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TESTING FOR FORECAST RATIONALITY IN FINANCIAL MARKETS: THE CASE OF THE PHILIPPINES

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The study examines a segment of the Philippine financial system within the efficient market framework. The period under study is broken down into three periods and tests for forecast rationality using a nonlinear least squares procedure were conducted. The main result of this study is not at all surprising. Philippine financial markets are in general efficient in conveying information except during the crisis period. The results may be explained by the fact that the crisis generated noise not normally present in non-crisis periods. This has a temporary effect of confusing market participants who are unable to distinguish market movements from the noise emanating from the uncertainties of the period and thus contaminating information sets. This leads to a rejection of the maintained hypothesis of rationality in the crisis period.

1. Introduction

The recent liberalization of the Philippine capital markets in the early 90s as part of a development strategy has led to increased activity in all major segments of the Philippine financial system. The rise in activity is attributable to the increased capital mobility engendered by the liberalization efforts. Foreign funds, sometimes alluded to as "hot money," come in and out of the country with relative ease. The rise in the average daily volume of transactions and the increased volatility of expected rates of return, especially in the stock market, have made domestic residents and local investors aware of the presence of unexploited profit opportunities.

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It should be noted that financial activity started to heighten after the country emerged from the effects of the fourth *BOP* crisis. However, because of these recent surges in financial market activity, monetary authorities, fearing a Mexico-like debacle, directed monetary and exchange rate policies partly towards containment of financial market activity levels that is, from their viewpoint, manageable.

The result of these developments is a rising level of sophistication of the financial markets and the increasing number of financial assets being traded. Likewise, the innovations taking place and the reactions of monetary authorities to these, potentially give rise to larger information set. Yet, there has not been any quantitative assessment of how accurately Philippine financial markets convey information. Theory tells us that if economic agents use all available information in an efficient manner, unexploited profit opportunities will cease to exist, i.e., markets are efficient if expectations are rational. This article conducts empirical tests of the efficient markets/rational expectations hypothesis using a methodology due to Mishkin (1981, 1982, 1983).[1] Aggregate monthly Philippine financial data is used. The focus of this paper is on the rationality of forecasts of relevant variables used in forming expectations by market participants in the 91-day treasury bills market.

To motivate the article, the next section gives a brief account of the evolution of the Philippine financial and macroeconomic environment from 1976 to 1994. The third section discusses the framework and methodology pursued in this article. The fourth section presents the empirical results while the last section concludes.

2. Philippine Economic Environment

The most significant episode in Philippine economic history during the last two decades was the fourth balance-of-payments

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[1] For applications of this technique, see also Cuthbertson and Taylor, 1986, 1988.

crisis that was triggered by the Aquino assassination. This period can be divided into three sub-periods: A pre-crisis period from 1976 to 1983; the crisis period from the last quarter of 1983 to 1986; and the recovery and return to normalcy period from 1987 to present.[2]

The first period was characterized by a stable macroeconomic environment. Growth was made possible through sufficient injections of funds from foreign sources. This was referred to as "debt-driven growth."

Foreign borrowing was also the preferred method of adjustment, rather than currency depreciation, when imbalances in the foreign sector accounts occur. From the policymakers' viewpoint, adjusting the exchange rate within a narrow band in conjunction with standard monetary policy tools was a convenient way of avoiding the inflationary effects of foreign fund inflows.

During this period, one can observe that the financial system did not develop, mainly because of the financially repressive usury laws and other regulations that did not encourage the development of a long-term capital market. Another less obvious reason seems to be that because of the regular flow of foreign funds, participants in the financial markets did not find it necessary to take an aggressive and imaginative stance in seeking funds from the local sources. This may also explain the low savings rates in the Philippines (See Lim, 1995).

The financial liberalization in 1981 was overtaken by events—the Aquino assassination, the capital flight and the subsequent balance-of-payments crisis that commenced in late 1983—which exposed the weaknesses of the financial system. Because of the crisis, there were no clear indications of gains made from the financial liberalization effort during this period until the beginning of the recovery period in 1987 when financial activity began to rise. Inspection of the graphs of the 91-day Treasury bills rate and the

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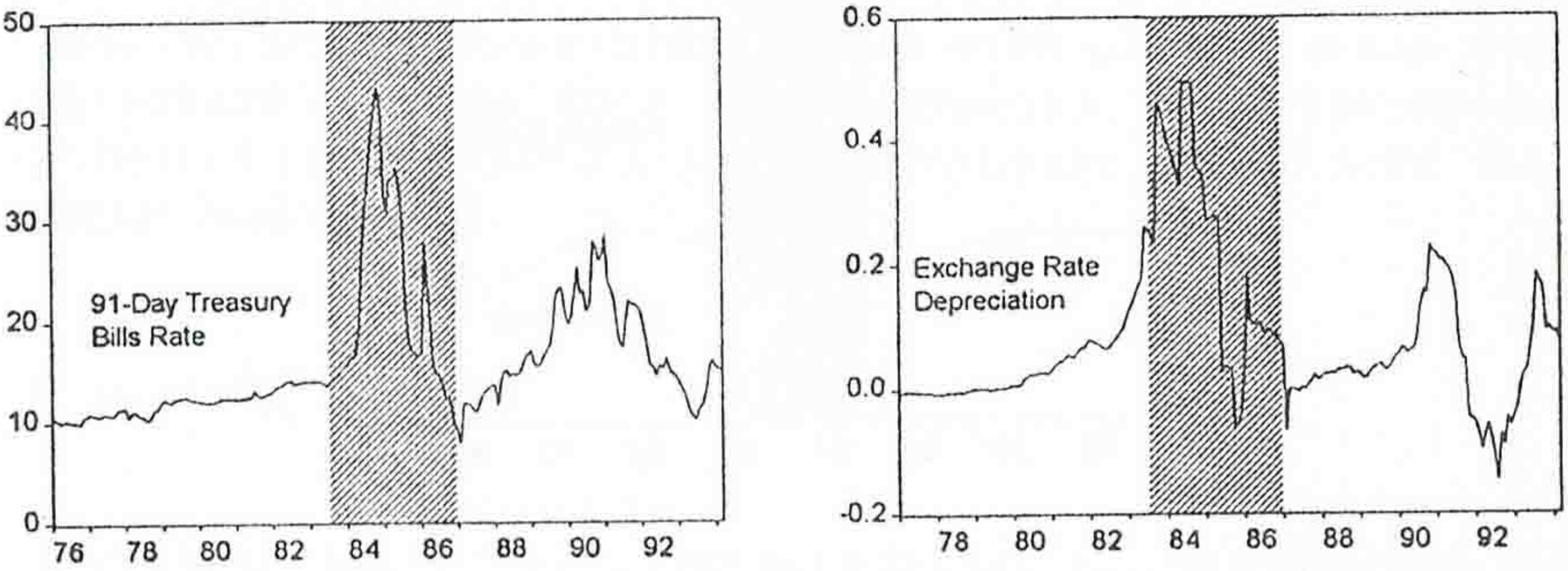
[2] There was a mild downturn in 1991 but the magnitude was not as great as in the crisis period. Bautista et al. (1995) consider this as one of the trend breaks in their analysis.

exchange rate depreciation below shows more volatile movements in the post crisis period as compared with the period of repression.[3]



Absent foreign funds, macroeconomic adjustment was forced through successive depreciation of the currency at the start of the crisis period. To prevent further capital outflows, the monetary authorities tried hard to make domestic assets more attractive than foreign exchange by raising domestic interest rates through tight monetary control. This is easily seen in the diagram above if one focuses on the shaded areas. It will be noticed that the depreciation rate rose at the beginning of the crisis period. Interest rates were then raised in the middle of 1984.

The efforts of the monetary authorities to stabilize the economy succeeded so that by the beginning of 1987, the recovery phase began. This can be seen in the diagram below showing the annual inflation and GDP growth rates. This third period is also marked by a change in the political leadership. During the recovery period, macroeconomic policy was largely geared towards structural adjustment rather than simply stabilization.

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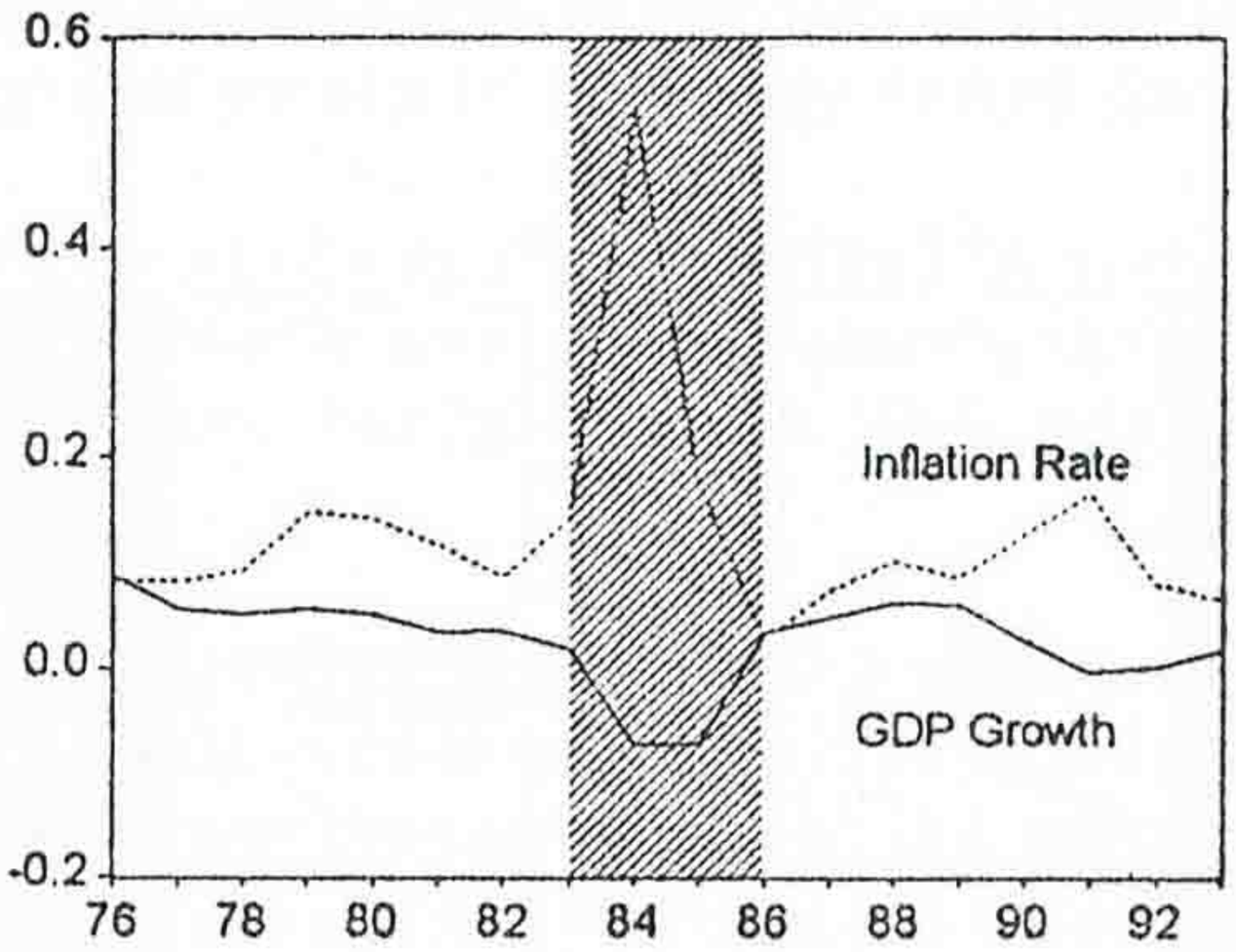
[3] Rates are on an annual basis. The basic monthly data used in computing these rates are end-of-month values. See Lamberte (1989) for a detailed discussion of the problems of the Philippine financial system.



From 1987 onwards, it will be noticed that the abolition of the usury law and other related regulations revitalized the domestic asset markets but did not encourage entry of private foreign money until 1991. Freer capital mobility followed after foreign exchange regulations and other restrictions on capital movements were relaxed further as part of the structural adjustment program, and foreign bank entry were liberalized. One will notice in the graph of the depreciation rate the impact of further deregulation. By the end of 1993, Philippine financial markets belonged to the so-called emerging markets in Asia.

3. Framework and Empirical Methodology

Efficient Markets/Rational Expectations (EM/RE) Hypothesis

The efficient markets framework in Finance shows itself as the rational expectations hypothesis in Macroeconomics.[4] The ob-

[4] A classic survey of the efficient markets literature is Fama (1970). A good discussion of the rational expectations hypothesis can be found in Hoover (1988).

ject of interest in the *EM/RE* analysis is the manner by which expectations are formed. In particular, it is hypothesized that, because errors are costly, economic agents form expectations in a way that eliminates avoidable or systematic expectational errors. While systematic errors can be avoided, the hypothesis does not rule out all errors. Expectational errors with little systematic component can still be committed but they occur at random and are unsystematic in nature. Thus, for any variable z_{t+i}, and expectation was formed during period t, the economic agent would want the expectational error,

$$(1) \quad z_{t+i} - z^e_{t+i}$$

to be zero on the average. The expectation, z^e_{t+1}, is subjective in nature.

Unlike other expectations mechanisms that are expressed as a formula, the *EM/RE* hypothesis, to rule out systematic errors, is expressed in terms of an analytical condition.[5] Moreover, the way to operationalize the hypothesis is to assume that the subjectively-held expectations of the variable by economic agents is equal to expected value (mean of the probability distribution) of that variable being forecasted, given available information:

$$(2) \quad z^e_{t+i} \Big| \Phi_t = E\left(z_{t+i} \Big| \Phi_t\right)$$

Equation (2) says that the subjective expectation should equal the objective or mathematical expectation of z_{t+i} conditional on

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[5] The adaptive expectations hypothesis, expressed as a formula, is $z^e_t - z^e_{t-1} = \lambda(z_t - z^e_{t-1})$; $0 \leq \lambda \leq 1$. By repeated substitution, it can be rewritten as $z^e_t = \sum_{i=0}^{\infty} \lambda(1-\lambda)^i z_{t-1}$. Note that if z_t is known to increase regularly, z^e_t will always be above the actual, i.e., systematic expectational error occurs.

the information available at time t, Φ_t. By using (2) in (1) and taking expectations, one gets the efficient markets condition:[6]

$$(3) \quad E\left[z_{t+i} - E\left(z_{t+i} \middle| \Phi_t\right)\right] = 0$$

Empirical Methodology

Let r_t denote the return from holding a financial asset. The efficient market condition given above can be expressed as:

$$(4) \quad Er_t - E\left(r_t^e \middle| \Phi_{t-1}\right) \middle| \Phi_{t-1} = 0$$

where the time subscript is reset and i is set to 1.

By itself, condition (4) does not have any testable implication. However, as in Mishkin (1983), one can give empirical content to the general condition above by specifying a model of market equilibrium relating the expectation formation process to some subset of the given information set Φ_{t-1}. Thus one can write: $r_t^e \mid \Phi_{t-1} = f\left(\psi_{t-1}\right) = r_t^*$ and therefore:

$$(5) \quad E\left(r_t - r_t^* \middle| \Phi_{t-1}\right) = 0$$

where $\psi_{t-1} \subset \Phi_{t-1}$. $rt^* \mid \Phi_{t-1}$ is a representation of how the market reaches equilibrium depending on the information subset upon which economic agents base their forecast. For example, the simplest model is the random walk where the sole information available is the past value of the variable that evolves as a difference stationary process:

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[6] The equality in (3) follows because, using the law of iterated expectations, one gets: $E[z_{t+i} - E(z_{t+i} \mid \Phi_t)] = E(z_{t+i}) - E[E(z_{t+i} \mid \Phi_t)] = E(z_{t+i}) - E(z_{t+i}) = 0$.

(6) $r_t = \alpha_0 + \alpha_1 r_{t\text{-}1} + u_t,$

u_t is a white noise proces and $|\alpha_1| = 1$.

In practice, market participants make use of information other than the past values of the variable. In this case, the values of other variables relevant to the pricing of the financial asset also have to be anticipated. Suppose these variables are represented by the vector x_t. Let x_t^e be the forecast of these variables. Then rationality of expectations implies that:

(7) $$E\left(x_t - x_t^e \middle| \Phi_{t-1}\right) = 0$$

Let y_t be a vector of variables used by market participants in forming expectations about x_t as shown by the following regression equations:

(8a) $$x_t = a_0 + \sum_{i=1}^{T} a_i y_{t-i} + u_{1t}$$

(8b) $$x_t^e = a_0^* + \sum_{i=1}^{T} a_i^* y_{t-i} + u_{2t}$$

where $Eu_{1t} = Eu_{2t} = 0$. According to Modigliani and Shiller (1973), forecast rationality implies that the estimates of a_1 must not be significantly different from the estimates of a_i^* in a statistical sense. The null hypothesis in this case is $a_i = a_i^*$ for all i. Based on this, the model in equation (6) can be extended to include other variables. The equation that satisfies the efficient markets condition (4) now becomes:

(9a) $$r_t = \alpha_0 + \alpha_1 r_{t-1} + \beta(x_t - x_t^e) + \varepsilon_t$$

β is a vector of coefficients of the unanticipated movements of the variables. ε_t is an econometric error term with mean zero and constant variance, is independent of x_t, and is not serially correlated. One can make use of (8b) in rewriting (9a) to give:

$$(9b)\quad r_t = \alpha_0 + \alpha_1 r_{t-1} + \beta \left[\chi_t - \left(\alpha_0^* + \sum_{i=1}^{T} \alpha_i^* y_{t-1} \right) \right] + \varepsilon_t$$

Equations (8a) and (9b) form a system of equations which can be estimated econometrically. The rationality restriction, $\alpha_i = \alpha_i^*$, (the null hypothesis) imposes cross equation restrictions that can be tested using a likelihood ratio statistic.

4. Empirical Study

Econometric Implementation

This section evaluates the 91-day treasury bills market using the framework above. It was chosen because it is the most active domestic asset market covered by the sample period. The empirical model constructed considers the pricing of the 91-day treasury bills. The implementation of the model in this paper makes use of monthly Philippine financial data that are available from the 1995 International Financial Statistics (*IFS-CDROM*) from January 1976 to March 1994.

It should be noted that, as outlined in section 2, the Philippine economy went through drastic changes that may have altered its structure. Thus, the econometric investigation also sought to test for forecast rationality under different sub-periods of the study. The sub-periods were chosen based on the breaks in the trend in the 91-day treasury bills.[7] Breakpoint Chow tests conducted on OLS estimates of the efficient markets equation (10b) rejects the hypothesis of no changes in the regression coefficients for the chosen sub-periods. Two breaks in the trend, the middle of 1983, the start of the crisis, and the end of 1986, the start of recovery from the crisis, gives three sub-periods where rationality tests are conducted.

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[7] The choice of the break in the trend is clearly subjective as there is no known procedure in the breaking trend literature that can determine unknown breaks (See Perron, 1989).

Other issues have implications on the conduct of the study's empirical investigation. First, it was noted that financial market activity levels for the sub-periods differ. Financial repression during the first period was followed by a crisis that negated the results of financial liberalization in the latter portion of the first period. During the third period, it was noted that financial market activity in general rose as the effect of financial deregulation during normal times took place. A prominent development was when a previously thin stock market came to life during the third period of the study. This means that the information set of market participants may have changed through time during the period under study. To accommodate this notion, the study conducts rationality tests with and without stock prices in the information set.

Second, the model shows the results of a random walk model is $\alpha = 1, \beta \neq 0$ and there are no forecast errors. No attempt was made to test or restrict the parameter α_1 to equal one. However, augmented Dickey-Fuller (*ADF*) tests for the full sample and the sub-periods are conducted to test for the presence of unit roots in the treasury bills rate.

The *ADF* statistic presented in Table 1 shows that the null hypothesis of a unit root against the alternative that the series is trend stationary cannot be rejected for the full period and all sub-periods.[8] These results imply that the Treasury bills rate does evolve as a random walk process.

Table 1 - Dickey Fuller Test, Treasury Bills Rate

	Full	First	Second	Third
ADF Test Statistic	-2.518	-3.402	-1.330	-1.494
1% Critical Value	-4.006	-4.068	-4.189	-4.066
5% Critical Value	-3.432	-3.462	-3.518	-3.461

[8] Similar results for the Treasury bills rate were obtained in Gochoco (1991) using quarterly data. Perron (1989) examines full sample macroeconomic data for units roots in the presence of a *single* exogenous trend break and shows that the computed test statistic rejects the null. This cannot be implemented here as the trend breaks occur more than once.

The specific form of the efficient markets model used in this study assumes that the market participants consider the general price level represented by the wholesale price index, the nominal exchange rate and stock prices represented by the index of commercial issues as the factors that influence the movement of the treasury bills rate, r_t. One may argue on theoretical grounds that a scale variable, e.g., *GNP* should appear as an explanatory variable in the equation to account for the level of economic activity. Two reasons are offered for the omission. First, it is implicitly assumed that the chosen breaks in the trend in the variables reflect the distinct activity levels where economic agents form their decisions to invest. Thus, income may be thought as exogenous in the model. Second, the investor whose information set contains monthly series, may not really be using such variable which is not available on a monthly basis to begin with.

Thus, based on (9a), the efficient markets model can be written as:

$$(10a) \quad r_t = \alpha_0 + \alpha_1 r_{t-1} + \beta_1(e_t - e_t^e) + \beta_2(p_t - p_t^e) + \beta_3(S_t - S_t^e) + \varepsilon_t$$

The linear forecasting equations for the right-hand-side variables of (10a) assume that market participants base their forecast on T lags of the variables themselves:

$$(11) \quad e_t = \eta_{10} + \sum_{i=1}^{T} \eta_{1i} e_{t-i} + \sum_{i=1}^{T} \eta_{2i} p_{t-i} + \sum_{i=1}^{T} \eta_{3i} S_{t-i} + \mu_{1t}$$

$$p_t = \theta_{10} + \sum_{i=1}^{T} \theta_{1i} e_{t-i} + \sum_{i=1}^{T} \theta_{2i} p_{t-i} + \sum_{i=1}^{T} \theta_{3i} S_{t-i} + \mu_{2t}$$

$$S_t = \gamma_{10} + \sum_{i=1}^{T} \gamma_{1i} e_{t-i} + \sum_{i=1}^{T} \gamma_{2i} p_{t-i} + \sum_{i=1}^{T} \gamma_{3i} S_{t-i} + \mu_{3t}$$

By making the relevant substitutions, one can rewrite (10a) as:

$$(10b)\quad r_t = \alpha_0 + \alpha_1 r_{t-1} + \beta_1 \left[e_t - \left(\eta_{10} + \sum_{i=1}^{T} \eta_{1i}^{*} e_{t-i} + \sum_{i=1}^{T} \eta_{2i}^{*} p_{t-i} + \sum_{i=1}^{T} \eta_{3i}^{*} S_{t-i} \right) \right]$$

$$+ \beta_2 \left[p_t - \left(\theta_{10} + \sum_{i=1}^{T} \theta_{1i}^{*} e_{t-i} + \sum_{i=1}^{T} \theta_{2i}^{*} p_{t-i} + \sum_{i=1}^{T} \theta_{3i}^{*} S_{t-i} \right) \right]$$

$$+ \beta_3 \left[S_t - \left(\gamma_{10} + \sum_{i=1}^{T} \gamma_{1i}^{*} e_{t-i} + \sum_{i=1}^{T} \gamma_{2i}^{*} p_{t-i} + \sum_{i=1}^{T} \gamma_{3i}^{*} S_{t-i} \right) \right] + \varepsilon_t$$

The rationality restrictions implied by the *EM/RE* hypothesis are the cross equation constraints, $\eta_{ki} = \eta_{ki}^{*}$, $\theta_{ki} = \theta_{ki}^{*}$, $\gamma_{ki} = \gamma_{ki}^{*}$, which can be subjected to empirical testing.

For the forecasting variables, both the original and deseasonalized series were used in estimating the model. This did not make a difference in the rationality test but the deseasonalized series yielded significant *t*-values. Only the results using the deseasonalized series are presented below.

Non-linear Least Squares Estimates

For all least squares estimates, the optimal lag length was chosen based on Akaike's information criterion. The equations given by (10b) and (11) are estimated simultaneously using non-linear multivariate regression where cross equation constraints are first imposed and then relaxed.[9] Given the constrained and unconstrained estimates, a likelihood ratio test is used to examine the hypothesis of rationality. The likelihood ratio statistic given by:

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[9] *PCTSP* version 4.3's generalized non-linear least squares procedure for equation systems was used in the estimation.

$$LR(k) = T\ln\left(\frac{|\Sigma_c|}{|\Sigma_u|}\right)$$

is distributed as χ^2 with the number of degrees of freedom equal to the number of cross equation constraints, k. $|\Sigma_c|$ and $|\Sigma_u|$ are the determinants of the residual covariance matrices of the constrained and unconstrained estimates respectively.

Two sets of estimates are presented in this section. The first set assumes that market participants base their anticipation of Treasury bills rate movement on their own forecasts of the price level and exchange rate. The second set adds the growth of the stock price index of commercial issues.

Tables 2a and 2b present the first set of results. The lag length of two was used based on the Akaike information criterion. The p-value also shown in the Table is the probability of obtaining the absolute value of that test statistic, $LR(k)$, greater than or equal to that of the sample statistic if the null hypothesis is true (or that the rationality constraints are valid). Thus a p-value of, say, below 0.05 indicates that the test is significant at the 5 percent level and therefore a rejection of the null.

As can be seen for the full sample, the rationality hypothesis is rejected. However, breaking the sample into three and testing provides interesting results. A rejection of rationality is again seen for the crisis (second) period but not for the first and third periods.

Table 2a - Rationality Test Results: 2 variables, 2 lags

	Whole Period	First Sub-Period	Second Sub-Period	Third Sub-Period
$LR(4)$	35.756	4.547	20.294	3.568
p-value	0.000	0.337	0.000	0.468

Table 2b - Non-linear Estimates: 2 variables, 2 lags

All	Coefficient	*t*-value
α_0	0.536	1.556
α_1	0.968	49.342
β_1	1.266	0.348
η_{10}	0.009	2.497
η_{11}	0.915	12.297
η_{12}	0.053	0.707
η_{21}	0.002	0.014
η_{22}	-0.053	-0.500
β_2	-7.800	-1.340
θ_{10}	0.006	2.359
θ_{11}	0.028	0.570
θ_{12}	0.026	0.525
θ_{21}	1.241	17.355
θ_{22}	-0.321	-4.622

Period 1	Coefficient	*t*-value
α_0	0.472	1.481
α_1	0.964	37.109
β_1	-28.578	-8.226
η_{10}	0.000	-0.100
η_{11}	1.445	5.899
η_{12}	-0.332	-1.261
η_{21}	-0.051	-1.068
η_{22}	0.044	0.925
β_2	-46.108	-30.886
θ_{10}	0.008	1.411
θ_{11}	-0.648	-1.093
θ_{12}	0.659	1.037
θ_{21}	0.958	8.338
θ_{22}	-0.024	-0.210

Period 2	Coefficient	*t*-value
α_0	0.805	0.593
α_1	0.960	17.312
β_1	-21.281	-2.197
η_{10}	0.032	1.627
η_{11}	0.744	3.855
η_{12}	0.128	0.747
η_{21}	0.206	0.607
η_{22}	-0.237	-0.807
β_2	20.779	1.100
θ_{10}	-0.003	-0.287
θ_{11}	0.008	0.070
θ_{12}	0.166	1.722
θ_{21}	1.301	6.857
θ_{22}	-0.467	-2.872

Period 3	Coefficient	*t*-value
α_0	1.170	1.988
α_1	0.934	27.721
β_1	-2.038	-0.373
η_{10}	0.007	1.223
η_{11}	0.953	8.753
η_{12}	-0.014	-0.128
η_{21}	-0.010	-0.051
η_{22}	-0.047	-0.253
β_2	-38.093	-4.019
θ_{10}	0.005	1.656
θ_{11}	0.068	1.104
θ_{12}	-0.038	-0.620
θ_{21}	0.994	9.370
θ_{22}	-0.074	-0.709

The results may be explained by the fact that the crisis generated noise not normally present in non-crisis periods. This has a temporary effect of confusing market participants who are unable to distinguish market movements from the noise emanating from the uncertainties of the period. Moreover, these uncertainties discouraged participation by investors.

Without this noise, as in the first and third periods, one cannot reject the rationality constraints, i.e., markets are efficient.

Looking at the non-linear estimates in Table 2b, the full sample coefficient estimates of unanticipated variables (βs) are not significantly different from zero. By contrast, one can see that for the first period these are highly significant. For the next two periods however, the results are not as unambiguous. It seems that prior to the crisis when macroeconomic stability is well preserved, markets are more or less adequately conveying information compared to the next two periods.

The next set of results shown in Tables 3a to 3e adds the growth of share prices of commercial issues. The Akaike information criterion points to an optimal lag length of three. The rationality test results in Table 3a are no different from the results in Table 2. Looking at the effects of unanticipated variables, estimates for the full sample show that only one, the coefficient of the share price index, is significant. As in the first set of results in Table 2, the pre-crisis period is characterized by efficient markets. It can be seen however that for the second period, all β coefficient estimates are insignificant. For the post crisis period, two of the three β coefficients are statistically significant.

Table 3a - Rationality Test Results
3 variables, 3 lags

	Full Sample	77:4 - 83:6	83:7 - 86:12	87:1 - 94:3
LR(9)	59.356	9.341	36.612	8.617
P-value	0.000	0.406	0.000	0.473

Table 3b - Non-linear estimates: 3 variables, 3 lags
Full Sample

	Coefficient	*t*-value		Coefficient	*t*-value		Coefficient	*t*-value
β_1	6.111	1.615	β_2	-11.051	-1.854	β_3	-3.412	-3.912
η_{10}	0.012	2.873	θ_{10}	0.007	2.414	γ_{10}	0.042	2.467
η_{11}	0.021	1.206	θ_{11}	-0.007	-0.610	γ_{11}	0.994	14.326
η_{12}	-0.049	-2.026	θ_{12}	-0.010	-0.613	γ_{12}	-0.015	-0.155
η_{13}	0.019	1.085	θ_{13}	0.015	1.304	γ_{13}	-0.068	-0.979
η_{21}	0.909	12.062	θ_{21}	0.044	0.891	γ_{21}	-0.152	-0.498
η_{22}	0.029	0.290	θ_{22}	0.006	0.099	γ_{22}	0.568	1.415
η_{23}	0.043	0.571	θ_{23}	0.008	0.167	γ_{23}	-0.249	-0.814
η_{31}	0.017	0.144	θ_{31}	1.202	15.821	γ_{31}	0.042	0.090
η_{32}	-0.046	-0.255	θ_{32}	-0.187	-1.570	γ_{32}	-0.584	-0.794
η_{33}	-0.044	-0.389	θ_{33}	-0.106	-1.419	γ_{33}	0.215	0.468
α_1	0.967	48.865	α_0	0.556	1.598			

Table 3c - Non-linear estimates: 3 variables, 3 lags
First Period (77:4 - 83:6)

	Coefficient	*t*-value		Coefficient	*t*-value		Coefficient	*t*-value
β_1	-29.527	-8.626	β_2	51.338	-32.535	β_3	-5.379	-14.169
η_{10}	-0.001	-0.412	θ_{10}	0.007	1.169	γ_{10}	0.091	3.504
η_{11}	0.002	0.229	θ_{11}	0.013	0.554	γ_{11}	0.833	8.353
η_{12}	0.004	0.265	θ_{12}	-0.043	-1.355	γ_{12}	0.166	1.251
η_{13}	0.002	0.159	θ_{13}	0.052	2.282	γ_{13}	-0.214	-2.276
η_{21}	1.318	4.980	θ_{21}	-0.773	-1.250	γ_{21}	-0.986	-0.385
η_{22}	-0.052	-0.115	θ_{22}	0.766	0.728	γ_{22}	6.943	1.594
η_{23}	-0.147	-0.515	θ_{23}	0.060	0.090	γ_{23}	-6.582	-2.387
η_{31}	-0.062	-1.301	θ_{31}	0.919	8.214	γ_{31}	-0.343	-0.740
η_{32}	0.094	1.424	θ_{32}	0.082	0.528	γ_{32}	0.579	0.904
η_{33}	-0.027	-0.528	θ_{33}	-0.051	-0.424	γ_{33}	-1.065	-2.133
α_1	0.963	36.611	α_0	0.496	1.534			

Table 3d - Non-linear estimates: 3 variables, 3 lags
Second Period (83:7 - 86:12)

	Coefficient	*t*-value		Coefficient	*t*-value		Coefficient	*t*-value
β_1	0.675	0.066	β_2	4.310	0.222	β_3	-2.739	-0.885
η_{10}	0.028	1.045	θ_{10}	-0.003	-0.234	γ_{10}	0.276	4.373
η_{11}	0.011	0.202	θ_{11}	-0.029	-0.937	γ_{11}	0.638	4.579
η_{12}	-0.014	-0.204	θ_{12}	0.039	1.017	γ_{12}	0.137	0.802
η_{13}	-0.011	-0.182	θ_{13}	-0.017	-0.504	γ_{13}	0.260	1.713
η_{21}	0.768	3.888	θ_{21}	0.011	0.104	γ_{21}	-0.290	-0.590
η_{22}	0.052	0.223	θ_{22}	0.215	1.656	γ_{22}	-0.116	-0.199
η_{23}	0.187	1.033	θ_{23}	0.024	0.242	γ_{23}	-1.194	-2.657
η_{31}	0.096	0.258	θ_{31}	1.288	6.249	γ_{31}	0.853	0.925
η_{32}	-0.258	-0.460	θ_{32}	-0.736	-2.373	γ_{32}	0.131	0.094
η_{33}	0.023	0.070	θ_{33}	0.216	1.205	γ_{33}	-0.268	-0.335
α_1	0.983	17.321	α_0	0.285	0.205			

Table 3e - Non-linear estimates: 3 variables, 3 lags
Third Period (87:1 - 94:3)

	Coefficient	*t*-value		Coefficient	*t*-value		Coefficient	*t*-value
β_1	-8.250	-1.396	β_2	-36.900	-3.776	β_3	-4.132	-3.479
η_{10}	0.012	1.875	θ_{10}	0.005	1.418	γ_{10}	0.083	2.631
η_{11}	0.012	0.608	θ_{11}	0.007	0.613	γ_{11}	0.826	8.249
η_{12}	-0.068	-2.550	θ_{12}	-0.017	-1.094	γ_{12}	-0.110	-0.841
η_{13}	0.040	2.239	θ_{13}	0.011	1.065	γ_{13}	0.027	0.303
η_{21}	0.922	8.854	θ_{21}	0.077	1.246	γ_{21}	-1.086	-2.108
η_{22}	0.184	1.335	θ_{22}	-0.114	-1.399	γ_{22}	0.693	1.015
η_{23}	-0.198	-1.911	θ_{23}	0.071	1.161	γ_{23}	0.223	0.436
η_{31}	0.039	0.218	θ_{31}	0.982	9.299	γ_{31}	2.142	2.426
η_{32}	0.041	0.165	θ_{32}	0.088	0.601	γ_{32}	-2.103	-1.710
η_{33}	-0.142	-0.784	θ_{33}	-0.160	-1.494	γ_{33}	-0.473	-0.528
α_1	0.930	27.446	α_0	1.243	2.102			

5. Concluding Remarks

The study examines a segment of the Philippine financial system within the efficient markets framework. The period under study is broken down ito three periods and test for forecast rationality were conducted. The main result of this study is not at all surprising. Philippine financial markets are in general efficient in conveying information except during the crisis period.

The results may be explained by the fact that the crisis generated noise not normally present in non-crisis periods. This has a temporary effect of confusing market participants who are unable to distinguish market movements from the noise emanating from the uncertainties of the period and thus contaminating information sets.[10] This leads to a rejection of the maintained hypothesis of rationality in the crisis period.

There were no significant changes in the rationality test results when the stock market variable was added. It however improved the estimates of the coefficients of the unanticipated variables. As shown in Table 3, *t*-values for the first and third periods are generally higher while all coefficients of the unanticipated variables in the second period are insignificant.

It should be noted that, as in most empirical exercises on market efficiency, the framework was applied to markets. The maintained hypothesis was that the market as a whole is efficient but it did not preclude the idea that some individual participants may be acting irrationally.

The statistical procedure used is just one of the methods for analyzing efficiency of markets. A wide array of techniques are available from the simple *OLS* to the more recent developments in cointegration analysis. This study's results are in line with the findings of financial market efficiency by authors for other countries using these techniques.

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[10] These uncertainties in fact discouraged participation by investors.

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