FACTORS THAT INFLUENCE THE DETERMINATION OF INTEREST RATE IN MALAYSIAN BANKING SYSTEM

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FACTORS THAT INFLUENCE THE DETERMINATION OF INTEREST RATE IN MALAYSIAN BANKING SYSTEM

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DECLARATION

I hereby declare that this thesis entitled **Factors that Influence the Determination of Interest Rate in Malaysian Banking System** is the result of my own research except as cited in the references.

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FACTORS THAT INFLUENCE THE DETERMINATION OF INTEREST RATE IN MALAYSIAN BANKING SYSTEM

ABSTRACT

This study determines interest rate of a bank for an economy which has recently pursued financial liberalization. As a method we follow the Fisher's Equation. Through this equation, a nominal interest rate formula has been expanded to calculate the determinants of the equation that is the real interest rate and inflation rate. These equations were also expanded to form a simple formula. The purpose of this project is to pursue the method which has been identified to determine the factors that influence the determination of interest rate. In order to that, multiple regression analysis has done to achieve the purpose of this study.

FAKTOR-FAKTOR YANG MEMPENGARUHI PENENTUAN KADAR FAEDAH DALAM SISTEM PERBANKAN MALAYSIA

ABSTRAK

Kajian ini menganalisis faktor-faktor yang mempengaruhi kadar faedah bank untuk ekonomi yang menjalankan pengaliran kewangan. Kita menggunakan kaedah Persamaan Fisher dimana menerusi persamaan ini, formula kadar faedah nominal dan kadar inflasi dikembangkan untuk mengira pekali pembolehubah-pembolehubah bagi persamaan iaitu kadar faedah sebenar dan kadar inflasi. Formula ini juga dikembangkan untuk membentuk satu persamaan ringkas. Motif kajian ini adalah untuk menjalankan kajian kaedah yang telah dikenalpasti untuk menentukan faktor-faktor yang mempengaruhi penentuan kadar faedah. Oleh itu, analisis regresi berganda dijalankan untuk mencapai motif kajian ini.

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LIST OF ABBREVIATIONS

Abbreviations

BLR	Base Lending Rate
BNM	Bank Negara Malaysia
EMS	Excess Money Supply
IRR	Internal Rate of Return
QTM	Quantity Theory of Money
SPSS	Statistical Package for Social Science
YTM	Yield to Maturity

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CHAPTER 1

INTRODUCTION

According to *The Economist's Dictionary of Economics,* the interest rate is defined as the proportion of a sum of money that is paid over a specified period of time in payment for its loan. It is the price that a borrower has to pay to enjoy the use of cash which he does not own, and the return a lender enjoys for deferring his consumption or parting with liquidity. The rate of interest is a price that can be analyzed in the normal framework of demand and supply (Barror's, 2006).

The *Economics Glossary* defines the interest rate as the yearly price charged by a lender to borrower in order for the borrower to obtain a loan. Hence, it is usually expressed as a percentage of the total amount loaned.

According to Stephen G. (2009), interest may be defined as the compensation that a borrower of capital pays to a lender of capital for its use. Thus, interest can be viewed as a form of rent that the borrower pays to the lender to compensate for the loss of use of the capital by the lender while it is loaned to the borrower. In theory, capital and interest need not be expressed in terms of the same commodity.

1.1 Types of Interest

Interest can be classified as in many types such as simple interest, compound interest, nominal interest, cumulative interest, effective interest and stochastic interest rate.

1. Simple interest is calculated only on the principal, or on that portion of the principal which remains unpaid (Classell, 1990). The amount of simple interest is calculated according to the following formula:

$$I = P \times r \times t \tag{1.1}$$

where P is the initial balance or principals, r is the interest rate per annum, and t is the number of periods elapsed that is calculated annually.

According to the *Financial and Investment Dictionary*, simple interest contrasts with compound interest, which is applied to principle plus accumulated interest with reference of Consumer Credit Protection Act of 1968 (Barror's, 2006).

However, the Stephen G. (2009) gives the definition of simple interest as accrued of interest according to the linear accumulation function pattern that is:

$$a(t) = 1 + it \quad \text{for } t=1,2,3,\ldots \tag{1.2}$$

where

i = interest rate

by considering the investment of one unit such that the amount of interest earned during each period is constant. The accumulated value of 1 at the end of the first period is $1+i$, at the end of second period it is $1+2i$, and etc.

Simple interest has the property that the interest is not reinvested to earn additional interest. It is occasionally used for short-term transaction and as an approximation for compound interest over fractional periods.

2. Compound interest is very similar to simple interest; the difference is that unpaid interest is added to the balance due. Put another way, the borrower is charged interest on previous interest charges (Classell, 1990). Assuming that no part of the principal or subsequent interest has been paid, the debt is calculated by the following formulas:

$$I_{comp} = P_0[(1+r)^n - 1]$$

$$P_n = P_0 + I_{comp} \tag{1.3}$$

where I_{comp} is the compound interest, P_0 the initial balance, P_n the balance after n periods (where n is not necessarily an integer) and r the period interest rate. The effective interest rate is a common convention in economics which is to disclose the interest rate as though the term were one year, with annual compounding. The discussion at compound interest shows how to convert to and from the different measures of interest.

According to the Economic Dictionary, compound interest is interest that is added not only to the principle of loan or savings account but also to the interest which already added to the loan or account (E.D.Hirsch, 2002).

Stephen G. (2009) define the word "compound" as the process of interest being reinvested to earn additional interest. The theory of compound interest handles this problem by assuming that the interest earned is automatically reinvested. With compound interest the total investment of principal and interest earned to date is kept invested at all times.

The compound interest is used almost exclusively for financial transactions covering a period of one year or more and is often used for shorter term transaction as well.

3. In economics, interest is considered the price of money. Therefore, it is also subject to distortions due to inflation. The nominal interest rate, which refers to the price before adjustment to inflation, is the one visible to the consumer (*i.e.*, the interest tagged in a loan contract, credit card statement, etc). Nominal interest is composed by the real interest rate plus inflation, among other factors. A simple formula for the nominal interest is:

$$I = r + \pi \tag{1.4}$$

where I is the nominal interest, r is the real interest rate, and the π is inflation. This formula attempts to measure the value of the interest in units of stable purchasing power.

According to Stephen G. Kellison, nominal rates of interest is the interest paid more frequently than once per measurement period. Nominal rate of interest payable m times per period, $i^{(m)}$, where m is a positive integer > 1. By a nominal rate of interest $i^{(m)}$, that mean a rate payable monthly, i.e., the rate of interest is $i^{(m)}$/m for each month of a period and not $i^{(m)}$.The formula to determine the nominal rate of interest:

$$i^{(m)} = m\left[(1+i)^{\frac{1}{m}} - 1\right] \qquad (1.5)$$

4. The cumulative interest is calculated using the formula:

$$I = \left[\frac{FV}{PV} - 1\right] \qquad (1.6)$$

It ignores the 'per year' convention and assumes compounding at every payment date. It is usually used to compare two long term opportunities.

5. The effective rate of interest was defined as a measure of interest paid at the end of the period. However, the effective rate of discount, *d*, is defined as the ratio of the amount of interest earned during the period to the amount invested at the end of the period (Stephen G., 2009).

Assume that a person borrows 1 money at an effective rate of discount *d*. Then, in effect, the original principal is 1-*d* and the amount of interest (discount) is *d*. However, from the basic definition of *i* as the ratio of the amount of interest (discount) to the principal, we obtain:

$$i = \frac{d}{1 - d} \qquad (1.7)$$

When it is expressed *d* as a function of *i* :

$$i = \frac{d}{1-d}$$

$$i - id = d$$

$$d(1+i) = i$$

$$d = \frac{i}{1+i} \tag{1.7}$$

6. Stochastic approaches to interest are also a type of interest. Firstly, the rate of interest should be considered directly as a random variable. Then, basic introduction provided to several models with a stochastic basis which have important applications in practice. Finally, the approach of scenario testing used as a means of dealing with future uncertainty.

Using the basic knowledge of the interest rate, it is been analyzed that the model which has already set by the Bank Negara Malaysia to identify and determine the factors they consider to develop the model of the interest rate.

1.2 Malaysian Banking System and Interest Rate

Bank Negara Malaysia, the central bank of Malaysia sets an interest at which it lends to financial institutions. This interest rate affects the whole range of interest rate set by commercial banks, building societies and other institutions for their own savers and borrowers. However, some objectives for the setting of interest rate were identified as below (BNM, 1999):

1. To achieve financial stability of our currency.

2. To maintain the overall economic growth in our country.

3. To dictate flows of investment.

4. To influence the overall level of expenditure in the economic.

5. To control inflation when the interest rate changes.

Those are the aims that BNM would like to achieve basically by setting the interest rate.

1.3 Problem Statement

Nominal interest rate is the summation of inflation rate and real interest rate so if the nominal interest rate leads to zero, then the real interest rate is same as inflation rate. In order to that, we identify the significance of each factor. There are so many other factors that influence interest rate but to identify if they are the factors, then we have to take a look at the significance of the factors. If the factors are significant then they are the factors and can influence the interest rate.

Through this project, we will identify if the factors did influence the interest rate by using Fisher's Equation with real interest rate and inflation rate as the factor for nominal interest rate.

1.4 Objective of the Project

The present project is basically used the data or information which is based on how do Malaysian banks set interest rate. In order to analyze this task, we base on the Bank Negara Malaysia as the central bank who sets and fixed the interest rate for the other banks in Malaysia. The objectives of my project are:

1. To identify and analyze the factors which influence the interest rate setting behavior of banks

2. To identify the model used to set interest rates which relate to Mathematics.

The objective listed above should be able to achieve in order to apply the mathematics formula to calculate the interest rate.

1.5 Factors Influence The Interest Rate in Malaysia

The bank's interest rate setting behavior generally does not act as a price-taker but sets its loan rates taking into account the demand for loans and deposits (Santomero, 1984). There are a number of forces that must be taken into account when attempting to evaluate the current and future movement of interest rates, (Leonardo Gambacorta, 2007) such as:

1. Condition of the country's economy.
2. Inflationary pressure.
3. Loan and deposit demand.
4. Bank efficiency, credit risk and interest rate volatility.
5. Interest rate channel.
6. Bank lending channel.
7. The currency in international trade.
8. Condition of financial system.
9. Foreign exchange market.

These are some factors that have been accounted in order to set interest rate in Malaysia.

1.6 Research Scope

The data used in this project is collected from Bank Negara Malaysia to view the factors influence the interest rates in Malaysian Banks. Data which are collected are base lending rate, real interest rate, inflation rate and excess money supply. These data are focused for 30 years only that is from 1979 to 2008 in which before 1979.

We scope the research to only nominal interest rate rather than other interest rate. This is because we use Fisher's Equation that is determining nominal interest rate with real interest rate and inflation rate. However, we also use excess money supply as the factor when came to substitute the real interest rate from the Fisher's Equation.

CHAPTER 2

LITERATURE REVIEW

In this chapter, a brief explanation about the references which have been used in this research will be discussed further. There are variety of references had been used to obtain a journal regarding this research. Throughout this chapter, the references will be summarized to analyze the author's review about the topic of research. Besides that, some books and lecture notes related to interest rate was also used to explain this research in detail. Other than that, information or references from the Bank Negara Malaysia and some related data that are used in this project were also analyzed.

2.1 Interest Rate

According Frankel J.A. (1979), he came up with an approach, called "Chicago" theory which explains that prices are perfectly flexible. As a consequence, the changes in the nominal interest rate reflect changes in the expected inflation rate. If the domestic interest rate rises relative to the foreign interest rate because the domestic currency is expected to lose value through inflation and depreciation. However, the demand for the domestic currency falls relative to foreign currency. Hence, it is said that there was a positive relationship between the exchange rate and nominal interest differential.

According to the statement of the "Keynesian" approach by Rudiger, D. (1976), price are proportional to the real interest differential, that is the nominal interest differential minus the expected inflation differential. However, if the nominal interest differential is high because money is tight, then the exchange rate lies below its equilibrium value.

Francis E. Laatsch and Daniel P.Klein (2002) test whether changes in nominal interest rates are related to changes in expected inflation. As a result, the studies indicate that changes in nominal interest rate are significantly related to changes in expected inflation in which the hypothesis that nominal interest rates adjust on a one-for-one basis with the change in expected inflation cannot be rejected.

2.2 Interest Rate Determination

In 1985, Edward and Khan have developed a model to estimate interest rates which consider domestic and international factors. The international factors are changes in exchange rates and the world interest rate while the domestic factors are variations in domestic money, price expectations and national income or gross domestic product.

A model was developed by Ho and Saunders in 1981 and its extension by Angbazo (1997) about the interest rate on loans that should be affected by interbank interest rate than that on deposits.

In 1988, Bernanke and Blinder introduce a model with the bank lending channel, a factor which influence interest rate is not operative when both loan demand and loan supply are perfectly elastic with respect to loan rate. There is a further attempt to test the implication of this model that is by Kashyap et al. in 1993 who examine the changes in the mix between bank loans and commercial paper following monetary policy shocks. Oliner and Rudebusch in 1995, advanced the method to analyze the response of the debt mix to monetary shocks by identifying important differences in the small and large firm's behavior.

Hannan and Berger in 1991 used different approach that is time-series data to examine interest rate rigidly using error-correction methodologies. He differentiates between different types of deposit rate rigidities which concerns on symmetric relationship in respond to shocks to the wholesale interest rate. While Neumark and Sharp in 1992 extends it by examining both deposit rates and lending rates which concerns asymmetric relationships.

In 1991, Gochoco estimated a model of interest rate determination which closely continuous of Edwards and Khan (1985) by using monthly data and generalized least squares procedures by considering the case of Philippines. Ohad had applied Edward's method in 1993 to examine on how the regulation of foreign exchange transactions affected the openness of Israel's capital account. Two simple correction models were developed by Cottarelli et al. in 1995 and followed by Lim in 2000 and Weth in 2002 to estimate the bank rates in the case of heterogeneous banks basically in Germany. This model establishes a log-run relationship between each bank rate and the money market rate.

Awang et al. in 1993, traced the impact of liberalization on interest rate behavior in Malaysia from 1973 to 1991 using the model developed by Edwards and Khan (1985). Then in 1996, Ariff used the same model to measure the effect of international factors on domestic financial markets from financial liberalization in four Asian countries including Malaysia and he found that interest rates in Malaysia are very responsive to the world interest rates and price levels.

According to Hakan Berument (1999), the behavior of Treasury interest rates that are determined via auctions is analyzed and showing that interest rates are affected by both expected inflation and inflation risk. This analysis basically takes the Fisher Hypothesis framework as the reference point.

Coleman et al (1992), recognize that monetary shocks which induce a premium on short term interest rates relative to long term interest rates while Strongin and Tarhan (1990) defend that the expected liquidity effect is the dominant factor in the behavior of the short term interest rates up to three years.

Malaysia's Central Bank, Bank Negara Malaysia (BNM) has suspended the market determination of interest rates for the period from October 1985 to January 1987. However, in September 1987 the BNM turned to the use of the base lending rate (BLR) to control interest rates and this control remained in force till 1 February 1991. Hence the BLR of the banking institutions has been freed from the administrative control of the BNM (BNM, 1999). BNM has liberalized the market for deposits, and allowed the banks to determine their own deposit rates, which has not been the case with the lending rate. In 1983, the central bank introduced a Base Lending Rate system to set the 'floor' for commercial bank lending rates. (Barry Scolnick, 1996).

2.3 Fisher's Equation

Hakan Berument (1999) analyzes Turkish Treasury interest rate behavior using Fisher's hypothesis to show that interest rate are affected by both expected inflation and inflation risk. However, Fisher hypothesis suggests that (expected) inflation is the main determinant of the interest rates in which the empirical evidence indicates that the interest rates increase with expected inflation.

On the other hand, Tobin (1965) had argued that the real interest rate decreases with inflation. However in further studies, Fisher (1979), Darby (1975), Felstein (1976) and Stulz (1986) assumed that the real wealth is kept constant in the form of financial assets (money and capital stock). So, as the inflation rate increases, the opportunity cost of holding money will increase and money demand will decrease.

According to Friedman (1977), there are positive relationship between inflation and inflation risk. They include inflation risk as an additional explanatory variable in the regression analysis because both the variables move together and considered that inflation proxies the inflation risk.

Coppock L. (1999), uses long-term cross-country data to examine the Fisher hypothesis if the nominal interest rates respond to changes in the expected inflation rate. However, evidence was found that interest rates fail to fully adjust to inflation due to variation in the implicit liquidity premium on financial assets.

Fisher equation holds a change in the quantity of money which induces an equal change in nominal rates of interest according to quantity theory of money (QTM) (Lucas, 1980). This relationship has been discussed by Sidrauski (1989) in which an increase in inflation has no effect on real interest rates and on capital accumulation, output, employment and consumption as exemplified. However, Fried and Howitt (1983) reexamine the relationship by introducing bonds in Sidrauski

(1967) and showed that inflation reduces the real interest rate on bonds while left the capital unaffected.

Numerous studies had provided research to measure expected inflation and the level of real interest rates and to help to explain relationship between nominal interest rates and expected inflation in U.S. One of them are Fisher (1896), who argued that in a competitive capital market, rational investors would demand to be compensated for anticipated losses in purchasing power such that their nominal rate of return,i would approximately equal the sum of the expected real rate, rr and expected inflation, π^e. However, according to his hypothesis, i and π^e are independent of each other. In such, Mundell (1963) argued that changes in i would be less than one-for-one with changes in i, since, as inflation would affect the real wealth of individuals, any increases in i would lead individuals to increase their savings to make up for decline in real wealth, causing rr to decline.

CHAPTER 3

METHODOLOGY

This chapter consists of the method which will be used in the present research. In this research, we use the Fisher's Equation in order to determine the interest rate or more specifically the nominal interest rate. With the equation, we would use multiple regressions to identify the factors effect the nominal interest rate.

3.1 Data Collection and Statistic Software Packege

In this present project, data has been collected from Bank Negara Malaysia, BNM. Data that has collected is excess money supply, inflation rates, real interest rate and Base Lending Rate (BLR) which we assume as nominal interest rate. We collected at least 30 data from 1979 to 2008 for each of the variables to run the multiple regressions.

In order to analyze the data that has collected, we use SPSS version 11.5 software. SPSS software is one of the statistical software to analysis the multivariate correlation and multivariate regression equation.

3.2 Fisher's Equation

The Fisher's equation in financial mathematics and economics estimates the relationship between nominal and real interest rate under inflation (Darby, 1975 and Tanzi, 1976). It is named after Irving Fisher who was famous for his works on the theory of interest. In finance, the Fisher equation is primarily used in Yield to Maturity (YTM) calculations of bonds or Internal Rate of Return (IRR) calculations of investments. While in economics, this equation is used to predict nominal and real interest rate behavior. In this research, we follow the approach that is used in economics to determine the nominal interest rate.

It is obvious that the process of determination of interest rates will be significantly different under alternative degrees of openness of capital account of the balance of payments (Mathieson, 1982). This is a simple model for determining interest rate in the developing economies which will be presented briefly in this study. The Fisher's approach is assuming that the country in question is completely closed to the rest of the world. The nominal interest rate can be specified as equal to:

$$i_t = rr_t + \pi_t^e \tag{3.1}$$

where,

i_t = nominal rate of interest

rr_t = real interest rate

π_t^e = inflation rate

3.2.1 Nominal Interest Rate

Basically, nominal interest rate has been determined for commercial banks and finance companies according to Bank Negara Malaysia. For both commercial banks and finance companies, the nominal interest rate that is taken into account are fixed deposit rate (3-month and 12- month), saving deposit rate, and base lending rate.

In this project, the nominal interest rate that is being used is the Base Lending Rate (BLR) for commercial bank. We used BLR to represent nominal interest rate. This is because most of the packages in market are offering BLR +/- of the certain percentage (%).

Base Lending Rate (BLR) is a minimum interest rate calculated by financial institutions based on a formula which takes into account the institutions cost of funds and other administrative cost. The interest rate is computed from a complicated formula under the control of Bank Negara Malaysia. BLR is fixed and standardized in all banks. The BLR is a fluctuation rate. In other word, whatsoever loan packages under BLR +/-, is kind of rate that subject to market fluctuation.

3.2.2 Real Interest Rate

Real interest rate is determined using the following equation by using the factors that affect the real interest rate that is excess money supply. The real interest rate in turn can be specified as:

$$rr_t = \rho - \lambda EMS_t + \omega_t \tag{3.2}$$

where,

ρ = constant (represent the long-run equilibrium real interest rate)

EMS = variable which represent the excess supply for money

λ = parameter (λ>0)

ω = random error term

By following the above equation (3.2), real interest rate would deviate from its long-run value ρ if there is monetary disequilibrium. In the long run, however the money market would be in equilibrium and the variable *EMS* would play no role in behavior of rr_t.

Hence, the solution for the nominal interest rate in a closed economy therefore determined as:

$$i_t = \rho - \lambda EMS_t + \pi_t^e + \omega_t \tag{3.3}$$

Generally, the EMS_t can effect π_t^e but it to be assumed that π_t^e have no direct effects on rr_t (Mundell, 1963).

3.3 Multiple Regression

Multiple Regression model is the regression models that employ more than one independent variable. It is often done to determine whether the inclusion of additional predictor variables leads to increased prediction of the outcome variable. In this case study, we have two independent variables that are excess money supply and actual inflation rate (assume as expected).

The purpose of the multiple regressions is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable (Bowerman, 2005).

The simple linear regression model assumes that the mean of the response variable y depends on the explanatory variable x according to a linear equation:

$$y = \beta_0 + \beta_1 x \tag{3.4}$$

For any fixed value of x, the response y varies normally around this mean and has a standard deviation σ that is the same for all values of x.

In the multiple regression setting, the response variable y depends on not one but several explanatory variables. We will denote these explanatory variable by x_1, x_2, ...,x_p. The mean response is a linear function of the explanatory variables:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_p x_p \tag{3.5}$$

This expression is the population regression equation. We can think of subpopulations of response, each corresponding to a particular set of values for all of the explanatory variables x_1, x_2,...,x_p. In each subpopulation, y varies normally with a mean given by the population regression equation. The regression model assumes that the standard deviation σ of the response is the same as in all subpopulations. We do not observe the mean response, y because the observed values of y vary about their subpopulation means.

The variables in the equation are y (the independent variable) and β_1, β_2,..., β_p (the dependent variables in the equations). The "p" in x_p indicates that the number of predictors included is up to the researcher conducting the study. In the equation above, "β_0" is the y-intercept which indicates the point at which the regression plane intersects the y-axis when the values of the predictor scores are all zero. The terms β_1, $\beta_2, \ldots, \beta_p$ all regression coefficients which are used as multipliers for the corresponding predictor variables.

In this case study, we identify 2 factors which affect the nominal interest rate, i_t. So in this case, the regression model which can be build for the factors are as below:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \tag{3.6}$$

where,

y = nominal interest rate (which is the Base Lending Rate, BLR)

x_1 = excess money supply

x_2 = expected inflation rate

β_0 = y-intercept

β_i = regression coefficient ($i = 1, 2$)

Other than that, we also run another multiple regression analysis to analyze the other two factors that directly influence the nominal interest rate. So now the model will be:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \tag{3.7}$$

where,

y = nominal interest rate (which is the Base Lending Rate, BLR)

x_1 = real interest rate

x_2 = expected inflation rate

β_0 = y-intercept

β_i = regression coefficient ($i = 1, 2$)

3.4 STATISTICAL ANALYSIS

Basically, the statistical analysis started with the collection of normally distributed data. After that, multiple regression analysis is done to identify the parameters which influence the Bank Negara nominal interest rate. In order to run this analysis, Statistical Package for Social Science (SPSS) software is used. Through SPSS, basic statistics like percentages, average (mean), and multiple regression analysis outcome that is, correlation coefficient *(R)*, *t*-test, and regression coefficients (β).

3.4.1 Statistical Significance Testing

In order to predict if the model is good or not, we use multiple analyses for prediction that is to decide if *SSreg* (Sum Square Regression) is large enough relative to *SSres* (Sum Square Residual) so as to be confident about using the regression equation to predict scores on the criterion. To aide this decision, researchers often uses statistical significance testing to guide them. Formally, it is stated that the null hypothesis that *SSreg* is equal to zero, against alternative hypothesis that *SSreg* is greater than zero:

$$H_0 : SSreg = 0$$
$$H_1 : SSreg > 0$$

3.4.2 Analysis of Variance T-Tests

We can obtain intervals and perform significance test for each of the regression coefficients β_j as we did in simple linear regression. The standard errors of the *b*'s have more complicated formulas, but all are multiples of *s*. We again rely on statistical software for the calculations.

A confidence interval for β_j is

$$b_j \pm t^* SE_{b_j} \tag{3.8}$$

where SE_{b_j} is the standard error of b_j, and t^* is the value for the t *(n-p-1)*. In order to test the hypothesis H_0: $\beta_j = 0$, t statistic is computed as:

$$t = \frac{b_j}{SE_{b_j}} \tag{3.9}$$

In terms of a random variable T having the *t (n-p-1)* distribution, the *P*-value for a test of H_0 against:

$$H_a : \beta_j > 0 \text{ is } P(T \geq t)$$

$$H_a : \beta_j < 0 \text{ is } P(T \leq t)$$

$$H_a : \beta_j \neq 0 \text{ is } 2P(T \geq |t|)$$

We may wish to construct confidence intervals for a mean response and prediction intervals for a future observation from multiple regression models.

3.4.3 Analysis of Variance F-Test

In multiple regression model, the hypothesis

$$H_0 : \beta_1 = \beta_2 = \ldots = \beta_p = 0$$

$$H_1 : \beta_i \neq 0 \text{ ; i = 1, 2,}\ldots, p \text{ for at least one } i$$

is tested by the analysis of variance F statistic

$$F = \frac{MSM}{MSE} \tag{3.10}$$

where

MSM = Mean Square Model

MSE = Mean Square Error

H_0 has to be rejected when at least one independent variable, x gives meaning to the model. The *P*-value is the probability that a random variable having the *F (p,n-p-1)* distribution is greater than or equal to the calculated value of the F statistic.

3.4.4 Squared Multiple Correlation R^2

R^2 is the fraction of total squared error that is explained by the model. The smaller the variability of the residual values around the regression line relative to the overall variability, the better is our prediction. The *R*-square value is an indictor of how well the model fits the data. It is noted that the square sample correlation could be written as the ratio *SSM* to *SST* and could be interpreted as the proportion of variation in y explained by x . A similar statistic is routinely calculated for multiple regression. The statistic:

$$R^2 = \frac{SSM}{SST} = \frac{\sum(\hat{y}_i - \bar{y})^2}{\sum(y_i - \bar{y})^2} \tag{3.11}$$

is the proportion of the variation of the response variable y that is explained by the explanatory variables $x_1, x_2, ..., x_p$ in a multiple linear regression. Often, R^2 is multiplied by 100 and expressed as a percent. The square root of R^2 called the multiple correlation coefficients is the correlation between the observations y_i and the predicted values $\hat{y}_i$.

In order to identify how strong the influence of the independent parameters on nominal interest rate, correlation *(R^2)* is determined. The R^2 value that is accepted to represent the testable model is at 50% (0.5). If the value is below 50%, it represent the relationship of the parameters are weak.

3.4.5 Statistical Anova Table

The Anova table will show the sum of squares, degree of freedom, and mean square, *F-value* and *p-value*. The "Sum of Squares" term reflect how the total variance in criterion (bank nominal interest rate) is partitioned by the regression effect due to intelligence and residual. In order to compute the F-ratio, the sum of square regression and sum squares residual are divided by their respective degree of freedom, resulting in the mean square values. The F-ratio is computed by dividing the Mean Square Regression by Mean Square Residual. The resulting F-ratio is compared to an F-table of critical values to see if the observed F-ratio is greater than would be expected on the basis of chance.

CHAPTER 4

RESULT AND DISCUSSION

We will be discussing result which has obtained in this chapter. We have gathered data and come up with the results through the main method that is the Fisher's Equation that has been explained in Methodology chapter. We use SPSS 11.5 version software to run the collected data for analyzing factors that influence the determination of nominal interest rate by using past historical data via regression.

4.1 FISHER'S EQUATION

Through the Fisher's Equation, we have explored the factors that influences the Base Lending Rate (BLR), i_t are the excess money supply and inflation rate as the independent variables. Hence, we identify how well they influence the dependent variable, BLR. The equation is declared as:

$$i_t = \rho - \lambda EMS + \pi_t^e + \omega_t \tag{4.1}$$

From this equation, we found that we used the historical data of excess money supply and inflation rate for 30 years.

Table 4.1 Percentage of excess money supply (*EMS*), inflation rate and Base Lending Rate from 1979 - 2008

Year	Excess Money Supply (EMS) (%)	Inflation rate (%)	Base Lending Rate (%)
1979	3.80	3.60	7.50
1980	4.00	3.70	7.50
1981	4.30	3.80	8.50
1982	3.70	4.80	8.50
1983	3.85	3.70	7.00
1984	3.80	3.90	7.75
1985	3.75	2.59	6.25
1986	3.85	2.35	7.75
1987	3.65	2.74	8.00
1988	4.00	2.29	7.50
1989	4.10	2.56	7.00
1990	4.00	3.04	7.00
1991	4.20	4.36	7.50
1992	4.10	4.77	9.00
1993	4.10	3.56	9.50
1994	4.20	3.70	8.25
1995	4.30	3.20	6.60
1996	4.10	3.48	8.50
1997	3.75	2.66	9.25
1998	4.10	4.29	7.50
1999	3.75	2.73	8.00
2000	3.65	2.55	6.75
2001	3.90	2.43	6.75
2002	3.65	2.79	6.50
2003	4.10	2.07	6.50
2004	4.25	2.42	6.00
2005	3.65	3.05	6.00
2006	3.75	3.59	6.00

2007	3.85	2.11	6.75
2008	4.25	2.43	6.75

Source: Economic Bulletin, BNM, various issues International Monetary Funds.

Table 4.2 Percentage of real interest rate from 1979 - 2008

Year	Real Interest Rate (%)
1979	2.20
1980	2.30
1981	3.20
1982	2.60
1983	1.50
1984	1.10
1985	2.80
1986	3.10
1987	3.00
1988	2.10
1989	1.40
1990	2.10
1991	3.00
1992	3.00
1993	2.90
1994	1.40
1995	2.92
1996	3.04
1997	4.91
1998	3.35
1999	3.51
2000	2.71
2001	3.30
2002	2.60
2003	2.81
2004	2.70
2005	1.27
2006	3.21
2007	2.20
2008	3.50

Source:BNM

4.2 MULTIPLE REGRESSION ANALYSIS (*EMS* AND INFLATION RATE AS FACTORS)

The multiple linear regressions for this present project which consist of two factors represent the following equation:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \tag{4.2}$$

where

y = nominal interest rate (BLR)

x_1 = excess money supply (EMS)

x_2 = inflation rate

Table 4.3 Variable Coefficient Table

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	0.933	2.948		0.317	0.754
excess money supply	1.189	0.734	0.264	1.619	0.117
inflation rate	0.562	0.203	0.451	2.763	0.010

From the Table 4.2 above, the multiple regression analysis equation given as:

$$y = 0.933 + 1.189 x_1 + 0.562 x_2 \tag{4.3}$$

where

$\beta_0 = 0.933$

$\beta_1 = 1.189$

$\beta_2 = 0.562$

4.2.1 Model Summary

Table 4.4 Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin Watson
0.532	0.283	0.230	0.85296	0.283	5.323	2	27	1.507	1.507

a. Predictors: (Constant), inflation rate, excess money supply
b. Dependent Variable: nominal interest rate (BLR)

The model summary above were extracted from the SPSS output and the analysis had done to it. In the column labeled *R* is the values of the multiple correlation coefficients between the predictors and the outcome. When the inflation rate and the excess money supply are used as predictor, this is a multiple correlation between nominal interest rates (BLR) with 0.532.

The R^2 which is a measure of how much of the variability in outcome is accounted for by the predictors. The model shows the value as 0.283, which means that inflation rate accounts for 28.3% of the variance in nominal interest rates. It means that only 28.3% of the variance of BLR is influence by inflation rate and excess money supply.

4.2.2 Hypothesis Test

Basically, we test the null hypothesis:

$$H_0 : \beta_1 = \beta_2 = 0$$

which says that there is no change in the mean value of y associated with an increase in x, versus the alternative hypothesis:

$$H_a : \beta_1 \neq \beta_2 \neq 0$$

which says that there is (positive or negative) change in the mean value of y associated with an increase in x. It would be reasonable to conclude that x is significantly related to y if we can be quite certain that we should reject H_0 in favor of H_a.

According to this project, null hypothesis means the factors (x) that do not related to nominal interest rate (y) versus the alternative hypothesis which are the factors (x) related to nominal interest rate (y). The result will be is either to accept or reject the null hypothesis. This is done by conducting F-test and T-test.

4.2.3 ANOVA Table (*F*-Test)

The next part is the output which contain an analysis of variance (ANOVA) that test whether the model significantly better at predicting the outcome than using the mean as a 'best guess'. However, the *F*-ratio represents the ratio of the improvement in analyze factors that results from fitting the model (labeled 'Regression' in the table).

Table 4.5 ANOVA Table (*F*-test)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	7.745	2	3.872	5.323	0.011
Residual	19.644	27	0.728		
Total	27.388	29			

With the significant level, $\alpha = 0.05$, $F_{0.05,(2,27)} = 3.35$ and $F_0 = 5.323$.

Since, $F_0 > F_{0.05,(2,27)}$, hence, H_0 is rejected.

4.2.4 *T*-Test hypothesis

The T-test has done on each independent variable, x_i to find out which of these really influence the BLR or significant to dependent variable, BLR. For which if to assume that the significance level is 0.05, then $t_{\frac{0.05}{2},27} = 2.052$ (according to Statistical Table).

Here we test the independent variable with the $\alpha = 0.05$.

According to Table 4.3 above (section 4.2), the excess money supply factor,

$$\text{if } t_0 = 1.619\text{, then } t_0 < t_{0.025,27}.$$

This shows that H_0 is accepted at the significant level of $\alpha = 0.05$. Hence, it is concluded that the independent variable, excess money supply does not significant to the model.

However, for the inflation rate factor according to the same Table 4.3 (section 4.2),

$$\text{if } t_0 = 2.763\text{, then } t_0 > t_{0.025,27}.$$

This shows that H_0 is rejected at the significant level of $\alpha = 0.05$. Hence, it is concluded the independent variable that is the inflation rate is significant to the model.

From the t-test, we could conclude that the excess money supply does not relate to nominal interest rate. So the equation now will be:

$$y = 0.933 + 0.562x_1 \tag{4.4}$$

with x_1 will be the inflation rate.

4.3 MULTIPLE REGRESSION ANALYSIS (REAL INTEREST RATE AND INFLATION RATE AS FACTORS)

In this analysis, we conduct multiple regression analysis to analyze the real interest rate and inflation rate. Following is the output from SPSS which gives the multiple regression equation.

Table 4.6 Variable Coefficient Table (for different factors)

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	4.374	0.860		5.083	0.000
Real interest rate	0.405	0.191	0.337	2.119	0.043
inflation rate	0.617	0.203	0.495	3.117	0.004

From the table above the equation is:

$$y = 4.374 + 0.405x_1 + 0.617x_2 \tag{4.5}$$

where

$\beta_0 = 4.374$

$\beta_1 = 0.405$

$\beta_2 = 0.617$

4.3.1 Model Summary

Table 4.7 Model Summary (for different factors)

R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin Watson
0.570	0.325	0.275	0.82726	0.325	6.510	2	27	1.507	1.676

a. Predictors: (Constant), inflation rate, real interest rate
b. Dependent Variable: nominal interest rate (BLR)

The model summary above were extracted from the SPSS output and the analysis had done to it. In the column labeled *R* is the values of the multiple correlation coefficients between the predictors and the outcome. When the inflation rate and the real interest rate are used as predictor, this is a multiple correlation between nominal interest rates (BLR) with 0.570.

The R^2 which is a measure of how much of the variability in outcome is accounted for by the predictors. The model shows the value as 0.325, which means that inflation rate accounts for 32.5% of the variance in nominal interest rates. It means that only 32.5% of the variance of BLR is influence by inflation rate and real interest rate.

4.3.2 ANOVA Table (*F*-Test)

The next part is the output which contain an analysis of variance (ANOVA) that test whether the model significantly better at predicting the outcome than using the mean as a 'best guess'. However, the *F*-ratio represents the ratio of the improvement in analyze factors that results from fitting the model (labeled 'Regression' in the table).

Table 4.8 ANOVA Table (*F*-test) (for different factors)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	8.911	2	4.455	6.510	0.005
Residual	18.478	27	0.684		
Total	27.388	29			

With the significant level, $\alpha = 0.05$, $F_{0.05,(2,27)} = 3.35$ and $F_0 = 6.510$.

Since, $F_0 > F_{0.05,(2,27)}$, hence, H_0 is rejected.

4.3.3 *T*-Test Hypothesis

We also test with t-test like for the factors before by assuming that the significance level is 0.05, then $t_{\frac{0.05}{2},27} = 2.052$ (according to Statistical Table).

Here we test the independent variable with the $\alpha = 0.05$.

According to Table 4.6 above (section 4.3), for the real interest rate factor,

$$\text{if } t_0 = 2.119, \text{ then } t_0 > t_{0.025,27}.$$

This shows that H_0 is rejected at the significant level of $\alpha = 0.05$ in the favor of the H_a. Hence, it is concluded that the independent variable, real interest rate is significant to the model.

However, for the inflation rate factor according to the same Table 4.6 (section 4.3),

$$\text{if } t_0 = 3.117 \text{, then } t_0 > t_{0.025,27}.$$

This shows that H_0 is rejected at the significant level of $\alpha = 0.05$. Hence, it is concluded the independent variable that is the inflation rate is significant to the model.

From the t-test, we could conclude that both the real interest rates and inflation rates are related to nominal interest rate. So the equation will remain the same be:

$$y = 4.374 + 0.405x_1 + 0.617x_2 \qquad (4.6)$$

with x_1 and x_2 respectively be the real interest rate and inflation rate.

CHAPTER 5

CONCLUSION

In this chapter, we will discuss about the overall project and the result from the output. This project basically is to analyze whether the factors influence the nominal interest rate are strong factors or significant to the model related.

In order to run the multiple regression analysis, we obtain the data from the Bank Negara Malaysia (2008) basically because Bank Negara Malaysia is the central bank of Malaysia in which control and set the interest rate equally for all commercial banks.

We use Fisher's Equation to identify the factors influence the nominal interest rate, (Base Lending Rate) that is the excess money supply, inflation rate and real interest rate. Through the equation, we manage to analyze if the factors really influence the nominal interest rate by looking at how significant it is to the model obtained.

We analyze the factors using the *F*-test, *T*-test and the correlation (R^2). From the F-test we realize that the null hypothesis is rejected. The *T*-test showed that the inflation rate is significant to the multiple regression model compare to the excess

In another multiple regression analysis, we use the Fisher's Equation to analyze the real interest rate and inflation rate factors. We use the same tests as before which we use to analyze the excess money supply and inflation rate factors. From the F-test we realize that the null hypothesis is rejected. The *T*-test showed that the inflation rate and real interest rate are significant to the multiple regression model. However, the correlation, R^2 analysis gives the percentage of how much both the factors influence the nominal interest rate that is 32.5%.

In overall, it is clear that the inflation rate is more significant to the model which means that it influence the nominal interest rate.

We would like to suggest that we may also use other nominal interest rate like fixed deposit rate and saving deposit rate. This may identify if the same factors did influence the nominal interest rate.

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APPENDIX A

SPSS OUTPUT FROM MULTIPLE REGRESSION (MODEL 1)

Descriptive Statistics

	Mean	Std. Deviation	N
BLR	7.4117	.97182	30
excess money supply	3.9483	.21595	30
inflation rate	3.1753	.77936	30

Correlations

		BLR	excess money supply	inflation rate
Pearson Correlation	BLR	1.000	.283	.462
	excess money supply	.283	1.000	.041
	inflation rate	.462	.041	1.000
Sig. (1-tailed)	BLR	.	.065	.005
	excess money supply	.065	.	.415
	inflation rate	.005	.415	.
N	BLR	30	30	30
	excess money supply	30	30	30
	inflation rate	30	30	30

Variables Entered/Removed(b)

Model	Variables Entered	Variables Removed	Method
1	inflation rate, excess money supply(a)	.	Enter

a All requested variables entered.
b Dependent Variable: BLR

Model Summary(b)

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
				R Square Change	F Change	df1	df2	Sig. F Change	
32(a)	.283	.230	.85296	.283	5.323	2	27	.011	1.50

a Predictors: (Constant), inflation rate, excess money supply
b Dependent Variable: BLR

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.745	2	3.872	5.323	.011(a)
	Residual	19.644	27	.728		
	Total	27.388	29			

a Predictors: (Constant), inflation rate, excess money supply
b Dependent Variable: BLR

Coefficients(a)

del		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
	(Constant)	.933	2.948		.317	.754	-5.115	6.981
	excess money supply	1.189	.734	.264	1.619	.117	-.317	2.69
	inflation rate	.562	.203	.451	2.763	.010	.145	.97

a Dependent Variable: BLR

Coefficient Correlations(a)

Model			inflation rate	excess money supply
1	Correlations	inflation rate	1.000	-.041
		excess money supply	-.041	1.000
	Covariances	inflation rate	.041	-.006
		excess money supply	-.006	.539

a Dependent Variable: BLR

Residuals Statistics(a)

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	6.6960	8.6072	7.4117	.51678	30
Std. Predicted Value	-1.385	2.313	.000	1.000	30
Standard Error of Predicted Value	.16289	.41430	.26376	.05738	30
Adjusted Predicted Value	6.6688	8.4976	7.4122	.51431	30
Residual	-1.4090	1.9477	.0000	.82302	30
Std. Residual	-1.652	2.283	.000	.965	30
Stud. Residual	-1.716	2.364	.000	1.011	30
Deleted Residual	-1.5594	2.0871	-.0006	.90378	30
Stud. Deleted Residual	-1.784	2.605	.009	1.051	30
Mahal. Distance	.091	5.875	1.933	1.321	30
Cook's Distance	.000	.153	.033	.040	30
Centered Leverage Value	.003	.203	.067	.046	30

a Dependent Variable: BLR

APPENDIX B

SPSS OUTPUT FOR MULTIPLE LINEAR REGRESSION FOR MODEL 2

Descriptive Statistics

	Mean	Std. Deviation	N
interest rate (BLR)	7.4117	.97182	30
real interest rate	2.6577	.80730	30
inflation rate	3.1753	.77936	30

Correlations

		interest rate (BLR)	real interest rate	inflation rate
Pearson Correlation	interest rate (BLR)	1.000	.287	.462
	real interest rate	.287	1.000	-.099
	inflation rate	.462	-.099	1.000
Sig. (1-tailed)	interest rate (BLR)	.	.062	.005
	real interest rate	.062	.	.300
	inflation rate	.005	.300	.
N	interest rate (BLR)	30	30	30
	real interest rate	30	30	30
	inflation rate	30	30	30

Variables Entered/Removed(b)

Model	Variables Entered	Variables Removed	Method
1	inflation rate, real interest rate(a)	.	Enter

a All requested variables entered.
b Dependent Variable: interest rate (BLR)

Model Summary(b)

ode	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
	.570(a)	.325	.275	.82726	.325	6.510	2	27	.005

a Predictors: (Constant), inflation rate, real interest rate
b Dependent Variable: interest rate (BLR)

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.911	2	4.455	6.510	.005(a)
	Residual	18.478	27	.684		
	Total	27.388	29			

a Predictors: (Constant), inflation rate, real interest rate
b Dependent Variable: interest rate (BLR)

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.374	.860		5.083	.000
	real interest rate	.405	.191	.337	2.119	.043
	inflation rate	.617	.198	.495	3.117	.004

a Dependent Variable: interest rate (BLR)

Residuals Statistics(a)

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	6.5220	8.5350	7.4117	.55432	30
Std. Predicted Value	-1.605	2.026	.000	1.000	30
Standard Error of Predicted Value	.15938	.45827	.25215	.07086	30
Adjusted Predicted Value	6.4389	8.5222	7.3926	.55695	30
Residual	-1.8915	1.7526	.0000	.79822	30
Std. Residual	-2.287	2.119	.000	.965	30
Stud. Residual	-2.361	2.169	.010	1.019	30
Deleted Residual	-2.0166	1.8371	.0191	.89459	30
Stud. Deleted Residual	-2.601	2.342	.010	1.057	30
Mahal. Distance	.110	7.933	1.933	1.725	30
Cook's Distance	.000	.481	.042	.088	30
Centered Leverage Value	.004	.274	.067	.059	30

a Dependent Variable: interest rate (BLR)

CURRICULUM VITAE

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FACTORS THAT INFLUENCE THE DETERMINATION OF INTEREST RATE IN MALAYSIA BANKING SYSTEM - SUBHASHINI A/P QUNASEGRAN