Pakistan Journal of Applied Economics, Vol. XII No.2; XIII No.1, (171 - 184)

FORECASTING ECONOMIC VARIABLES IN THE AGRICULTURAL SECTOR:
Testing the Rational Expectations Hypothesis on Survey Data

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In the last decade, there has been an increasing interest in the hypothesis of how expectations were formed by economic agents. More recently, many applied studies have tried to test the implications of rational expectations hypothesis on survey data. This paper provides empirical evidence on the rationality of survey data of agricultural firms' economic forecasts on gross revenue, capital expenditure and employment. The results of this paper indicate that agricultural firms' forecasts do not violate the statistical properties of unbiasedness, efficiency or orthogonality.

I. Introduction

Forecasts of economic variables is very important for planning and policy making purposes. Forecasts is an important input in decision making processes because obtaining reliable forecasts of some relevant macroeconomic variables is necessary for efficient management of funds, time and resources. Business has always recognised the need for a view of the future and has used explicit forecasts in the design and execution of their economic and/or business policies. Faced with incomplete information about the future and also the erratic external economic environment, forming expectations about the future economic conditions has been one of the critical functions of business management. Heady (1992) points out that the need of an efficient management is important in these present conditions. A correct assessment of both micro and macro-economic performances of the business conditions greatly raises the probabilities of making the decisions successfully. Thus, the uncertainties of future business and economic conditions, make the role of the managers in managing a firm more demanding and pressing. Heady notes that, 'The funda-

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mental role of the coordinating unit, management in its true sense, is this: First, it must formulate expectations of the conditions which will prevail in the future. This task ordinarily is encountered before investment is made or production plans are committed. It involves the anticipation of movement of future prices and production rates. Second, after expectations of the future have been established, a plan of production (investment) must be formulated which is logical and consistent with these 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 consequence.'

For example, a firm trying to decide upon its investment programme will have to take into account not only the current known set of circumstances but also the unknown economic and business conditions in the future. The firm has to form a view about the future, such as the likely sales, costs, prices, competitors' reactions, labour requirements, government regulations and so on. These views about future values of economic variables are frequently referred to as 'expectations,' that is what the firm expects will happen in the future.

The value of economic forecasts of certain macroeconomic variables can be derived from several methods. The three main methods for deriving economic forecasts are (i) time series, (ii) econometric models, and (iii) survey of intentions of concerned agents and organizations. Time series analysis and econometric modelling are the two most widely used methods in economic forecasting, but their drawbacks have been noted by Holden and Peel (1983). More recently, economists have turned their direction of interest in evaluating the rationality of economic forecasts from surveys of market participants. The empirical literature on the direct tests of the rational expectations hypothesis is vast and growing. The results of some of these studies are reviewed by Holden, Peel and Thompson (1985), Lovell (1986), Wallis (1989), Maddala (1991) and Pesaran (1991). The aim was to determine whether survey data on economic forecasts are accurate in the Muth's (1961) sense, that is whether participating economic agents used all available information at the time forecasts are made. In other words, the rational expectations hypothesis of the economic forecast was put to test. In general, the empirical studies do not support the rational expectations hypothesis.

The purpose of this paper is to present some empirical evidence on the rationality of agricultural firm managers' expectations using survey data. This study is important because it adds to the current literature on the testing of rationality of survey data, in particularly it provides empirical evidence from a developing country. As for the country under study, the finding of the study

could establish whether the forecasts documented by such survey are accurate or not; and if not ways to produce more accurate forecasts must be found. 'Rationality' here means that manager use all available information at the time the forecasts are made. It will be such that, the forecast error, that is the difference between the actual value and the forecast is unpredictable, given what the forecaster knew when making the forecast.

II. Methodology

Following Muth (1961), expectations are said to be rational if the subjective probability distribution of expected outcomes coincides with the objective probability distribution of actual outcomes. Such expectations must possess several properties. Let A_t denote the realisation of output in period t, and ${}_{t-1}F_t$ denote the forecast made on output for period t made in period t-1. If the forecast is based on rational expectations then:

$$A_t = E({}_{t-1}F_t/I_t) \tag{1}$$

where E_t is an operator that denotes a mathematical expectation and I_t is the set of information available to agents at the end of period t. It follows that:

$$E[(A_t - {}_{t-1}F_t)/\Omega_t] = 0 \tag{2}$$

where Ω_t is a subset of the full information set I_t. Letting η_t represent the forecast error $(A_t - {}_{t-1}F_t)$. Equation (2) can then be written as:

$$E[\eta_t/\Omega_t] = 0 \tag{3}$$

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:	A_t	$= {}_{t-1}F_t + \eta_t$	
(ii) No serial correlation:	$E[\eta_t/\eta_{t-i}]$	$= 0$	$i = 1,2,\ldots, N$
(iii) Efficiency:	$E[\eta_t/A_{t-i}]$	$= 0$	$i = 1,2,\ldots, N$
(iv) Orthogonality:	$E[\eta_t/\Omega_{t-i}]$	$= 0$	$i = 1,2,\ldots, N$

Thus, there are four standard tests to evaluate the rationality of survey data, namely; the unbiasedness, no serial correlation, efficiency and orthogonality tests.

a) The Unbiasedness Test

To test for the absence of biasness, the following equation proposed by Theil (1966) is usually estimated:

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

where α and β are the parameters to be estimated, and ε_t is a random term with zero mean and constant variance. The output forecasts are unbiased predictors of actual output if the joint hypothesis that $\alpha = 0$ and $\beta = 1$ cannot be rejected. The F-test used to test the joint hypothesis on both the intercept (α) and the slope (β) coefficients of equation (4) is given by

$$F_{(r,n-k-1)} = [(RSSR - USSR)/r]/[USSR/(n-k-1)] \quad (5)$$

where RSSR is the restricted sum of squares residual (that is the residual sum of squares of the regression in which the coefficient are restricted to their hypothesised values), USSR the unrestricted residual sum of squares, r is the number of restrictions, k is the number of independent variables and n is the number of observations [Maddala, (1977)]. The likely sign and magnitude of the slope coefficient give us the following interpretations: (1) If $\beta = 1$, then on the average forecast values are actually equal to the observed realised output values, (2) If $\beta = 0$, then on the average forecast values are unrelated to actual values, (3) If $\beta < 1$, then on the average forecast values tend to over-predict the actual output values, (4) If $\beta > 1$, then on the average forecast values underestimate the actual values, and (5) If $\beta < 0$, then on the average the direction of forecast tends to be opposite of the actual value. In estimating equation (4), the estimated residuals should not exhibit serial correlation if the forecasts are unbiased predictions of the observed values of actual output.

b) No Serial Correlation Test

Under rational expectations hypothesis, past forecast errors are part of the information set, thus, it follows that forecast errors are serially uncorrelated. A direct test of no serial correlation between the forecast errors and its past values is to regress η_t on lagged values of itself. That is, we estimate the following equation:

$$\eta_t = \delta_0 + \Sigma^N_{i=1} \delta_i \eta_{t-i} + \varepsilon_t \quad (6)$$

and test the null hypothesis that δ_0 and δ_i (i=1,2,...,N) equal to zero.

c) The Efficiency Test

Managers with rational expectations will use information about past realisation of output produced efficiently in making predictions about the future course of the output variable. This concept of efficiency requires that the process generating observed realisation in output will be identical to the process generating the forecasts. Since past history of output values has been included as the only information set, the test is usually noted as a 'weak-form' of efficiency test.

Pesando (1975) proposes estimating an autoregressive model whereby observed and forecasts were generated solely by the past realisation of output values. The following equations are in order

$$A_t = a_0 + \Sigma^N_{i=1} a_i A_{t-i} + \mu_{1t} \quad (7)$$

$$_{t-1}F_t = b_0 + \Sigma^N_{i=1} b_i A_{t-i} + \mu_{2t} \quad (8)$$

where μ_{1t} and μ_{2t} are random error terms. The efficiency condition requires that the null hypothesis, H_0: $a_i=b_i$ for all i (i=1,2,....,N), which were tested using the usual Chow (1960) test for equality of the coefficients. Substracting equations (8) form (7), we have the following estimating equation suggested by Mullineaux (1978):

$$A_t - {}_{t-1}F_t = \theta_0 + \Sigma^N_{i=1} \theta_i A_{t-i} + \eta_t \quad (9)$$

where $\theta_0 = (a_0-b_0)$, $\theta_i = (a_i-b_i)$, and $\eta = (\mu_1-\mu_2)$. The null hypothesis to be tested is that the estimated $\theta_0 = (a_0-b_0)$ and $\theta_i = (a_i-b_i)$ are not statistically significantly different from zero for all i (i=1,2,...,N) as a group. Moreover, the estimated error structure η_t, should not exhibit serial correlation.

d) The Orthogonality Test

This is a strong-form efficiency test. Managers with rational expectations, in the sense of Muth, will use all available information to form their expectations. Thus, the errors in their expectations reported at time t, should be uncorrelated with all information available at time t-1, and with any subsets of that information. The results imply that in a regression on forecast errors, all of the coefficients on a subset of the information contained in I_{t-i} should have coefficients equal to zero. To test that the forecast errors be orthogonal or systematically uncorrelated with all relevant available information, we estimate the following equation:

$$A_t - {}_{t-1}F_t = \phi_0 + \Sigma^N_{t=i} \phi_i I_{t-i} + \omega_t \quad (10)$$

The null hypothesis of rational expectation implies that all the coefficients in equation (10) should be equal to zero. The information set I_{t-i}, refers to the lagged values (i=1,2,....,N) of all relevant variables that were incorporated at the time the forecasts are made.

However, what constitutes 'relevant' information is of course controversial. There are wide ranges of economic variables to choose from. According to Feige and Pearce (1976), the question of what variables should be included in the information set I_{t-i}, actually depend on costs and benefits. They coined the word 'economically' rational expectations, that individuals will set the marginal cost equal to the marginal benefit of acquiring information. Holden and Peel (1983) postulated that the benefits of making accurate forecasts by acquiring information over the costs of acquiring those information are substantial.

Consequently, in this study, we have selected several sets of information that are available which could be acquired without incurring any costs. The information sets used are narrow money supply, total net exports, rate of inflation and income. Of course, one could in principle conduct a widespread search among possible and logical candidates for the information set I, doing so would clearly render meaningless any statistical test based on a stated number of degrees of freedom. Instead the tests presented here arbitrarily consider four familiar macroeconomic series that not only are costlessly available to market participants but also feature prominently in typical discussions on the national economic outlook.

e) Sources of Data

In Malaysia, explicit forecasts of economic variables from expectations survey data have been conducted by both the government and the private sector. These include *'Business Expectations Survey of Limited Companies'* by the Department of Statistics on bi-annual basis; *'Industrial Trends Survey'* by Malaysian Industrial Development Authority (MIDA) on bi-annual basis; *'Survey of Industrial Trends'* by Central Bank of Malaysia on quarterly basis; *'Business conditions Survey Report'* and *'Consumer Sentiments Survey Report'* by Malaysian Institute of Economic Research (MIER) on quarterly basis, and *'Survey on Key Sectors/Industries of the Economy'* by Public Bank Berhad on quarterly basis. Of all the above survey reports, *'Business Expectations Survey of Limited Companies'* published by the Department of Statistics, Malaysia is consistent and readily available to the general public. The other reports are of more recent events and are not easily accessible to the public.

The Department of Statistics conduct 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 flor the next six months Other informations that were 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 sector. 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 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, the period of study is from 1978:1 to 1992:2 giving a total of thirty time series observations. Agricultural sector in this study refers to both rubber and oil palm sectors. Bi-annual time series data on observed realisation of gross revenue, capital expenditure and employment and their respentive forecast values made by manager of the agricultural firms were compiled from various issues of the *'Business Expectations Survey of Limited Companies'* published bi-annually by the Department of Statistics, Malaysia. On the other hand, information on money supply, net exports, income (proxy by industrial production index) and inflation rate were collected from various issues of the *'Monthly Statistical Bulletin'* published by the Central Bank of Malaysia (Bank Negara Malaysia).

III. Discussions on Empirical Results

Results of the unbiasedness test are presented in Table 1. The F-tests failed to reject the null hypothesis (H_0 : $\alpha=0$ and $\beta=1$) for predicting gross revenue and capital expenditure. Furthermore, the finding that the slope coefficient is generally less than one suggests that farm-firms have over-estimated actual gross revenue, capital expenditure and employment for the period under study.

Interestingly, in accordance with rational expectations, there are no significant evidence of autocorrelated errors as shown by the Durbin-Watson statistics. A direct test of no serial correlation was also conducted and the results

TABLE 1

Results of Unbiasedness Tests

	α	β	R2 D.W.	F-Test
Gross Revenue	109.62 (1.098)	0.91858 (9.899)*	0.784 2.11	1.20
Capital Expenditure	21.439 (1.288)	0.72805 (4.4149)*	0.419 2.19	1.66
Employment	24.373 (3.2805)*	0.75994 (10.028)*	0.788 1.92	10.77*

Notes: Figures in parentheses are t-statistics; *denotes Statistically significant at 5% level; t=2.042; F(1.27)=4.21.

TABLE 2

Test for No Serial Correlation

Lags	F-Statistics		
	Gross Revenue	Capital Expenditure	Employ-ment
1	0.29	0.36	0.00
2	0.26	0.85	0.17
3	0.69	0.73	0.12

Notes: Critical values at 5% level are: F(1.27)=4.21, F(2.25)=3.39, F(3.23)=3.03.

are presented in Table 2. Clearly enough the F-tests failed to reject the null hypothesis of no serial correlation. This implies that farm-firms have incorporated all the information available to them from other variables which may themselves be serially correlated.

To be rational, expectations must efficiently use the available information. According to the weak-form efficiency test, expectations and realisations should identically incorporate the information contained in past realisations as shown by equation (3). Tables 3 and 4 report the results of the weak-form efficiency tests, employing the Pesando's and Mullineaux's approaches respectively. For the Pesando test, we apply White's test for heteroscedasticity on the data. The results show that the null hypothesis of homoscedasticity is not rejected at five per cent level. As such we proceed using the usual Chow test for equality of the coefficients. The F-tests clearly rejected the null hypothesis of no equality of the coefficients for one lagged, two lagged and three lagged of past realisations of the variable of interest.

On the other, results of the Mullineaux test (see Table 4) on efficiency show that in all cases the F-tests failed to reject the null hypothesis that all coefficients equal zero as a group. The Durbin-Watson statistics also indicate that serial correlation is not present among the residuals. Thus, the above results clearly suggest that for the period under study, we cannot reject the hypothesis that farm-firms efficiently use the information contained in past realisations of gross revenue, capital expenditure and employment in forming their respective predictions.

Last but not least is the orthogonality test. Under the rational expectations hypothesis, forecast error are orthogonal to (or are uncorrelated with) the variables in the agent information set. Table 5 presents the F-statistics, from per-

TABLE 3

Pesando's Weak-Form Efficiency Test

Lags	Gross Revenue		Capital Expenditure		Employment	
	F-Test	Chi-Square	F-Test	Chi-Square	F-Test	Chi-Square
1	0.15	1.74	0.93	3.40	0.32	5.88
2	0.61	5.24	1.07	8.75	0.15	6.40
3	1.30	3.46	0.73	17.65	0.68	4.09

Notes: Chi-square critical values at 5% level, for lag 1, 2 and 3 are 5.991, 11.07 and 18.307, respectively. Critical values for F-statistics are as per Table 2.

TABLE 4

Mullineaux's Weak-Form Efficiency Test

	θ_0	θ_1	θ_2	θ_3	R^2 D.W.	F-Test
A) Gross Revenue	150.36	-0.1181			0.059	1.70
	(1.494)	(1.279)			2.00	
	173.94	-0.1496	0.0119		0.068	0.91
	(1.4219)	(0.9963)	(0.0839)		1.94	
	223.98	-0.0643	0.1962	-0.3247	0.254	0.00
	(1.7534)	(0.4427)	(1.1862)	(2.3041)*	2.17	
B) Capital Expenditure	11.030	-0.1692			0.044	1.26
	(0.7341)	(1.1047)			1.89	
	3.1900	-0.2504	0.1760		0.089	1.20
	(0.1687)	(1.4252)	(1.0137)		1.80	
	1.0900	-0.2946	0.1612	0.0833	0.092	0.77
	(0.0505)	(1.2733)	(0.8308)	(0.3626)	1.74	
C) Employment	7.7000	-0.0625			0.013	0.35
	(0.7323)	(0.5904)			2.27	
	6.2700	-0.0438	-0.0024		0.005	0.06
	(0.4991)	(0.2006)	(0.0129)		2.26	
	4.1021	-0.0373	-0.3287	0.3318	0.134	1.19
	(0.2666)	(0.1599)	(1.2779)	(1.8030)	2.30	

Notes: Figure in parentheses are t-statistics, *denotes statistically significant at 5% level, t=2.069, Others are as per Table 2.

TABLE 5

Results of Strong-Form Efficiency Tests

	Money Supply	Net Exports	Inflation Rate	Income
A) One Month Lag				
Gross Revenue	0.64	1.78	0.40	1.05
Capital Expenditure	0.43	0.72	0.10	1.62
Employment	0.39	0.20	0.31	0.20
B) Two Months Lag				
Gross Revenue	0.59	1.64	0.69	1.18
Capital Expenditure	8.13*	0.47	0.13	1.11
Employment	0.48	0.45	0.43	0.13
C) Three Months Lag				
Gross Revenue	0.62	1.56	1.06	1.31
Capital Expenditure	6.32*	0.37	0.33	0.81
Employment	0.38	0.32	0.31	0.10

Notes: *denotes Statistically significant at 5% level; F(1.28)=4.21, F(2.27)=3.35, F(3.26)=2.98.

forming the orthogonality test with respect to four macroeconomic series. Results in Table 5 show that gross revenue, capital expenditure and employment uniformly appear to be rational in the sense of efficiently incorporating the information contained in three common macroeconomic series, that is total net exports, inflation rate and income. But, as for money supply, the farm-firm could have significantly improved their predictions on capital expenditure by better exploiting the information contained in these sources.

IV. Conclusions

The evidence in this paper suggests that gross revenue, capital expenditure and employment forecasts of the agricultural firms reported in the 'Business Expectations Survey of Limited Companies' are rational because their forecast errors are unpredictable. These results are consistent with a study conducted by Colling and Irwin (1990) for the farm-firms in the United States.

Our results show that we cannot reject the hypothesis that agricultural firms in Malaysia optimally use the information they have when they make their forecasts.

The rationality of the forecasts implied by the present study suggest that *'Business Expectation Survey of Limited Companies'* published by the Department of Economics, Malaysia, with regard to the agricultural sector is a useful and an important source of reference for planning, coordinating and simulation purposes for the general public, the corporate sectors, research institutions and the relevant international bodies. In forming their expectations about the future developments in the agricultural sector these forecasted values can be incorporated in their 'plan' for their future action.

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