CHAPTER 4

METHODOLOGY

4.0 Introduction

In Malaysia, both the government and the private sector have conducted forecasts of economic variables from expectations survey data. This includes '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 and 'Survey on Key Sectors/Industries of the Economy' by Public Bank Berhad on a quarterly basis. In this present study, the 'Business Expectations Survey of Limited Companies' is used as the source of survey data as it is consistent and readily available to the general public.

The rationality tests employed in this research consist of the unbiasedness, no serial correlation, and the weak-form efficiency tests, which are used to examine the rationality of gross revenue, capital expenditure and employment. The program E-Views version 3.1 is used in this study.

4.1 Sample Selection

The data used in this research is obtained from the 'Business Expectations Survey of Limited Companies' published by the Department of Statistics of Malaysia. 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 three-stage sampling, 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 Revenue, Employment and Net Fixed Assets in the overall corporate sector. In the second-stage sample selection, the representation of industries within 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.

4.2 Data

The period of study is from 1984:I to 2001:II, giving a total of thirty-six time series observations. Bi-annual time series data on observed realization of gross revenue, capital expenditure and employment and their respective forecast values were compiled from various issues of the 'Business Expectations Survey of Limited Companies'. The sectors covered in this study are banks and other financial institutions, manufacturing, logging, and constructions. Based on data collected twice a year in the form of annual times series, two types of units were used in this study. Volume of money in gross revenue and capital expenditure, both actual and forecasts are stated in Ringgit Malaysia (RM). Whereby, unit for employment is recorded in percentage.

4.3 The Model

According to Habibullah (1994), the concept of rational expectations was first introduced by Muth (1961). His concept has been widely tested on expectations survey data. Based on Muth's literature, there are three standard tests to evaluate the rational expectations hypothesis used in this study, namely; the unbiasedness, no serial correlation and efficiency tests.

Following Muth (1961), let x_t denote the realization of a variable of interest in period t, and ${}_{t-1}Xe_t$ denote the forecast made on the variable for period t made in period t-1. If the forecast is based on rational expectations, then,

(1) $$Xt = E({}_{t-1}Xe_t \mid I_t)$$

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

(2) $$E[(X_t - {}_{t-1}Xe_t) \mid \Omega_t] = 0$$

Where Ω_t is a subset of the full information set I_t. Letting η_t represent the forecast error $X_t - {}_{t-1}Xe_t$, Equation (2) can be written as

(3) $E[\eta_t|\Omega_t] = 0$

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, Equation (1), (2) and (3) suggest the following testable tests of rationality;

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

(ii) No Serial Correlation: $E[\eta_t|\eta_{t-i}] = 0$ $\quad i = 1,2...,K$

(iii) Efficiency: $E[\eta_t|X_{t-i}] = 0$ $\quad i = 1,2,...,K$

4.4 Method of Analyses

4.4.1 Unit Root Tests

Unit Root Test is an alternative test of stationarity. A time series (x_t) is stationary if its mean, $E(x_t)$ is independent of t and its variance, $E[x_t - E(x_t)]^2$ is bounded by some finite number and does not vary systematically with time. Thus, it will tend to return to its mean and fluctuations around this mean will have broadly constant amplitude. A stationary series tends to return to its mean and fluctuate around it within a more-or-less constant range. A non-stationary series would have a different mean at different points in time. One of the characteristics of a stationary series then is that it tends to return to, or cross its mean values repeatedly and this property is the one, which is exploited by most stationarity test. Generally, the mathematical model can be expressed as follow:

$X_t = \rho Xe_t + \varepsilon_t$

Where ; Xt = realized variable

Xe_t= expected variable

Unit Root Test is conducted on the level of the logarithms of the actual and expected values of the variables gross revenue, capital expenditure and employment. These three variables are transformed to logarithms because often a series with a non-stationary variance will be stationary in the natural logarithms. This transformation is appropriate if the standard deviation of the original series is proportional to the mean, so that the percentage fluctuation is constant through time.

Existence of unit root in a time series indicates that the time series is non-stationary. In the unit root test, the null hypothesis is that there is a unit root, which maintain that the time series are difference stationary. This null hypothesis is maintained unless there is overwhelming evidence to reject it.

The null hypothesis and alternative in unit root tests for stationary and non-stationary can be adopted as:

H_0: $\rho = 1$ (The model is non-stationary)

H_A: $\rho \neq 1$ (The model is stationary)

The null hypothesis can be rejected if the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) t-test statistics are smaller than the critical value for all tests at the 10%, 5% and 1% significance level. (In this study the critical value is 5%).

4.4.1.1 Augmented Dickey-Fuller Test

To examine the stationarity of time-series data, we use Augmented Dickey-Fuller test for the unit roots on survey forecasts. The ADF test for unit roots is estimated by running the following OLS regression:

(4) $$Y_t - Y_{t-1} = \beta_0 + \beta_1 Y_{t-1} + \beta_2 \Delta Y_{t-1} + \beta_3 \Delta Y_{t-2} + \ldots + \beta_n Y_{t-n} + \varepsilon_t$$

Where ; Yt = realized variable

Y_{t-1} = expected variable

There are three choices in running the ADF test regression. One is whether to include a constant term in the regression. Another is whether to include a linear time trend. The third is how many lagged differences are to be included in the regression. In each case the test for a unit root is a test on the coefficient in the regression. If the coefficient is significantly different from zero then the hypothesis that y contains a unit root is rejected and the hypothesis is accepted that y is stationary rather than integrated.

4.4.1.2 Phillips-Perron Test

Phillips and Perron developed an alternative test for a unit root. Unlike the ADF test, there are no lagged difference terms. Instead, the equation is estimated by ordinary least squares (with the optional inclusion of constant and time trend) and then the t-statistic of the coefficient is corrected for serial correlation.

Hypothesis:

H_0 = No Stationary

H_A = Stationary

A large negative t-statistic rejects the hypothesis of a unit root and suggests that the series is stationary. Under the null hypothesis of a unit root, the reported t-statistic does not have the standard t distribution. We must refer to the critical values presented in the test output. The reported critical values are chosen on the basis of the number of observations and the estimation option. (In this study the critical value is 5%)

4.4.2 Cointegration test

If realized variable and its expected value are non-stationary and follow unit root process, a cointegration test for these variables has been suggested. Granger (1981) was the first to point out that a vector of time series, all of which are stationary only after the differencing, may have linear combination which are stationary without differencing. In such case, those variables are said to be cointegrated. Two sequences of random variables, realized variables and expected variables are said to be cointegrated if

i) they are non stationary in levels

ii) they are stationary in first difference, and

iii) there exist a linear combination of levels which is stationary.

The theory of cointegration addresses the issue of integrating short-run dynamics with long-run equilibrium. For the rationality of expectations, the following three conditions (Granger, 1981) are required :

i) realized variables and expectation variables must be cointegrated

ii) the cointegrated factor must be 1, and

iii) forecasts error must be a white noise process

The cointegration of realized variable and expectation variable implies that the regression equation makes sense because realized and expected values do not drift too far apart from each other over time. If realized and expected are not cointegrated, there is no long run relationship between them. In our study, we employs cointegration tests for those series which are non-stationary in levels and stationary in first differences.

(5) $A = \alpha + \beta F + \mu$

Where;

A = actual

F = forecast

Test for cointegration is an important ingredient in the analysis of cointegrated systems. A time series y_t is said to be integrated of order 1 or $I(1)$ if Δy_t is a stationary time series. If y_t is a random walk it will be a special case of $I(1)$ series. White noise is also a special case of a stationary series. A time series y_t is said to be integrated of order 2 or is $I(2)$ if $\Delta 2y_t$ is $I(1)$ and so on. If $y_t \sim I(1)$ and $u_t \sim I(0)$, then their sum $Z_t = y_t + u_t \sim I(1)$.

The procedure to test the cointegration is first applied in a unit root test to check that x and y are both $I(1)$. Next, we regress y on x (or x on y) and consider $\hat{u} = y - \hat{\beta} x$. We than apply unit root test on $\hat{u}$. If x and y are cointegrated, $u = y - \beta x$ is $I(0)$. Conversely, u will be $I(1)$ if they are not cointegrated. Since unit root test will be applied to u, the null hypothesis is that there is a unit root. Thus the null hypothesis and the alternative in cointegration test are:

H_0: u has a unit root or x and y are not cointegrated

H_1: x and y are cointegrated

The additional problem is that u is not observed. Hence, the estimated residual $\hat{u}$ from the cointegrating regression is used. Engel and Granger (1987) suggest that using the ADF (Augmented Dickey-Fuller) test to test for unit roots in $\hat{u}_t$ is best.

In the case of cointegration tests, the null hypothesis is no cointegration, we maintain that there are no long run relationships. The way the null hypothesis and the alternatives are formulated and the significance levels commonly used for these tests suggest that the test favor unit roots and no cointegration. With similar hypotheses for Y_t, then the cointegration test is:

H_0: X_t and Y_t are not cointegrated

H_1: X_t and Y_t are cointegrated

4.4.3 Test for Unbiasedness

Forecast of economic variable are unbiased predictions of the actual value if the actual ,A and forecasted ,F values differ only by some random term. Mathematically, this requirement can be stated as

(6) $A = \alpha + \beta F + \mu$

Where μ is the disturbance term with zero mean and constant variance.

To evaluate if the values are consistent with unbiased, an F-test can be used to examine the joint, null hypothesis $\alpha = 0$ and $\beta = 1$. Furthermore, the estimated residual from Equation should not exhibit serial correlation if the forecasts are predictions of the actual values in A.

4.4.4 Serial Correlation Test

Expectations of economic agents are said to be rational if there are equal to the true mathematical expectation conditioned on all relevant information known at the time forecasts are made. Such expectation must possess several properties. If expectations are rational then

(7) $\quad {}_{t-1}Xe_t = E(X_t \mid I_{t-1})$

where I_{t-1} is the information available at the end of t-1. It follows that

(8) $\quad E\{(X_t - {}_{t-1}Xe_t) \mid \Omega_{t-1}\} = 0$

Where Ω_{t-1} is any set of information consisting a subset of I_{t-1}.

According to equation (8), forecast error X_t - ${}_{t-1}Xe_t$, are uncorrelated with each variable in the information set. If forecast errors are correlated with available information, then forecasts could not be rational in the Muth sense since they could be improved by taking account of the correlation. Since ${}_{t-1}Xe_t$ is in I_{t-1}, forecast error is uncorrelated with forecasts. Assuming also that X_{t-i} for $i \geq 1$ (and ${}_{t-1}Xe_s$ for $s<t$) are in I_{t-1}, so that past forecast error are part of the information set, it follows that forecast errors are serially uncorrelated (Evans and Gulamani, 1984).

The hypothesis of zero correlation can be tested as follows. Let $\eta_t = X_t - {}_{t-1}Xe_t$ represent measured forecast error, then we regress η_t on lagged values of itself as shown below

(9) $\eta_t = \sum^k_{t-1} \delta_t \eta_{t-1} + v_t$

and test the null hypothesis Ho: $\delta_i = 0$, $i = 1, 2, \ldots, K$ for range of choice of K. In this study we chose K from 1 to 3 lag terms.

4.4.5 Weak Form Efficiency Test

The efficiency condition requires that forecasts fully reflect all available information. This concept of efficiency requires that the process actually generating the forecasts of these values is the same. The simplest process to assume that the observed and expected values are generated solely by information in past realizations or the past history of the series itself. According to Pesando (1975) this concept of weak-form efficiency can be stated as

(10) $X_t = \varnothing_0 + \sum^k_{i=1} \varnothing_i X_{t-i} + \omega_t$

(11) ${}_{t-1}Xe_t = \psi_0 + \sum^k_{i=1} \psi_i X_{t-i} + \pi_t$

where ω_t and π_t are random error terms. According, the weak-form efficiency requires that $\varnothing_i = \psi_i$ for all i; $i=1,2,\ldots,K$. The null hypothesis of rationality or weak-form efficiency can be tested by imposing the constraint that $ø_i = \Psi_i$, and then testing its significance with the standard Chow (1960) test.

4.4.6 Lagrange Multiplier (LM)

The Lagrange Multiplier (LM χ^2) is used to test for serial correlation between the residuals. The null and alternative hypotheses involved are:

H_0: No-serial correlation

H_A: Serial correlation

If the p-value of the calculated observed R-squared is less than the level of significance, the null hypothesis is rejected at that significance level, indicating that there exists problems of serial correlation.

4.5 Conclusion

The above methods discussion can be summarized as follow:

Test	Hypothesis	Result
1) Unit Root Test	H_0: $\rho = 1$ (non-stationery) H_A: $\rho \neq 1$ (stationery)	Reject H_0 if t-test statistics smaller than critical value.
2) Cointegration Test	H_0: X_t and Y_t are not Cointegrated H_A: X_t and Y_t are Cointegrated	Reject H_0 if absolute calculated t-value exceeds the critical value.

3) Unbiasedness Test	H_O: The forecast is Unbiased H_A: The forecast is biased	Reject H_O if calculated F-statistic and χ^2-statistics values exceed F and χ^2 critical value.
4) Lagrange Multiplier	H_O: No-serial correlation H_A: Serial correlation	Reject H_O if ρ-value of the calculated observed R-squared is less than the level of significance.
5) Serial Correlation Test	H_O: No Serial Correlation H_A: Serial Correlation	Reject H_O if calculated F-statistics and χ^2-statistics values exceed F and χ^2 critical values
6) Efficiency Test	H_O: The forecast is efficient H_A: The forecast is not efficient	Reject H_O if calculated F and χ^2-statistics value exceed F and χ^2critical values

The tests above provide an outline of the methods used to analyze the given data in this research.

CHAPTER V

RESULTS & FINDINGS

5.0 Introduction

The results and findings of the 1) Unit Root Test, 2) Cointegration Test, 3) Unbiasedness Test, 4) Serial Correlation Test, and 5) Efficiency Test for the analyzed sectors (Logging, Manufacturing, Construction and Finance) are further discussed as follow:

5.1 Results of the Unit Root Test (Stationary Test)

The Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test are used to test for unit roots. These two tests are used to determine the stationarity of the data series. They consist of running a regression of the level and the first difference of the series against a constant and a time trend. All variables are transformed to logarithmic form.

The results of the Unit Root Test for these periods are presented in Table 1A, 1B, 1C and 1D. For both the ADF and PP tests, the critical value of 5 percent is used to indicate statistical significance. Each variable consists of two types of series which can be categorized as constant without trend considered as intercept and constant with trend considered as trend and intercept respectively in level and first difference for ADF test and PP test.

Table 1A, 1B, 1C and 1D report the results in level and first difference respectively with trend and without trend for ADF and PP tests, which used the optimal lag-length of 3 periods. Results for the ADF test reveal that all the series in level for all sectors are insignificant at the 5% significance level and the null hypothesis cannot be rejected because the t-calculated values in absolute terms are less than the t-critical values. This indicates that the series are non-stationary in level except LEN in Finance sector. This situation may have led to incorrect findings of bias where it did not exist. Similarly to the ADF test, the PP test demonstrates that all the series in level without trend are insignificant at the 5% level, except logging sector, which shows that this sector are stationary in level.

On the other hand, the PP test exhibits that of all the series in level with trend for Logging sector, only one series are insignificant (i.e. LAN) whereas the other five series are significant at the 5% level. This indicates that LAN is non-stationary. As for Manufacturing sector, the only stationery series are LAK, LAG and LEG. Whereas, Construction sector is still non-stationery for all series in level with trend and a stationery series (i.e. LEK) for Finance sector.

However, the results of the PP test with trend and without trend after the first-differencing of the series are significant at the 5% significance level for all sectors except for Construction PP without trend (LAN, LEN) and also Manufacturing which is insignificant LAG for both PP test with trend and without trend. These show that all the variables are stationary in first-difference, because the t-calculated values in absolute terms exceed the t-critical values except for Construction (LAN,LEN) and Manufacturing (LAG). This suggests that after first differencing, the hypothesis of a unit root can be rejected for all series except Manufacturing and Construction.

Table 1A: Results of the Unit Root Test (Logging)

	Augmented Dickey-Fuller test (ADF)		Phillips-Perron test (PP)	
	Constant Without trend	Constant With trend	Constant Without trend	Constant With trend
Level				
LAK	-2.663406	-2.864467	-4.465451*	-4.717629*
LEK	-2.339267	-2.571920	-3.511170*	-3.561758*
LAG	-2.141562	-1.509241	-4.444684*	-4.552022*
LEG	-2.117231	-2.190384	-3.663047*	-4.265843*
LAN	-2.002959	-1.869883	-3.100151*	-3.526441
LEN	-2.424529	-1.852058	-3.411133*	-3.812641*
First difference				
LAK	-5.053287*	-5.159145*	-10.58525*	-10.45678*
LEK	-4.965254*	-4.918773*	-6.986884*	-6.947479*
LAG	-4.803506*	-5.228229*	-12.05280*	-12.44445*
LEG	-4.123671*	-4.202067*	-9.945145*	-10.33986*
LAN	-2.889059	-2.647468	-8.909777*	-9.337095*
LEN	-2.507293	-2.535289	-9.248586*	-9.194509*

Notes:
* denotes significance at the 5% significance level
LAK ~ logarithm of actual capital, LEK ~ logarithm of expected capital, LAG ~ logarithm of actual gross revenue, LEG ~ logarithm of expected gross revenue, LAN ~ logarithm of actual employment, LEN ~ logarithm of expected employment.

Table 1B: Results of the Unit Root Test (Manufacturing)

	Augmented Dickey-Fuller test (ADF)		Phillips-Perron test (PP)	
	Constant Without trend	Constant With trend	Constant Without trend	Constant With trend
Level				
LAK	-0.041877	-2.140215	-0.917231	-4.064817*
LEK	-1.777693	-0.113345	-1.636914	-0.721275
LAG	-1.535494	-0.118642	-1.542008	-0.824445*
LEG	-0.612651	-2.856585	-1.962993	-5.283124*
LAN	-1.761050	-1.111150	-1.122243	-2.079003
LEN	-1.625797	-1.725658	-1.008043	-2.415610
First difference				
LAK	-1.634832	1.489986	-6.986295*	-6.914012*
LEK	-1.717029	2.385028	-7.544190*	-7.655361*
LAG	-1.357852	1.106023	-2.882009	-2.794595
LEG	-4.331026*	4.252564*	-11.53364*	-11.39490*
LAN	-2.659647	2.825371	-5.068888*	-5.041836*
LEN	-3.115497*	3.154661	-5.235048*	-5.118206*

Notes:
* denotes significance at the 5% significance level
LAK ~ logarithm of actual capital, LEK ~ logarithm of expected capital, LAG ~ logarithm of actual gross revenue, LEG ~ logarithm of expected gross revenue, LAN ~ logarithm of actual employment, LEN ~ logarithm of expected employment.

Table 1C: Results of the Unit Root Test (Construction)

	Augmented Dickey-Fuller test (ADF)		Phillips-Perron test (PP)	
	Constant Without trend	Constant With trend	Constant Without trend	Constant With trend
Level				
LAK	-1.197640	-1.609724	-1.656071	-2.999311
LEK	-1.530153	-1.919413	-1.649456	-2.450545
LAG	-1.079584	-1.239101	-1.002992	-2.391601
LEG	-1.026179	-1.346334	-1.023571	-1.461302
LAN	-2.442695	-3.114956	-2.095439	-2.225097
LEN	-0.698559	-0.267044	-0.557100	-0.468095
First difference				
LAK	-2.836405	-2.970479	-8.710773*	-8.568180*
LEK	-2.661814	-2.645086	-7.042095*	-6.925395*
LAG	-2.547679	-2.674901	-8.685505*	-8.597654*
LEG	-2.001188	-2.019888	-6.052559*	-5.986996*
LAN	-1.949806	-1.936140	-2.987986*	-3.105914
LEN	-0.956746	-0.771386	-3.144522*	-3.016548

Notes:
* denotes significance at the 5% significance level
LAK ~ logarithm of actual capital, LEK ~ logarithm of expected capital, LAG ~ logarithm of actual gross revenue, LEG ~ logarithm of expected gross revenue, LAN ~ logarithm of actual employment, LEN ~ logarithm of expected employment.

Table 1D: Results of the Unit Root Test (Finance)

	Augmented Dickey-Fuller test (ADF)		Phillips-Perron test (PP)	
	Constant Without trend	Constant With trend	Constant Without trend	Constant With trend
Level				
LAK	-0.702263	-2.381212	-1.581926	-3.167201
LEK	-0.951189	-3.205251	-1.269112	-3.612869*
LAG	-0.938558	-1.813630	-1.185913	-1.883181
LEG	-0.794199	-1.810393	-1.157429	-1.858607
LAN	-2.859823	-2.874884	-2.195785	-2.818766
LEN	-3.132423*	-2.982831	-2.176825	-2.603565
First difference				
LAK	-2.979133*	-2.912123	-9.051887*	-8.920367*
LEK	-3.788411*	-3.782665*	-7.925156*	-7.913282*
LAG	-2.294212	-2.284245	-6.667105*	-6.588758*
LEG	-2.064018	-2.050175	-7.141959*	-7.106184*
LAN	-2.846101	-2.693646	-5.836737*	-5.755428*
LEN	-2.562685	-2.223725	-5.071056*	-4.959487*

Notes:
* denotes significance at the 5% significance level
LAK ~ logarithm of actual capital, LEK ~ logarithm of expected capital, LAG ~ logarithm of actual gross revenue, LEG ~ logarithm of expected gross revenue, LAN ~ logarithm of actual employment, LEN ~ logarithm of expected employment.

5.2 Results of the Cointegration Test

The meaning of cointegration is that individual non-stationary variables tend to be stationary in one or more linear combinations. The analysis of cointegration helps to discover a tendency for some linear relationships to hold between the actual and the forecast variables if it exists. If there is a stationary combination between the two selected variables, we can conclude that the two variables are cointegrated, indicating that the forecasts are rational.

The results of the Cointegration test are presented in Table 2A, 2B, 2C and 2D. The results are based on the optimal lag-length of one period. The null and alternative hypotheses are as follows:

H_0: Actual (LAK, LAG, LAN) and Expected (LEK, LEG LEN) are not cointegrated

H_A: Actual (LAK, LAG, LAN) and Expected (LEK, LEG LEN)are cointegrated

Using the ADF test, it is found that the absolute calculated t-value exceeds the critical value at the 5% significance level for all the three series; capital expenditure, gross revenue and employment and all sectors except employment for construction sector and capital expenditure for manufacturing sector. This indicates that these three series are stationary, suggesting that cointegration exists between the actual and forecast variables.

5.3 Results of the Unbiasedness Test

H_0: The forecast is unbiased.

H_A: The forecast is biased.

From table 2A, 2B, 2C and 2D, the results indicate that the unbiasedness hypothesis can be firmly rejected at the 5% level of significance in the case of the capital expenditure, gross revenue and employment. This indicates bias in the survey forecasts for these variables, which shows that the calculated F and χ^2-statistic values exceed their respective F and χ^2-critical values at 5% level of significance.

The results presented in Table 2A, 2B, 2C and 2D also suggest that the survey forecasts for gross revenue and employment tend to overpredict the realized (actual) values. This is due to the fact that the estimated slope coefficients are significantly less than unity. The forecast for capital expenditure tend to underpredict the realized (actual) value under manufacturing and finance sectors. The slope of the three series can be seen from figures 1(A, B, C), 2(A, B, C), 3(A, B, C,) and 4(A, B, C) at Appendix Chapter V.

On the other hand, the adjusted R^2 postulates that 47% (construction), 22% (manufacturing), 53% (logging) and 54% (finance) of the variation in the actual capital is explained by the variation in the capital forecast, whereas 60% (construction), 27% (manufacturing), 60% (logging) and 65% (finance) of the variation in the actual gross revenue is explained by the variation in the forecast revenue. Meanwhile, 4% (construction), 49% (manufacturing), and 63% (logging and finance) of the variation in the actual employment is explained by the variation in the employment forecast. Generally, this indicates that a 1% increase in the capital and gross revenue forecast does significantly affect in the actual capital and gross revenue. On the contrary, a 1% increase in the employment forecast does not significant affect the actual employment for construction sector.

The results of the Lagrange-Multiplier χ^2 test can be seen from Table 2A, 2B, 2C and 2D. Basically, this test is used to diagnose the serial correlation problems pertaining to the residuals of the series. The null and alternative hypotheses for the LM ~ χ^2 test are stated as:

H_0: No Serial Correlation

H_A: Serial Correlation

The observed*R-squared for capital expenditure is insignificant at the 5% level for all sectors except manufacturing sector, suggesting that there exists serial correlation problems. Nevertheless, gross revenue and employment do not exhibit serial correlation, as can be seen from the insignificance of the observed*R-squared for logging and manufacturing except finance and construction.

Table 2A: Results of Cointegration Test and Unbiasedness Test (Logging)

	Capital	Revenue	Employment
Constant (α_1)	6.401275	5.763237	0.169377
	(0.784202)*	(3.926295)*	(2.539600)*
Slope (β_1)	0.381536	0.555017	0.595535
	(3.798853)*	(4.837811)*	(3.832706)*
R^2-adjusted	0.528401	0.601622	0.627233
ADF (1)	-3.466596*	-4.182443*	-4.908233*
F-statistic (α_1=0, β_1=1)	904.6205*	55608.83*	227.2919*
χ^2 statistic (α_1=0, β_1=1)	1809.241*	111217.7*	454.5837*
LM χ^2(4) [obs* R^2]	2.868464	5.627129	2.298351

Notes:
* denotes significance at the 5% significance level
t-values are in parentheses under coefficients
LM ~ Lagrange Multiplier
Obs*R^2 ~ observed R-squared

Table 2B: Results of Cointegration Test and Unbiasedness Test (Manufacturing)

	Capital	Revenue	Employment
Constant (α_1)	-0.715378	4.651932	0.179286
	(-0.474139)	(2.504939)*	(0.984504)
Slope (β_1)	1.053289	0.726483	0.951973
	(9.953492)*	(6.628809)*	(19.17816)*
R^2-adjusted	0.216294	0.267117	0.485746
ADF (1)	-0.322276	-2.235288*	-4.509320*
F-statistic (α_1=0, β_1=1)	7297.038*	16785.81*	15675.1*
χ^2 statistic (α_1=0, β_1=1)	15854.08*	33571.62*	313502.0*
LM χ^2(4) [obs* R^2]	10.18436*	8.379536*	1.573869*

Notes:
* denotes significance at the 5% significance level
t-values are in parentheses under coefficients
LM ~ Lagrange Multiplier
Obs*R^2 ~ observed R-squared

Table 2C: Results of Cointegration Test and Unbiasedness Test (Construction)

	Capital	Revenue	Employment
Constant (α_1)	2.954996	1.222585	0.184334
	(3.925104)*	(1.754918)	(2.970772)*
Slope (β_1)	0.744161	0.912544	0.383603
	(9.187463)*	(17.81197)*	(3.940489)*
R^2-adjusted	0.467616	0.601977	0.037023
ADF (1)	-3.502664*	-4.132651*	-1.514606
F-statistic (α_1=0, β_1=1)	2218.951*	3.3858.14*	86.68226*
χ^2 statistic (α_1=0, β_1=1)	4437.901*	67716.27*	173.3645*
LM χ^2(4) [obs* R^2]	4.615644	3.045909	25.98765*

Notes:
* denotes significance at the 5% significance level
t-values are in parentheses under coefficients
LM ~ Lagrange Multiplier
Obs*R^2 ~ observed R-squared

Table 2D: Results of Cointegration Test and Unbiasedness Test (Finance)

	Capital	Revenue	Employment
Constant (α_1)	-1.229575	0.765496	0.475040
	(-0.792365)	(1.122894)	(2.377984)*
Slope (β_1)	1.066678	0.950346	0.808289
	(8.550287)*	(21.77239)*	(10.10182)*
R^2-adjusted	0.542211	0.647449	0.629628
ADF (1)	-3.557262*	-4.612954*	-2.471802*
F-statistic (α_1=0, β_1=1)	14177.77*	123943.0*	19227.67*
χ^2 statistic (α_1=0, β_1=1)	28355.55*	247885.9*	38455.34*
LM χ^2(4) [obs* R^2]	1.943657	5.990984	9.591357*

Notes:
* denotes significance at the 5% significance level
t-values are in parentheses under coefficients
LM ~ Lagrange Multiplier
Obs*R^2 ~ observed R-squared

5.4 Results of the Serial Correlation Tests

Results showing Serial Correlation Tests are presented in Table 3A, 3B, 3C and 3C. In Table 3A, the F-statistics show that the null hypothesis of zero correlation cannot be rejected at the 5% level of significance for gross revenue and capital (two and three lag terms), and employment (one and three lag terms).

Using the χ^2 – statistic similar results are obtained with the exception of gross revenue null hypothesis is rejected at two lag term, capital expenditure at three lag term, and employment at three lag term. This circumstance shows that capital expenditure, gross revenue and employment demonstrate serial correlation problem between its forecast errors.

Generally in Table 3B, the F-statistics show that the null hypothesis of zero correlation cannot be rejected at the 5% level of significance for gross revenue and employment when forecast errors are regressed on its one, two and three lag terms. However, for capital expenditure the null hypothesis can be rejected at the 5% level when forecast error is regressed on its three lag terms. Using the χ^2 – statistic similar results are obtained. This circumstance shows all series demonstrate serial correlation problem between its forecast errors except capital expenditure (three lag term).

In Table 3C, the F-statistics show that the null hypothesis of zero correlation rejected at the 5% level of significance except employment and gross revenue (three lag terms). Using the χ^2 – statistic similar results are obtained. This circumstance shows that only capital expenditure and gross revenue (lag two and three term) demonstrate no serial correlation problem between its forecast errors.

Finally in Table 3D, the F-statistics show that the null hypothesis of zero rejected at the 5% level of significance for capital expenditure and gross revenue (lag three term). Using the χ^2 – statistic similar results are obtained with an additional of insignificant for employment at two lag term. This circumstance shows gross revenue (lag one and three term) and employment (except lag two term) demonstrate serial correlation problem between its forecast errors.

Table 3A: Results of the Serial Correlation Test (Logging)

Variables	F-statistic			χ^2-statistic		
Lags:	1	2	3	1	2	3
Revenue	4.047228*	2.809542	2.038428	8.094457*	8.428627*	8.153714
Capital	3.470338*	2.039770	2.529980	6.940675*	6.119309	10.11992*
Employment	2.631396	2.938949*	2.608989	5.262791	8.816848*	10.43596*

Notes:
* denotes significance at the 5% significance level.

Table 3B: Results of the Serial Correlation Test (Manufacturing)

Variables	F-statistic			χ^2-statistic		
Lags:	1	2	3	1	2	3
Revenue	0.034622	0.027972	0.025175	0.069244	0.083916	0.100699
Capital	0.089677	2.603591	3.019638*	0.179355	7.810772	12.07855*
Employment	0.213133	0.472417	0.428201	0.426267	1.417252	1.712803

Notes:
* denotes significance at the 5% significance level.

Table 3C: Results of the Serial Correlation Test (Construction)

Variables	F-statistic			χ^2-statistic		
Lags:	1	2	3	1	2	3
Revenue	0.738184*	0.871937*	0.736067	1.476369*	2.615811*	2.944266
Capital	9.043278*	5.598729*	4.792629*	18.08656*	16.79619*	19.17052*
Employment	0.209984	0.162033	0.135189	0.419969	0.486098	0.540756

Notes:
* denotes significance at the 5% significance level.

Table 3D: Results of the Serial Correlation Test (Finance)

Variables	F-statistic			χ^2-statistic		
Lags:	1	2	3	1	2	3
Revenue	2.092558	1.376275	1.115107*	4.185115	4.128824	4.460429*
Capital	17.05051*	1.376275*	9.379460*	34.10101*	4.128824*	37.51784*
Employment	0.440457	2.837688	2.250755	0.880914	8.513063*	9.003020

Notes:
* denotes significance at the 5% significance level.

5.5 Results of the Efficiency Test

H_0: The forecast is efficient

H_A: The forecast is not efficient

The results in Table 4A, 4B, 4C and 4D shows the efficiency of forecasters using information in past realizations when forecasting. Table 4A suggest that forecasters are inefficiently using information in past realizations when forecasts on employment are made. For the three lag-terms, the F and χ^2-statistics reject the null hypothesis at the 5% level of significance. On the other hand, the variable gross revenue yields mixed results. As seen from the table, for lag-1 and lag-2, the F and χ^2-statistics are significant at the 5% level, indicating that they are inefficient forecasts. However, gross revenue is insignificant at the 5% level for both F and χ^2-statistics at one lag term. In this instance, when the lag-term is extended to three, the null hypothesis cannot be rejected, suggesting that the forecast is efficient. Hence, when the information set becomes larger, it can be said that forecasters are able to obtain more past information to make efficient forecasts.

The results in Table 4B suggest that forecasters are efficiently using information in past realizations when forecasts on employment and revenue are made. For the three lag-terms, the F and χ^2-statistics cannot reject the null hypothesis at the 5% level of significance. On the other hand, for capital expenditure forecasts, forecasters are not efficiently utilizing information in past realizations. This is because the F and χ^2-statistics allow the rejection of the null hypothesis for all lag-2 and lag-3. . As seen from the table, for lag-2 and lag-3, the F and χ^2-statistics are significant at the 5% level, indicating that they are inefficient forecasts.

The results in Table 4C suggest that forecasters are efficiently using information in past realizations when forecasts on employment and gross revenue are made. For the three lag-terms, the F and χ^2-statistics cannot reject the null hypothesis at the 5% level of significance except gross revenue shows significant at lag-2 term for χ^2-statistics. On the other hand, for capital expenditure forecasts, forecasters are not efficiently utilizing information in past realizations. This is because the F and χ^2-statistics allow the rejection of the null hypothesis for all lag-terms.

The results in Table 4D suggest that forecasters are inefficiently using information in past realizations when forecasts on gross revenue are made. This is because the F and χ^2-statistics allow the rejection of the null hypothesis for all lag-terms. However, the variable gross revenue and employment yields mixed results. As seen from the table, gross revenue: for lag-3 and employment: for lag-2, the F and χ^2-statistics are insignificant at the 5% level, indicating that they are efficient forecasts.

Table 4A: Results of the Weak-Form Efficiency Test (Logging)

Variables	F-statistic			χ^2-statistic		
Lags:	1	2	3	1	2	3
Revenue	8.165448*	3.305436*	2.347573	16.33090*	9.916308*	9.390293
Capital	4.176409*	2.151693	1.605246	8.352818*	6.155078	6.420985
Employment	3.303241*	4.073871*	3.409712*	6.606482*	12.22161*	13.63885*

Notes:
* denotes significance at the 5% significance level.

Table 4B: Results of the Weak-Form Efficiency Test (Manufacturing)

Variables	F-statistic			χ^2-statistic		
Lags:	1	2	3	1	2	3
Revenue	0.109982	0.118129	0.133882	0.219963	0.354386	0.535527
Capital	0.792429	5.026022*	3.742326*	1.584857	15.07807*	14.96931*
Employment	0.764011	0.721029	0.680727	1.528023	2.163087	2.722907

Notes:
* denotes significance at the 5% significance level.

Table 4C: Results of the Weak-Form Efficiency Test (Construction)

Variables	F-statistic			χ^2-statistic		
Lags:	1	2	3	1	2	3
Revenue	1.648394	2.716418	2.205908	3.296789	8.149253*	8.823630
Capital	10.76698*	7.453237*	6.590045*	21.53396*	22.35971*	26.36018*
Employment	0.611489	0.377378	0.397340	1.222978	1.132135	1.589358

Notes:
* denotes significance at the 5% significance level.

Table 4D: Results of the Weak-Form Efficiency Test (Finance)

Variables	F-statistic			χ^2-statistic		
Lags:	1	2	3	1	2	3
Revenue	0.736308*	0.970682*	0.829211	1.472616*	2.912047*	3.316845
Capital	20.18822*	13.86556*	11.69200*	40.37644*	41.59668*	46.76798*
Employment	3.834770*	2.270369	6.325318*	7.669540*	6.811108	25.30127*

Notes:
* denotes significance at the 5% significance level.

5.6 Summary of Results

The results and findings on the analysis can be summarized as follow:

Test	Variables	Logging	Manufacturing	Construction	Finance
1) Unit Root Test	Capital	Reject H_0	Reject H_0	Reject H_0	Reject H_0
	Revenue	Reject H_0	Reject H_0	Accept H_0	Reject H_0
	Employment	Reject H_0	Accept H_0	Reject H_0	Reject H_0
2) Cointegration Test	Capital	Reject H_0	Accept H_0	Reject H_0	Reject H_0
	Revenue	Reject H_0	Reject H_0	Reject H_0	Reject H_0
	Employment	Reject H_0	Reject H_0	Accept H_0	Reject H_0
3) Unbiasedness Test	Capital	Reject H_0	Reject H_0	Reject H_0	Reject H_0
	Revenue	Reject H_0	Reject H_0	Reject H_0	Reject H_0
	Employment	Reject H_0	Reject H_0	Reject H_0	Reject H_0
4) Lagrange Multiplier	Capital	Accept H_0	Reject H_0	Accept H_0	Accept H_0
	Revenue	Accept H_0	Reject H_0	Accept H_0	Accept H_0
	Employment	Reject H_0	Reject H_0	Reject H_0	Reject H_0
5) Serial Correlation Test	Capital	Reject H_0	Reject H_0	Reject H_0	Reject H_0
	Revenue	Accept H_0	Accept H_0	Accept H_0	Reject H_0
	Employment	Reject H_0	Accept H_0	Accept H_0	Accept H_0
6) Efficiency Test	Capital	Accept H_0	Reject H_0	Reject H_0	Reject H_0
	Revenue	Accept H_0	Accept H_0	Accept H_0	Accept H_0
	Employment	Reject H_0	Accept H_0	Accept H_0	Reject H_0

5.7 Conclusion

The above statistical results show all four sectors' variables are stationery except employment for Manufacturing sector and revenue for Construction sector. Realized variables and its expected value are also cointegrated except capital for Manufacturing sector and employment for Construction sector. Forecast of economic variables are biased predictions of the actual value for all sectors. Logging sector employment and capital are rational where their forecast error are not correlated with available information. Revenue and employment for Manufacturing and construction sector are rational. As for Finance sector, capital and revenue variable are irrational. The efficiency condition shows revenue and employment for both Manufacturing and Construction sectors are efficient but employment for Logging sector and revenue for Finance sector are inefficient.

Figure 1A:
Actual and Expected Capital Expenditure
Logging sector (1984-2001)

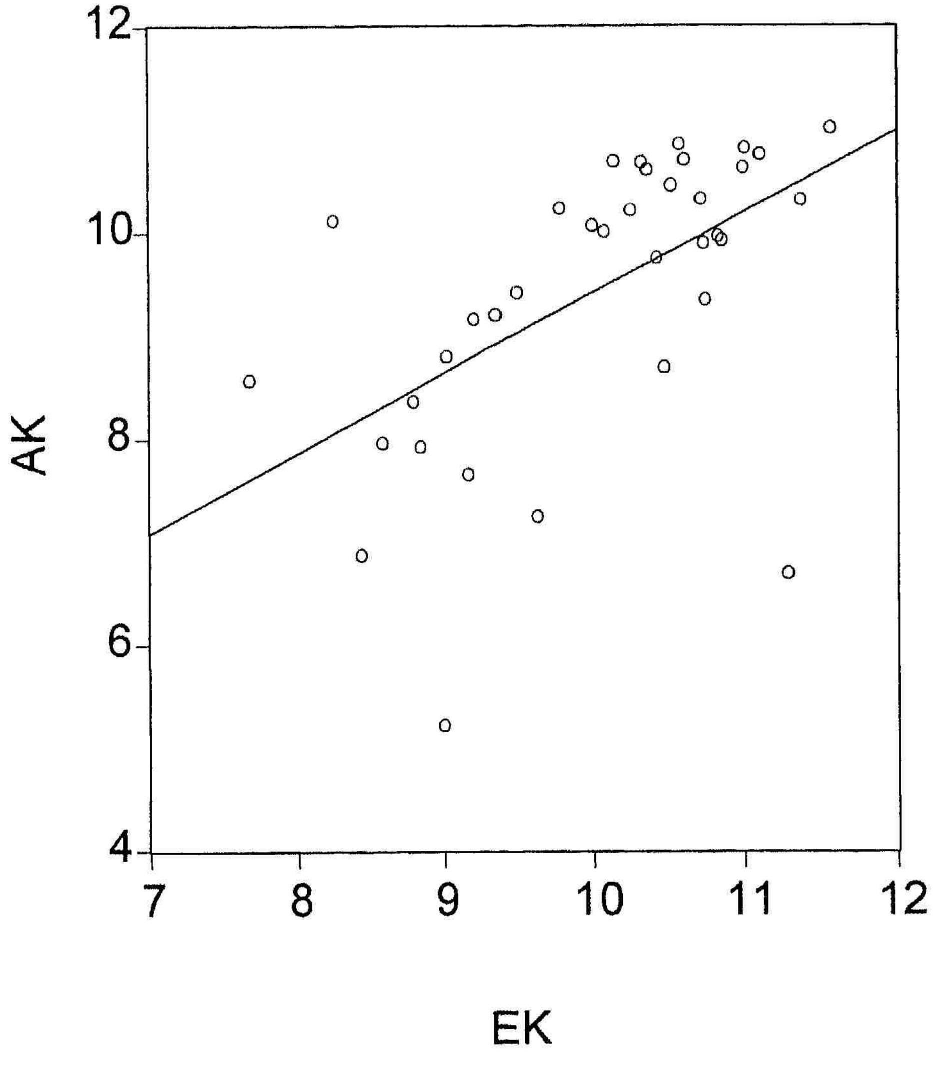

Figure 1B:
Actual and Expected Gross Revenue
Logging sector (1984-2001)

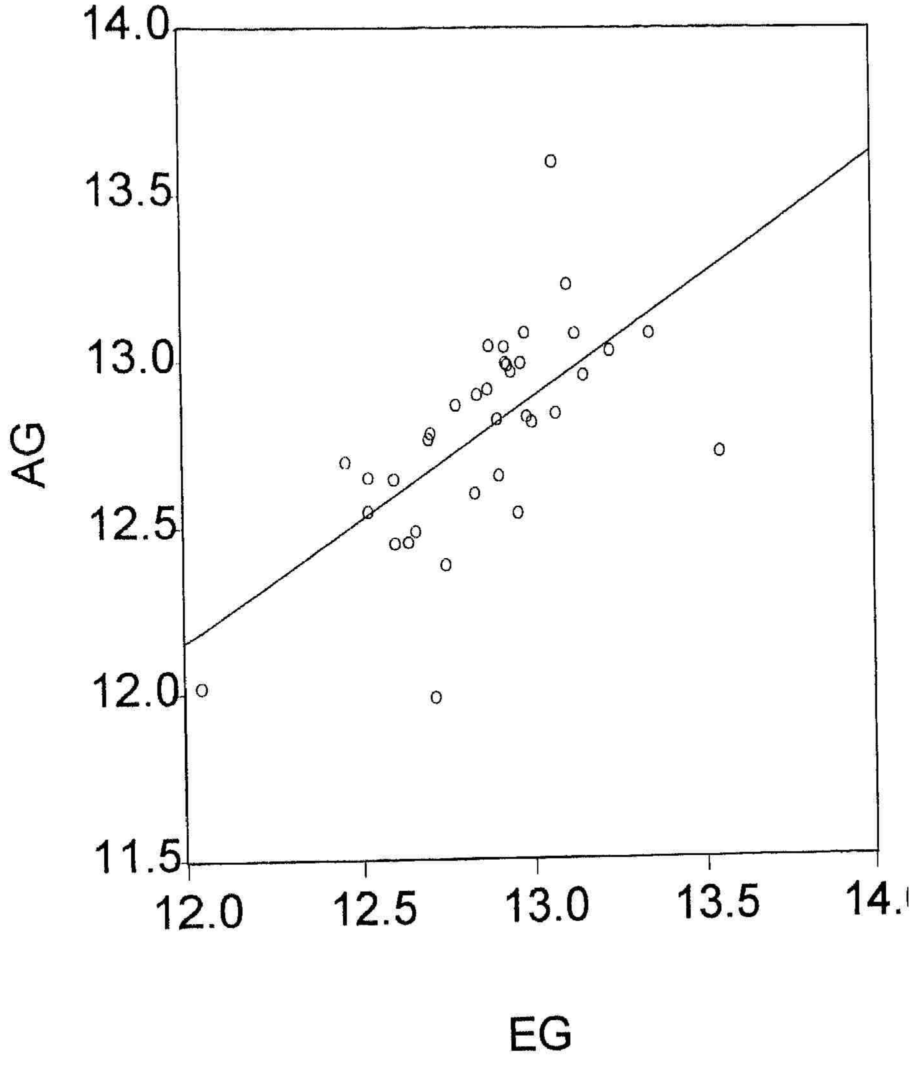

Figure 1C:
Actual and Expected Employment
Logging sector (1984-2001)

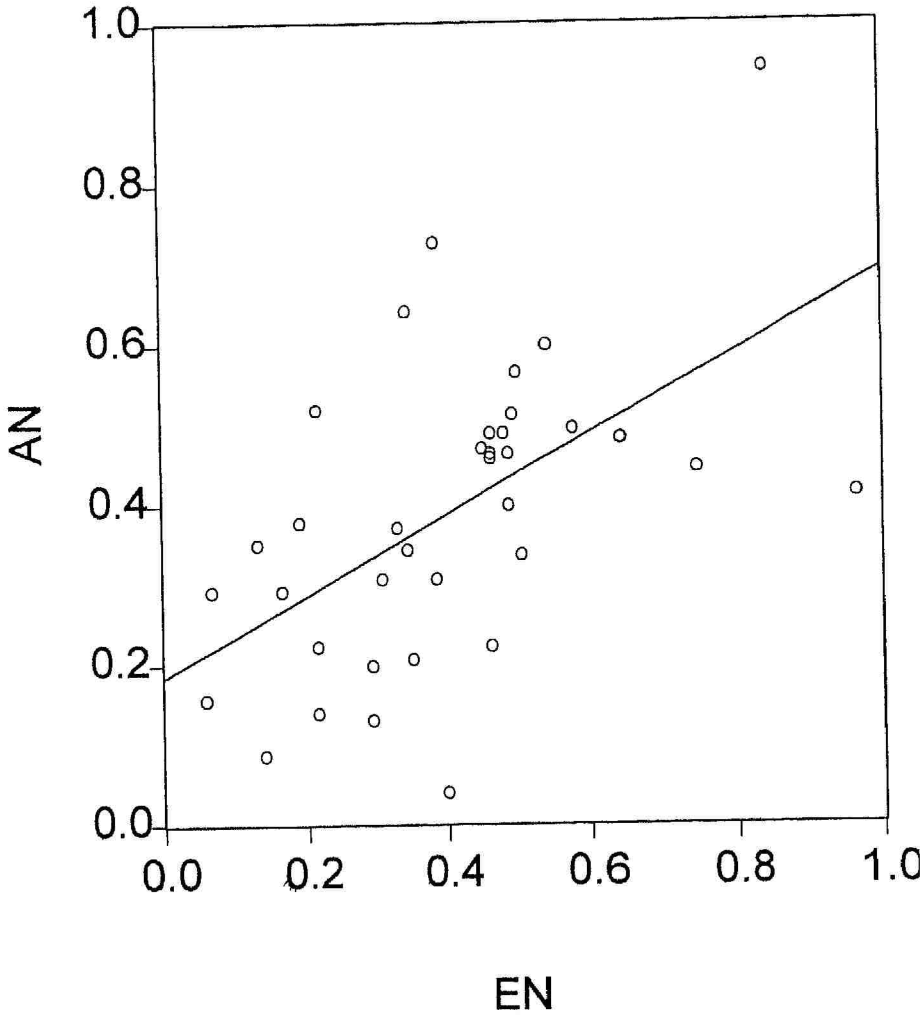

Figure 2A:
Actual and Expected Capital Expenditure
Manufacturing sector

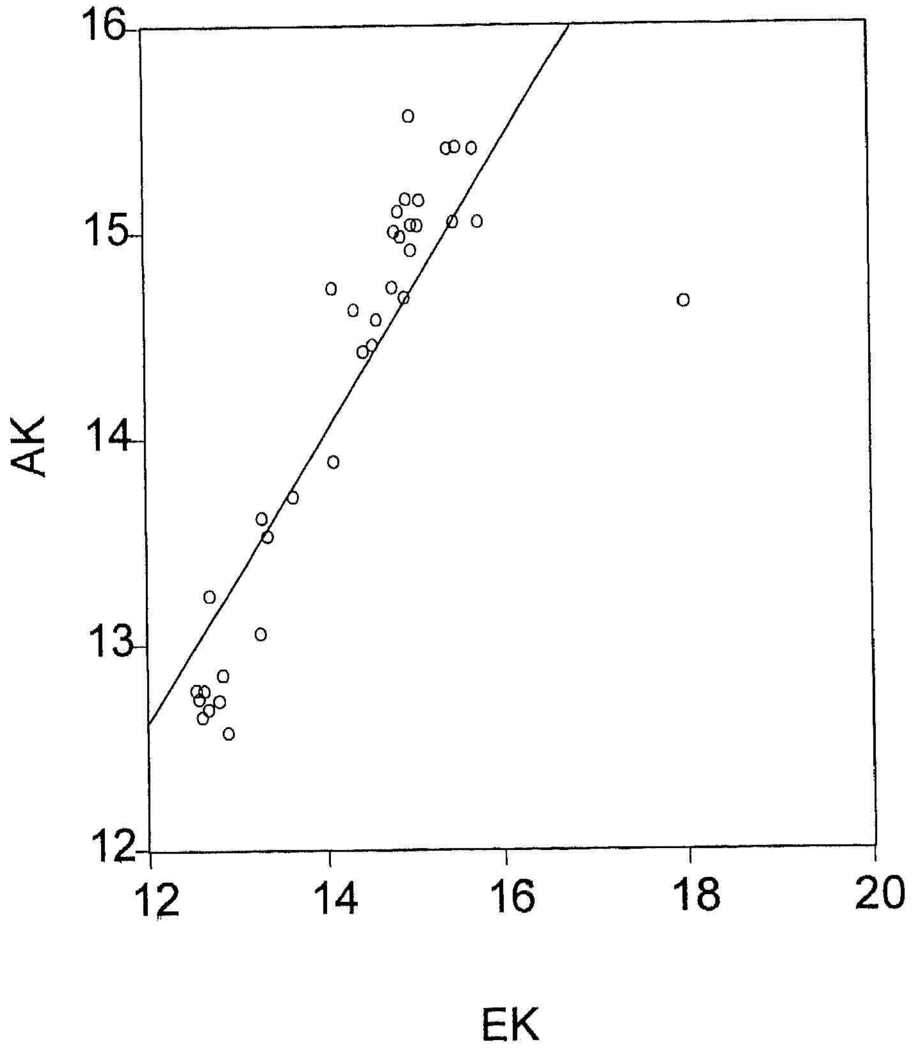

Figure 2B:
Actual and Expected Gross revenue
Manufacturing sector (1984-2001)

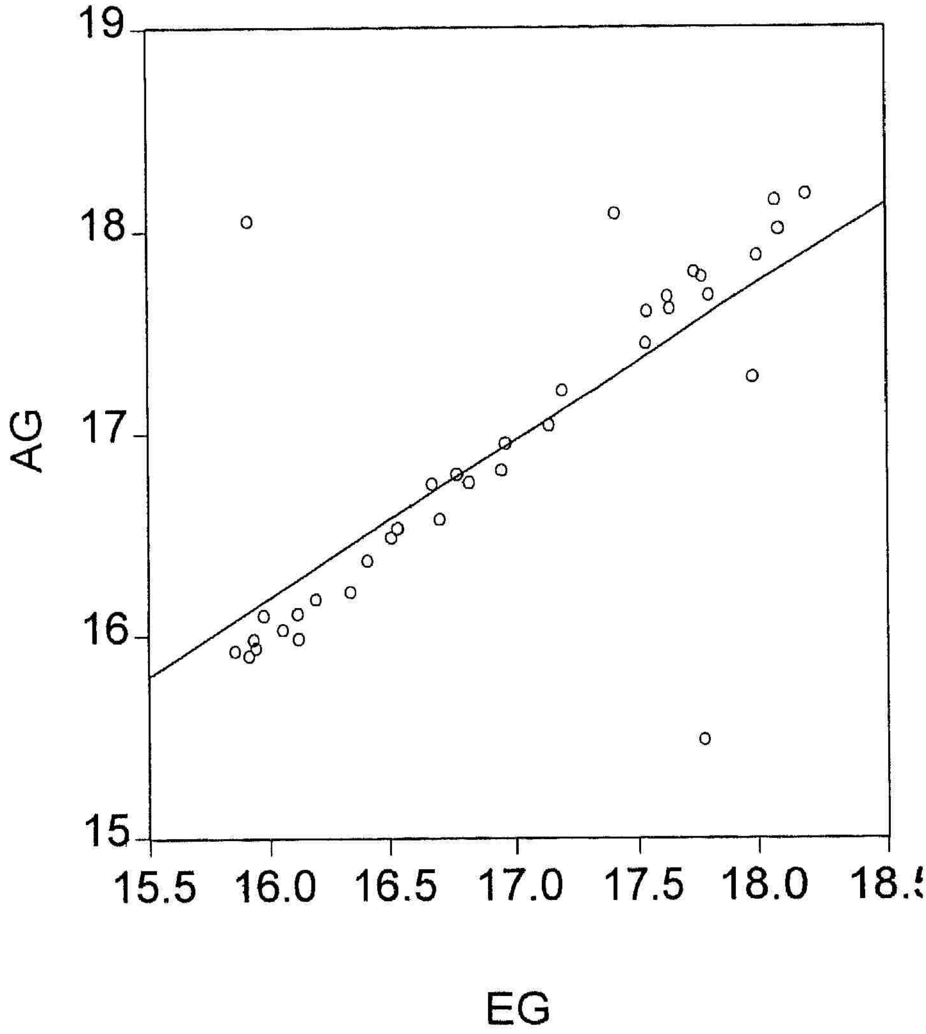

Figure 2C:
Actual and Expected Employment
Manufacturing sector (1984-2001)

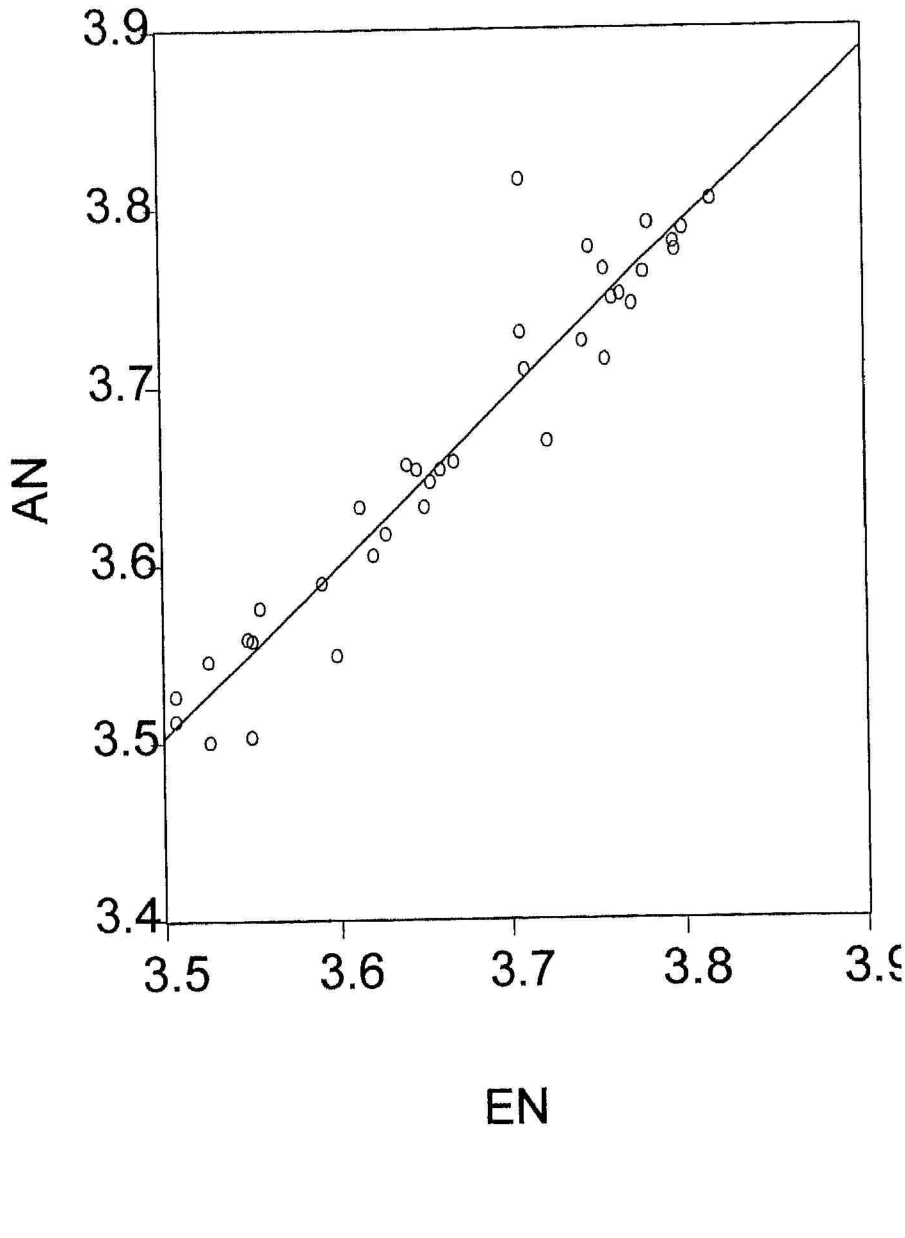

Figure 3A:
Actual and Expected Capital Expenditure
Construction sector (1984-2001)

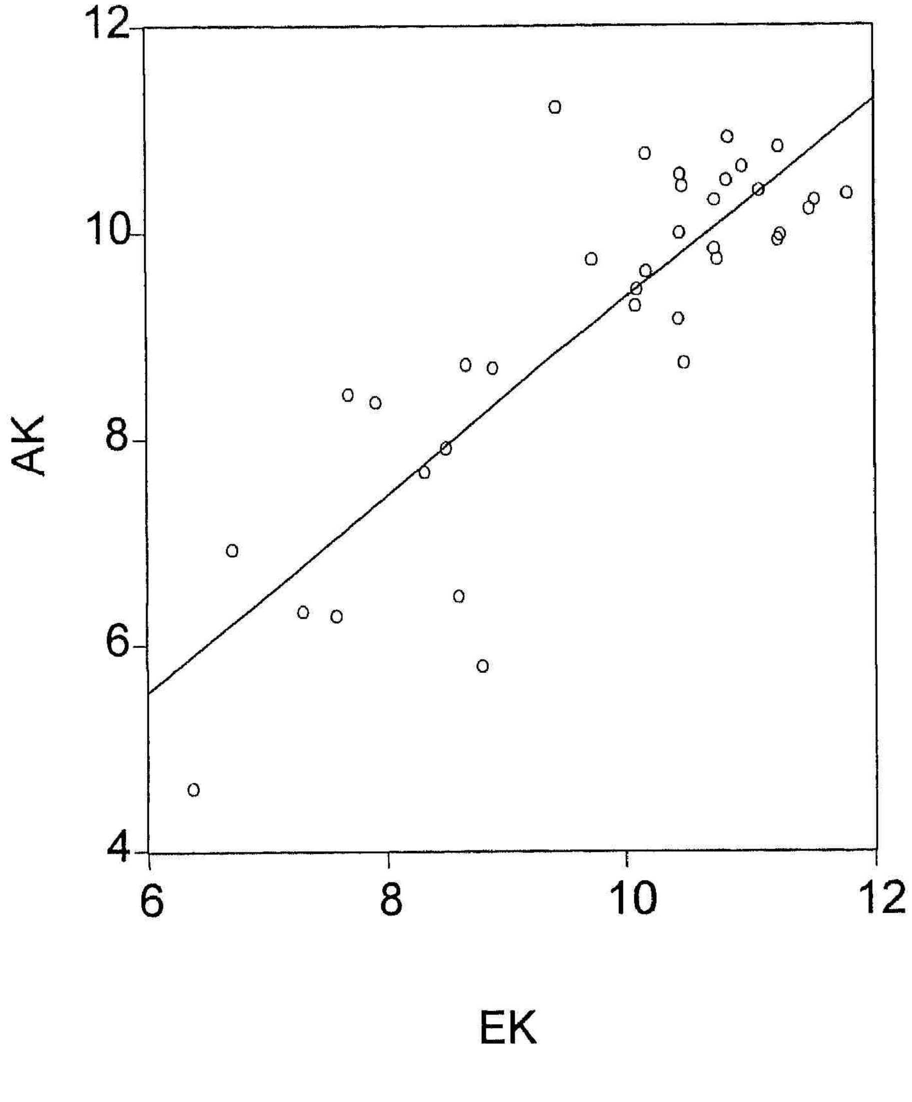

Figure 3B:
Actual and Expected Gross Revenue
Construction sector (1984-2001)

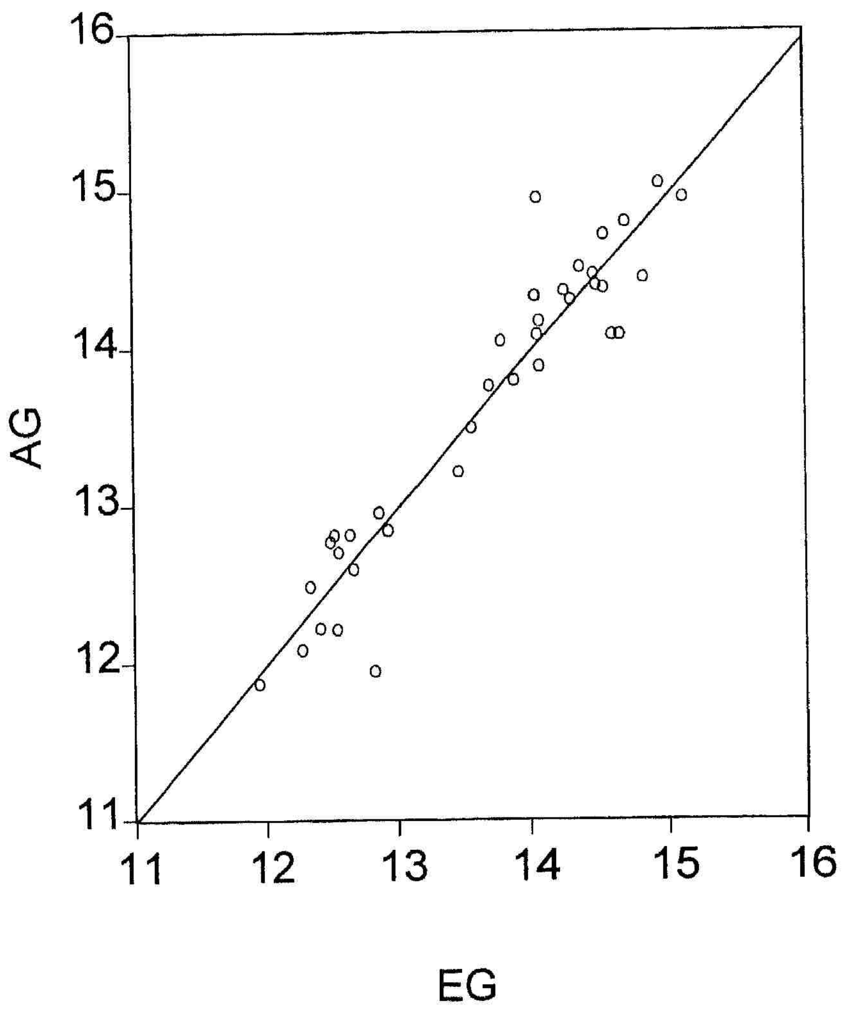

Figure 3C:
Actual and Expected Employment
Construction sector (1984-2001)

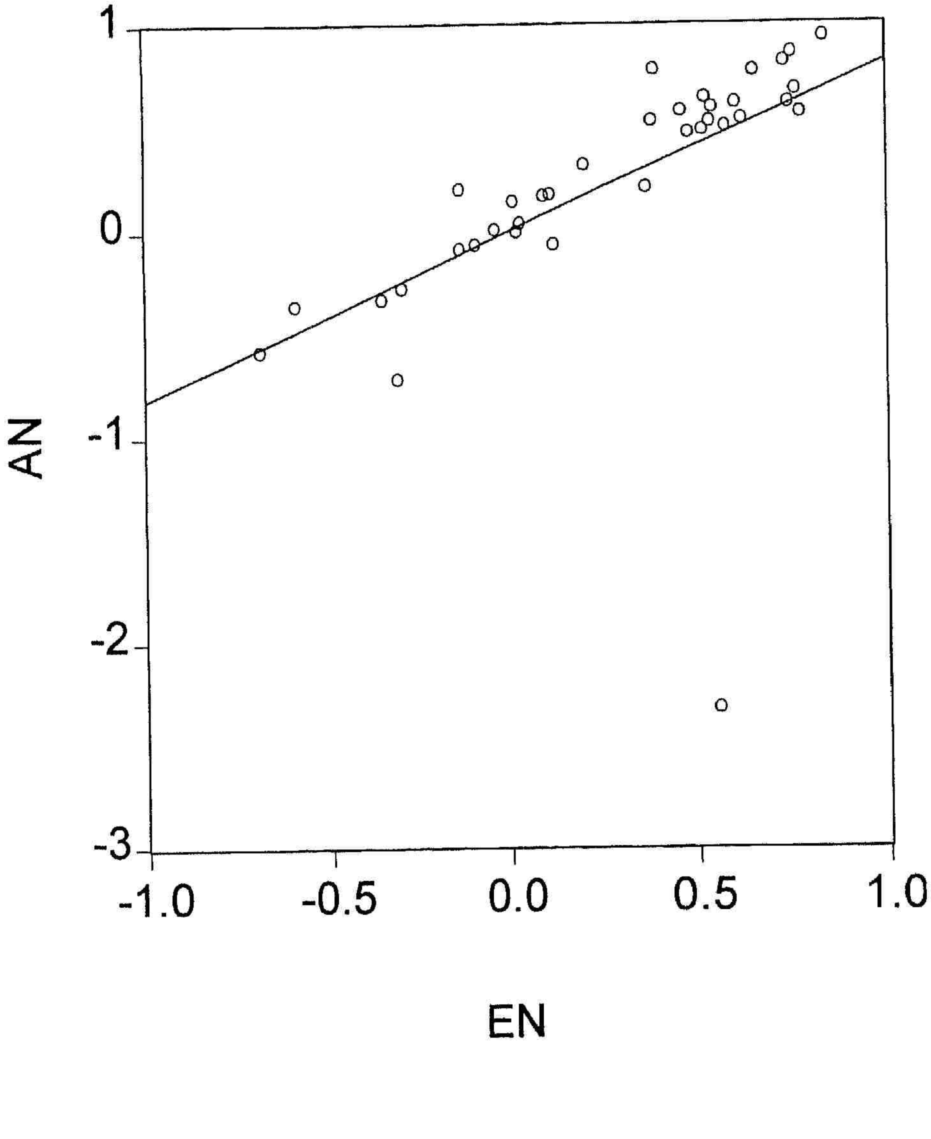

Figure 4A:
Actual and Expected Capital Expenditure
Finance sector (1984-2001)

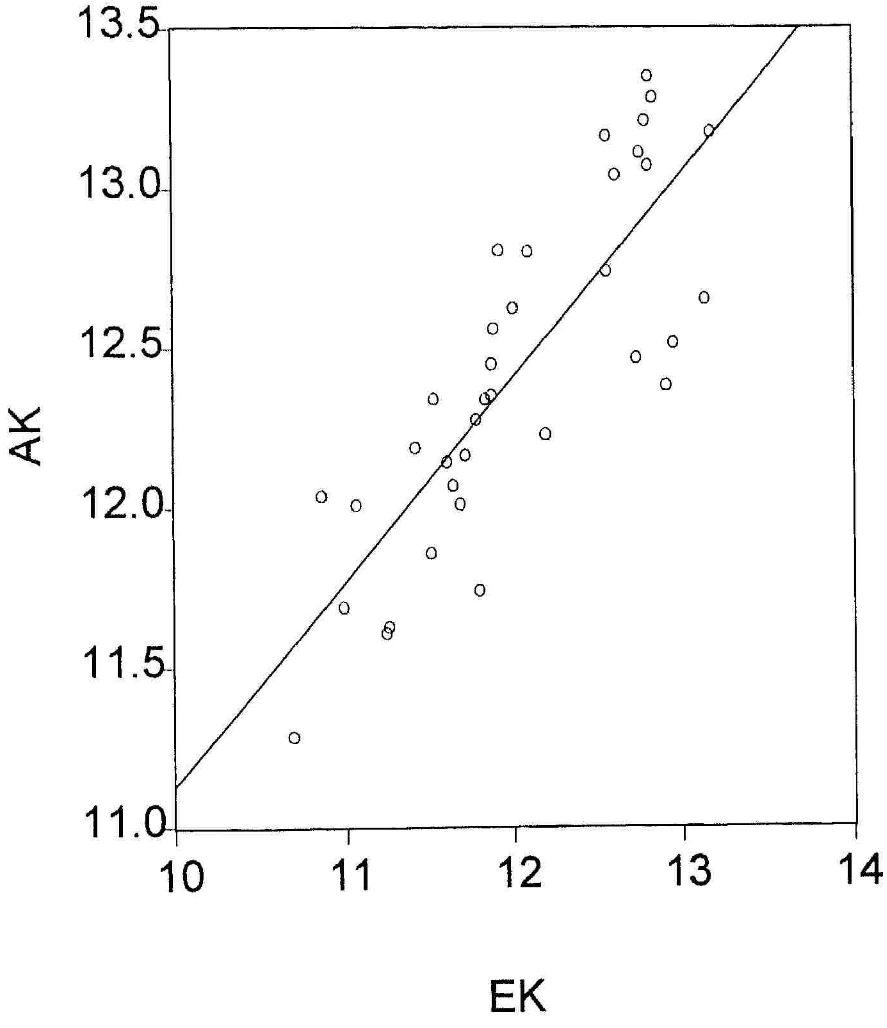

Figure 4B:
Actual and Expected Gross Revenue
Finance sector (1984-2001)

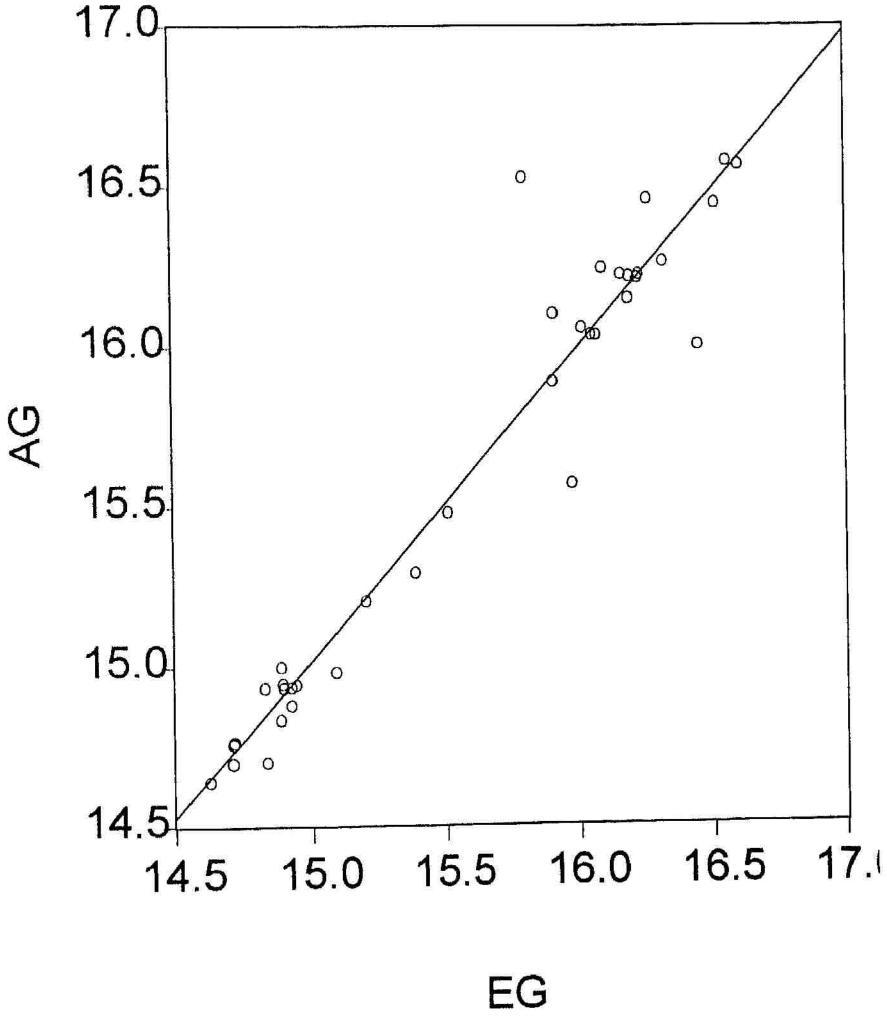

Figure 4C:
Actual and Expected Emplyment
Finance sector (1984-2001)