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KANDUNGAN

KATA-KATA ALUAN PENAUNG

Assalamualaikum Warahmatullahi Wabarakatuh

Tahniah diucapkan kepada Jawatankuasa Jurnal Akademik UiTM Cawangan Kedah khasnya dan warga akademik UiTM Cawangan Kedah amnya kerana telah berjaya menerbitkan penerbitan pertama WAHANA AKADEMIK iaitu Jurnal Akademik UiTM Cawangan Kedah. Usaha ini adalah sejajar dengan cabaran era globalisasi yang memerlukan keupayaan penguasaan dalam pelbagai bidang ilmu. Masyarakat yang tidak mempunyai ilmu akan terus ketinggalan dan terkebelakang dalam segala segi. Sebagai sebuah universiti, para pensyarah dapat memainkan peranan yang penting dalam menghadapi cabaran ini kerana ilmu yang diturunkan dalam bentuk penulisan dapat mengubah nasib sesebuah masyarakat. Oleh itu para pensyarah perlulah berusaha untuk melengkapkan diri dengan meningkatkan pengetahuan tentang bidang masing-masing serta komited dengan penulisan dan penerbitan.

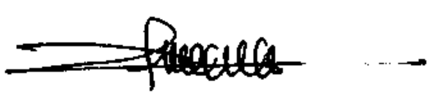
Saya amat berharap kewujudan jurnal WAHANA AKADEMIK akan menjadi pemacu kepada percambahan dan pertumbuhan ilmu serta menjadi saluran utama kepada penerbitan pensyarah UiTM khasnya UiTM Cawangan Kedah.

Saya juga berharap penerbitan jurnal ini dapat dimanafaatkan oleh semua warga kampus UiTM khasnya dan masyarakat amnya dalam usaha untuk memperbanyakkan lagi khazanah ilmu.

Akhir kata, saya sekali lagi mengucapkan setinggi-tinggi penghargaan dan syabas di atas kejayaan menerbitkan WAHANA AKADEMIK.

Sekian. Terima kasih.

Wassalam.



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KATA-KATA ALUAN PENASIHAT

Assalamualaikum Warahmatullahi Wabarakatuh

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Kegiatan penulisan dalam pembentukan profesyen seorang pensyarah di institusi pengajian tinggi adalah sangat penting. Ini adalah kerana dengan melibatkan diri di dalam penulisan akademik, pensyarah dapat menunjukkan bahawa ia sentiasa berusaha untuk melengkapkan diri dan berkemampuan untuk meningkatkan ilmu pengetahuan sesuai dengan tarafnya sebagai seorang ahli akademik. Walau pun sibuk dengan beban pengajaran yang banyak, tetapi pensyarah tidak wajar menjadikannya sebagai alasan untuk tidak terlibat dalam bidang penulisan. Oleh itu, saya menyeru agar pensyarah sekelian berusaha menjadikan penulisan sebagai satu budaya serta memainkan peranan dengan sebaik-baiknya bagi menyempurnakan kegiatan yang berfaedah ini.

Saya juga berharap agar pensyarah menggunakan peluang untuk mendalami ilmu, mengemukakan pendapat dan seterusnya menyebarkan pengetahuan melalui ruang yang disediakan oleh WAHANA AKADEMIK ini dengan sebaik mungkin. Sesungguhnya penerbitan jurnal ini merupakan satu mekanisma yang dapat mempertingkatkan status akademik pensyarah UiTM Cawangan Kedah di mata masyarakat.

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DARI KETUA PENYUNTING

Assalamualaikum Warahmatullahi Wabarakatuh

Syukur kepada Allah kerana penerbitan pertama 'WAHANA AKADEMIK,' iaitu jurnal akademik pertama Universiti Teknologi MARA Cawangan Kedah akhirnya dapat diterbitkan. Usaha untuk menerbitkan jurnal ini lahir daripada kesedaran bahawa budaya penulisan perlu dipupuk di kalangan ahli akademik. 'Wahana' yang bermakna alat untuk melahirkan atau menyampaikan fikiran atau pendapat diharap akan dapat dimanafaatkan oleh ahli akademik dalam usaha untuk menyalur dan berkongsi maklumat mengenai perkembangan pelbagai bidang akademik kepada pembaca.

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Wan Faizah bt. Wan Abdullah

HOW TO ANALYSE TIME SERIES DATA USING COINTEGRATION TECHNIQUES

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ABSTRACT

This paper examines the methods and procedures that are employed in order to analyse time series data. Unit root tests (Augmented Dickey-Fuller and Phillips-Perron) are performed to investigate the order of integration of each variable that enters the model. Models containing non-stationary variables normally lead to problems of spurious regression whereby the obtained statistical results indicate significant relationships between the variables in the equation when in actual fact they are only evidence of contemporaneous correlations instead of true causal relations. Analysis of cointegration enables researchers to deal with models involving non-stationary variables.

Key words: ***Time Series Data, Cointegration Techniques***

INTRODUCTION

Nelson and Plosser (1982) pointed out that most economic variables, including financial variables could be characterised as a non-stationary process. A series is said to be non-stationary when the mean and variance of the variable have to be referred to some particular time period. The simplest example of non-stationary process is the random walk, where the variance is given by $t^* \sigma^2$, where t is time variable and σ^2 is the variance of the series (a random series has a finite constant variance, σ^2 for any t). The variance becomes indefinitely large as $t \rightarrow \infty$. Clearly neither the mean nor the variance is a meaningful concept for the non-stationary process. If these non-stationary series are used in econometric estimation, it will give spurious correlation between the variables. Therefore, the correlation analysis that is commonly used to examine the degree of market integration may yield misleading conclusions.

The analytical tool used is Vector Autoregressive (VAR), to ensure the maximum precision and confidence in the result attained. The application of these techniques is expected to obtain results with minimised errors. VAR assists us to precisely comprehend in depth the interaction and movement among variables in the series. These techniques are the latest and the most robust econometric tool today capable of handling a number of variables dynamically at one time as compared to multivariate regression and correlation analysis. VAR analysis is a flow of tests that commence from the test of stationarity or unit root test (randomness or stochastic), cointegration test, error correction mechanism, Granger's and Sim's causality tests, impulse response test, and conclude with variance decomposition generalisation.

Correlation tests and regression analysis are less powerful as compared to cointegration techniques. Correlation looks at two variables at a time, focusing at a particular point of study and is not dynamic in comparison to the cointegration test, which looks at long-term relationship and equilibrium. In addition, correlation analysis cannot examine cause and effect between variables as in Granger's causality test. A very high R^2 may have no meaningful relationship between the two variables due to the presence of the trend. R^2 measures the strength of a linear relationship between two variables and not by how much of the change in one variable is caused by the other variable. Regression regresses one dependent variable on one or more independent variables where the normality assumption of dependent variables comes into effect. Whereas in cointegration analysis, all the variables are assumed to be dependent variables and are analysed together at one time. In regression, there is no long-term relationship and equilibrium as in cointegration.

Cointegration techniques have many advantages over the other approaches. First, cointegration techniques cater to the problem of non-stationary series, which may lead to spurious correlation. Second, unlike the other approaches, the cointegration approach does allow for any short run dynamics. Cointegration allows all the historical information to be taken into account at once enabling us to separate short run and long run covariance. Meaning that markets often diverge considerably in the short run, but may actually be well integrated over longer periods. This decomposition of short and long run comovements would help in making accurate and more sensible long-term decisions.

The cointegration test consists of two steps. The first step is to determine the order of integration of the individual series. A series Y_t is said to be integrated of order *d* if the series becomes stationary after differencing *d* times and is denoted as $Y_t \sim I(d)$. The second step is to test whether the linear combination of the series that becomes stationary after the first difference is cointegrated. Only variables of the same order of integration may constitute a cointegration relationship.

UNIT ROOT TEST AND ORDERS OF INTEGRATION

The prerequisite for a series to be cointegrated is that the series must have the same order of integration. The order of integration of a series is determined by the number of times that the series must be differenced before becoming stationary. A series, Y_t is said to be integrated of order *d* if the series becomes stationary after differencing d times and denoted as $Y_t \sim I(d)$. For instance, if price series (Y_t) is not stationary at its level but becomes so after the first differencing, (i.e. $Y_t - Y_{t-1}$ is stationary) we describe this as $Y_t \sim I(1)$. If Y_t is stationary at its level before the first difference, then we describe it as $Y_t \sim I(0)$. Thus, the very first step in the cointegration analysis is to determine the order of integration of the series.

There are several unit root tests documented in the literature to determine the order of integration of the individual series. However, the most widely used methods are Augmented Dickey-Fuller test (ADF), which was proposed by Said and Dickey (1984) and Phillips-Perron test (PP) by Phillips and Perron (1988). In this paper, both the ADF and the PP are utilised in the analysis since Schwert (1987) has noted that the ADF statistics may reject the null hypothesis of unit root too often in the presence of the first order moving average process. Recently, however Campbell and Perron (1991) have also shown that the ADF class of statistics has better small-sample properties.

In testing the order of integration using the ADF approach, the following two ADF regression equations could be estimated:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{i=1}^{L} \delta_i \Delta Y_{t-i} + v_t \qquad (1)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 T + \sum_{i=1}^{L} \delta_i \Delta Y_{t-i} + \tau_t \qquad (2)$$

where, ΔY_t is the first difference of the series, α_0 is intercept, α_1 and α_2 are constant, v_t and τ_t are disturbance terms, T is time or trend variable and L is the number of lagged terms. To ensure disturbance terms v_t and τ_t are approximately white noise, a sufficient number of lagged differences L should be estimated. The optimum lag length L may be determined by using the Akaike Information Criteria (AIC) suggested by Akaike (1977).

The null hypothesis states that the level of the series, Y_t, contains a unit root H_0: Y_t is I(1) and the alternative hypothesis is that H_1 : Y_t is not I(1). We reject the null hypothesis when α_1 is found to be negative and statistically significant. The rejection (or acceptance) of the null hypothesis is made by calculating a t-ratio of α_1 to its standard error. The critical value for the test is compared to critical values provided by Fuller (1976).

The unit root test in the level is only a necessary but not a sufficient condition for the series to be integrated of order one, I(1). To confirm that the series is I(1), then the sufficient condition has to be tested using unit root test on the first difference for equations 1 and 2. The test is carried out by the following regression:

$$\Delta^1 Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{i=1}^{L} \delta_{1,i} \Delta^1 Y_{t-i} + v_t \qquad (3)$$

$$\Delta^1 Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 T + \sum_{i=1}^{L} \delta_i \Delta^1 Y_{t-i} + \tau_t \qquad (4)$$

where, $\Delta^1 Y_t$ is the first difference of the series. The null hypothesis is H_0: Yt ~I(1), which is rejected in favour of I(2) if α_1 is found to be negative and statistically different from zero. This test is known as unit root test in first difference.

Phillips - Perron (PP) unit root test proposed by Phillips and Perron (1988) is more robust in the sense that PP allows for a wide variety of serial correlation and time dependent heteroscedasticity. It is also considered to be a powerful test to moderate and small sample size. The PP test estimates the following equations for a series Y_t,

$$\Delta Y_t = \mu_1 + \alpha_1 Y_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta Y_t = \mu_t + \alpha_1 Y_{t-1} + \alpha_2 t + \varepsilon_t \quad (6)$$

where, ΔY_t is the first difference of ΔY_{t-1}, t is trend variable. In equation 5, for Y_t to be stationary, the adjusted t-statistic $Z(t^*_\alpha)$ should be negative and significantly different from zero. For Y_t to be stationary around linear trend in equation 5, the adjusted t-statistic $Z(\hat{t}_\alpha)$ should be negative and significantly different from zero. The critical value for PP tests are given in MacKinnon (1991). Like the ADF test, the PP test is also sensitive to the choice of truncated lag parameters. The criteria discussed in Schwert (1989) may be used to determine the appropriate lag length in the PP tests.

JOHANSEN-JUSELIUS MULTIVARIATE COINTEGRATION TEST

Once we have determined the order of integration of each series, the next step is to test for cointegration relationships among the series. The Johansen-Juselius, which is based on maximum-likelihood estimation is designed to test a number of linearly independent cointegrating vectors existing among the variables. The model also utilises the likelihood ratio test statistic that has an exact limiting distribution, which can be used to estimate cointegration relationships among a group of two or more variables. Besides, it can estimate a number of linearly independent vectors. Perman (1991) pointed out that the advantage of Johansen-Juselius approach over Eagle-Granger approach is that the procedure allows testing for linear restriction on the cointegrating parameters. The test statistic in the Johansen and Juselius can also be compared to known critical values.

To illustrate this approach, let Y_t be a vector of N time series variables, each of which is integrated of order 1. Assume that Y_t can be modelled by the vector autoregression:

$$Y_t = \beta_1 Y_{t-1} + ... + \beta_k Y_{t-k} + \alpha + \upsilon_t \qquad \text{where, t=1, ..., T} \quad (7)$$

here, Y_t is Nx1 vector of stochastic variables; all Y_{t-k} are assumed predetermined; α is a Nx1 vector of constant; v_t is a vector of normal distributed error with zero mean and constant variance; and k is the maximum number of lag length processing the white noise. The lag length of k is chosen by using the Akaike Final Prediction Errors (FPE) criterion. In brief, the technique chooses the length which minimises the forecast error of the series. The following formulation is used;

$$FPE = [(T+k)/(T-k)]\sigma^2 \quad (8)$$

Dickey, D. & Pantla, S. 1987. Determining the Order of Differencing in Autoregressive Process. *Journal of Business and Economic Statistic* **5**: 455 461

Engle, R. 1986. Autoregressive Conditional Heteroscedasticity, with Estimates of the Variance of United Kingdom Inflation. *Econometrica* **50**: 987 1008.

Dickey, D.A & W.A Fuller. 1981. "Likelihood Ratio Statistic for Autoregressive Time Series with a Unit Root", *Econometrica* **49**:1057 1072.

Engle, R.F & C.W Granger. 1987. "Cointegration and Error Correction: Representation, Estimation and Testing", *Econometrica* **55**: 251 276.

Engle, R.F & S. Yoo. 1987. "Forecasting and Testing in Cointegrated Systems", *The Journal of Econometric* **35**:143 159.

Fuller, W.A. 1979. *Introduction to Statistical Time Series.* New York: John Wiley & Sons.

Granger, C.W. W., & Newbold, P. 1974. Spurious Regression in Econometrics. *Journal of Econometrics* **2**: 111 120.

Granger, C.W.J. 1981. Some Properties of Time Series Data and Their Use in Econometric Model Specification. *Journal of Econometrics* **28**: 121 130.

Granger, C.W.J. 1986. Developments in the Study of Cointegrated Economic Variables. *Oxford Bulletin of Economics and Statistics* **48** (3): 13 228.

Johansen, S. and Juselius,K. 1990. Maximum Likelihood Estimation and Inference on Cointegration-With Application to the Demand for Money. *Oxford Bulletin of Economics and Statistics* **52:** 169 210.

Johansen,S. 1988. Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control* **12**: 231 254.

Johnston, J. 1984. *Econometric Methods.* 3rd Ed. New York : McGraw Hill Book Company.

Johnston, S. 1972. *Econometric Methods.* New York: McGraw-Hill.

Nelson, C.R., & Plosser, C. I. 1982. Trend and Random Walks in Macroeconomic Time Series: Some Evidence and Implication. *Journal of Monetary Economics*: 139 162.

Newbold, P., & Granger, C.W. 1984. Experience with Forecasting Univariate Time Series and the Combination of Forecasts. *Journal of Royal Statistical Society* **137**: 131 146.

MacKinnon,J. 1991. Critical Values for Cointergation Test. In Engle,R F & Granger, C W J. Ed. *Long–Run Economic Relationships: Reading in Cointegration.* New York: Oxford University Press.

Perman, R. 1991. Cointegration: An Introduction to the Literature. *Journal of Economic Studies* **18** (3): 3 30.

Phillips P.C.B. 1986. Understanding Spurious Regression in Econometrics. *Journal of Econometrics* **33**: 311 340.

Phillips, P.C.B. 1987. Time Series Regression with a Unit Root. *Econometrica* **55** (2): 277 301.

Phillips, P.C.B & P.Perron. 1988. Testing for a Unit Root in Time Series Regression. *Biometrica* **75**: 335 346.

Said, S.E. & Dickey, D.A. 1984. Testing for Unit Root in Autoressive-Moving Average of Unknown Order. *Biometrica* **71**: 599 607.

Sim, C.A. 1980. Macroeconomics and Reality. *Econometrica* **48**: 1 48.

Stock, J.H.· 1987. Asymptotic Properties of Least Squares Estimators of Cointegrating Vectors. *Econometrica* **55**: 372 380.

Schwert, C.W. 1987. Effects of Model Specification on Tests for Unit Roots in Macroeconomic Data. *Journal of Monetary Economics* **20**: 73 103.

Schwert, G.W. 1989.Test for Unit Root: A Monte Carlo Investigation. *Journal of Business and Economic Statistics* **75**: 147 159.

Osterwald-Lenum, M. 1992. A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statics. *Oxford Bulletin of Economics and Statistics* **54**: 461 472.