Diagnosing Shocks in Stock Markets of Southeast Asia, Australia and New Zealand

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Abstract Relatively infrequent but important events such as wars, natural disasters, currency crises, and changes of political leaders can have important effects on stock market performance. In this article we are interested in determining the importance of large shocks in stock markets of Southeast Asia, Australia and New Zealand. We attempt to establish the frequency, timing, and persistent of large shocks and whether they are important contributors to the variation in each stock market. Furthermore, we try to match these shocks with identifiable social and economic events.

1. Introduction

Through 1996, average annual growth rates in this decade of real GDP of the ASEAN-5 (Indonesia, Malaysia, Philippines, Singapore and Thailand) had been in the range of 7-8 percent. This slowed sharply in 1997 as the so-called Asian financial crisis started. Despite of the financial turmoil, U.S. investment in these five countries at the end of 1998 stood at more than US$41 billion, grew 9.2% over the 1997 figure. It shows that U.S. investors still have strong confidence in the future economic development of this region.

It is important for investors to understand reactions of these economies to massive external and internal shocks. Since stock market is a good indicator of real economy, a study of responses of stock markets in the ASEAN-5 to internal and external interventions could be useful. Chen and Liu (1993) developed a procedure to identify and estimate shocks in a time series. This method was employed by Balke and Fomby (1994) to examine shocks and fluctuations of 15 post-World War II macroeconomic time series in the U.S.. Liu (1991) applied similar techniques to study U.S. gasoline and crude oil prices during energy crises. In this article, we adopt Chen and Liu's (1993) procedure to analyse the ASEAN-5 stock markets. For comparison purpose, two nearby but more mature stock markets (Australia and New Zealand) are also included in the study.

2. Methodology

Shocks in a time series can be quantified by outlier models. In this section we review the time series outlier detection approach due to Chen and Liu (1993). We shall restrict the discussion to points necessary for describing the applications in this paper. Further details can be found in Tsay (1988), Chen and Liu (1993) and Chan and Wang (1998).

Suppose that an outlier-free time series Y_t has the stationary ARMA(p,q) representation:

$$\phi(B)Y_t = \theta(B)a_t \qquad (1)$$

where B is the backwards shift operator such that $B^sY_t = Y_{t-s}$,

$$\phi(B) = 1 - \phi_1 B - \ldots - \phi_p B^p,$$

$$\theta(B) = 1 - \theta_1 B - \ldots - \theta_q B^q,$$

and a_t is i.i.d. $N(0,\sigma^2)$.

Time series are often susceptible to external shocks such as famine, war, changes in government policies and so on. The consequences of these interruptive shocks create aberrant observations, which are usually referred to as outliers. Most outliers are not simply spurious observations (e.g., recording or typing errors). They may contain important information about the external shocks affecting the series. In general, outliers in time series can be viewed as the result of nonrepetitive interventions. Thus, a contaminated time series Z_t consists of an outlier-free time series Y_t plus an exogenous intervention effect $\Delta_t(T,\omega)$, i.e.,

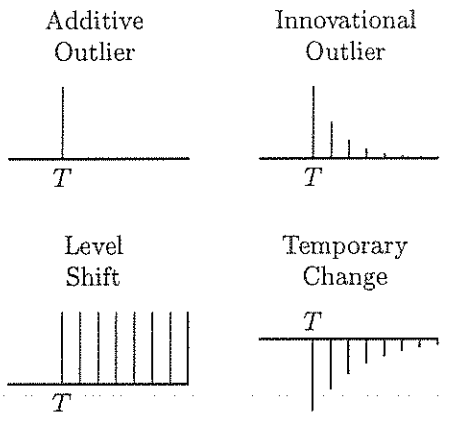
$$Z_t = Y_t + \Delta_t(T,\omega)$$

where T is the location of the outlier and ω is the magnitude of the outlier.

Four commonly used types of outliers (see Tsay, 1988) are employed to quantify the possible impact of a shock. They are additive outlier (AO), innovational outlier (IO), level shift (LS), and temporary change (TC). An additive outlier affects only the level of the given observation

while an innovational outlier affects all observations beyond the given time through the memory of the underlying outlier-free process. A level shift is an event that affects a time series at a particular time point whose effect becomes permanent. A temporary change is an event having an initial impact and whose effect decreases exponentially according to a fixed dampening parameter, say, δ. In practice the value of δ often lies between 0.6 and 0.8 (Liu and Hudak, 1994, p.76). We employ $\delta = 0.7$ in this article as recommended by Chen and Liu (1993). Figure 1 provides a graphical description of these outlier models.

Figure 1:
Possible Impacts of a Shock at Time T



Chen and Liu (1993) suggested a method for modelling time series with outliers. Their approach consists of three-stage iterative procedure based on detection, estimation and adjustment. The outlier-free time series Y_t in equation (1) can be written as a linear combinations of the current and past innovations, i.e.,

$$Y_t = \psi(B)a_t \qquad (2)$$

where

$$\psi(B) = \theta(B)/\phi(B) = 1 - \psi_1 B - \psi_2 B^2 \ldots . \quad (3)$$

The fitted residuals $\hat{e}_t = (Z_t - \hat{Z}_t)$, which may be contaminated with outliers, can be expressed by a dummy variable time series regression:

$$\hat{e}_t = \omega D(i,t) + a_t \qquad (4)$$

for $i = \text{AO, IO, LS and TC}$, where $D(i,t) = 0$ for all i and $t < T$, $D(i,t) = 1$ for all i and $t = T$, and

$$\begin{aligned} D(\text{AO},t) &= -\psi_{t-T} \\ D(\text{IO},t) &= 0 \\ D(\text{LS},t) &= 1 - \sum_{j=1}^{t-T} \psi_j \\ D(\text{TC},t) &= \delta^{t-T} - \sum_{j=1}^{t-T-1} \delta^{t-T-j}\psi_j - \psi_{t-T} \end{aligned}$$

for $t > T$.

The maximum value of the standardized t-statistic for the slope (outlier effects) of the above regression in equation (4) can be used for detecting outliers, i.e.:

$$\mathcal{T} = \max_{1 \le T \le n} \max_{i \in \{\text{AO,IO,LS,TC}\}} \left\{ \tau(i,T) \right\}$$

where

$$\tau(i,T) = \frac{\hat{\omega}(i,T)}{\sqrt{\text{Var}[\hat{\omega}(i,T)]}}$$

with

$$\hat{\omega}(i,T) = \frac{\sum_{t=T}^{n} \hat{e}_t D(i,t)}{\sum_{t=T}^{n} [D(i,t)]^2}$$

and

$$\text{Var}[\hat{\omega}(i,T)] = \frac{\hat{\sigma}_a^2}{\sum_{t=T}^{n} [D(i,t)]^2}.$$

For a given location, these standardized statistics follow a normal distribution approximately. An outlier is detected if $\mathcal{T}$ is greater than a critical value C. We employ $C = 3.5$ (as recommended by Liu and Hudak, 1994) in this paper. With the type and the location of an outlier, we can jointly re-estimate the model parameters and the outlier effects. After the estimation, one can adjust the outlier effects on the observations. The detection-estimation-adjustment cycle is repeated for the adjusted series until no new outliers are found. Finally, the model is re-estimated for the ARMA parameters and all outlier effects simultaneously.

3. The Data

Table 1 shows the selected market indices to represent market activities of the various countries in our study. Our sample covers the period from 14 September 1992 to 4 January 1999, giving a total of 330 weekly time series observations for each country. The data were obtained from the Asian Wall Street Journal.

Figure 2 shows the weekly Jakarta Stock Exchange Composite Index (the upper curve is the price series and the lower curve is the return series) from September 1992 to January 1999. There are two peaks observed during

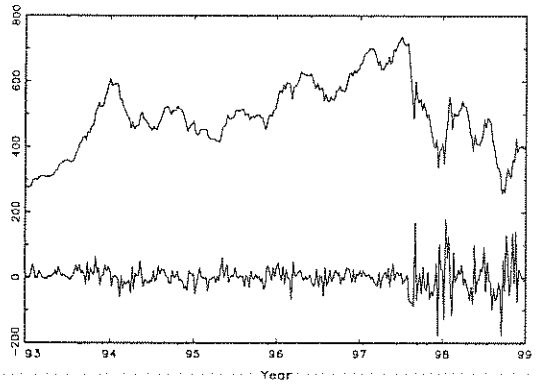
this period. The first one was in January 1994, the index climbed to 607.69. However, it quickly slipped down to 415.32 in just around 15 months.

Table 1: Stock Market Indices

Country	Index
Indonesia	Jakarta Composite
Malaysia	KLSE Composite
Philippines	PSE Composite
Singapore	DBS 50
Thailand	SET
Australia	All Ordinaries
New Zealand	NZSE-40

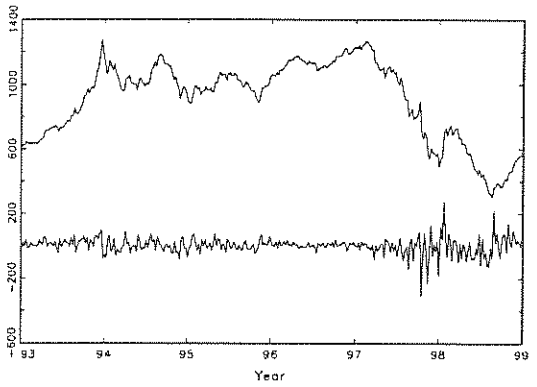
Then the index recovered. It climbed up again and reached the historical highest position at 738.01 in July 1997. Unfortunately, the devaluation of the baht in July 1997 triggered the Asian financial crisis. Heavy devaluation of the rupiah and huge amount of bad debts caused most of the companies traded in the Jakarta Stock Exchange technically insolvent. The composite index collapsed from 738.01 to 261.31 (a 64.6% reduction) within the next 15 months. The volatility of the return is also exceptionally high during this period. The outlook of the index has improved markedly in the last few months. The recent economic stability in Indonesia, supported by generally good macroeconomic policies and foreign official financing, was essential in helping ensure a peaceful background for the elections. The market showed some upward momentum after October 1998.

Figure 2: Stock Market of Indonesia



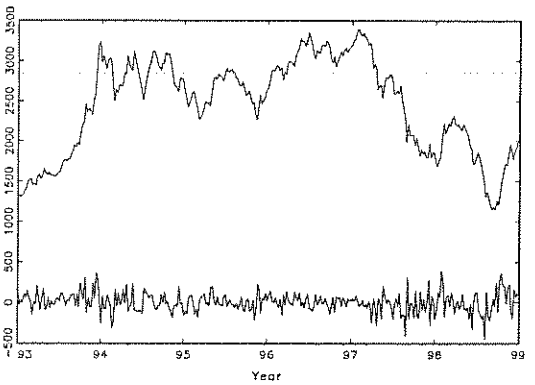
Like Indonesia, the KLSE Composite Index also experienced two peaks during our study period as shown in Figure 3. After the first peak in early 1994, the index went up steadily to 1271 at the Summer of 1997 and slumped to the level of 303 a few months later. Malaysia is one of the countries at the heart of the Asian financial crisis. For the past few months, the composite index is probably past the turning point. However, strong fluctuations are still often observed. It shows that the recovery still remains fragile.

Figure 3: Stock Market of Malaysia



Among the potential victims of the Asian financial crisis, the Philippines economy performed exceptionally. The Philippines was in an IMF program at the start of the crisis, and it skilfully pursued good policies, both by allowing the exchange rate to adjust when it came under pressure, and by defending it through interest rate policy. Even though the PSE Composite Index dropped significantly during the crisis, as shown in Figure 4, its volatility still remains fairly stable.

Figure 4: Stock Market of the Philippines

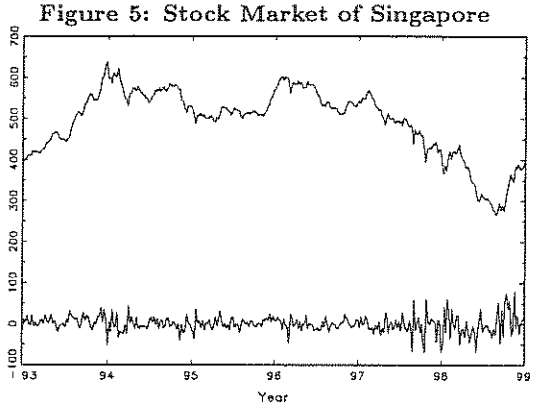


Singapore, when compared to its neighbours has been very fortunate lately. The Asian financial crisis has caused little real damage in the island nation so far. Economists are convinced it will emerge even stronger than its neighbours after the crisis. The DBS 50 Index, as shown in Figure 5, only fell from 500 to 398 during the valley of the crisis. It suffered the least when comparing with her neighbouring countries.

Thailand was popular with foreign investors, who were attracted by high bank deposit rates and the high returns available through the Thai stock market. But all was not well with the

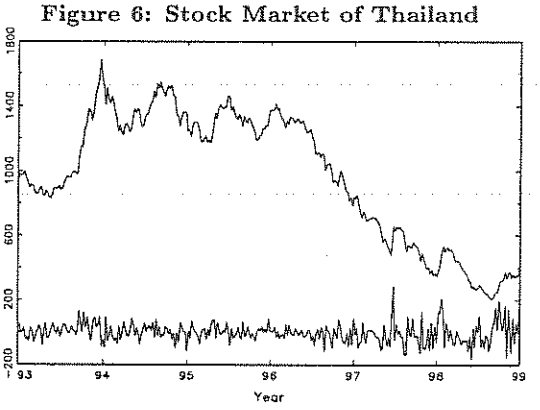
Thai economy in 1996. The country was threatened by overspeculation, fueled largely by banks and finance companies lending for development. The current account deficit was large relative to

Figure 5: Stock Market of Singapore



GDP, forcing the government to maintain high interest rates to avoid losing foreign reserves. As global investors became aware of economic problems they began to liquidate investments. The Stock Exchange of Thailand lost more than 42% of its value in 1996, dropping from 1364 to 787 (see Figure 6). It further collapsed from 787 to 207 in 1997. Fortunately, an early sign of recovery was observed in the first 10 months of 1998.

Figure 6: Stock Market of Thailand



In addition to the ASEAN-5 stock markets, which have similar economic and geographic backgrounds, we also consider the two nearby developed markets for comparison purpose. They are stock markets of Australia and New Zealand.

Over recent years, average returns from the Australian stock market have been much lower than those from United States and European stocks, and much higher than those from Asia. But less attention has been given to another recent feature of the Australian market: it has become one of the world's most stable bourses. Figure 7 shows the Australian ALL Ordinaries Index. It steadily gains from 1500 to 2800 over the past seven years.

Figure 8 displays the NZSE-40 index. The New Zealand stock market is slightly more volatile than the Australian one. It also suffered during the Asian financial crisis, the index dropped around 20% after July 1997.

Figure 7: Stock Market of Australia

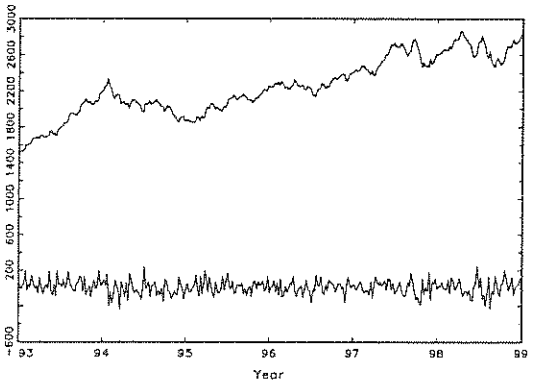
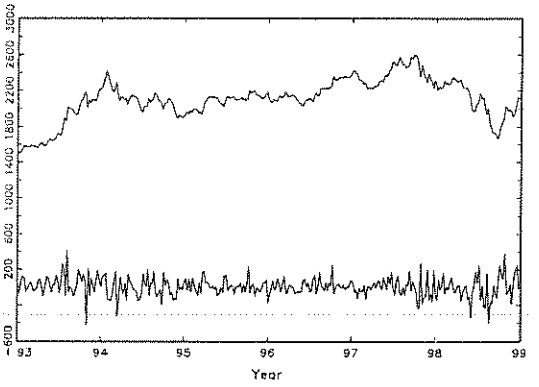


Figure 8: Stock Market of New Zealand



4. Empirical Results

Table 2 provides several descriptive statistics, including mean ($\overline{x}$), standard deviation ($\hat{\sigma}$), skewness (τ_3) and excess kurtosis (τ_4) for each return series. All but Thailand have positive long run return on their stock markets. The coefficients of skewness are all positive except for Malaysia and the Philippines. Tests of significance of excess kurtosis in these markets indicate that both Indonesia and Malaysia have very heavy "tail" return distributions.

Table 2: Descriptive Statistics

Country	$\overline{x}$	$\hat{\sigma}$	τ_3	τ_4
Indonesia	0.0009	0.048	0.15	6.08
Malaysia	0.0000	0.043	-0.48	7.81
Philippines	0.0011	0.041	-0.04	1.11
Singapore	0.0002	0.026	0.04	2.19
Thailand	-0.0022	0.046	0.54	1.84
Australia	0.0019	0.017	0.00	0.10
New Zealand	0.0012	0.022	0.02	1.68

Following the methodology outlined in Section 2, large shocks in each market are detected. The results are reported in Table 3.

Table 3: Detected Shocks in Each Stock Market

Week Starting	Outlier Size	Outlier t-ratio	Outlier Type	Event
Indonesia				
18-08-97	-0.108	-4.42	TC	Indonesian government let rupiah float
08-09-97	0.243	8.10	IO	Market rebounded
15-12-97	-0.207	-7.30	AO	Currency crisis expected to persist
22-12-97	0.118	3.94	IO	Japan agreed to provide Indonesia a loan of 20 billion yen
12-01-98	-0.202	-6.72	IO	Rupiah dipped
19-01-98	0.218	8.91	TC	Market rebounded
09-02-98	-0.123	-4.38	AO	Thai stock exchange suspended stock trading of two banks
16-02-98	-0.176	-6.22	AO	Political crisis broke out
25-05-98	0.149	4.97	IO	Market rebounded
10-08-98	-0.139	-4.65	IO	Political crisis deepened: 3 people killed in an ethnic riot
21-09-98	-0.180	-6.27	AO	Latin America's currencies fell like dominoes
12-10-98	0.172	5.94	AO	U.S. cut interest rate in an unprecedented manner
09-11-98	0.164	5.43	IO	Bullish U.S. market brought confidence to investors
16-11-98	0.130	4.34	IO	Bullish U.S. market brought confidence to investors
30-11-98	-0.138	-4.61	IO	Investors pocketed profits
Malaysia				
03-01-94	-0.100	-4.00	TC	Investors worried possible political crisis
20-10-97	-0.263	-8.01	IO	Reserves of Malaysian Central Bank fell significantly
17-11-97	-0.156	-4.89	AO	Malaysian ringgit was under attack by currency speculators
05-01-98	-0.147	-4.56	AO	Central bank intervened the foreign exchange market
26-01-98	0.213	6.61	AO	U.S. buying sent regional markets soaring
03-08-98	-0.097	-3.87	TC	Use of U.S. dollars in Malaysian business discouraged
31-08-98	0.212	6.63	AO	Central bank announced pegging of ringgit
The Philippines				
01-09-97	-0.141	-3.77	AO	Devaluation of Thai baht triggered the currency crisis
10-08-98	-0.151	-4.03	AO	Manila further rise interest rate to protect peso
12-10-98	0.123	4.31	TC	U.S. cut interest rate in an unprecedented manner
Singapore				
01-09-97	-0.085	-3.72	AO	Devaluation of Thai baht triggered the currency crisis
27-10-97	-0.087	-3.78	AO	Unstable ringgit affected investors in Singapore
05-01-98	-0.087	-3.80	AO	Malaysian central bank intervened ringgit market
08-06-98	-0.084	-3.66	AO	Investors worried the currency storm in Hong Kong
12-10-98	0.087	5.29	TC	U.S. cut interest rate in an unprecedented manner
23-11-98	0.092	4.00	AO	Bullish U.S. market brought confidence to investors
Thailand				
30-06-97	-0.232	-5.50	IO	Market shaken as two Thai ministers resigned
01-09-97	-0.133	-4.24	TC	Devaluation of Thai baht triggered the currency crisis
12-10-98	0.130	4.15	TC	U.S. cut interest rate in an unprecedented manner

Table 3 (Cont'd)

Week Starting	Outlier Size	Outlier t-ratio	Outlier Type	Event
Australia (no outliers detected)				
New Zealand				
16-08-93	0.080	4.00	AO	Some Newzealanders were upset by a dismissive quip by U.S. President Clinton
08-11-93	-0.085	4.23	AO	Trough observed
24-08-98	-0.065	-4.54	TC	Investors worried about slow recovery of Asian economies
12-10-98	0.055	3.82	TC	U.S. cut interest rate in an unprecedented manner

5. Concluding Remarks

We have identified shocks in the stock markets of Southeast Asia, Australia, and New Zealand from September 1992 to January 1999. Furthermore, we have attempted to link each shock to a social or economic event that occurred at or near that week. There is significant evidence that a few large shocks are an important source of volatility in the ASEAN-5 stock markets. Table 4 gives the summary statistics of the return series after adjusting the outliers. As compared to Table 2, we found that most of the excess skewness and kurtosis observed in the raw data can be explained by the outliers.

Australian stock market has been very stable recently. It did not response wildly to external shocks (even the Asian financial crisis). On the other hand, we found that New Zealand market has mildly reacted to shocks from time to time.

Table 4: Descriptive Statistics (After Outlier Adjustment)

Country	$\overline{x}$	$\hat{\sigma}$	τ_3	τ_4
Indonesia	-0.0004	0.031	-0.11	0.91
Malaysia	0.0029	0.033	-0.06	1.23
Philippines	0.0008	0.037	0.31	0.62
Singapore	0.0001	0.023	0.02	1.01
Thailand	-0.0057	0.042	-0.05	0.43
Australia	0.0019	0.017	0.00	0.10
New Zealand	0.0013	0.020	0.01	0.65

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