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Rationality of Insurance Firms' Forecasts : Results of Unbiasedness and Efficiency Tests

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ABSTRACT

Many applied studies have tried to test the implications of rational expectations hypothesis on survey data. This study provides evidence on the rationality of economic forecasts made by insurance firms in a developing economy-Malaysia. Our unbiasedness test results suggest that anticipated gross revenue and employment are unbiased predictors of actual gross revenue and employment respectively. Furthermore, our efficiency tests results indicate that insurance firms utilized relevant information efficiently at the time the forecasts were made.

ABSTRAK

Banyak kajian telah dijalankan untuk menguji implikasi hipotesis jangkaan rasional terhadap data tinjauan. Kajian ini memaparkan bukti kerasionalan ramalan yang dilakukan oleh firma insurans di negara membangun-Malaysia. Hasil ujian ketakbiasan mencadangkan bahawa masing-masing jualan kasar dan guna tenaga yang dijangka merupakan peramal takbias untuk jualan kasar dan guna tenaga sebenar. Seterusnya, hasil ujian kecekapan menunjukkan bahawa firma insurans telah mengambil kira maklumat berkaitan semasa ramalan dilakukan.

INTRODUCTION

In recent years the performances of many microeconomics and macroeconomics series have been erratic. For example, rate of inflation, price of crude oil, prices of primary commodities, rate of interest and other pertinent economic variables have been fluctuating widely and have caused concern among the public, politicians, economists and also businessman. According to Mayes (1981), with such non-uniformity of economic variables observed in the last two decades, the role of expectations has become more relevant in the economic agents' decision-making process. Mayes (1981), further states that under the present conditions it has become more important to consider what expectations actually are and how they are formed.

Heady (1952), supports such contentions and acknowledges that the need for an efficient management has become more prevalent in the present conditions. This is because a careful evaluation of the pertinent economic and business conditions, by incorporating not only the current situations but also a view of the future conditions of that variable, if correct, will greatly increase the probability of making successful decisions. Business firms have recognized the role of expectations in making their decisions, and thus, the role of management in the present context has become more challenging. Heady (1952) postulates that 'the fundamental role of the coordinating unit, management in its true sense, is this: first, it must formulate expectations of the conditions that will prevail in the future. This task ordinarily is encountered before investment is made or production plans are ready to be committed. It involves the anticipation of future prices and production rates. Second, and after expectations of the future have been established, a plan of production (investment) must be formulated which is logical and consistent with expectations. Decisions must be made. Third, the production plan must be put into action. An auxiliary responsibility of management is the acceptance of the economic consequences of plans. In summary then, the important steps in coordination include expectations, plans, action and acceptance of consequences'.

Therefore, business firms have always recognized the need for a view for the future and explicit forecasts in the decision-making process. The value of economic forecasts of certain macroeconomic variables can be derived from several methods. There are at least three main methods in deriving economic forecasts, that is, from time series and econometric models, and survey of intentions of concerned agents and organizations. There is no doubt that time series analysis and econometric modeling are the two most widely used methods in economic forecasting, but their weaknesses have been noted by Holden and Peel (1983). However, explicit forecasts were derived directly from survey expectations. The role of economists in this direction is to evaluate the rationality of forecasts from surveys of market participants.

Empirical literature on direct tests of the rational expectations hypothesis is vast and growing. Holden *et al.* (1985), Lovell (1986), Wallis (1989), Maddala (1991) and Pesaran (1991), are among others who reviewed some of these studies. In general, the studies do not support the rational expectations hypothesis. Most of the studies carried out to evaluate the rationality of business firms' forecasts of economic variables were conducted on developed nations. Madsen (1993), studies the formation of output expectations in the manufacturing industry in Japan, Denmark, Finland, France, Germany, Netherlands, Norway, Sweden and the United Kingdom. He found that the rational expectations hypothesis was weakly rejected. Williams (1988) and Chazelas (1988), found that investment forecasts were biased predictors of the actual investment value for firms in the United Kingdom and France. A study by Meganck *et al.* (1988) conclude that investment forecasts of the manufacturing firm in Belgium were unbiased predictors of the actual values. However, Daub (1982) fails to find any rationality of the Canadian capital investment intention survey data. On the other hand, a study by Leonard (1982) on employment forecasts by the United States services sectors found that the forecasts were biased and the rationality of these employment forecasts were rejected.

Nevertheless, there are two empirical studies pertaining to the developing economies by Kinoshita (1988) on Singapore and Yokoyama (1989) on Malaysia. Yokoyama (1989) uses the survey data of the Business Expectations Survey of Limited Companies published by the Department of Statistics, Malaysia. However, Yokohama did not test the rationality criteria of the business firms' forecasts for Malaysia. Thus, the issue of testing for rationality of the business expectations survey data in Malaysia is still an open issue.

The principal objective of this paper is to provide empirical evidence on the rationality of insurance firms' expectations about economic variables using survey data in Malaysia. This study evaluates the degree of accuracy of forecasts made by the insurance firms on gross revenue, capital expenditure and employment as reported in the Business Expectations Survey of Limited Companies published half-yearly by the Department of Statistics, Malaysia. The study is important because it adds to the current literature on testing of the rationality of survey data and provides empirical evidence from the perspective of a developing country.

METHODOLOGY

Testing Rationality of Survey Data

According to Muth (1961), for expectations to be rational, they must be based on all relevant information at the time they are formed. It has been recognized that the concept of rational expectations has been widely tested on survey data. Since surveys are the only way of measuring expectations directly from market participants, the explicit forecast on economic variables of interest can be tested on whether the survey supports rational expectations hypothesis or other alternatives.

There are three reported standard tests to evaluate the rationality of forecasts of economic variables from survey data, namely, unbiasedness; non-serial correlation and efficiency tests. Let Q_t [Equation (1)] denotes the realization of a variable of interest in period t, and ${}_{t-1}Qe_t$ denotes the forecast made on a variable at period t made in period $t-1$. If the forecast is based on rational expectation then,

$$Q_t = E({}_{t-1}Qe_t \mid \Omega_t) \qquad (1)$$

where E is an operator that denotes a mathematical expectation and Ω_t is the set of information available to economic units at the end of period t. It follows that:

$$E\left[(Q_t - {}_{t-1}Qe_t) \mid \Omega_t\right] = 0 \qquad (2)$$

Letting η_t represent the forecast error $Q_t - {}_{t-1}Qe_t$, Equation (2) can be written as:

$$E\left[\eta_t \mid \Omega_t\right] = 0 \qquad (3)$$

which implies that the forecast error in Equation (3) is uncorrelated with each variable in the information set Ω_t. Defining the sampling interval of the forecasts as one period, Equations (1), (2) and (3) suggest the following testable tests of rationality:

(i) Unbiasedness: $Q_t = {}_{t-1}Qe_t + \eta_t$

(ii) Non-serial correlation: $E[\eta_t \mid \eta_{t-i}] = 0$ $i = 1, 2, \ldots, K$

(iii) Weak-form efficiency: $E[\eta_t \mid \Omega_{t-i}] = 0$ $i = 1, 2, \ldots, K$

Sources of Data

In Malaysia, explicit forecasts of economic variables from surveys of expectations have been conducted both by the government and the private sector. These include 'Business Expectations Survey of Limited Companies' by the Department of Statistics on a bi-annual basis; 'Industrial Trends Survey' by the Malaysian Industrial Development Authority (MIDA) on a bi-annual basis; 'Survey of Industrial Trends' by the Central Bank of Malaysia on a quarterly basis; 'Business Conditions Survey Report' and 'Consumer Sentiments Survey Report' by the Malaysian Institute of Economic Research (MIER) on a quarterly basis; and 'Survey on Key Sectors/Industries of the Economy' by Public Bank Berhad on a quarterly basis. Of all the above survey reports, 'Business Expectations Survey on Limited Companies' published by the Department of Statistics, Malaysia is consistent and readily available to the general public. Other than these sources, the Annual Report by Bank Negara Malaysia and the Economic Report by the Ministry of Finance also provide forecasts on some key macroeconomic variables on a yearly basis.

The Department of Statistics conducted their survey by mail on a half-yearly basis. The types of information collected and published in the report include the actual values on gross revenue, capital expenditure, employment, and also their respective forecasted values for the next six months. Other information that is included in the report are constraints anticipated and level of output/operation anticipated.

The sectors covered in the survey include Rubber, Oil Palm, Logging, Mining, Manufacturing, Construction, Wholesale, Retail, Hotels, Banks and other Financial Institutions, Insurance, Real Estate and Business Services and Transport.

According to the Department of Statistics, the Business Expectations Survey covers the biggest companies within each of the sectors. A total of 220 companies were selected using a three-stage sampling method, based on the list of companies given in the Financial Survey of Limited Companies. In the first sampling, the allocation of the 220 companies among the sectors is based on the respective sectors' contribution to gross revenues, employment and net fixed assets in the overall corporate sector. In the second-stage sample selection, the representation of industries within the sector is based on the industries' contribution to gross revenue in the sector. In the final stage, the companies to be selected within each industry would be based on the individual company's contribution to gross revenue. In this case, the companies with the highest gross revenue in the industry would be selected.

In this study, for the insurance industry, the period of study is from 1978:1 to 1999:1 giving a total of forty-three time series observations. Bi-annual time series data on observed realization of gross revenue, capital expenditure and employment and their respective forecasted values made by insurance firms were compiled from various issues of the 'Business Expectations Survey of Limited Companies' published bi-annually by the Department of Statistics, Malaysia.

ESTIMATION AND DISCUSSION ON EMPIRICAL RESULTS

Table 2 shows the results of the unbiasedness test to determine whether or not the economic forecasts are unbiased predictors of the actual values. Supposing the actual value is denoted as Q_t and $_{t-1}Qe_t$ is the forecast value, then theunbiasedness test is performed by estimating the following equation:

$$Q_t = \alpha + \beta_{t-1}Qe_t + \varepsilon_t \quad (4)$$

where ε_t is random error with zero mean and constant variance. The following *F*-test is used to examine the joint null hypothesis that $\alpha = 0$ and $\beta = 1$, that is consistent with unbiased forecast:

$$F_{(R,K-N-1)} = \left[(RSSR - USSR)/R\right]/\left[USSR/(K-N-1)\right]$$

where *RSSR* is the restricted sum of squares residual of the regression in which the coefficients are restricted to their hypothesized values, *USSR* is the unrestricted sum of squares residual, *R* is the number of restrictions, *N* is the number of independent variables and *K* is the number of observations [*see* Maddala (1977)]. Furthermore, the estimated residuals from Equation (4) should not exhibit serialcorrelation if the forecasts are unbiased predictions of the actual values in Q_t.

Before estimating Equation (4), the stationarity of variables Q_t and $_{t-1}Qe_t$ are evaluated using the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. First, we test the series in levels and then in their first

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differences. When we test for unit root in levels, both constant and trend are included in the regression, but in first differences, the trend is excluded. All series in their natural logarithm were tested for the order of integration.

The standard procedure for determining the order of integration of a time series (i.e. the unit root test) is the application of the augmented Dickey-Fuller test (Dickey and Fuller, 1979) which requires regressing ΔQ_t on a constant, a time trend, Q_{t-1} and several lags of the dependent variables to render the disturbance term white-noise. Then the *t*-statistic on the estimated coefficient of Q_{t-1} is used to test the following null and alternative hypothesis:

$$H_0 : Q_t \sim I(1) \quad \text{vs} \quad H_1 : Q_t \sim I(0)$$

The null hypothesis is saying that variable Q_t is stationary to the order one or it is integrated of order one compared to the alternative that Q_t is integrated of order zero. If the null cannot be rejected, it is said that Q_t probably needs to be differenced once to achieve stationarity. If, on the other hand, the null is rejected then Q_t is stationary in its level form. The critical values are called the 'ADF statistics' and are available in Fuller (1976), Engle and Yoo (1987) and in MacKinnon (1991).

If the null hypothesis cannot be rejected then Q_t is non-stationary and it may be $I(1)$ or $I(2)$, or have an even higher order of integration. To find out the order of integration, thetest is repeated ted with ΔQ_t in place of Q_t, thus regressing $\Delta^2 Q_t$ on a constant, ΔQ_{t-1} and several lags of $\Delta^2 Q_t$. The ADF statistic therefore tests the following:

$$H_0 : \Delta Q_t \sim I(1) \quad \text{vs} \quad H_1 : \Delta Q_t \sim I(0) \quad \text{i.e.}$$
$$H_0 : Q_t \sim I(2) \quad \text{vs} \quad H_1 : Q_t \sim I(1)$$

If the ADF statistic is not large and negative then we cannot reject H_0 and Q_t cannot be $I(1)$. In this case the test is repeated with $\Delta^3 Q_t$ as the dependent variable and so on, until the order of integration is determined. To supplement the ADF unit root test, we also estimate the Phillips and Perron (1988; hereafter the PP test) unit root test. The PP unit root test is a non-parametric method of detecting whether a time series contains a unit root. This test is robust to a wide variety of serial correlations and time dependent heteroskedasticity.

Table 1 contains the results of the unit root tests. Generally, our results suggest that the unit root hypothesis cannot be rejected at the 5 percent level for both the actual and anticipated series for gross revenue, capital expenditure and employment in their levels. Generally, the ADF (except two) and PP test statistics suggest that all six variables are stationary in first difference[1]. Thus, traditional regression analysis based on Equation (4) can lead to spurious regression results because these variables are nonstationary in levels.

Table 1
Results of Integration Tests

Series	Level ADF	PP	First Difference ADF	PP
Actual gross revenue	0.13	-1.11	-3.06**	-9.86**
Anticipated gross revenue	0.01	-1.08	-2.75	-7.10**
Actual capital expenditure	-1.36	-2.37	-2.97**	-10.70**
Anticipated capital expenditura	-1.02	-1.94	-3.16**	-9.65**
Actual employment	-2.04	-1.55	-2.85	-5.62**
Anticipated employment	-3.17	-1.78	-3.20**	-6.85**

Notes: Lag length chosen for ADF was 3, based on Schwert (1987) formula: $\text{int}\{4(T/100)^{0.25}\}$ where T is the total number of observations. For PP, the lag length chosen was also 3 based on the Bartlett kernel. All estimations were made possible using EViews 3.1. ADF and PP critical values is -2.95 (5%). See MacKinnon (1991). Asterisk (**) denotes statistically significant at 5 percent level.

Given that the series are of the same order of integration, we can proceed to estimate Equation (4), provided that Q_t and ${}_{t-1}Qe_t$ are cointegrated. According to Fischer (1989), if $Q_t \sim I(1)$ and ${}_{t-1}Qe_t$ is a rational forecast of Q_t based on available information set Ω_{t-i} at time $t-i$, then ${}_{t-1}Qe_t$ must also be $I(1)$ and that ${}_{t-1}Qe_t$ must be cointegrated with Q_t. If two or more time series are cointegrated, their OLS regression estimate in levels are efficient and consistent.

To conduct the cointegration test, we follow the popular Engle and Granger (1987), two-step procedure for testing the null of non-cointegration. The first step of the Engle and Granger's procedure is to determine a as the slope coefficient estimate from the OLS regression of Q on a constant (α) and Qe. A test of cointegration is that the residuals m_t (i.e. Q_t-a-βQe_t) from the 'cointegrating regression' be stationary. So in the second step, the ADF unit root test is conducted on the residual m_t so as to reject the null hypothesis of integration (of order 1) in favour of stationarity, using the critical values provided in Engle and Yoo (1987) and MacKinnon (1991). If the ADF statistics are not large and negative then it is likely that the series are not cointegrated[2]. A less powerful test of cointegration is the 'cointegrating regression Durbin-Watson' (CRDW) statistic where cointegration is rejected if the Durbin-Watson statistic is too low. The critical values for CRDW are tabulated in Engle and Yoo (1987).

Table 2 presents the results on cointegration and the unbiasedness tests. The results contained in Table 2 indicate that actual values and anticipated values on gross revenue, capital employment and employment are cointegrated. The cointegrating regression Durbin-Watson (CRDW), ADF and PP tests statistics are significantly different from zero at the 5 percent level. The results suggest that the null of non-cointegration can be rejected. Furthermore, the LM test statistics for all three equations indicate that the disturbance terms are white-noise. However, the joint null hypothesis that $\alpha = 0$ and $\beta = 1$ is firmly rejected for capital expenditure equation. Only in the cases of gross revenue and employment equations the calculated *F*-statistics for the null hypothesis that $\alpha = 0$ and $\beta = 1$ cannot be rejected at the 5 percent significance level. Thus, the null hypothesis of unbiasedness is rejected only in the case of capital expenditure for the insurance firms.

Table 2

Results of Unbiasedness Tests

	Dependent Variable is Actual Values of:		
	Gross Revenue	**Capital Expenditure**	**Exployment**
Constant (α)	0.1546 (0.7440)	0.7173 (2.3787)**	0.1002 (0.8698)
Stope (β)	0.9787 (33.569)**	0.7071 (7.5712)**	0.9096 (11.633)**
R-squared	0.9698	0.6208	0.7945
CRDW	2.20**	2.09**	1.57**
ADF(1)	-4.27**	-3.88**	-3.52**
PP(3)	-6.57**	-6.30**	-4.76**
F-statistics (α=0, β=1)	0.280 [0.757]	5.223 [0.010]**	1.165 [0.323]
LM $\chi^2(4)$	2.787 [0.593]	0.373 [0.984]	2.068 [0.723]

Notes: Critical value for CRDW at 5% level is 0.78 (see Engle and Yoo, 1987). Critical values for ADF and PP is -1.94 (5%) (see MacKinnon, 1991). The LM Chi-square statistic for serial correlation with four lags is 9.48 with four degree of freedom at 5 percent level. Figures in square brackets are *p*-values. Asterisk (**) denotes statistically significant at 5 percent level.

The next test for rational expectations examines whether survey data incorporates past information. In this study we used the non-serial correlation and the weak-form efficiency tests. For the former, the information set is the past forecast errors, while for the latter, past actual values are the information set. For the non-serial correlation test, the following equation is estimated:

$$\eta_t = \sum_{i=1}^{K} \delta_i \eta_{t-i} + \nu_t \qquad (5)$$

where $\eta_t = Q_t - {}_{t-1}Qe_t$ is the forecast error. The hypothesis of zero correlation is tested for the null hypothesis H_0: $\delta_i = 0$, $i = 1, 2, \ldots, K$ for a range of choice of K. To save the degree of freedom, we have chosen from 1 to 3 lag terms. The results in Table 3 clearly show that the calculated F-statistics could not reject the null hypothesis of non-serial correlation only in the cases of gross revenue and employment for the insurance firms.

In Table 3, we also present the results of the weak-form efficiency test, that is, to determine whether or not bankers used information on past values of actual variables. This is done by estimating the following equation proposed by Mullineaux (1978):

$$Q_t - {}_{t-1}Qe_t = \phi_0 + \sum_{i=1}^{K} \phi_i Q_{t-i} + \varpi_t \qquad (6)$$

where the dependent variable $(Q_t - {}_{t-1}Qe_t)$ represents the forecast error in predicting values in Q and the independent variables Q_{t-i} are the actual values in Q.[3] The null hypothesis to be tested is that the estimated ϕ_i are not statistically different from zero for all i $(i = 1, 2, \ldots, K)$ as a group. Generally, the results in Table 3 show that insurance firms make rational economic forecasts on gross revenue and employment. In other words, past realizations of the actual values of the variables in question are used efficiently.

Table 3

Results of Non-Serial Correlation and Weak-Form Efficiency Tests

Lag Length	Test with Respect to Lagged Forecast Error: Gross Revenue	Capital Expenditure	Employment	Test with Respect to Lagged Actual Values: Gross Revenue	Capital Expenditure	Employment
F-statistic with respect to lag length:						
1	0.229 [0.796]	0.355 [0.703]	0.902 [0.415]	1.627 [0.211]	0.502 [0.609]	0.505 [0.607]
2	0.136 [0.937]	0.285 [0.835]	0.578 [0.633]	1.353 [0.274]	0.285 [0.835]	0.342 [0.794]
3	0.284 [0.885]	0.159 [0.956]	0.416 [0.795]	1.169 [0.344]	0.203 [0.934]	1.109 [0.371]

Notes: Figures in square brackets are p-values. Asterisk (**) denotes statistically significant at 5 percent level.

CONCLUSION

Empirical evidence on the testing of rationality of survey data is lacking in the developing countries. This is probably due to the unavailability of such expectation surveys in a particular country. However, Malaysia is fortunate because both the government and the private sectors recognized the need for such surveys and have conducted and published reports on survey of expectations made by households and firms. Thus, the objective of the present study is two-fold. First, to evaluate the accuracy of the economic forecasts made by one sector - the insurance industry as reported in the 'Business Expectations Survey of Limited Companies' published by the Department of Statistics, Malaysia. Second, the present study adds to the current growing empirical literature on testing rationality of survey data, in which, we provide evidence from the perspective of a developing economy, Malaysia.

In this study, the economic variables of interest are namely; gross revenue, capital expenditure and employment. These variables are subjected to the unbiasedness, non-serial correlation and weak-form efficiency tests. Generally, it was found that insurance firms in Malaysia make rational economic forecasts for gross revenue and employment but not for capital expenditure. This implies that insurance firms can improve its forecasts on capital expenditure by incorporating past trends on capital expenditure in their information set whenever they make forecasts in future. Making accurate forecast is very important in businesses especially for planning and budgeting purposes and when ringgit and sen are involved.

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ENDNOTES

1. Since the Phillips-Perron unit root test is more robust than the augmented Dickey-Fuller test, we take that all series are $I(1)$.

2. In this study we supplement the ADF test with the PP test.

3. When estimating Equation (6), Q_{t-i} are in their first difference form since Q is $I(1)$.

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