PRE THE PHILIPPINE REVIEW OF ECONOMICS
Vol. L No. 1, June 2013 pp. 45–56

Are there rational speculative bubbles in the Philippine stock market?

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ASEAN stock markets have experienced episodes of long price run-ups followed by large drops over the past 20 years. These apparent bouts of boom and bust have prompted the popular press to conjecture the presence of speculative asset bubbles in these markets causing stock prices to deviate from fundamental values. We use descriptive statistics and McQueen and Thorley's [1994] duration dependence test to examine the presence of rational speculative bubbles—a special case of speculative bubbles—in the Philippine stock market over the period from 1991 to 2009. We do not detect the presence of rational speculative bubbles in the Philippines using both monthly and weekly returns. This implies that the long run-ups in prices and the subsequent drops over the sample period could have been justified by fundamental value changes. However, it is also possible that there were bubbles caused by irrational investor behavior. We suggest that further research in this area is warranted.

JEL classification: G14
Keywords: rational speculative bubbles, duration dependence, Philippines

1. Introduction

Over the past 20 years, ASEAN stock markets have experienced episodes of long price run-ups followed by large drops. The popular press usually consider these apparent bouts of boom and busts as evidence of asset bubbles where prices deviate from fundamental values. Prior studies have tested the presence of rational speculative bubbles in the Asian stock markets—for example, Chan, McQueen, and Thorley [1998] and Sarno and Taylor [1999]. However, the results of these studies contradict each other. So far, there is still no conclusive evidence of whether or not rational speculative bubbles exist in Asian stock markets. In this study we use descriptive statistics and duration dependence tests to examine the presence of rational speculative bubbles in the Philippine stock market in order to determine if prices have deviated from their fundamental values over the period from 1991 to 2009. This is an important issue because of its apparent connections with the efficient allocation of investment resources and asset pricing. The stellar growth posted by the Philippine Stock Exchange (PSE) composite index in 2012 with a series of all-time highs shows renewed investor interest in Philippine equities.

Bubbles are empirically characterized by two attributes: (a) a long run-up in price or returns and (b) a sudden drop in the crash that follows. In an efficient market, rational asset pricing models postulate that stock prices reflect their fundamental value, which is defined as the present value of their future cash flows. During a bubble episode, asset prices deviate from their fundamental values and this is often attributed to irrational investor behavior. A rational speculative bubble is special case of a bubble that can exist without assuming irrational investors. In a rational bubble, even though investors realize a bubble exists, they will find it rational to stay in the market if the growth rate of the bubble ensures that probable future returns exactly compensate them for the possibility of a crash.[1]

One category of bubble tests relies on an examination of stock returns for empirical attributes of bubbles such as serially dependent returns (autocorrelation), skewness, and kurtosis. These attributes necessarily derive from the two characteristics of bubbles—namely, (a) extended runs of positive returns and (b) crashes. The long series of positive returns means that returns are autocorrelated. These serially correlated returns

[1] Negative bubbles are ruled out because they require prices to exhibit negative runs over time, which is problematic given that security prices are bounded.

together with the singular large negative return characterizing the crash mean that the bubble process must be skewed while leptokurtosis (fat-tailed distributions) is consistent with the occasional large deviation in price characterizing the crash. However, autocorrelation, skewness, and kurtosis are not unique to bubbles. Autocorrelation could be induced by time-varying risk premiums [Fama and French 1988] and fads [Poterba and Summers 1988], skewness could be due to assymetric fundamental news, and leptokurtosis could be caused by batched arrival of information [Tauchen and Pitts 1983].

Another test for the presence of bubbles involves an examination of the long-run relationship between stock prices and fundamental variables such as dividends or earnings using cointegration analysis. A lack of cointegration between prices and fundamentals indicates the presence of bubbles. However, a major weakness of the cointegration test is that it is a joint test for the presence of bubbles and the correct identification of the fundamental variables. Brooks and Katsaris [2003] suggest that a lack of cointegration may be caused by model misspecification through the exclusion or misidentification of significant variables that affect stock prices. Johansen [1991] shows that the lack of cointegration between stock prices and dividends may also be caused by factors other than rational bubbles, such as large and highly persistent shocks in the system. A change in the economic regime could also bias the cointegration test in favor of a no-cointegration relationship [Chow 1998]. The cointegration test also has low power when a limited data span is used [Pierse and Snell 1995].

A third category of tests involves the use of the duration dependence developed by McQueen and Thorley [1994]. McQueen and Thorley [1994] show that rational speculative bubbles are characterized by runs of positive returns whose conditional probability of ending (also referred to as the hazard rate) is a decreasing function of the duration of the run.[2] In other words, the longer is the sequence of positive returns, the smaller is the probability that the run will end.[3] McQueen and Thorley [1994] model the unexpected price changes in a rational bubble process as coming from two sources: changes in fundamental value and changes in the bubble. As the bubble component grows, it dominates the fundamental component, which

[2] A run is a sequence of the returns that have the same sign.

[3] See McQueen and Thorley [1994] for a detailed mathematical derivation of this testable implication of rational speculative bubbles. McQueen and Thorley's test, however, cannot be used to detect for the presence of "'irrational"' bubbles.

means that negative shocks to fundamental value will have minimal impact on total returns, hence the bubble continues to grow until it eventually crashes.[4] This characteristic is called negative duration dependence and is unique to rational speculative bubbles. One advantage of the duration dependence test over cointegration tests is that it does not require the specification of the underlying fundamental value relationship model. Another advantage is that it does not require the time series behavior under investigation to be normally distributed.

The volatility exhibited by stock prices in recent years has sparked renewed interest in speculative asset price bubbles. Chan, McQueen, and Thorley [1998] evaluated evidence of rational speculative bubbles in six Asian stock markets—namely, Hong Kong, Japan, Korea, Malaysia, Thailand, and Taiwan—and the US stock market, examining both monthly and weekly stock market returns over the sample period of January 1975 to April 1994. They found that though the return distributions from the seven stock markets generally exhibited positive autocorrelation, negative skewness, and leptokurtosis consistent with the existence of rational speculative bubbles, the results of duration dependence tests showed otherwise. For the runs of positive monthly returns, the log-logistic function parameters (β) from the duration dependence test are negative in Hong Kong, South Korea, Malaysia, and Thailand, but none of the coefficients are significant, which implies the absence of rational speculative bubbles in these stock markets. The results of weekly returns are similar to monthly returns except for Thailand whose positive weekly returns exhibited negative duration dependence, which implies the presence of rational speculative bubbles. The results reported by Sarno and Taylor [1999], however, partly contradict those of Chan, McQueen, and Thorley [1998]. Sarno and Taylor [1999] employ cointegration tests between monthly aggregate stock prices and dividends for eight East Asian countries—China, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand—to test the existence of rational speculative bubbles from 1989 to 1997. Their results imply the existence of rational speculative bubbles in these East Asian stock markets. However, the differing results could be due to the different sample periods. Chan, McQueen, and Thorley [1998] covered the period from 1975 to 1994 while Sarno and Taylor [1999] used 1989 to 1997. It could be argued that Chan, McQueen, and Thorley [1998] missed the two

[4] Unfortunately, as Chan, McQueen, and Thorley [1998] note, we do not as yet have a coherent theory about how bubbles evolve and burst.

most important years for Asian stock markets, 1995 and 1996, when the Asian economies and stock markets grew dramatically, a time when rational speculative bubbles might have likely existed.

2. Data and methods

We use monthly closing prices of the PSE composite index collected from DataStream over the period from February 1991 to December 2009. We test for the presence of rational speculative bubbles using both descriptive statistics and duration dependence.

Duration dependence tests for rational bubbles are conducted using real returns, hence the monthly (weekly) index closing prices are transformed into continuously compounded monthly (weekly) returns, $R_t = 100(\ln P_t - \ln P_{t-1})$ where P_t is the index closing price for month (week) t, and P_{t-1} is the closing price for the month (week) preceding. The monthly (weekly) returns are then converted to real returns, *Real return* = $[(1+R_t)/(1+\textit{Inflation rate})] - 1$. The inflation rate is computed by taking the difference of the natural logarithm of the consumer price index (CPI), $\textit{Inflation rate} = 100(\ln CPI_t - \ln CPI_{t-1})$.

McQueen and Thorley suggest that it may be more appropriate to use monthly rather than weekly returns in duration dependence tests because the latter could contain more noise, making the detection of bubbles difficult. However, the relatively short data series provided by monthly data could result in lack of power for monthly tests. Hence we use both monthly and weekly indices.

To apply the duration dependence tests, real returns are first transformed into run lengths of positive and negative observed returns. The numbers of positive or negative runs of particular length, i, are then counted. For example, if we have a return series consisting of two positive returns followed by four negative, three positive, and five negative returns, this data set is transformed into runs of positive returns with values of 2 and 3, and runs of negative returns with values of 4 and 5.[5]

The sample hazard rate for each length i can then be computed as $h_i = N_i / (M_i + N_i)$. This is derived from maximizing the log likelihood function of the hazard function:

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[5] The use of duration dependence largely follows the description given in the original paper by McQueen and Thorley [1994]. See their paper (from page 386) for a complete description of the methodology.

$$L(\theta|S_Y) = \Sigma_{i=1}^{a} N_i \ln h_i + M_i \ln(1 - h_i) + Q_i \ln(1 - h_i) \quad (1)$$

where θ is a vector of unknown parameters, N_i is the number of completed runs of the length i in the sample, and M_i and Q_i are the numbers of completed and partial runs with length greater than i, respectively. We can then observe the relation between the sample hazard rates and length of the run i, with a negative relationship signifying the presence of rational bubbles.

To formally test for the presence of rational bubbles, we first define a functional form for the hazard function as

$$h_i = 1/[1+e^{-(\alpha+\beta lni)}]. \quad (2)$$

The parameters of the hazard function (2) are estimated using a logit regression, where the independent variable is the log of the current run length and the dependent variable is 1 if the run ends in the next period and 0 if it does not. Under the null hypothesis of no bubble, the hazard rate should be constant or H_0: $\beta = 0$, which means that the hazard rate does not depend on the length of a run i. The alternative hypothesis suggests that the probability of a positive run's ending should decrease with the length of the run (negative duration dependence), or H_1: $\beta < 0$. Under the null hypothesis of no rational speculative bubble ($\beta = 0$), the likelihood ratio test (LRT) is asymptotically distributed χ^2 with one degree of freedom.

LRT = 2[log unrestricted – log restricted] ~ χ^2

3. Empirical results

3.1. Descriptive statistics

Figure 1 shows the monthly time series plot of the PSE composite index. The financial boom from 1993 up to the eventual bust in 1997, in what has become known as the Asian financial crisis, is evident from the time series plot. The Asian financial crisis that started in Thailand in July 1997 caused sharp reductions in stock market values in Asia, with the PSE composite index dropping 1000 points from a high of some 3000 points in 1997. Also quite evident from Figure 1 is a long price run-up coinciding with the US housing bubble that began in 2001 and ended with the subprime loan financial crisis in 2007.

Figure 1. Monthly Philippine Stock Exchange (PSE) composite index level

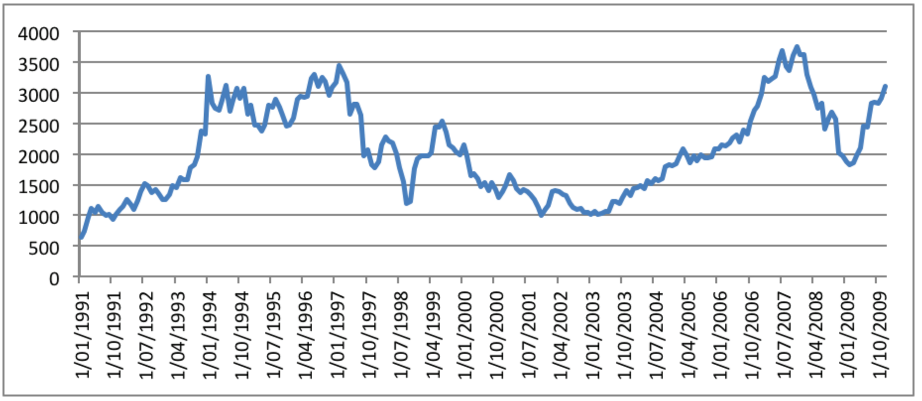

Table 1. Real monthly and weekly returns, 1991:02–2009:12

	Monthly returns	Weekly returns
T	227	987
Mean	0.001758	0.000276
Maximum	0.336165	0.180984
Minimum	-0.294769	-0.216020
Standard deviation	0.083648	0.039632
Skewness	0.183939	-0.043448
(SE)	(0.162578)	(0.077968)
Kurtosis	5.222854	5.551043
(SE)	(0.325156)	(0.155936)
Jarque-Bera	48.01441	267.9447
ρ 1	0.109	-0.011
ρ 2	0.074	0.064
ρ 3	-0.049	0.079
ρ 4	-0.044	-0.020
ρ 5	0.011	0.035
ρ 6	-0.023	-0.016
ρ 12	0.073	-0.006
Q(6)	5.1811	12.218
Q(12)	11.048	24.632

Notes:

1. All returns are continuously compounded. Monthly (weekly) real returns in local currency are nominal returns less monthly (weekly) inflation rates.

2. T is the number of monthly (weekly) observations. Numbers in parentheses below the skewness and excess kurtosis coefficients are asymptotic standard errors, $(6/T)^{1/2}$ and $(24/T)^{1/2}$, respectively.

3. ρt is the sample autocorrelation at lag t.

4. Q(6) and Q(12) are the Ljung-Box portmanteau test statistics identifying the presence of 6-order and 12-order autocorrelation, distributed as χ^2 with 6 and 12 degrees of freedom.

Table 1 provides a general understanding of the nature of the overall Philippine stock market with summary statistics of monthly and weekly returns. The PSE composite index had an average monthly real return of 0.18 percent, with a maximum of 33.6 percent and a minimum of -29.5 percent. The average weekly return was 0.03 percent, with a maximum of 18.1 percent and a minimum of 21.6 percent. The Jarque-Bera test statistics reported in Table 1 indicate nonnormality for both monthly and weekly return distributions. The statistics of most interest to us are the coefficients of skewness, kurtosis, and autocorrelation. If bubbles are present, we expect to see negative coefficients of skewness. The positive, though insignificant, skewness coefficient of the monthly returns indicates the absence of rational bubbles. However, when we consider weekly returns, there appears to be evidence of rational bubbles based on the marginally significant negative skewness coefficient. The kurtosis coefficients for both monthly and weekly returns indicate leptokurtosis (i.e., large concentrations around the mean and fat tails) consistent with the presence of rational speculative bubbles. Finally, rational bubbles imply autocorrelated returns. Using sample autocorrelation coefficients, we find that the monthly return series do not appear to be autocorrelated. However, in the case of weekly returns, serial dependence is evident, indicative of the presence of rational bubbles. We also conduct two Ljung-Box (LB) tests, one that included the first six-order autocorrelation coefficients (Q(6)) and the other that included the first 12-order autocorrelation coefficients (Q(12)). On the monthly series, the two LB tests agree with the conclusions derived from the individual autocorrelation coefficients that returns are not serially correlated; therefore, no evidence of bubbles. In the case of weekly returns, there is a slight disagreement between the LB tests and the individual autocorrelation coefficients. The Q(6) values suggest serial independence, which means no bubbles, while the individual autocorrelation coefficients suggest otherwise.

On balance, the descriptive statistics of the monthly and weekly return distributions give us inconclusive results. Hence we conduct duration dependence tests in the next section.

3.2. Duration dependence test

3.2.1. Monthly returns

The results of the duration dependence tests on monthly returns are reported in Table 2. Table 2 shows that the longest positive run is only five months, which appears too short to be considered a bubble. An analysis of the patterns in the hazard rates reported in the third column should give a better indication of the presence or absence of rational bubbles. Should share prices exhibit bubble-like tendencies, the hazard rate should be a decreasing function of the length of positive runs. But a cursory examination of the sample hazard rates indicates an increasing, not a decreasing pattern, which is opposite to the pattern we would expect in the presence of rational speculative bubbles.

Table 2. Tests of duration dependence for positive runs of monthly and weekly returns for the full period (1991:02–2009:12)

	Monthly returns		Weekly returns	
Run length	Actual run counts	Sample hazard rates	Actual run counts	Sample hazard rates
1	26	0.4643	122	0.5126
2	12	0.4000	59	0.5086
3	11	0.6111	24	0.4211
4	5	0.7143	11	0.3333
5	2	1.0000	12	0.5455
6			7	0.7000
7			3	1.0000
8				
9				
10				
11				
12				
13				
Total	56		238	
α		0.2801		0.0262
β		0.5555		-0.0747
LRT of H0: β=0		2.2331		0.2230
(p-value)		0.1351		0.6367

Notes:

1. The sample hazard rate, $N_i/(M_i+N_i)$, represents the conditional probability that a run ends at *i*, given that it lasts until *i*, where N_i is the count of runs of length *i* and M_i is the count of runs with a length greater than *i*.
2. The log-logistic function is $h_i = 1/[1+e^{-(\alpha+\beta \ln i)}]$. β is the hazard rate, which is estimated using the logit regression, where the independent variable is the log of the current length of the run and the dependent variable is either 1, if the run ends, or 0, if it does not end in the next period.
3. The LRT (likelihood ratio test) of the null hypothesis, H1: β = 0, of no duration dependence (constant hazard rate) follows the $\chi^2(1)$ distribution.
4. The p-value is the marginal significance level, which is the probability of obtaining that value of the LRT, or higher, under the null hypothesis.

Table 3. Tests of duration dependence for positive runs of monthly and weekly returns for subperiods

		Monthly	Weekly
1991–1997	α	-0.39061	-0.0772
	β	0.869177	0.105562
	LRT	1.7131	0.1523
	p - value	0.1906	0.6964
1998–2001	α	0.351353	0.174027
	β	-0.32962	-0.08751
	LRT	0.1599	0.0509
	p - value	0.6892	0.8216
2002–2007	α	-0.36268	0.097248
	β	0.5304	-0.26455
	LRT	0.7969	1.0574
	p - value	0.3720	0.3038
2008–2009	α	-1.10348	-0.29281
	β	1.892696	0.118261
	LRT	1.9281	0.0680
	p - value	0.1650	0.7943

Notes:

1. The log-logistic function is $h_i = 1/[1+e^{-(\alpha+\beta \ln i)}]$. β is the hazard rate, which is estimated using the logit regression where the independent variable is the log of the current length of the run and the dependent variable is either 1, if the run ends, or 0, if it does not end in the next period.
2. The LRT (likelihood ratio test) of the null hypothesis, H1: β = 0, of no duration dependence (constant hazard rate) follows the $\chi^2(1)$ distribution.
3. The *p*-value is the marginal significance level, which is the probability of obtaining that value of the LRT or higher under the null hypothesis.

We conduct a more formal test of the pattern in the hazard rates by running a log-logistic test on the level of beta. Recall that a significantly negative beta coefficient indicates the presence of a rational bubble, while an insignificant coefficient signifies no bubble. The bottom part of Table 2 shows the results of the log-logistic test. We note that the beta coefficient is of the wrong sign and is statistically insignificant. Therefore, based on monthly returns, we conclude that there were no rational speculative bubbles over the sample period.

3.2.2. Weekly returns

The results of the duration dependence tests on weekly returns are reported in columns 4 and 5 of Table 2. Column 4 shows that over the sample period the longest positive run lasted only seven weeks but the hazard rates appear to be decreasing, which is consistent with the presence of rational speculative bubbles.

As in the monthly returns, we also conduct a more formal test of the pattern in the hazard rates by running a log-logistic test, the results of which are reported at the bottom of Table 2. The results show that while the beta coefficient is negative, it is not statistically significant. Therefore, based on weekly returns, we also conclude that there is no evidence of rational speculative bubbles in the Philippines over the sample period.

3.2.3. Subperiod analysis

Finally, we divide our sample into four subperiods—1991–1997, 1998–2001, 2002–2007, and 2008–2009—and report the results of the log-logistic test for both monthly and weekly returns in Table 3. The first subperiod coincides with the run-up toward the Asian financial crisis of 1997, while the second subperiod covers its immediate aftermath. The third subperiod encompasses the run-up toward the subprime financial crisis while the fourth period is its immediate aftermath. For monthly returns, the only negative beta coefficient can be found in 1998–2001, but it is not statistically significant. The rest of the beta coefficients are positive though insignificant. Therefore, consistent with the results for the full sample, we find no evidence of rational speculative bubbles in any subperiod using monthly returns. We find similar results with weekly returns. Though we report negative beta coefficients in the periods 1998–2001 and 2002–2007, they are both not statistically significant. The rest of the beta coefficients are positive but insignificant. In sum, we find no evidence of rational speculative bubbles in any our subperiods for either monthly or weekly returns.

4. Concluding remarks

The apparent episodes of long price run-ups followed by large drops in ASEAN stock markets have prompted the popular press to conjecture the presence of asset bubbles in these markets causing stock prices to deviate from fundamental values. We use both descriptive statistics and the duration dependence test to formally examine the presence of rational speculative bubbles in the Philippine stock market over the period from 1991 to 2009 to determine if prices deviated from fundamental value. Though our descriptive statistics appear inconclusive, the more stringent duration dependence test suggests the absence of rational speculative bubbles in the Philippines using both monthly and weekly returns over our full sample period as well as in selected subperiods. This implies that the run-up in prices and the subsequent drops seen over the sample period could have been justified by fundamental value changes. However, it is also possible that there were bubbles caused by irrational investor behavior that cannot be detected using duration dependence tests, or that our tests lack power to rationally detect bubbles. We suggest that further research in this area is warranted.

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