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Stock Returns and the Macroeconomic Environment Prior to the Asian Crisis in Selected Southeast Asian Countries

Abstract: *This paper investigates the relationship between domestic macroeconomic variables and stock excess returns to evaluate the effects of macroeconomic variables on excess returns and assess market efficiency in the Southeast Asian economies prior to the 1997 Asian crisis. Based on various tests, monthly stock excess returns are best specified by autoregressive conditional heteroskedasticity–type models. The null hypothesis of a martingale process is rejected, and some macroeconomic variables are identified that seem to have a certain predictive power for excess returns. Moreover, it appears that Asian monetary authorities seem to have had a credibility problem in keeping inflation within a target range. The lack of credibility and transparency may have contributed to the 1997 crisis.*

Key words: *Asian crisis, emerging markets, macroeconomic factors, stock returns.*

The proper link between macroeconomic variables and stock returns is open to debate. One early hypothesis on the subject is Fama's proxy hypothesis (Fama 1981). According to Fama, there is a negative relationship between stock excess returns and inflation, which can be explained through two channels. First, such negative relations are induced by the negative, inflation-real activity effect via the

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quantity theory of money, and stock returns are positively related to real variables such as capital expenditures and output. Second, higher inflation rates may induce higher nominal risk-free rates and a discount rate that, in turn, may decrease stock prices, because stock prices may be viewed as the discounted value of expected dividends. Abdullah and Hayworth (1993) and Mukherjee and Naka (1995) suggest that the money supply can be linked to stock prices through portfolio substitution or inflationary expectations. If one applies the portfolio-balance model, as suggested by the quantity theory of money, an increase in money supply may either rebalance other assets, including securities in the portfolio, raise the discount rate through inflationary expectations, and, in turn, reduce stock prices or increase stock prices, the latter via a corporate-earnings effect.

Studies in this area, such as that by Adrangi et al. (1999), support Fama's proxy hypothesis for the emerging markets of Peru and Chile. Moreover, Balduzzi (1995) uses vector autoregression (VAR) methods to test Fama's proxy hypothesis and finds a negative relationship between stock returns and inflation. However, Abdullah and Hayworth suggest that stock returns are related positively to inflation and money growth but negatively to budget deficits, trade deficits, and both short- and long-term interest rates.

As some portion of the inflation rate is anticipated by economic agents and capital markets, the unanticipated portion of the inflation rate may surprise capital markets and cause a dramatic movement of stock prices through changes in investors' compensation in the form of additional yield, as suggested by Shen (1998). It is known that the unpredictability of future inflation is a major component of the welfare loss associated with inflation. In addition, when inflation is unpredictable, capital investors who commonly dislike risk will incur loss and require compensation for bearing the inflation risk. A higher degree of this unpredictability also reflects high levels of inflation volatility, which means increased uncertainty of inflation. This inflation uncertainty, in turn, increases the uncertainty associated with future risky investments and wealth, which may result in an increase in risk premiums (stock excess returns). If this were true, then stock excess returns would be positively related to inflation uncertainty. However, the empirical literature has not resolved the issues surrounding the relationship between stock returns and macroeconomic variables.

Of particular interest are Asia's emerging economies. Since the 1970s, and up to the 1997 Asian financial crisis, they have recorded impressive economic growth with low inflation, macroeconomic stability, openness, strong fiscal position, high savings rates, and a thriving export sector. Then came the financial crisis in July 1997, which dragged many Asian countries into economic recession. At the core of the crisis were large-scale foreign capital inflows into financial systems that became vulnerable to panic, reflecting sudden reversals of market confidence (Charumilind et al. 2006; Jeon and Seo 2003; Nagayasu 2001). Moreover, because most of the economic activity was highly productive in those countries supported by capital inflows, the loss of economic activity resulting from the sudden reversal in capital flows was enormous, which, in turn, forced the economies into sharp downturns. This crisis also hit the most rapidly growing economies in the world, and prompted the largest financial bailouts in history. It was the most severe financial crisis to hit the developing world since the 1982 debt crisis in Latin America, and one of the least anticipated. For example, Indonesian gross domestic product (GDP) contracted by more than 15 percent in 1998, and the Korean and Thai economies contracted by approximately 7 percent and 10 percent, respectively. The crisis threatened the growth of other emerging and transition economies; as such, it is important to understand whether such crises emerge because of a contagion or whether the underlying macroeconomic environment is vulnerable.

Recent empirical work in finance has documented that equity excess returns are partially forecastable given information known in advance (see, e.g., Cooper et al. 2003). This indicates that forecast errors are not orthogonal to past information. Moreover, the observed excess returns have been found to have conditional first and second moments that change over time. To capture the time-varying variance, autoregressive conditional heteroskedasticity (ARCH)–type models are commonly employed. The objective of this paper is to revisit the link between macroeconomic variables and excess returns in emerging Asian stock markets, and implied market efficiency (see, e.g., Wang et al. 2003) before the Asian crisis. The economic variables include the inflation rate, GDP, the money supply, the interest rate (risk-free rate), and a January dummy variable. These variables enter the conditional expected excess returns and the underlying variance, which is presumed to follow a univariate generalized autoregressive conditional heteroskedasticity (GARCH) process. Second and most importantly, we examine the relationship between monthly stock excess returns and inflation uncertainty. We proxy inflation uncertainty by the conditional variance of inflation using ARCH methods. Using ARCH-type techniques, the conditional mean and variance can be estimated jointly using conventionally specified models for economic variables.

Because these economies contracted severely because of the Asian crisis, it took them several years to rebound; as such, it is highly likely that they underwent structural change. Due to inference problems inherent in data with structural change, and in order to assess any effect of the crisis on the behavior of excess returns and the performance of emerging Asian stock markets, we restrict the sample to the period before the mid-1997 financial crisis in Asia.

Data

We focus on six Asian countries and stock markets: Thailand (Stock Exchange of Thailand), the Philippines (Philippine Stock Exchange), Indonesia (Jakarta Stock Exchange), Malaysia (Kuala Lumpur Stock Exchange), Korea (Korean Composite Index), and Taiwan (Taiwan Stock Exchange). We use monthly data from January 1987 to December 1996. The monthly closing prices of these six Asian stock markets are collected from the *World Stock Exchange Fact Book* (2000). The national interest rates on treasury bills and government bonds are used as proxies for the risk-free rate of return. Due to the unavailability of those two interest rates in Indonesia and Taiwan, the market rate and the short-term bill market rate, respectively, are used instead. While the interest rate data series of five countries is drawn from the *International Financial Statistics (IFS)* (August 2000) of the International Monetary Fund on CD-ROM, Taiwanese interest rates are directly downloaded from the Taiwanese government Web site.[1] The other three macroeconomic variables, namely, the consumer price index (*CPI*), the narrow money supply (*M1*), and the real GDP, are also collected from the IFS CD-ROM, except for Taiwan, since the IFS has not continuously reported those macroeconomic data series for Taiwan. These data for Taiwan are obtained from *Financial Statistics of Taiwan, Annual Report,* in the same format as provided by the IFS.

Excess returns, r_t, of stock returns, $R_{s,t}$, net of risk-free rate, $R_{f,t}$, are defined as $r_t = R_{s,t} - R_{f,t}$, where $R_{s,t}$ is the first difference of the logarithm of stock prices, $\ln(SPI_t) - \ln(SPI_{t-1})$ and all data are for the closing values of stock market indices. All returns are expressed as percent per annum based on local currency.

Methodology

Before estimating the impact of the conditional variance of monthly stock returns h_t, the mean equation for each data series must first be specified in one of two ways. If a national stock return series exhibits significant serial autocorrelation, an $ARMA(m,n)$ specification is adopted as a mean equation for that series. Otherwise, a naïve constant mean equation is employed. We then test for the possible existence of conditional heteroskedasticity by regressing the squared residuals on their lagged values and testing for their joint significance. If any coefficient is statistically significant, an ARCH error process is assumed.

The generalized ARCH model, as introduced by Bollerslev (1986), allows the conditional variance to be a function of the lagged q^2 residual terms and its own lagged p conditional variances. That is, the GARCH(p,q) specification defines the conditional variance of monthly stock returns at time t to be of the form

$$h_t = a_0 + \sum_{i=1}^{q} a_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} b_i h_{t-i} \qquad \text{where } a_i, b_i \geq 0 \tag{1}$$

and a and b are parameters to be estimated. For $p = 0$, Equation (1) becomes the ARCH(q) process (Engle 1982). Moreover, the GARCH(p,q) formulation can be extended to be the GARCH(p,q) in mean or GARCH(p,q)-M specification (Engle et al. 1987). This model allows the conditional mean to be a formulation of the conditional variance h_t that is expressed as

$$R_t = \phi + \sum_{i=1}^{m} \alpha_i R_{t-i} + \sum_{i=1}^{n} \beta_i \varepsilon_{t-i} + \delta h_t + \varepsilon_t \tag{2}$$

or

$$R_t = \phi + \delta h_t + \varepsilon_t, \tag{3}$$

where the conditional variance is defined in the same way as the GARCH(p,q) model. If this conditional variance is determined the same way as ARCH(q), then it is known as the ARCH(q)-M specification.

Furthermore, it is possible to add exogenous variables in either the conditional mean or conditional variance equation in order to test the potential predictability of these variables for national monthly stock returns. The additional explanatory variables include (a) *INF*—the inflation rate; (b) *M1*—the narrow money supply; (c) *GDP*—the gross domestic product series; (d) *INT*—the interest rate, as the rate on government bonds, treasury bills, short-term bills market, or money market for the respective countries; and (e) *D*—the January dummy variable, which takes one for January, and zero otherwise. The conditional variance h_t is obtained from the ARCH, ARCH-M, GARCH, and GARCH-M equations by maximum likelihood as

$$L = -0.5\left[\log\left(h_t + \frac{\varepsilon_t^2}{h_t}\right)\right]. \tag{4}$$

The parameters are estimated using maximum likelihood (L) based on the Berndt/Hall/Hall/Hausman (BHHH) nonlinear optimization algorithm.

In order to estimate inflation uncertainty, we adopt an ARCH-type model. The conditional mean equation is formulated as

$$\Pi = \Pi_t^e + \varepsilon_t \tag{5}$$

$$\Pi^e = E\left(\Pi_t \mid \Omega_{t-1}\right) = Z_t'\phi, \tag{6}$$

where Π_t is the inflation rate and Π_t^e is the expected inflation rate. The ε_t are the error terms or the unexpected inflation rate component, and Z_{t-1} is the information available to economic agents at time $t-1$, which is a subset of Ω_{t-1}, that is, $Z_{t-1} \in \Omega_{t-1}$. Letting Z_t contain the local macroeconomic variables—namely, *M1*, *INT*, *GDP*, and the lagged inflation rate—we will carry out various specification tests for the ARCH-model of the inflation rate. With these equations, the conditional mean equation can be rewritten as

$$\Pi = \phi + \sum_{t=1}^{T} \phi_i Z_{t-1} + \varepsilon_t, \tag{7}$$

where the error terms ε_t are serially uncorrelated with a zero mean, but are not necessarily homoskedastic, that is, $\varepsilon_t \sim N(0,h_t)$. The conditional variance is defined in the same way as the ARCH-type models of returns. This conditional variance h_t is taken as a proxy for inflation uncertainty. Under market efficiency, the stock returns should be orthogonal to the information set available as of time *t*, hence, macroeconomic variables should have no significant predictive power over stock returns.

Summary Statistics

Table 1 contains summary statistics for the excess return series for each of the six stock markets. Not surprisingly, the excess returns on stock indexes have high means but also high standard deviations. The mean excess returns over the sample are almost all positive, with the exception of the Korean stock market. These statistics also suggest that fluctuations in the monthly stock excess returns on the Taiwanese stock exchange are the most volatile over the sample period, whereas the Korean stock exchange is the least volatile over the same period. Moreover, the considerable size of the minimums and maximums as compared to the mean and the standard deviation of the series indicate that the series have heavy tails. This is confirmed by the Jarque–Bera (JB) statistics, which reject the null hypothesis of normal distribution for the error terms at conventional significance levels. The Ljung–Box statistics $Q(k)$ and $Q^2(k)$ for $k = 4$, 8, 12, and 24 lags are used to test for autocorrelation in the monthly stock excess returns. These statistics show significant serial correlations for the excess return series, but not in the Philippines and Taiwan. In addition, the null hypothesis of homoskedastic monthly stock excess returns (uncorrelated squared stock excess returns) is significantly rejected, except for Malaysia. These results suggest that the autoregressive conditional heteroskedasticity process is appropriate for capturing time-series characteristics of the monthly stock excess returns in most markets that exhibit statistically significant serial correlation in the squared term.

Empirical Results

Using the BHHH algorithm, an ARCH/GARCH model relating the conditional variance to lagged squared residuals is estimated for each national stock excess return series. For comparison purposes, we estimate ordinary least square (OLS) models with and without particular macroeconomic variables, and ARCH-type models. A likelihood ratio (LR) statistic is undertaken to each pair of nested specifications. If the simple model fits well, the errors should be unrelated to the information or the LR statistic should be small. It should be noted that the use of a Gaussian distribution is inappropriate. To accommodate the presence of nonnormality, we assume that the errors are drawn from a conditional *t*-distribution (see Bollerslev 1986). A variable starting with *G* indicates the variable is expressed in logarithmic first-difference form.

Table 1

Preliminary Statistics for Monthly Stock Excess Returns, January 1987–December 1996

	Thailand	Philippines	Indonesia	Malaysia	Korea	Taiwan
Number of observations	168	168	168	168	168	168
Maximum	302.22	480.10	817.71	290.86	216.06	483.33
Minimum	–435.12	–610.27	–254.11	–517.28	–253.96	–596.17
Mean	3.41	3.68	2.30	5.07	–1.69	13.05
Standard deviation	99.77	132.40	104.34	91.81	82.22	153.90
Skewness	–0.70	–0.26	3.27	–0.97	0.28	–0.43
Kurtosis	3.45	4.29	23.52	5.80	0.17	2.83
JB	15.11*	13.61*	3,246.30*	81.39*	58.05*	5.46**
$Q(4)$	10.36*	1.07	10.32**	7.16	5.13	2.38
$Q(8)$	15.88**	3.58	23.95*	13.50***	9.53	5.68
$Q(12)$	24.77*	6.09	25.59*	17.70	18.50*	9.91
$Q(24)$	38.69*	22.46	35.36**	27.96	41.24*	26.13
$Q^2(4)$	13.75*	10.03**	0.46	1.28	12.22*	77.92*
$Q^2(8)$	1.45***	11.41	13.82***	5.92	17.75*	85.93*
$Q^2(12)$	14.92	12.59	13.92	7.86	28.00*	88.18*
$Q^2(24)$	18.93	21.25	15.56	10.89	35.99**	91.62*

Notes: Monthly stock market returns are the first-difference form of logarithmic stock prices, and monthly stock market excess returns are calculated from domestic currency–denominated market indices less the relevant interest rate as a proxy for the risk-free rate of returns. Excess returns are measured in percent per annum. JB is standard Jarque–Bera test; Q-statistics and Q^2-statistics are Ljung–Box values. *, **, and *** denote significance at levels of 1 percent, 5 percent, and 10 percent, respectively.

Thailand

As seen in Table 2, generally for all the GARCH(1,1) models, the estimated *t*-statistics on the coefficients of conditional variance are largely significant at the 1 percent level. This result is also supported by the LR test statistics, which clearly reject the OLS model in favor of the GARCH model at conventional levels. The strength of this significance suggests that the GARCH(1,1) process is appropriate for capturing the characteristics of the time-varying variance of the stock excess returns on the Thai exchange. Moreover, the GARCH(1,1) successfully accounts for the stock returns volatility clustering and considerably improves the log of the likelihood function. Thus, this model is superior to OLS estimation.

It is interesting that macroeconomic variables and the January dummy have weak explanatory power for the conditional mean and variance. In addition, the growth rate of money supply (*GM1*) and growth rate of the gross domestic product (*GGDP*) have a statistically significant impact on the conditional mean (Equation (4)). In addition, the values of skewness and kurtosis still reject the normal distribution for error terms, indicating that this inclusion fails to explain the abnormal return premiums. The GARCH(1,1) without including these variables is, therefore, superior to other specifications of estimation for monthly stock excess returns on the Thai exchange. Nevertheless, the empirical statistics show evidence of the predictive power of the macroeconomic variables on excess returns and variances that change over time.

Finally, the sum of the GARCH coefficients is very close to unity, indicating that the GARCH is integrated in variance. The aggregate value of coefficients in GARCH(1,1) implies that shocks to variance have substantial persistence, and stock price volatility cannot be explained by rational expectations of future market movements. Consequently, current news affects the market over long horizons due to imperfections in the Thai stock market. It should be noted that the significance of the parameter estimates of the AR(|1,4|) may be the result of stock market regulations, speculative actions, and the political environment in the Thai market (see, e.g., Charumilind et al. 2006).

The Philippines

In order to conserve space, we summarize the results on the predictability of excess returns for countries other than Thailand in Table 3.[2] The January seasonal effect and local macroeconomic variables do not appear to have a statistically significant impact on excess returns and their time-varying variance on the Philippine market according to the LR statistics. However, the asymptotic *t*-statistics show that a lagged first difference of the interest rate on treasury bills (*GINT*) may have a substantial effect on the conditional variance at the 1 percent significance level. The January seasonal effect appears to have explanatory power on the time-varying variance.

Table 2

The Evidence for the Predictability of Monthly Stock Excess Returns on the Thai Market Using Local Information Variables

Base AR(|1,4|) : $R_t = \alpha_1 R_{t-1} + \alpha_4 R_{t-4} + \varepsilon_t$ I

Base AR(|1,4|)-GARCH(1,1) : $R_t = \alpha_1 R_{t-1} + \alpha_4 R_{t-4} + \varepsilon_t$ III.1

$h_t = a_0 + a_1 \varepsilon^2_{t-1} + b_1 h_{t-1}$ III.2

	Equation I		Equation II		Equation III		Equation IV		Equation V	
Conditional mean equation										
α_1	0.16	(2.83)	0.16	(2.91)	0.16	(1.72)	0.20	(2.34)	0.18	(2.03)
α_4	–0.47	(–1.98)	–0.14	(–1.99)	–0.08	(–0.81)	–0.08	(–0.95)	–0.12	(–1.17)
INF	—		–7.78	(–0.64)	—		0.36	(0.03)	—	
GM1	—		–0.63	(–0.32)	—		–3.60	(–2.58)	—	
GGDP	—		0.47	(0.13)	—		–8.77	(–2.22)	—	
GINT	—		18.99	(0.49)	—		–2.55	(–0.15)	—	
JAN	—		–1.72	(–0.06)	—		15.83	(0.39)	—	
Conditional variance equation										
a_0	—		—		234.85	(2.67)	116.00	(1.81)	80.72	(0.30)
a_1	—		—		0.19	(3.64)	0.17	(3.46)	0.15	(3.03)
b_1	—		—		0.83	(27.65)	0.85	(29.09)	0.81	(14.00)
INF	—		—		—		—		1,577.68	(2.49)
GM1	—		—		—		—		198.00	(1.37)
GGDP	—		—		—		—		102.14	(0.23)
GINT	—		—		—		—		81.98	(0.15)
JAN	—		—		—		—		–2,547.70	(–1.53)

Number of observations	164	164	164	164	164
Log(*L*)	–834.22	–833.81	–817.82	–813.82	–810.27
Skewness	–0.73	–0.73	–0.77	–0.77	–0.74
Kurtosis	3.71	3.80	3.84	4.03	3.79
JB	18.10*	19.14*	21.24*	23.59*	19.38*
LR(3)			6.19*	7.69**	
LR(5)		0.17		1.86	3.14
LR(8)				7.86	9.15

Notes: CPI, M1, INT, and GDP represent the logarithmic form of the consumer price index, the narrow money supply, the interest rate, and the gross domestic product of each market, respectively. G indicates the variable in first-difference form. JAN represents the January seasonal dummy. LR is the likelihood ratio test statistic, which tests for the alternative models, that is, LR(3), LR(5), and LR(8) are the tests for the significance of the inclusion of ARCH (or GARCH) error effects, economic variables X_{t-1}, and both inclusions, respectively. δ is the coefficient on the variance of stock returns h_t, Log(*L*) = value of log likelihood, and the numbers in parentheses are the *t*-statistics. * and ** denote significance at levels of 1 percent, 5 percent, and 10 percent, respectively.

Table 3

Summary of the Evidence for the Predictability of Excess Returns Using Some Local Information Variables for Other Countries in the Sample

	Philippines	Indonesia	Malaysia	Korea	Taiwan
Autocorrelation	No	Yes	Yes	No	Yes
GARCH effects?	Yes	Yes	No	Yes	Yes
Macroeconomic variables in the mean equation?	No	Yes*	No	Yes*	No
Macroeconomic variables in the variance equation?	Yes*	Yes	No	Yes*	Yes*
January effect in the mean equation?	No	No	No	No	No
January effect in the variance equation?	Yes	Yes	No	No	Yes
GARCH effects persistent?	Yes	Yes	NA	Yes	Yes

* Statistically significant based on asymptotic *t*-statistics.

The values of skewness and kurtosis still reject the normal distribution for the error term. Further, because the log of the likelihood function does not improve much with exogenous variables, the plain GARCH model seems to be a proper specification. The analysis would then concern the GARCH effect compared to the OLS method. The calculated *t*-statistics show that the GARCH effect is significant. The high degree of this significance suggests that the GACH(1,1) process is more appropriate than the OLS estimation, because it successfully accounts for the characteristics of the time-varying variance of the stock excess returns. Moreover, the GARCH(1,1) model considerably improves the log-likelihood function.

For each sample period, the aggregate value of the parameter estimates of the GARCH(1,1) model is relatively high. Consequently, this process is characterized by a high degree of persistence in conditional variance, but it is stationary. The innovations have persistent impact on the future changes of the Philippine exchange.

Indonesia

The time-series evidence indicates that Indonesia's stock excess returns exhibit first- and seventh-order serial correlation. In general, this first-order serial correlation can be explained by institutional factors, such as nonsynchronous trading in individual stocks. The seventh-order serial correlation can be, for instance, due to stock market regulations and political conditions. It seems that the Indonesian stock market is more open to foreign investors.

The results reject the nested OLS model in favor of the GARCH model, and this is true of all the asymptotic *t*-statistics at the 1 percent level. Therefore, it is appropriate to describe the Indonesian excess-return-generating process as a GARCH(1,1) model.

Further, the LR test is unable to reject the GARCH model with lagged macroeconomic variables in both conditional mean and variance. The calculated *t*-statistics appear to be significant in some coefficients. The empirical results show that the interest rate and the seasonal January variable have explanatory power in forecasting time-varying volatility. Moreover, the sum of the GARCH(1,1) coefficients $(a_1 + b_1)$ is 1.23, indicating second-order nonstationarity. Consequently, this model, too, is characterized by a high degree of persistence in conditional variance, which is mostly due to market imperfections or speculative activities.

Malaysia

The LR test on local information available at time $t - 1$ can be rejected in favor of plain models for Malaysia's stock excess returns. The test of the possible existence of heteroskedasticity is rejected in this case. The OLS model appears to be the proper specification. According to the asymptotic *t*-statistics, the coefficients of exogenous factors have very weak explanatory power for excess returns. The outcome of the LR test also provides a clear rejection of the model. Including local information appears to deteriorate the value of skewness and kurtosis. The Malaysian stock market seems to conform to the martingale hypothesis before the Asian financial crisis. Moreover, the LR test rejects the model with local information. Nevertheless, the *t*-statistics provide strong predictive power of *GM1* on the conditional mean, and of *INF* and *GINT* on the conditional variance. Interestingly, the inclusion of these variables can fully explain the leptokurtosis.

Korea

The LR statistics reject the local information in the sample period. Moreover, the statistical results appear to reject the GARCH-M process in favor of the simple OLS, except for the full sample period when ignoring exogenous variables. Again, in all of the GARCH-M estimations, the coefficients are significantly greater than zero at conventional levels, according to asymptotic *t*-statistics. As the coefficient of conditional variance is significant, the GARCH-M model is assumed to contain the possible effects of the time-varying variance on the mean of the monthly stock excess returns.

There is strong evidence that the GARCH-M not only successfully accounts for the stock excess returns volatility clustering, but also considerably improves the log of the likelihood function. The OLS model is apparently inferior to the GARCH-M estimation. However, the GARCH(1,1)-M still rejects the normal distribution for the error terms.

The computed asymptotic *t*-statistics show that lagged inflation and the growth rate of money supply, respectively, have significant explanatory power for the conditional mean and variance. Moreover, the model incorporating domestic information also deteriorates the values for the log of the likelihood function. Therefore, the GARCH-M model without exogenous variables is the most appropriate specification. In addition, the sum of GARCH's coefficients (a_1 and b_1) is close to unity, indicating that shocks to variance have substantial persistence. This persistence may again be due to the inefficient characteristics of this market.

Taiwan

For Taiwanese stock excess returns, the LR statistics reject the models incorporating local information. In contrast, the GARCH models cannot be rejected against the simple OLS model at the 1 percent level. Moreover, in the GARCH(1,1) model, the coefficients are all significantly greater than zero, according to asymptotic *t*-statistics. Even though the results of the LR test appear to reject the inclusion of macroeconomic variables, the computed asymptotic *t*-statistics evidently show that macroeconomic variables, except *GM1* and a January seasonal effect, have significant explanatory power for the time-varying variance. In addition, regardless of which sample period is used, the aggregate value of a_1 and b_1 suggests that the

GARCH model is integrated in variance. Generally, the estimates suggest that the 1997 Asian financial crisis mildly affected Taiwan.

Overall, the results suggest that the ARCH framework is superior to OLS models in most cases. Evidently, some particular macroeconomic variables also appear to have strong explanatory power for monthly excess returns.

Inflation Uncertainty and Equity Returns

Despite what appears to be a profound dislike of inflation by economic agents, there are disagreements regarding the identification and the effects of inflation in economic theory. Moreover, because inflation uncertainty will increase uncertainty about the future of risky investments and wealth, it possibly results in an increase in the risk premium. Therefore, the rest of the empirical section discusses the effects of inflation uncertainty and the existence of a risk premium that can be interpreted as the amount of monthly stock excess returns that is a compensation for inflation. This uncertainty is calculated using ARCH techniques and is based on the available information at time $t - 1$ to economic agents.

We construct a time series for expected inflation to get an estimate for the variance of unexpected inflation as follows. The first step consists of regressing the observed inflation rates on a set of instruments. Hence, the following conditional mean equation of inflation is estimated as

$$\Pi = \phi + \sum_{i=1}^{k} \omega_i \Pi_{t-i} + \sum_{i=1}^{h} \rho_i \varepsilon_{t-i} + \sum_{j} \sum_{i} \beta_{ij} X_{j,t-i} + \varepsilon_t, \qquad (8)$$

where X is the information set that includes GGDP, GM1, and GINT. The variance model (ARCH framework) is formulated as in Equations (1) through (3). To economize space, only those exogenous factors that have significant explanatory power will be reported.

Table 4 presents the results from both an OLS estimation of Equation (8) and ARCH models for Thailand.[3] The following diagnostic tests for model adequacy are also provided: the JB test of normality of the residuals, *JB*; the Ljung–Box test for serial correlation, *Q*; the Lagrange multiplier test for ARCH effects, nR^2; and the LR test for nested models, *LR*.

Even though the normality of error terms still cannot be explained, the values of skewness and kurtosis are much improved in most of the cases. The models incorporating some particular macroeconomic variables appear to be superior to the simplest OLS model (equation I of Table 4); accordingly, they considerably improve the adjusted-R^2 or the log of the likelihood function, Log(L). In addition, the coefficients of the macroeconomic variables seem to have important effects on future inflation, except for Taiwan.

The ARCH tests imply that the possible existence of an ARCH process cannot be rejected in the case of the Philippines and Malaysia. Moreover, in the ARCH/GARCH

Table 4

The OLS Estimation of the Equation for the Conditional Expectation of Inflation on Thailand

	Equation I		Equation II	
Conditional mean equation				
ϕ	0.33	(7.66)	0.42	(4.71)
ω_1	–0.31	(–1.97)	–0.40	(–1.78)
ρ_1	0.64	(4.94)	0.66	(2.78)
GGDP{1}	—		0.04	(1.82)
Adj. R^2	0.08		0.10	
Skewness	0.23		0.17	
Kurtosis	1.06		1.39	
JB	27.11*		24.35*	
$Q(4)$	1.41		0.73*	
$Q(8)$	4.94		3.76	
$nR^2(4)$	2.81		0.75	
$nR^2(8)$	14.58		14.63	
LR(1)			6.18*	

Notes: The numbers in parentheses are the t-statistics. ωs and ρs are the coefficients of lagged inflation and its lagged disturbance. Q is the Ljung–Box statistic. nR^2 is the Lagrange multiplier test statistic. LR is the likelihood ratio test of the null hypothesis regarding the significance of the macroeconomic variables. * Statistically significant at the 1 percent level.

estimation, the coefficients are significantly greater than zero, according to asymptotic t-statistics. The LR statistics also reject the simple OLS model in favor of the ARCH/GARCH estimation at conventional significance levels. This suggests that the ARCH framework is appropriate for capturing the characteristics of the time-varying variance of the inflation series for these three countries. Moreover, the ARCH framework successfully accounts for the inflation volatility clustering and strongly improves the log of the likelihood function. This finding allows us to proxy inflation uncertainty as changing over time in the sample. Therefore, the fitted values of Equation (8) and the ARCH framework provide a series for expected inflation, and the value of the conditional variance (h_t) of the regression is taken as a proxy for the inflation uncertainty.

The level of inflation uncertainty can be obtained from the OLS estimations where the ARCH effects are insignificant. Consequently, the fitted values of Equation (8) alone provide a series for expected inflation, and the square of the residual of the regression is a point estimate of the variance of unexpected inflation.

Table 5, equations II, and IV and V, respectively, show the OLS and GARCH estimates with one-lagged inflation (*INF*) and its uncertainty (*UN*) effect included in the monthly stock excess returns on the Thai exchange. In order to assess whether the inclusion of these two factors improves estimations, an LR test is conducted. According to the calculated test statistics, the model with inflation and its uncertainty displays no significant difference to the model without such effects. However, the computed asymptotic *t*-statistics imply that inflation uncertainty has great predictive power to forecast monthly stock excess returns but not the market volatility. This finding indicates that uncertainty about inflation was very important before the crisis. Thus, it seems that investors were generally risk averse with respect to inflation uncertainty, and they required a higher expected return to compensate for uncertainty in future real returns. This reveals that Thai macroeconomic policy prior to the Asian financial crisis was conducive to inflation uncertainty.

For the Philippine exchange, the inflation variables fail to improve the estimates in both OLS and GARCH specifications according to the LR test statistics. Despite the LR tests, the conditional expectation of inflation has significant explanatory power for forecasting the volatility of the excess returns on the Philippine market, but not inflation uncertainty, according to asymptotic *t*-statistics. Thus, market participants in the Philippines most likely took the inflation rather than its uncertainty into account to compensate for the uncertainty (volatility) of future excess returns.

For Indonesia, the LR test and *t*-statistics provide a clear rejection of the GARCH(1,1) model, including expected inflation and its uncertainty against the model without them. Hence, inflation and its uncertainty do not seem to have posed a problem for capital investors in the Indonesian exchange before the Asian crisis.

Moving on to the Malaysian exchange, the LR test results indicate the absence of significant effects due to inflation and its uncertainty. However, the inclusion of these two factors in conditional variance significantly improves the values for the skewness, kurtosis, and the log-likelihood function, but not the conditional mean. In addition, according to calculated asymptotic *t*-statistics, it seems there was no inflation aversion in Malaysia, or monetary authorities did not suffer from a credibility problem before the Asian crisis.

In the case of the Korean stock market, the implication from the estimates of monthly stock excess returns is that inflation and its uncertainty fail to improve the estimates in both OLS and GARCH-M models for the subsample period, according to various test statistics. Finally, the results for Taiwan indicate that inflation and its uncertainty have statistically significant predictability for forecasting the time-varying variance of the Taiwanese stock excess returns. The strength of this significance suggests that investors in Taiwan were highly risk averse with respect to uncertain movements in inflation.

Table 5

The Evidence for the Predictability of Monthly Stock Excess Returns on the Thai Market Using Inflation and Inflation Uncertainty

	Equation I	Equation II	Equation III	Equation IV	Equation V
Conditional mean equation					
α_1	0.16 (2.74)	0.16 (2.79)	0.14 (1.62)	0.13 (1.50)	0.14 (1.61)
α_4	–0.15 (–1.94)	–0.14 (–1.88)	–0.15 (–1.34)	–0.16 (–1.49)	–0.10 (–0.97)
INF	—	–4.62 (–0.36)	—	9.25 (0.63)	—
UN	—	0.01 (0.67)	—	0.04 (2.44)	—
Conditional variance equation					
a_0	—	—	333.65 (2.15)	229.05 (2.24)	—
a_1	—	—	0.19 (3.51)	0.19 (3.27)	0.14 (2.75)
b_1	—	—	0.82 (20.66)	0.83 (20.55)	0.76 (10.61)
INF	—	—	—	—	1,990.80 (3.34)
UN	—	—	—	—	2.64 (1.40)
Number of observations	161	161	161	161	161
Log(*L*)	–820.22	–819.95	–806.53	–803.73	–801.53
Skewness	–0.72	–0.71	–0.70	–0.66	–0.74
Kurtosis	3.61	3.54	3.52	3.17	3.63
JB	16.36*	15.34*	14.97*	11.84*	17.16*
LR(2)		0.42		1.65	3.05

Notes: LR(2) represents the likelihood ratio statistic that tests the significance of lagged inflation (INF) and its uncertainty (UN). * Statistically significant at the 1 percent level.

Conclusions

This paper investigated the characteristics of monthly stock excess returns and the link between excess returns and the macroeconomic environment in six Southeast Asian countries before the 1997 Asian financial crisis. Considering the volatility in these countries' stock markets, the monthly stock excess returns can best be specified by the process of conditional heteroskedasticity, except for Malaysia, before the financial crisis. Specifically, the monthly stock excess returns volatility on the Korean exchange is characterized as the GARCH(1,1)-M process for both sample periods, whereas other markets are modeled by the GARCH(1,1) process and various AR processes.

Based on the empirical evidence, the martingale hypothesis in Thailand, Indonesia, Malaysia, Korea, and Taiwan is rejected. Moreover, some macroeconomic variables evidently had a certain predictive power for excess returns and their volatility according to computed asymptotic *t*-statistics. In the Indonesian exchange, for instance, the interest rate appears to have had a statistically significant impact on the conditional mean, and the interest rate and January dummy have explanatory power for time-varying volatility before the Asian crisis. These results add to the body of empirical evidence for inefficiency in those countries' stock markets. These results provide a good basis for implementing appropriate reform in the form of rules and regulations to improve market performance, foster market development, and prevent excessive price volatility. The lack of policy transparency is perhaps another important reason for stock market imperfections.

Furthermore, this study investigates the effects of inflation uncertainty. Generally, there is strong evidence of the significant impact of inflation uncertainty on monthly stock excess returns or on their time-varying variance. The effects of inflation uncertainty can reveal the policy credibility of monetary authorities. Here, the evidence points to the low credibility of the monetary authorities. According to another interpretation, capital market participants are risk averse with respect to inflation uncertainty. Therefore, they require compensation for bearing inflation risk in the form of additional returns. It seems that the lack of transparency in policy formulation is a plausible reason why capital investors were risk averse with respect to inflation uncertainty. This lack of credibility and transparency in the policy formulation of policymakers may have contributed to the Asian crisis.

Notes

1. See www.cbc.gov.tw. Instead of obtaining GDP data through interpolation, we use quarterly values for corresponding months.
2. An appendix containing the full results is available from the authors.
3. Results for countries other than Thailand are detailed in an appendix available from the authors.

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