CHAPTER IV

METHODOLOGY

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l Introduction

This chapter describes the econometric framework and techniques of analysis applied to ›eting the objectives of the study. In this study, model equations are formulated in line with the ›oretical arguments.

The methodology used in this study includes an evaluation model and statistical tests, ıich assess the interrelation between the variables mentioned in the model and their influence sectoral production in Malaysia. A necessary step prior to the core analysis was to assess the tionarity of the variables using the unit root test. The augmented Dickey-Fuller (ADF) and the ilips Perron (PP) unit root test procedures were used in testing for stationarity of the variables.

The next step involves testing for cointegration between variable using the Johansen and ıelius (1990) test. Finally, the MWALD test for testing Granger non-causality (Toda and ımamoto, 1995) was constructed using Seemingly Unrelated Regressions (SUR).

; Scope of the Study

The data of each variable used for the period of 1991:q1 to 2001:q2. In the study, several :istical tests are used to provide consistent estimates of the parameters

This study employs quarterly data series over the period of 1990; q1 to 2001: q2. Three ndard monetary aggregates namely, M1, M2 and M3[4.1] are utilized in this study. The sectors died are agricultural (AG), mining and quarrying (MN) , manufacturing (MF), construction 3), electric, gas and water (EW), transport, storage and communication (TR), wholesale and ail trade and hotel and restaurant (WR), finance and insurance and real estate and business vice (FB), government services (GS) and other services (OS) in Malaysia. Two additional ancial variable namely, commercial bank loans (CR) and tock prices (CI) are also utilized.

Sources of Data

Data on monetary aggregates, sectoral production, and commercial bank loans are racted from various of issues of the Quarterly and Monthly Bulletin published by Bank gara Malaysia (BNM). The stock price indices were obtained from the Kuala Lumpur Stock change (KLSE).

M1: Currency in circulation plus demand deposits.
M2: M1 plus fixed deposit, negotiable certificates (NCD) and saving and other deposits.
M3 M2 plus net deposit with non-bank financial institution by finance companies and post office saving.

Use of Software Packages

Econometric views (or Eviews) will be used to analyze and test the functional ationships for the above model such as the Augmented Dickey-Fuller (ADF) and the Philips ron (PP) unit root test, and the Johansen and Juselius (1990) test.

Other software will be used to analyze Granger-causality. The MWALD test using the R routine was implemented involving the programming of the corresponding matrices. To strate, we have programmed the steps using RATS software and the programs are presented Appendix A.1. The attached appendix in this report is just one part of the three models sented and discussed.

Properties of Time Series

.1 Trend

There is an important step in dealing with the time-series data, which is to identify the ic pattern or components inherent in the data. Once these components have been identified, methods that best describe these patterns can be employed. The time-series data usually isist of four basic components, which are trend (T_t), seasonal variation (S_t), cycle (C_t) and gularity fluctuation (I_t). With regard to the data used in this study, which is from the period of 1- 2001, we are dealing with the trend component.[4.2]

Trend component is a persistent upward or downward movement of the data over the g period of time. It reflects the long-term growth or decline in the time series. In the case of study, we are dealing with long-term movement of sectoral production and financial iables in Malaysia. If a time-series does not contain any trend component, the data is said to stationary (see Nelson and Plosser, 1982).

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efer to the Correlogram by using Eviews and we have to determine if this trend is stochastic or rministic.

ı.2 Stationarity

A type of stochastic process that has received a great deal of attention and scrutiny by e series analysis is the so-called stationary stochastic process. Broadly speaking, a stochastic cess is said to be stationary if its mean and variance are constant over time and the value of 'ariance between two time periods depends only on the distance or lag between the two iods and not on the actual time at which the covariance is computed.

There are important differences between stationary and nonstationary time-series. In tionary time-series, shocks are considered as temporary; the effect of the shocks will disappear l the time series will be reverting to its long-run mean level. On the other hand, a ıstationary series has a permanent component. The mean and variance of a nonstationary ies are time-dependent and there is no long-run mean to which the series returns.

; Unit Root Tests

An alternative test of stationarity that has recently become popular is known as the unit t test. When the series indicates the presence of unit roots, it means that the time series of the ;ervation indicates non-stationarity.

In econometrics, a time series that has a unit root is known as random walk (time series). ; need to apply first differences to achieve stationarity. Therefore, the time series is said to be t-order integrated, denoted by I (1). When a time series is stationarity in level form it is ıoted as I (0). Similarly, when the original series is integrated of order 2, it is denoted by I (2). obtaining stationarity, a variable is understood that its mean, variance and co-variance are all ariant with respect to time period.

The analysis of cointegration starts with the determination of the univariate properties of time series. If the series do not follow the same order of integration, then there is no aningful relationship between them. In the present context, if all the variables are integrated of same order, we can proceed to the cointegration test. Two asymptotically equivalent ›cedures for detecting unit roots are employed here, namely the Augmented Dickey Fuller DF) (see Said and Dickey, 1984) and the Philips Perron (PP) (Philips and Perron, 1988) tests.

.1 The Augmented Dickey Fuller (ADF) Unit Root Test

Dickey and Fuller (1979) introduced the Dickey-Fuller test to check the presence of unit t in economic time series. The Augmented Dickey Fuller (ADF) (Said and Dickey, 1984) test n extension of the Dickey Fuller by allowing a higher order of autoregression process. ADF is ıducted from the OLS estimation of regression as shown below:

$$\Delta X_t = \alpha_0 + \alpha_1 X_{t-1} + \sum_{i=2}^{p} \beta_i X_{t-i+1} + \mu_t \qquad (4.1)$$

$$\Delta X_t = \alpha_0 + \alpha_1 X_{t-1} + \alpha_2 t + \sum_{i=2}^{p} \beta_i X_{t-i+1} + \mu_t \qquad (4.2)$$

Where

ΔX_t	$= X_t - X_{t-1}$ (the first difference of the series)
α_0	= intercept
α_1, α_2	= constant parameters
μ_t	= white noise error term
t	= time or trend variables
p	= the number of lagged variables

Equation (4.1) is with-constant, no trend variable regression and equation (4.2) is with-ıstant, with trend variable regression. The number of lagged variable, k is important to avoid problem of autocorrelation i.e. to ensure terms are uncorrelated.

In order to implement the ADF test, it is necessary to choose the order autoregression, k. practice, k is unknown, so the researcher must choose k. In this case, we cannot arbitrarily ›ose k because, as contended by Batten and Thorton (1985), if k is chosen to be too small, n the ensuing inference about the unit root is biased. Moreover, if k is chosen to be too large, n it may cause the deterioration in the finite-sample properties of the ADF tests. The optimal -length, k may be selected by using the Akaike's information Criterion (AIC) from Eviews. e lag length that produced that lowest AIC value for the equation was determined to be the ›ropriate lag length.

The null and alternative hypothesis under the ADF test; Ho: $\alpha_1 = 1$ against the H_a: $\alpha_1 = 0$, : Ho is rejected if the observed t statistic is sufficiently negative compared to the critical value the accepted level of significance. It means the series is stationarity. If the observed t statistic smaller than the reported critical value, Ho is not rejected; it means the series is non-ıtionarity.

.2 The Philips-Perron (PP) Unit Root Test

The distribution theory supporting the Dickey-Fuller test assumes that the errors are istically independent and have a constant variance. By applying this methodology, care must taken to ensure that the error terms are uncorrelated and have a constant variance. The PP test s introduced by Philips and Perron (1988) to develop a generalization of Dickey-Fuller ıcedure that allows for fairly mild assumptions concerning the distribution of the error.

The PP test accounts for possible relationship in the first-differences of the economics ies using the non-parametric correction as an alternative to the inclusion of lag variables. The t also allows for the presence of a non-zero mean and a deterministic linear time trend.

The PP test is based on the Ordinary Least Square (OLS). The approach is to first test for it roots from the regression equation with k=0. Then the statistics were converted to filter out e consequences of autocorrelation on the asymptotic distribution of the test statistic. The itical values are similar as those used for the Dickey-Fuller tests because the PP test is a odification of the DF t-statistic that takes into account the less restrictive nature of the error ocess. The PP test can be conducted using the following equations:

$$\Delta X_t = \dot{\alpha}_0 + \dot{\alpha}_1 X_{t-1} + \mu_t \qquad (4.3)$$

$$\Delta X_t = \overline{\alpha}_0 + \overline{\alpha}_1 X_{t-1} + \overline{\alpha}_2 t + \mu_t \qquad (4.4)$$

The t-statistic are calculated and then transformed to remove the effect of the serial elation on the asymptotic distribution of the test statistic. In both equations the adjusted ısformed) t-statistics for both α_1^* and $\bar{\alpha}_1$ should be negative and significantly different from for X_t to be stationarity. The null and alternative hypotheses in unit root test are:

Ho: X_t is non-stationarity/ a unit root process

Ha: X_t is stationarity

The critical for all tests are 5% significant level. The unit root test hypothesis of Dickey-ler and Philips-Perron can be rejected if t-test statistics from these tests are less than (more ;ative) the critical value tabulated. Critical values for both tests are tabulated in Osterwald-ıum (1992).

.7 Cointegration Tests

Cointegration tests provide the natural tool to investigate common trends between two me series over time. This analysis became invaluable when researchers realize that most of the me series are non-stationary in their levels, therefore, leading to spurious results. Two non-tationarity series are said to be co-integrated if a stationary linear combination of two series xists. For example, by using standard OLS regression techniques to estimate the parameters of he cointegrating regression, the estimates of the residual errors, U_t, may be determined. Where:

$$Y_t = \alpha + \beta X_t + U_t \tag{4.5}$$

Suppose variable are first order integrated, I(1), however, there exist values of α and β, such that $U_t = Y_t - \alpha - \beta X_t \sim I(0)$, $E(Z_t) = 0$. Then we conclude that the variables are cointegrated.

1 Johansen-Juselius (1990) Cointegration Tests

In earlier studies, the Engle-Granger (1987) two-step estimation procedure is frequently to test for cointegration. However, this procedure has been criticized for being static and ng several econometric problems. First, Banerjee *et al.* (1986) noted that although Engle-ıger procedure produces super consistent parameter estimates, for small sample the biases d be quite severe. Second, when cointegration relationships are not unique as in the present , then the Engle-Granger procedure performs less satisfactorily. The estimates are not riant to the choice of normalization. Finally, regressing integrated series by using OLS tends ıvalidate statistical inferences (see Perman, 1991).

This study adopts the Johansen-Juselius (1990) maximum likelihood method in the text of the multivariate regression test, which is generally applied to I(1) variables. This hod is the extended work of Johansen (1988) [4.3] and it provides a likelihood-ratio statistic to for the maximum number of independent equilibrium vectors on the co-integrating matrix.[4.4] ısider the following co-integrating vectors of the system,

$$\beta' X_t = Z_t \tag{4.6}$$

ohansen (1988) does not allow an intercept in the model.
'he complete testing procedure is reported in Johansen (1988) and Johansen and Juselius (1990).

e matrix $\beta$is called the co-integrating matrix. For N jointly determined variables, it will be of dimension N X N, but of the rank $r \leq N - 1$, where r is the number of linearly independent -integrating vectors. In specification form, the model be written as:

$$\Delta X_t = \delta + \sum_{i=1}^{k-1} \Pi_i \Delta X_{t-i} + \Pi X_{t-k} + \varepsilon_t \qquad (4.7)$$

here X_t is a column vector of two variables. There are three possibilities to consider. If Π has ro rank, no stationary linear combination can be identified. In other words, the variables in X_t e non-co-integrated. If the rank is r ($0 < r < n$), however, there will now exist r possible ationary linear combinations. From equation (4.7), the general hypothesis of the r co-tegrating vector can be formulated as:

$$\text{Ho: } \Pi = \alpha\beta'; \qquad (4.8)$$

here β' is the r x p matrix of cointegrating vectors, and α the p x r matrix of adjustment or ror correction coefficient. This procedure provides two different likelihood ratio tests to etermine the value of rank, r, of the matrix Π in (4.8). The first is known as the trace test. This st provides a test of the null hypothesis Ho: $r \leq r_0$ against H_a: $r > r_0$ where r refers to the umber of co-integrating vectors.

second likelihood ratio test is the maximal eigenvalue test (λ -max) statistic of Ho: $r = r_0$

inst H_a: $r = r_0 + 1$;

$$\lambda_{max} = T \ln (1 - \hat{\lambda}_{r+1})$$

ere $\hat{\lambda}$'s are the estimated eigenvalues from Π; and T is the number of observations. ansen and Juselius (1990) indicate that the trace test may lack power relative to the maximal nvalue test. Based on the power of the test, the maximal eigenvalue test statistic is often ferred. Critical values for both tests are tabulated in Osterwld-Lunum (1992).

According to cointegration analysis, if two variables are cointegrated, the finding of no-sality in either direction is ruled out. In other words, two variables that posses a common id, causality (in Granger sense) must exist in at least one direction, either unidirectional or bi-ctional. However, although cointegration indicates presence or absence of Granger-causality, oes not indicate the direction of causality between variables.

8 Granger Non-Causality Test

Testing for Granger Non-causality in the context of stable VAR models involves testing hether some parameters of the model are jointly zero. In the past such testing has involved a andard F-test in a regression context. However, recent research (see Toda and Philips, 1993) as shown that when the variables are integrated, the F-test procedure is not valid, as the test atistic does not have a standard distribution.

8.1 The Baseline Model

The vector autoregression (VAR) model is one of the popular tools for empirical studies n the monetary transmission, since Sim's (1980) seminal work. A conventional or standard AR is a reduced system, which can easily be estimated using Ordinary Least Squares (OLS) gression. A VAR consists of a set of variables and is regressed on lagged values of its ogenous variables and other exogenous variables in a system of equation. However, Sim, ock and Watson (1990) argue that the conventional asymptotic is not applicable in testing pothesis in level VAR's if the variable are integrated or cointegrated. Further, Toda and hilips (1993) has shown that the traditional F-test procedure is not valid. Unfortunately, several ternative methods for testing of non-causality such as error-correction model (ECM) (See ngle and Granger,1987) and Vector autoregression error-correction model (VECM) (See hansen and Juselius, 1990) are cumbersome and sensitive to the values of nuisance parameter n finite sample and therefore "virtues of simplicity and ease of application have been largely ost"(Rambaldi and Doran 1996).

.2 Toda and Yamamoto (1995) Test

The more recent Granger no-causality test developed by Toda and Yamamoto (1995) ıred simple procedures, which require researchers to estimate an augmented VAR model in a ightforward way. Moreover, in the context of integrated variable, conventional application of ɜst (i.e. in standard VAR model) was recently criticized by Toda and Philips (1993) for rious regression due to non-standard distribution of test statistic.

Toda and Yamamoto (1995) approach utilizes the Modified Wald (MWALD) test for ting linear restriction on the parameters. This test has an asymptotic χ^2 distribution when a ıR (k + d_{max}) is estimated, where d_{max} is the maximum degree of integration suspected to occur the system and k is the number of lag(s). Therefore, the Toda Yamamoto causality procedure s been labeled as the long-run causality test. Toda and Yamamoto (1995) point out that, for 1, the lag selection procedure is always valid since $k \geq 1 = d$. If $d = 2$, then the procedure is lid unless $k = 1$. Moreover, according to Toda and Yamamoto, the MWALD statistic is valid gardless whether a series is I(0), I(1) or I(2), non-cointegrated or cointegrated of an arbitrary der. In additional, Zapata and Rambaldi (1997) provide evidence that MWALD test has a mparable performance in size and power to LR and WALD tests if the correct number of lags r estimating k + d_{max} is identified and no importance variable are omitted.

Ranbaldi and Doran (1996) have demonstrated that the MWALD procedure for testing anger non-causality can be easily constructed by using Seemingly Unrelated Regression UR).

Specification of Model

This section summarizes the theoretical model underlying the empirical analysis. lowing Toda and Yamamoto (1995) Granger non-causality test for this study can by .mated SUR as follows:

$$\begin{bmatrix} Y_t^i \\ MS_t^i \\ CR_t \\ CI_t \end{bmatrix} = \alpha_0 + \alpha_1 \begin{bmatrix} Y_{t-1}^i \\ MS_{t-1}^i \\ CR_{t-1} \\ CI_{t-1} \end{bmatrix} + \alpha_2 \begin{bmatrix} Y_{t-2}^i \\ MS_{t-2}^i \\ CR_{t-2} \\ CI_{t-2} \end{bmatrix} + \alpha_3 \begin{bmatrix} Y_{t-3}^i \\ MS_{t-3}^i \\ CR_{t-3} \\ CI_{t-3} \end{bmatrix} + \alpha_4 \begin{bmatrix} \varepsilon_{Yit} \\ \varepsilon_{MSit} \\ \varepsilon_{CRt} \\ \varepsilon_{CIt} \end{bmatrix}$$

Where,

Y_t^i : Sectoral production with i = AG, MN, MF, CS, EW, TR, WR, FB, GS, and OS at time t;

MS_t^i : Money supply with i = M1 or M2 or M3 at time t;

CR_t : Total commercial bank loans at time t;

CI_t : Total Stock prices at time t;

ε_t : error terms.

For example to examine that MS_t^i does not Granger causes Y_t^i, the restriction test rocedure is applied with null hypothesis Ho: $\alpha_{12}^1 = \alpha_{12}^2 = \alpha_{12}^3 = 0$, where α_{12}^i are the coefficients f MS_t^i in the first equation of the above system. If the MWALD statistic for the lagged lependent variables (MS_t^i) are significant, a causality from MS_t^i to Y_t^i can be establish by

ecting the null hypothesis. A similar testing procedure can be applied to test the null pothesis that reverses causality running from Y_t^i to MS_t^i with Ho: $\alpha_{21}^1 = \alpha_{21}^2 = \alpha_{21}^3 = 0$, where $_{21}$ are the coefficients of Y_t^i in the second equation of the system. A similar procedure can used test the non-causality from CR_t to Y_t^i and from CI_t to Y_t^i and also for the reverse orders.

This study is based on the methods used by Azali and Habibullah (2000)[4.7]. They ıalyzed the responses of sectoral output namely manufacturing, services and agricultural sectors selected financial variables (i.e. money supply aggregates, credit and stock prices). A sectoral ıgmented VAR model based on Toda and Yamamoto's (1995) work was estimated. However, this study we analyze the response of 10 sectoral production levels (refer to Table 1.2: A ectoral Breakdown of GDP) to the same financial variables using quarterly data in Malaysia.

7 See Azali, M and M.S. Habibullah (2000). The journal paper of "Sectoral impact of monetary policy in Malaysia nd Singapore." *University Putra Malaysia, Faculty of Economy and Management, Working paper no. 7626.*

10 Conclusion

.This chapter states the methodology and data used in the study. It consists of a general scription on the technique adopted in completing the study. The augmented Dickey-Fuller .DF) and Phillip-Perron (PP) unit root test procedures; Johansen and Juselius (1990) integration test; and Toda and Yamamoto's (1995) test are conducted to achieve the jjectives of the study.