52	105	0.247
BSE SENSEX 30	**Hang Seng**	**39.324**	**21**	**0.009(*)**
	Kuala Lumpur	22.479	21	0.372
	Kse	21.392	21	0.435
	PSEi - Philippine SE	16.221	21	0.757
	Nikkei	**37.406**	**21**	**0.015(**)**
	All	130.03	105	0.049(**)
Kse	Hang Seng	20.982	21	0.46
	Kuala Lumpur	27.108	21	0.167
	BSE SENSEX 30	28.475	21	0.127
	PSEi - Philippine SE	14.779	21	0.834
	Nikkei	12.42	21	0.928
	All	113.43	105	0.27
PSEi - Philippine SE	Hang Seng	15.649	21	0.789
	Kuala Lumpur	28.142	21	0.136
	BSE SENSEX 30	14.758	21	0.835
	Kse	17.773	21	0.663
	Nikkei	26.468	21	0.189
	All	110.65	105	0.334
Nikkei	Hang Seng	22.871	21	0.351
	Kuala Lumpur	**33.682**	**21**	**0.039(**)**
	BSE SENSEX 30	24.551	21	0.267
	Kse	**34.03**	**21**	**0.036(**)**
	PSEi - Philippine SE	27.595	21	0.152
	All	145.26	105	0.006(*)

Table 10 – Granger causality Wald tests, Fourth Quartile (*) significant at the 1% of the C.I.; (**) significant at the 5% of the C.I.; (***) significant at the 10% of the C.I.