Interdependence of Philippine Stock Exchange Sector Indices: Evidence of Long-run and Short-run Relationship

Karl Anton M. Retumban
School of Statistics
University of the Philippines Diliman

The interdependence of the Philippine Stock Exchange Sector Indices was analyzed using Johansen's Cointegration test, Granger-Causality and Forecast Error Variance Decomposition. Daily, weekly and monthly data were used from January 2006 up to June 2015.The results confirm existence of cointegration among the six sector indices implying that the indices follow a common trend and have a long-run relationship. This is true across the daily, weekly and monthly data. There is also a uni-directional causality existing among the sector indices. Aside from the sector indices own shock largely influencing its own variation, the innovations from the financial sector index significantly contributes to the variation of other sector indices.

Keywords: Johansen's Cointegration, Granger Causality, Forecast Error Variance Decomposition, Philippine Stock Exchange Sector Indices

1. Introduction

Understanding the dynamics of the financial market of a particular economy is of great interest to various institutions and stakeholders. For the government, it helps in the formulation of various economic and financial policies used for regulatory purposes that will promote market equilibrium. While for other institutions and stakeholders, it gives them an edge in terms of investing and is a necessity for business survival. A good indicator of the general state of an economy is the stock market index. A stock market index is composed of major publicly listed companies in a particular economy. The Philippine Stock Exchange or PSE is the national stock exchange of the Philippines and has over 250 listed firms. The companies listed in the PSE are grouped into six sub-indices

representing different sector of the economy. These are the financials, holding firms, industrial, mining and oil, property and services market sector indices. The main metric of stock price movements and performance is the Philippine Stock Exchange Composite Index or PSEi.

The Philippines is one of the strongest emerging markets in Asia. For the past years, the country has performed well posting a 7.2 percent GDP growth on 2013. On the same year, the PSEi reached an all time high breaking the 7,000 index point mark. On the other hand, the economy has also been exposed to major shocks causing the domestic economy to plunge. During the 2008 Global Financial Crisis almost all sectors of the economy were affected including the financial markets. The PSEi reached a record low diving below the 2,000 index point level. Currently, the Philippine economy has recovered and is one of the top performing economies in Asia. The equity market is again on the rise with the PSEi reaching another all time high on April 2015 reaching the 8,000 index level.

The objective of this study is to examine the long-term and short-term dynamics among the six market sector indices of the PSE. It aims to determine if there is an existing long-run relationship among the sector indices. It also aims to capture whether there is a short-run causality among the sector indices and identify the direction of the causality. Moreover, it also aims to determine if the shock from one sector index can affect the variation of other sector indices.

2. Review of Literature

Various studies investigate on the co-movements of sector indices in a stock market of a particular economy. Results show evidence of interrelationship among market sector indices. A study on the Colombian capital market indices (Arbelaez et al., 2001) exhibit short-term and long-term linkages among the indices. It was also found that Colombian market index are integrated of order one and are highly correlated with each other. Daily stock price data was used for the six indices namely general, industrial, financial, commerce, various, and select, covering the time period January 2, 1988 through August 9, 1994.

Another study on the interdependence structure of the four market sector indices under the Qatar Exchange or QE suggests that the sector indices share a long-term equilibrium relationship (Ahmed, 2012). The study also provides evidence that the banking and financial institution sector index is a significant causal factor in regard to the price predictability of the remaining sectors in the short run. Moreover, the services sector index has the least influential role among the indices. Daily and weekly stock price data were used covering the period January 2, 2008 up to April 7, 2011. Another study about the Athens Stock Exchange (Patra and Poshakwale, 2008) suggests that even though the sector indices do not show a consistent and strong long-term relationship, the banking sector seems to have a strong influence on returns and volatility of other sectors at least in the short-run. The findings imply that changes in the banking sector index

could be potentially be used in predicting short term movements in other sector. Daily stock price data was used for the period January 1, 1996 up to December 31, 2003.

Similarly, the objective of this study is to investigate the interdependence of the six market sector indices of the Philippine Stock Exchange. It aims to determine the long-run and short-run dynamics and examine the interrelationship existing among the sector indices.

3. Methodology

Johansen's cointegration

Cointegration refers to a linear combination of time series that is stationary. It implies that the time series have a common stochastic trend and will tend to move together in the long-run. For illustration, consider the two non-stationary time series X_t and Y_t which are integrated of the same order. The two time series is said to be cointegrated if there exists a linear combination of the two time series that is integrated of order zero or follows I(0). Given this, the series X_t and Y_t have a long run relationship. In a case where there are more than two variables in a model, the set of time series may feature several cointegrating vectors. The Johansen's Cointegration Test determines the number of cointegrating relationship formed by a group of time series, hence jointly having a long run relationship.

Granger causality

Granger Causality refers to the usability of a particular time series in terms of forecasting another times series. It determines how much of the current variable, say Y_t, can be explained by the past values of another variable, say X_t. Given the two-time series, X_t is said to Granger-cause Y_t if it helps in the prediction of Y_t. The Granger-causality shows the short-run relationship between the variables. It determines whether the causal relationship existing between the time series is uni-directional which is a one-way relationship, or bi-directional which pertains to causality with feedback.

Forecast error variance decomposition

The forecast error variance decomposition determines the amount of variation attributed to its own shocks or innovations, and the amount of variation explained by other variables. It gives the amount of information each time series contributes to the other series in the vector of autoregressive system. Specifically, the technique breaks down the forecast error variance of a particular variable into proportions attributable to the shocks in that variable and in the remaining variables in the system, thus providing information about the magnitude of influence that the variables exert on each other over time (Ahmed, 2012).

4. Results and Discussion

The Philippine Stock Exchange has six sub-indices representing various sectors of the economy. The data used in the study was obtained from Bloomberg. Daily, weekly and monthly data was used from January 2006 up to June 2015. Table 1 below shows the overview of the sector indices in terms of the number of listed firms, market capitalization and market transactions as of June 2015. Figures were obtained from the Key Statistical Indicators Section of Bangko Sentral ng Pilipinas' website. Among the six sector indices, the industrial sector has the most number of listed firms; financials has the largest market capitalization; mining and oil has the largest transaction volume and the holdings sector index has the largest transaction value.

Table 1. Overview of PSE sector indices

Sector	Listed Firms	Market Capitalization	Transaction Volume	Transaction Value
	Number	In million pesos	In million shares	In million pesos
Financials	31	4,217,535.53	451.08	22,211.10
Holdings Firms	41	3,362,539.73	1,877.40	37,871.46
Industrial	66	2,645,465.23	1,778.11	34,548.51
Mining & Oil	26	413,592.13	12,199.57	6,701.81
Property	38	1,748,732.04	2,443.88	23,155.23
Services	59	2,166,616.99	2,582.31	27,078.95

**Figures on the number of listed firms were obtained for PSE website.*

4.1 Descriptive analysis

The graphs on Figures 1 to 3 show the daily, weekly and monthly subsector indices and PSEi from January 2006 up to June 2015. We can observe from the graphs that the sector indices are somewhat following the general trend of PSEi. On times where the PSEi has a peak and trough, the sector indices are also on an uptrend and downtrend, respectively. An example of this can be observed during the 2008 Global Financial Crisis in which the PSEi went down that year finally plunging to 1,825.09 index points on January 2009. All of the six sector indices dive down as well on the same period. The PSEi started recovering on 2009 and the movement of the recovery was also exhibited by the six sector indices. And when the PSEi reached another all-time high rallying its way up and breaking the 8,000 index point level on April 2015, the six sector indices are also on the same direction following an uptrend movement.

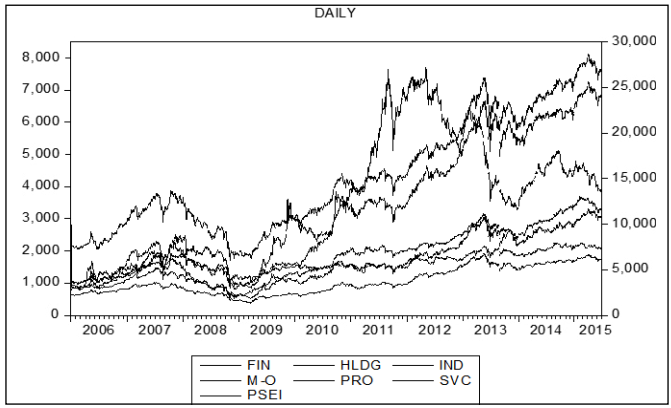

Figure 1. Philippine Stock Exchange Sector Indices and PSEi

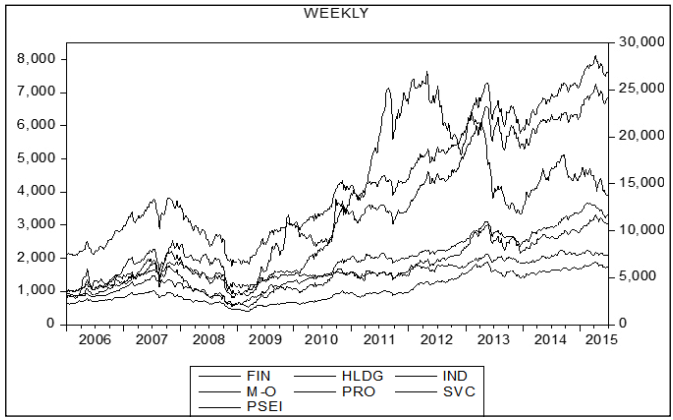

Figure 2. Philippine Stock Exchange Sector Indices and PSEi

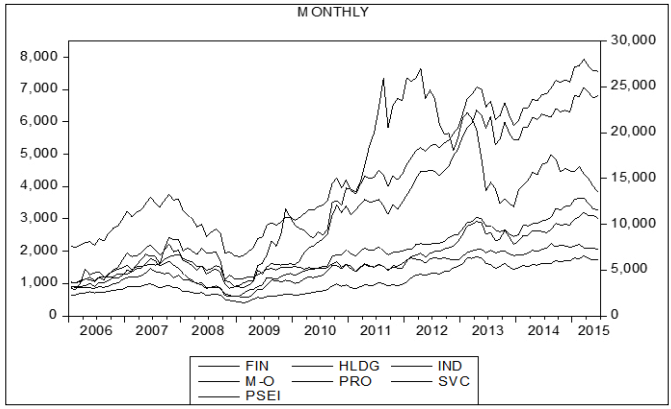

Figure 3. Philippine Stock Exchange Sector Indices and PSEi

The descriptive statistics of the daily, weekly and monthly subsector indices and PSEi are shown in Table 2. There are no significant changes among the statistics of the daily, weekly and monthly data. The sector index with the highest fluctuation is the mining & oil. The holdings sector index has almost the same level of index fluctuation with PSEi while the services sector has the lowest level of index fluctuation among the sector indices. Also the entire sector indices including PSEi are positively skewed indicating that sector index prices are above the average level of index price across the 10-year period. The distribution of the sector indices has a flatter and broader peak compared to a normal distribution as indicated by the kurtosis which are all less than 3. Based on the Jarque-Bera test, all of the sector indices and PSEi deviate from the normal distribution except for the monthly data of the services sector.

Table 2. Daily-Descriptive statistics of the sector indices and PSEi

Sector		FIN	HLDG	IND	M_O	PRO	SVC
Mean	Daily	1,049.45	3,292.31	6,427.03	12,151.55	1,662.66	1,626.09
	Weekly	1,053.82	3,313.15	6,458.79	12,195.46	1,671.02	1,629.71
	Monthly	1,055.24	3,326.24	6,485.42	12,205.66	1,675.46	1,634.89
Median	Daily	935.66	3,007.36	6,356.14	11,913.51	1,514.98	1,568.22
	Weekly	939.14	3,067.00	6,520.18	11,837.16	1,522.44	1,570.74
	Monthly	924.94	3,119.28	6,523.49	11,995.29	1,512.08	1,574.88
Maxi-mum	Daily	1,917.83	7,265.34	13,068.24	27,194.44	3,307.41	2,812.13
	Weekly	1,893.94	7,265.34	12,936.15	27,012.21	3,307.41	2,252.64
	Monthly	1,864.12	7,071.74	12,872.31	27,009.51	3,193.10	2,237.16
Mini-mum	Daily	382.94	797.25	2,081.51	2,774.91	518.64	951.21
	Weekly	387.59	797.25	2,082.43	2,776.13	527.81	977.73
	Monthly	407.60	860.94	2,145.65	2,899.87	564.68	1,027.13
Std. Dev.	Daily	418.54	1,968.83	2,973.58	6,727.15	716.33	310.20
	Weekly	419.43	1,973.95	2,983.89	6,705.80	718.45	308.19
	Monthly	420.74	1,983.23	3,017.40	6,737.27	724.51	307.60
Skew-ness	Daily	0.50	0.46	0.43	0.44	0.51	0.10
	Weekly	0.49	0.45	0.43	0.43	0.50	0.07
	Monthly	0.47	0.44	0.42	0.46	0.49	0.04
Kurtosis	Daily	1.88	1.74	1.99	2.03	2.14	2.43
	Weekly	1.86	1.73	1.98	2.03	2.12	2.29
	Monthly	1.84	1.70	1.98	2.10	2.07	2.25
Jarque-Bera	Daily	218.02	235.74	170.17	164.63	170.92	34.82
	Weekly	46.21	50.04	36.14	34.62	36.17	10.65
	Monthly	10.69	11.64	8.37	7.84	8.56	2.72
Prob-ability	Daily	0.00	0.00	0.00	0.00	0.00	0.00
	Weekly	0.00	0.00	0.00	0.00	0.00	0.00
	Monthly	0.00	0.00	0.02	0.02	0.01	0.26

The correlation among the sector indices and PSEi are shown in Table 3 for the daily, weekly and monthly data. The correlation values are almost the same across the data. The values are all positive indicating that the sector indices tend to move on the same direction with each other and with PSEi. Of the six sector

indices, the mining and oil sector index has the least degree of correlation with respect to the other sector indices and PSEi. Also, the mining and oil sector and services sector are the least correlated among the sector indices. All other sector indices except for mining and oil sector have a near perfect linear relationship with each other with at least 0.80 degree of correlation and with PSEi with at least 0.90 degree of correlation. The mining and oil sector index has 0.71 degree of correlation with PSEi, the lowest among the six sector indices.

Table 3. Correlation among sector indices and PSEi

Sector		FIN	HLDG	IND	M_O	PRO	SVC	PSEI
FIN	Daily	1.000	0.974	0.956	0.650	0.987	0.886	0.981
	Weekly	1.000	0.974	0.956	0.648	0.987	0.896	0.981
	Monthly	1.000	0.974	0.958	0.645	0.988	0.893	0.982
HLDG	Daily	0.974	1.000	0.989	0.711	0.970	0.882	0.994
	Weekly	0.974	1.000	0.989	0.710	0.970	0.892	0.994
	Monthly	0.974	1.000	0.989	0.704	0.971	0.889	0.994
IND	Daily	0.956	0.989	1.000	0.729	0.963	0.877	0.988
	Weekly	0.956	0.989	1.000	0.727	0.963	0.886	0.988
	Monthly	0.958	0.989	1.000	0.718	0.964	0.884	0.989
M_O	Daily	0.650	0.711	0.729	1.000	0.620	0.584	0.692
	Weekly	0.648	0.710	0.727	1.000	0.619	0.590	0.691
	Monthly	0.645	0.704	0.718	1.000	0.615	0.584	0.685
PRO	Daily	0.987	0.970	0.963	0.620	1.000	0.915	0.985
	Weekly	0.987	0.970	0.963	0.619	1.000	0.924	0.986
	Monthly	0.988	0.971	0.964	0.615	1.000	0.921	0.986
SVC	Daily	0.886	0.882	0.877	0.584	0.915	1.000	0.917
	Weekly	0.896	0.892	0.886	0.590	0.924	1.000	0.927
	Monthly	0.893	0.889	0.884	0.584	0.921	1.000	0.924
PSEI	Daily	0.981	0.994	0.988	0.692	0.985	0.917	1.000
	Weekly	0.981	0.994	0.988	0.691	0.986	0.927	1.000
	Monthly	0.982	0.994	0.989	0.685	0.986	0.924	1.000

The sector indices were then tested for stationarity. A variable is said to be stationary if it has a constant mean and constant variance. The Augmented Dickey Fuller test was used in detecting the presence of unit root. Presence of unit root implies that the variables are not stationary. Results suggest that six sector indices are not stationary in levels for the daily, weekly and monthly data. We then tested the first difference of each sector indices and this met the stationarity condition. This implies that each of the sector indices are integrated of order 1 or I(1). We now determine if the sector indices have a common stochastic trend or have a long-run relationship.

4.2 Johansen's cointegration

The Johansen's VAR-based test for cointegration was used since we have 6 variables. If the variables are greater than two, there is a possibility of the existence of more than one cointegrating vector. The selected lag length for the

daily and weekly data is 2 and 3, and for the monthly data, 1 is chosen. The selection is based on the Final Prediction Error (FPE), Akaike information (AIC), Schwarz information (SC), and Hannan-Quinn (HQ) information criteria. The results are shown on Table 4. The unrestricted co-integration rank test based on the trace statistic and maximum eigenvalue statistic both show the rejection of the null hypothesis of no cointegration and suggest the existence of one cointegrating relation among the sector indices, all for the daily, weekly and monthly data.

Table 4. Daily-Johansen's Cointegration Test

Panel A. Unrestricted Cointegration Rank Test (Trace)					
Hypothesized No. of CE(s)		Eigen-value	Trace Statistic	Critical Value	p-value
None *	Daily	0.021	102.13	95.75	0.017
	Weekly	0.101	101.47	95.75	0.019
	Monthly	0.327	102.79	95.75	0.015
At most 1	Daily	0.008	52.32	69.82	0.535
	Weekly	0.038	49.14	69.82	0.675
	Monthly	0.187	58.42	69.82	0.287
At most 2	Daily	0.008	33.24	47.86	0.543
	Weekly	0.034	30.13	47.86	0.713
	Monthly	0.146	35.20	47.86	0.437
At most 3	Daily	0.004	15.17	29.80	0.769
	Weekly	0.017	13.40	29.80	0.873
	Monthly	0.084	17.57	29.80	0.598
At most 4	Daily	0.003	5.87	15.49	0.711
	Weekly	0.010	5.12	15.49	0.797
	Monthly	0.067	7.74	15.49	0.494
At most 5	Daily	0.000	0.02	3.84	0.880
	Weekly	0.000	0.04	3.84	0.843
	Monthly	0.000	0.00	3.84	0.965

Panel B. Unrestricted Cointegration Rank Test (Maximum Eigenvalue)					
Hypothesized No. of CE(s)		Eigen-value	Max-Eigen Statistic	Critical Value	p-value
None *	Daily	0.021	49.81	40.08	0.003
	Weekly	0.101	52.33	40.08	0.001
	Monthly	0.327	44.37	40.08	0.016
At most 1	Daily	0.003	19.07	33.88	0.817
	Weekly	0.001	19.02	33.88	0.821
	Monthly	0.016	23.22	33.88	0.514
At most 2	Daily	0.008	18.08	27.58	0.489
	Weekly	0.034	16.73	27.58	0.603
	Monthly	0.146	17.64	27.58	0.526

At most 3	Daily	0.004	9.30	21.13	0.808
	Weekly	0.017	8.28	21.13	0.886
	Monthly	0.084	9.83	21.13	0.761
At most 4	Daily	0.003	5.85	14.26	0.633
	Weekly	0.010	5.08	14.26	0.732
	Monthly	0.067	7.74	14.26	0.406
At most 5	Daily	0.000	0.02	3.84	0.880
	Weekly	0.000	0.04	3.84	0.843
	Monthly	0.000	0.00	3.84	0.965

** denotes rejection of the hypothesis at the 0.05 level*

***MacKinnon-Haug-Michelis (1999) p-values*

This implies that the six sector indices have a long run relationship. This also means that individual sector indices may be affected by shocks isolated to that particular sector which can cause changes in behaviour, but the six sector indices still follow a common trend and move together in the long run. This is in consonance with the results of various literatures depicting evidence of cointegrating relationship in a domestic equity market. According to a study on the interdependence structure of market sector indices under the Qatar Exchange, this result correspond with the economic intuition that the various sectors within a single economy are more or less subject to forces from the domestic market attributes and country-specific fundamentals, i.e. financial development, inflation, interest rates, trade openness, politics and others, that ultimately drive them to follow the same stochastic trend, at least in the long run (Ahmed, 2012). Another study about the about the short-term and long-term linkages among the Colombian Capital market indices have the same result suggesting that the price indices are highly cointegrated with each other and suggests that future fluctuations of prices of one index can be determined or forecasted, to some extent, using a part of the information set provided by the other price indices (Arbelaez et al, 2001).

4.3 Granger causality

We now determine whether a particular sector index can be used in forecasting other sector indices. We also identify the direction of causality existing among them. The VEC Granger Causality/Block Exogeneity Wald Test was used since the six sector indices follow a cointegrating relationship. The selected lag lengths are same lags used in the Johansen's cointegration procedure. The results are shown in Table 5. Based on the results, the financials sector index is Granger-caused by the holdings sector index under the weekly and monthly data at 10 percent significance level. It is also Granger-caused by the industrial sector index under the daily and weekly data at 5 and 10 percent significance level, respectively. Checking the other way around for bi-directional causality, the holdings and industrial sector indices is not Granger-caused by the financials sector index, hence exhibiting only a uni-directional causality.

Table 5. VEC Granger Causality/Block Exogeneity Wald Tests

Panel A. Dependent variable: D(FIN)					Panel B. Dependent variable: D(HLDG)				
Excluded		Chi-sq	df	p-value	Excluded		Chi-sq	df	p-value
D(HLDG)	Daily	2.07	2	0.354	D(FIN)	Daily	0.97	2	0.617
	Weekly	5.10	2	0.078		Weekly	3.37	2	0.185
	Monthly	2.79	1	0.095		Monthly	0.93	1	0.335
D(IND)	Daily	9.08	2	0.011	D(IND)	Daily	4.75	2	0.093
	Weekly	5.02	2	0.081		Weekly	0.25	2	0.884
	Monthly	0.89	1	0.345		Monthly	0.25	1	0.617
D(M-O)	Daily	2.40	2	0.302	D(M-O)	Daily	3.69	2	0.158
	Weekly	0.30	2	0.859		Weekly	1.39	2	0.499
	Monthly	0.01	1	0.921		Monthly	1.27	1	0.260
D(PRO)	Daily	2.21	2	0.331	D(PRO)	Daily	0.17	2	0.920
	Weekly	1.11	2	0.573		Weekly	1.14	2	0.565
	Monthly	0.33	1	0.563		Monthly	0.65	1	0.421
All	Daily	15.58	10	0.112	All	Daily	12.99	10	0.224
	Weekly	11.23	10	0.340		Weekly	9.12	10	0.520
	Monthly	3.68	5	0.596		Monthly	4.97	5	0.419

Panel C. Dependent variable: D(IND)					Panel D. Dependent variable: D(M-O)				
Excluded		Chi-sq	df	p-value	Excluded		Chi-sq	df	p-value
D(FIN)	Daily	0.56	2	0.757	D(FIN)	Daily	0.41	2	0.813
	Weekly	0.93	2	0.627		Weekly	5.95	2	0.051
	Monthly	0.02	1	0.900		Monthly	4.72	1	0.030
D(HLDG)	Daily	0.68	2	0.712	D(HLDG)	Daily	0.58	2	0.747
	Weekly	2.42	2	0.298		Weekly	0.58	2	0.747
	Monthly	0.70	1	0.403		Monthly	0.02	1	0.882
D(M-O)	Daily	2.56	2	0.278	D(IND)	Daily	0.54	2	0.762
	Weekly	0.23	2	0.892		Weekly	0.37	2	0.830
	Monthly	0.00	1	0.986		Monthly	1.97	1	0.160
D(PRO)	Daily	0.69	2	0.707	D(PRO)	Daily	1.07	2	0.585
	Weekly	1.90	2	0.387		Weekly	3.31	2	0.191
	Monthly	0.48	1	0.490		Monthly	7.22	1	0.007
D(SVC)	Daily	0.15	2	0.926	D(SVC)	Daily	0.62	2	0.733
	Weekly	4.54	2	0.103		Weekly	0.51	2	0.777
	Monthly	0.00	1	0.781		Monthly	0.19	1	0.666
All	Daily	5.02	10	0.890	All	Daily	4.69	10	0.911
	Weekly	10.17	10	0.426		Weekly	13.55	10	0.194
	Monthly	1.19	5	0.946		Monthly	9.40	5	0.094

Panel E. Dependent variable: D(PRO)					Panel F. Dependent variable: D(SVC)				
Excluded		Chi-sq	df	p-value	Excluded		Chi-sq	df	p-value
D(FIN)	Daily	1.04	2	0.595	D(FIN)	Daily	0.30	2	0.862
	Weekly	0.18	2	0.914		Weekly	1.99	2	0.370
	Monthly	0.16	1	0.689		Monthly	1.53	1	0.217
D(HLDG)	Daily	2.26	2	0.322	D(HLDG)	Daily	1.36	2	0.507
	Weekly	9.59	2	0.008		Weekly	4.19	2	0.123
	Monthly	0.99	1	0.319		Monthly	0.41	1	0.520
D(IND)	Daily	3.56	2	0.169	D(IND)	Daily	0.62	2	0.734
	Weekly	1.70	2	0.427		Weekly	14.04	2	0.001
	Monthly	0.69	1	0.405		Monthly	5.07	1	0.024

D(M-O)	Daily	2.23	2	0.328	D(M-O)	Daily	4.27	2	0.118
	Weekly	2.09	2	0.351		Weekly	1.55	2	0.461
	Monthly	0.30	1	0.584		Monthly	1.07	1	0.301
D(SVC)	Daily	0.11	2	0.946	D(PRO)	Daily	0.01	2	0.995
	Weekly	5.26	2	0.072		Weekly	0.96	2	0.619
	Monthly	0.19	1	0.667		Monthly	2.13	1	0.144
All	Daily	8.57	10	0.573	All	Daily	7.80	10	0.648
	Weekly	19.53	10	0.034		Weekly	25.22	10	0.005
	Monthly	1.57	5	0.905		Monthly	7.79	5	0.168

The holdings sector index is Granger-caused by industrial sector index under the daily data at 10 percent significance level, but not the other way around. Hence exhibiting a uni-directional causality. The mining and oil sector index is Granger-caused by the financials sector index under the weekly and monthly data at 10 and 5 percent significance level respectively. It is also Granger-caused by the property sector index under the monthly data at 5 percent significance level. Checking for bi-directional causality, the financials and property sector indices is not Granger-caused by the mining and oil sector, hence also exhibiting a uni-directional causality.

The property sector index is Granger-caused by the holdings and services sector indices under the weekly data at 5 and 10 percent significance level, respectively. The relationship too is a uni-directional causality. The services sector index is Granger-caused by the industrial sector index under the weekly and monthly data at 5 percent significance level, exhibiting a uni-directional causality.

4.4 Forecast error variance decomposition

We now determine how much of the variation of a particular sector index is explained by its own shock and by other sector indices. The Cholesky ordering used is financials, holdings, industrial, mining and oil, property and services sector indices. Looking at the financials sector index under the daily, weekly and monthly data, we can see that most of its variation can be explained by its own innovations accounting to 100 percent on the one-month horizon and at least 97percent across the 2-10 month period. All other sector indices have negligible contribution to the variation in the financial sector index accounting to only less than 1 percent across the 10-month period.

For the holdings sector index under the daily data, the variation explained by its own innovations across the 10-month period is around 45 percent. On the other hand, the variation explained by the innovations from the financials sector index accounts for a large part across the 10-month period accounting to around 54 percent. The innovations from other sector indices have less than 1 percent contribution to the variation in the holding sector index under the daily data. Under the weekly data, the variation explained by its own innovations declines

from 40.6 percent on the 1-month down to 29.2 percent on the 10-month period. On the contrary, the variation explained the innovations from the financials sector index increases from 59.4 percent on the 1-month period up to 68.2 percent on the 10-month period. The innovations from other sector indices have 0 to 2 percent contribution to the variation in the holdings sector index. Under the monthly data, the variation accounted by its own innovations declines from 27.8 percent down to 8 percent across the 1-10-month period. A large part of the variation is due from the innovations of the financials sector indices whose contribution increased from 72.2 percent up to 88.7 percent across the 1-10-month period. The variations explained by the innovations from other sector indices are small having only 0 to 3 percent contribution across the 10-month period.

For the industrial sector index under the daily data, the variation explained by its own innovations slightly declined from 42.8 percent down to 41.6 percent across the 1-10-month period. The contribution from the innovations of the financials sector index slightly increased from 44.5 percent up to 46.7 percent across the 1-10-month period. On the contrary, the contribution from the innovations of the holdings sector index slightly decreased from 12.6 percent down to 11.5 percent. Under the weekly data, the variation explained by its own innovations slightly decreased from 41.8 down to 38.0 percent across the 1-10-month period. The variation explained by the innovations from financials sector index is almost constant across the 1-10-month period accounting to around 44.0 percent. The contribution from the innovations of the holdings sector index increased from 13.9 up to 15.3 percent. The variations explained by the innovations from other sector indices are small having only 0 to 1 percent contribution across the 1-10-month period. Under the monthly data, the variation of the industrial sector index explained by its own innovations slightly increased from 40.0 up to 41.1 percent across the 1-10-month period. Similarly, the variation explained by the innovations from the financials sector index slightly increased from 54.9 up to 56.0 percent. On the contrary, the variation explained by the innovations from the industrial sector decreased from 5.1 down to 2.1 percent. The variation explained by the innovations from other sector indices is small having less than 1 percent contribution across the 1-10-month period.

For the mining and oil sector index under the daily data, a large part of the variation is explained by its own innovations accounting to 78.8 percent on the 1-month period up to 80.0 percent on the 10-month period. The variation explained by the innovations of the financials sector index slightly decreased from 16.6 down 15.4 percent across the 1-10-month period. The variation explained by the innovations from other sector indices is small accounting to only 0 to 3.2 percent across the 1-10-month period. Similarly, under the weekly data, much of the variation of the mining and oil sector index is explained by its own innovations accounting to 83.5 percent on the 1- month period down to 81.0 percent on the

10-month period. The variation explained by the innovations from the financials sector index slightly increased from 13.6 up to 16.0 percent. The variation explained by the innovations from other sector indices is small having only 0 to 2.2 percent contribution across the 1-10-month period. Under the monthly data, the variation of the mining and oil sector index explained by its own innovations decreased from 74.8 percent down to 41.2 percent across the 1-10-month period. Similarly, the variations explained by the innovations from the financials sector index decreased from 24.0 percent down to 12.1 percent across the 1-10-month period. The variation explained by the innovations from the property and services sector indices increased from 0.0 percent up to 15.6 percent and 24.1 percent, respectively. The variation explained by the innovations from the holdings and industrial sector index are small having 0.0 to 5.0 percent contribution across the 1-10-month period.

For the property sector index under the daily data, the variation explained by its own innovations decreased from 38.6 percent down to 32.0 percent across the 1-10-month period. Similarly, the variation explained by the innovations from the holding sector index also decreased from 9.2 down to 7.3 percent. On the contrary, the variation explained by the innovations from financials sector index increased from 49.6 up to 57.7 percent across the 1-10-month period. The variation explained by the innovations from other sector indices is small having only 0.0 to 3.0 percent contribution across the 1-10-month period. Under the weekly data, the variation of the property sector index explained by its own innovations also decreased from 33.0 percent down to 10.5 percent across the 1-10-month period. Similarly, the variation explained by the innovations from the holdings sector index decreased from8.0 percent down to 7.0 percent. On the contrary, the variation explained by the innovations from the financials sector index increased from 57.0 up to 77.9 percent across the 1-10-month period. The variations explained by the innovations from other sector indices are small having only 0.0 to 4.5 percent contribution across the 1-10-month period. Under the monthly data, the variation of the property sector index explained by its own innovations decreased from 20.2 down to 8.7 percent across the 1-10-month period. On the contrary, the variation explained by the innovations from the financials sector index increased from 74.7 up to 84.0 percent across the 1-10-month period. Also, the variation explained by the innovations from the industrial sector index increased from 0.4 up to 6.4 percent. The variation explained by the innovations from other sector indices is small having 0.0 to 3.8 percent contribution across the 1-10-month period.

For the services sector index under the daily data, the variation explained by its own innovations slightly increased from 59.0 up to 60.1 percent across 1-10-month period. On the contrary, the variation explained by the innovations from the financials sector index slightly decreased from 31.8 down to 30.6 percent across the 1-10-month period. The variation explained by the innovations from

other sector indices is small having 0.0 to 3.7 percent contribution across the 1-10-month period. Under the weekly data, the variation of the services sector explained by its own innovations decreased from 58.6 down to 40.0 percent across the 1-10-month period. On the contrary, the variation explained by the innovations of the financials sector index increased from 30.1 up to 39.3 percent across the 1-10-month period. Also the variation explained by the innovations from the holdings sector index increased from 4.9 up to 11.8 percent. The variation explained by the innovations from other sector indices is small having only 1.0 to 3.7 percent contribution across the 1-10-month period. Under the monthly data, the variation of the services sector explained by its own innovations decreased from 54.9 down to 26.9 percent across the 1-10-month period. The variation explained by the innovations from the financials sector index increased from 32.7 up to 38.7 percent across the 1-4 month period and decreased to 34.0 percent going to the 10 month period. The variation explained by the innovations from the property sector index increased from 8.2 up to 33.8 percent across the 1-10 month period. The variation explained by the innovations from other sector indices is small having 0.0 to 3.8 percent contribution across the 1-10 month period. The results of the forecast error variance decomposition are sensitive to the Cholesky ordering used. Complete table of results are shown in Appendix A.

5. Conclusion

The interdependence of the Philippine Stock Exchange Sector Indices was examined. Long-run and short-run dynamics were determined. The Johansen's cointegration test was used for determining the existence of long-run relationship among the sector indices, Granger-causality for short-run dynamics and forecast error variance decomposition in determining if the shocks from other sector indices affect the variation of a particular sector index. Daily, weekly and monthly data of the PSE sector indices were used from January 2006 up to June 2015.

The results show that the financials, holdings, industrial, mining and oil, property and services sector indices have a cointegrating relationship. This is true for the daily, weekly and monthly data. This implies that the sector indices have a common stochastic trend and tend to move together in the long run. And this relationship can be observed across different frequency of the data.

Moreover, the financials sector index is Granger-caused by the holdings sector index under the weekly and monthly data. It is also Granger-caused by the industrial sector index under the daily and weekly data. The direction of the causality is uni-directional. Also, the holdings sector index is Granger-caused by industrial sector index under the daily data; the mining and oil sector index is Granger-caused by the financials sector index under the weekly and monthly data, and it is also Granger-caused by the property sector index under the monthly data; the property sector index is Granger-caused by the holdings and services sector

indices under the weekly data; and the services sector index is Granger-caused by the industrial sector index under the weekly and monthly data. All of the causal relations are one-way feedback hence having a uni-directional causality.

Aside from the sector indices own shocks influencing its own variation, the innovations from the financial sector index largely contributes to the variation of other sector indices. This result is consistent across the daily, weekly and monthly data. Most of the other sector indices' innovations have small contribution to the variation of other sector indices.

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APPENDIX A

Table A.1. Daily-Variance Decomposition of Financials

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	13.06	100.00	0.00	0.00	0.00	0.00	0.00
2	18.48	100.00	0.00	0.00	0.00	0.00	0.00
3	22.68	99.94	0.01	0.04	0.01	0.00	0.00
4	25.92	99.90	0.03	0.04	0.01	0.02	0.00
5	28.81	99.89	0.03	0.04	0.01	0.02	0.00
6	31.43	99.89	0.03	0.04	0.01	0.02	0.01
7	33.86	99.90	0.03	0.04	0.01	0.02	0.01
8	36.14	99.90	0.02	0.04	0.01	0.02	0.01
9	38.29	99.91	0.02	0.03	0.01	0.02	0.01
10	40.33	99.91	0.02	0.03	0.01	0.02	0.01

Table A.2. Daily-Variance Decomposition of Holding Firms

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	48.46	54.14	45.86	0.00	0.00	0.00	0.00
2	68.41	54.56	45.43	0.00	0.00	0.01	0.00
3	83.16	54.82	45.13	0.01	0.02	0.02	0.00
4	94.58	54.25	45.66	0.03	0.02	0.04	0.00
5	104.71	54.03	45.84	0.04	0.02	0.06	0.01
6	113.86	54.03	45.80	0.04	0.02	0.10	0.01
7	122.38	54.12	45.66	0.03	0.02	0.15	0.02
8	130.31	54.26	45.45	0.03	0.02	0.20	0.03
9	137.76	54.43	45.21	0.03	0.03	0.26	0.04
10	144.79	54.62	44.94	0.03	0.03	0.33	0.05

Table A.3. Daily-Variance Decomposition of Industrial

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	76.38	44.52	12.59	42.89	0.00	0.00	0.00
2	108.06	44.57	12.44	42.99	0.00	0.00	0.00
3	130.99	44.90	12.54	42.53	0.01	0.01	0.00
4	147.04	45.52	12.37	42.08	0.01	0.01	0.01
5	161.57	45.93	12.19	41.84	0.02	0.02	0.01
6	175.13	46.19	12.02	41.74	0.02	0.02	0.01
7	187.99	46.37	11.89	41.68	0.02	0.03	0.01
8	200.03	46.52	11.76	41.65	0.02	0.04	0.02
9	211.38	46.65	11.62	41.63	0.02	0.05	0.02
10	222.14	46.77	11.49	41.63	0.02	0.06	0.02

Table A.4. Daily-Variance Decomposition of Mining and Oil

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	246.05	16.63	3.02	1.58	78.77	0.00	0.00
2	348.01	16.61	3.03	1.58	78.78	0.00	0.00
3	425.83	16.80	3.13	1.62	78.45	0.00	0.00
4	487.35	16.31	3.07	1.59	79.02	0.01	0.00
5	541.98	16.00	3.03	1.56	79.39	0.02	0.00
6	591.38	15.81	3.00	1.54	79.62	0.03	0.00
7	637.24	15.68	2.99	1.54	79.76	0.03	0.00
8	680.04	15.59	2.99	1.53	79.86	0.03	0.00
9	720.31	15.51	2.99	1.53	79.95	0.03	0.00
10	758.44	15.44	2.99	1.52	80.02	0.04	0.00

Table A.5. Daily-Variance Decomposition of Property

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	28.34	49.56	9.20	2.29	0.34	38.61	0.00
2	39.82	50.53	8.91	2.42	0.32	37.82	0.00
3	48.39	52.16	8.50	2.66	0.27	36.40	0.01
4	54.82	52.99	8.43	2.53	0.21	35.81	0.03
5	60.47	53.79	8.30	2.49	0.17	35.21	0.04
6	65.55	54.57	8.11	2.50	0.15	34.62	0.06
7	70.22	55.37	7.92	2.54	0.13	33.95	0.09
8	74.54	56.15	7.72	2.61	0.11	33.29	0.11
9	78.56	56.92	7.52	2.68	0.10	32.64	0.14
10	82.33	57.67	7.31	2.75	0.09	32.01	0.18

Table A.6. Daily-Variance Decomposition of Services

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	21.34	31.76	3.61	2.49	0.52	2.43	59.18
2	30.17	31.73	3.67	2.47	0.53	2.50	59.11
3	36.81	31.71	3.45	2.47	0.76	2.54	59.08
4	42.15	31.33	3.35	2.33	0.77	2.62	59.60
5	46.88	31.10	3.32	2.24	0.77	2.70	59.88
6	51.18	30.93	3.31	2.19	0.77	2.77	60.03
7	55.15	30.82	3.32	2.15	0.78	2.84	60.08
8	58.85	30.73	3.34	2.12	0.78	2.91	60.11
9	62.33	30.66	3.37	2.09	0.79	2.98	60.12
10	65.62	30.59	3.40	2.07	0.79	3.05	60.11

Table A.7. Weekly-Variance Decomposition of FIN:

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	29.10	100.00	0.00	0.00	0.00	0.00	0.00
2	41.13	100.00	0.00	0.00	0.00	0.00	0.00
3	52.45	99.68	0.23	0.02	0.01	0.05	0.02
4	61.93	99.30	0.25	0.09	0.01	0.17	0.18
5	70.39	99.07	0.27	0.13	0.01	0.24	0.29
6	77.91	98.90	0.27	0.18	0.01	0.28	0.36
7	84.78	98.79	0.28	0.20	0.01	0.31	0.42
8	91.10	98.70	0.29	0.21	0.00	0.33	0.47
9	97.01	98.63	0.30	0.22	0.00	0.34	0.51
10	102.56	98.58	0.31	0.23	0.00	0.34	0.54

Table A.8. Weekly-Variance Decomposition of Holding Firms

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	95.74	59.37	40.63	0.00	0.00	0.00	0.00
2	135.20	60.00	39.96	0.00	0.00	0.03	0.01
3	170.93	61.93	37.69	0.00	0.01	0.33	0.04
4	200.65	63.77	35.24	0.00	0.04	0.66	0.29
5	227.08	65.16	33.41	0.01	0.07	0.95	0.40
6	250.48	66.10	32.13	0.02	0.10	1.21	0.44
7	271.95	66.83	31.13	0.04	0.12	1.42	0.45
8	291.84	67.38	30.35	0.05	0.14	1.62	0.46
9	310.49	67.81	29.71	0.07	0.16	1.78	0.47
10	328.09	68.16	29.18	0.09	0.17	1.93	0.47

Table A.9. Weekly-Variance Decomposition of Industrial

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	159.59	44.18	13.95	41.88	0.00	0.00	0.00
2	225.60	44.14	14.04	41.82	0.00	0.00	0.00
3	285.18	44.60	15.21	40.08	0.00	0.07	0.05
4	338.38	44.52	15.41	39.30	0.03	0.32	0.43
5	385.03	44.57	15.44	38.83	0.05	0.46	0.66
6	426.77	44.55	15.37	38.64	0.08	0.55	0.81
7	464.30	44.64	15.31	38.43	0.10	0.61	0.91
8	498.98	44.68	15.30	38.26	0.12	0.65	0.99
9	531.39	44.70	15.31	38.13	0.13	0.67	1.06
10	561.88	44.71	15.32	38.02	0.14	0.68	1.11

Table A.10. Weekly-Variance Decomposition of Mining and Oil

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	522.61	13.61	1.90	0.96	83.53	0.00	0.00
2	739.94	13.35	2.09	0.87	83.66	0.03	0.01
3	929.09	16.35	1.82	0.91	80.90	0.02	0.01
4	1096.45	16.45	1.66	0.89	80.93	0.06	0.01
5	1244.17	16.59	1.72	0.82	80.81	0.05	0.01
6	1376.22	16.63	1.74	0.80	80.78	0.04	0.01
7	1497.96	16.51	1.80	0.76	80.87	0.04	0.02
8	1611.16	16.36	1.89	0.71	80.95	0.06	0.02
9	1717.99	16.18	2.00	0.66	81.03	0.10	0.04
10	1819.48	16.00	2.11	0.61	81.09	0.14	0.05

Table A.11. Weekly-Variance Decomposition of Property

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	57.50	56.96	8.04	1.76	0.27	32.97	0.00
2	80.13	60.04	7.28	2.17	0.23	30.23	0.05
3	99.43	63.93	8.60	1.95	0.42	25.04	0.05
4	116.16	66.99	9.24	2.14	0.41	21.11	0.11
5	130.82	69.84	9.03	2.49	0.38	18.15	0.12
6	143.82	72.17	8.58	2.90	0.33	15.90	0.11
7	155.71	74.12	8.13	3.24	0.29	14.12	0.09
8	166.78	75.66	7.71	3.63	0.26	12.67	0.08
9	177.23	76.89	7.32	4.02	0.23	11.48	0.07
10	187.13	77.88	6.96	4.40	0.20	10.48	0.07

Table A.12. Weekly-Variance Decomposition of Services

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	44.18	30.08	4.89	2.87	1.98	1.55	58.63
2	62.14	29.79	5.49	2.65	2.09	2.20	57.79
3	75.65	32.77	6.68	1.90	2.63	2.21	53.81
4	86.28	35.14	7.94	2.35	2.65	2.24	49.68
5	95.86	36.78	8.81	2.53	2.70	2.40	46.77
6	104.54	37.65	9.53	2.62	2.74	2.64	44.83
7	112.48	38.32	10.22	2.59	2.78	2.86	43.23
8	119.87	38.77	10.83	2.53	2.83	3.12	41.93
9	126.85	39.09	11.36	2.46	2.88	3.38	40.83
10	133.46	39.31	11.83	2.38	2.93	3.65	39.90

Table A.13. Monthly-Variance Decomposition of FIN:

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	61.47	100.00	0.00	0.00	0.00	0.00	0.00
2	90.37	98.36	0.57	0.88	0.01	0.12	0.06
3	115.92	97.55	0.74	1.48	0.07	0.12	0.04
4	135.64	97.37	0.71	1.63	0.12	0.11	0.05
5	152.94	97.34	0.66	1.65	0.13	0.12	0.10
6	168.17	97.37	0.62	1.61	0.14	0.10	0.16
7	182.20	97.39	0.56	1.57	0.16	0.09	0.23
8	195.06	97.38	0.52	1.54	0.17	0.09	0.30
9	207.07	97.36	0.49	1.51	0.18	0.10	0.37
10	218.34	97.33	0.46	1.48	0.19	0.11	0.44

Table A.14. Monthly-Variance Decomposition of Holding Firms

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	209.57	72.23	27.77	0.00	0.00	0.00	0.00
2	289.41	78.46	19.52	0.56	1.37	0.09	0.00
3	371.89	84.33	12.96	1.46	1.18	0.05	0.01
4	439.83	85.96	11.03	2.05	0.88	0.06	0.01
5	498.04	86.81	10.00	2.34	0.78	0.06	0.02
6	548.35	87.59	9.16	2.43	0.72	0.06	0.03
7	595.86	88.05	8.71	2.49	0.66	0.05	0.04
8	639.48	88.32	8.44	2.53	0.62	0.04	0.05
9	680.12	88.56	8.19	2.55	0.59	0.04	0.07
10	718.45	88.73	8.01	2.57	0.57	0.04	0.08

Table A.15. Monthly-Variance Decomposition of Industrial

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	342.78	54.86	5.10	40.05	0.00	0.00	0.00
2	522.02	53.81	3.55	42.40	0.05	0.18	0.01
3	676.01	55.20	2.48	42.10	0.07	0.11	0.04
4	797.57	55.52	2.17	42.10	0.05	0.09	0.07
5	904.16	55.78	2.13	41.86	0.04	0.07	0.12
6	996.74	55.92	2.09	41.70	0.04	0.07	0.19
7	1081.92	56.05	2.09	41.49	0.03	0.10	0.25
8	1160.43	56.07	2.12	41.33	0.03	0.13	0.31
9	1233.58	56.07	2.15	41.21	0.02	0.17	0.37
10	1302.31	56.05	2.18	41.11	0.02	0.21	0.43

Table A.16. Monthly-Variance Decomposition of Mining and Oil

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	1219.05	24.09	0.18	0.86	74.87	0.00	0.00
2	1684.58	33.51	0.24	1.90	63.05	0.11	1.20
3	2034.99	31.42	0.23	1.30	61.17	0.10	5.77
4	2417.21	27.58	1.35	1.14	58.84	1.21	9.88
5	2798.10	23.90	2.71	1.16	54.95	3.50	13.78
6	3177.99	20.59	3.42	1.27	51.19	6.34	17.19
7	3566.36	17.76	4.05	1.37	47.94	9.25	19.63
8	3945.33	15.44	4.61	1.46	45.25	11.75	21.50
9	4308.55	13.60	4.99	1.55	43.04	13.82	23.00
10	4659.02	12.13	5.30	1.63	41.24	15.56	24.14

Table A.17. Monthly-Variance Decomposition of Property

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	113.68	74.71	3.73	0.35	0.98	20.24	0.00
2	172.72	77.15	1.82	2.76	0.42	17.72	0.12
3	215.82	79.25	1.34	4.61	0.36	14.35	0.08
4	251.42	80.51	1.00	5.44	0.51	12.45	0.09
5	280.89	81.67	0.80	5.88	0.54	11.04	0.08
6	307.28	82.55	0.68	6.05	0.53	10.13	0.07
7	332.36	83.12	0.58	6.15	0.53	9.55	0.06
8	355.70	83.50	0.51	6.24	0.54	9.16	0.05
9	377.55	83.80	0.45	6.30	0.54	8.87	0.05
10	398.23	84.01	0.40	6.35	0.54	8.65	0.04

Table A.18. Monthly-Variance Decomposition of Services

Period	S.E.	FIN	HLDG	IND	M-O	PRO	SVC
1	84.44	32.69	0.91	0.82	2.40	8.27	54.91
2	111.91	37.29	1.37	2.79	1.38	9.23	47.94
3	133.80	38.54	1.53	2.00	1.09	13.23	43.61
4	153.78	38.65	2.06	1.57	0.96	17.28	39.47
5	171.24	37.96	2.47	1.30	0.91	21.08	36.29
6	187.17	37.22	2.78	1.10	0.88	24.35	33.68
7	202.04	36.32	3.08	0.95	0.87	27.26	31.52
8	216.00	35.46	3.36	0.83	0.87	29.76	29.71
9	229.18	34.67	3.59	0.74	0.87	31.93	28.20
10	241.76	33.95	3.79	0.66	0.87	33.81	26.92