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TEST OF FISHER EFFECT IN A CASE OF INDONESIA: FURTHER EVIDENCE

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ABSTRACT

Studi ini merupakan kelanjutan dari studi tentang efek Fisher yang dilakukan oleh Purwandaya dan Suyanto (2000). Studi ini menggunakan data periode Januari 1991 sampai dengan Mei 2002. Dikarenakan adanya masalah endogeneity dalam model, estimasi OLS menjadi tidak konsisten lagi. Estimator variabel instrument kemudian digunakan untuk mendapatkan estimasi yang konsisten. Hasil estimasi dengan variabel instrument memperlihatkan bahwa koefisien variabel inflasi tidak sama dengan satu. Karena itu, belum bisa disimpulkan bahwa hipotesis Fisher terjadi di Indonesia.

***Keywords**: Fischer Effect, Inflation, Nominal Interest Rate*

Neo-classic economists believe that inflation could be lowered to some extent by reducing the growth of the money supply. The same suggestion was also given by Ahmed and Kapur (1990), economists from the World Bank, for Indonesian economy in their study about Indonesia's monetary policy. They argued that to some degree monetary variable has a positive effect on domestic inflation in Indonesia. The Indonesia's monetary authority, that had a target of single digit inflation, imposed a tight monetary policy to control inflation in July 1990. This policy was in purpose to reduce high inflation that could lead to overheating of the economy. In 1997, a tight monetary policy was also used by the monetary authority to diminish the effect of economic crisis on inflation.

From 1988 to 1990, the money supply (M2) grew on the average 2.8 percent monthly. It decreased sharply to only on the average 0.26 percent per month from 1991 to 1997. There was even a contraction of money supply in November 1997 and January, June, July, and September 1998. It increased again on the average 1.2 percent per month from 2000 to the first half 2002. On the other hand, the inflation rate grew quite rapidly following the banking reform introduced in October 1988. In 1991 and 1992, the inflation rate was 9.5 and 5 percent respectively. It began to increase in two digits in 1997 and reached a peak to 59.5 percent in 1998 because of the economic crisis. The inflation rate decreased to 2.14 and 8.9 percent in 1999 and 2000.

According to Leeahtam et. al. (1991) a monetary policy to reduce inflation would cause a high interest rate. A high interest rate in turn might produce an economic recession. Based on a Mundell-Fleming model (Mundell, 1963 and Flemming, 1962) and an economy with an open capital account policy, a tight monetary policy would depress the domestic economy and hence would cause increasing of interest rate and appreciation of exchange rate. Since Indonesia had applied a tight monetary policy, this problem could

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arise if the Indonesian economy follows the assumptions in a Mundell-Fleming model. However based on data, the tight monetary policy could not produce immediately effect to interest rate. The interest rate had a relative stable fluctuation (around 10 to 18 percent) until 1996. In the second half of 1997, it started to shoot to more than 30 percent. This sharp increase was caused mostly by the economic crisis, not the direct effect of a tight monetary policy. The effect of economic crisis then diminished in July 1999. The interest rate was back to the normal level between 10 and 18 percent.

Regardless the causal relationship between inflation and interest rate, a tight monetary policy with a high interest rate was a major problem for private sectors in Indonesia. It discouraged investment and created a serious bad debt problem (Purwandaya and Suyanto, 2000).

This study is a further study by Purwandaya and Suyanto (2000) that examines the relationship between the expected inflation rate and the nominal interest rate in Indonesia. In more specific, it attempts to examine whether the Fisher effects hold in Indonesian economy. Data from January 1991 to May 2002 are used in this analysis.

This study is divided into the following six parts. Part one is introduction. The second part explains a theoretical background and a selective literature review of empirical studies on the Fisher effect. Part three shows the empirical model. Part four contains data descriptions. The estimation results are presented in part five. The final part states the conclusion of the study.

THEORETICAL BACKGROUND AND RELATED STUDIES

Background theory underlying the model in this study is Theory of Interest by Fisher (1930) or famous as Fisher Effect Identity. This identity explains the relation between nominal rate of interest and expected inflation. Fisher argued that an increase in expected inflation or anticipated price level should bring an equivalent rise in the nominal interest rate over time. Hence, the real interest rate will not respond to any changes of expected inflation in the long run. In other words, the nominal interest rate fully reflects the variation in expected inflation in the long run. Thus, the real interest rate is stable overtime. There are many empirical studies that had been conduct to test this hypothesis.

Fama (1975) examines this hypothesis during the period of January 1953 to July 1971 using the rate of one to six-month Treasury Bills and US Inflation. He showed that there is a relationship between the current nominal interest rate and the rate of inflation in the next period.

Nelson and Schwert (1977) disagree with Fama result. They argued that the test used by Fama was not strong enough to reject the hypothesis of constant real interest rate. They introduced a new test that they thought more powerful than the test used by Fama. They used a Box & Jenkins method to estimate an optimal extrapolative predictor of realized interest rate. They claimed that this method enable them to have non-stationary behavior in the interest rate. They concluded their result by rejecting the hypothesis of constant real interest rate on the same time period used by Fama.

Atkins (1989) did a similar study using USA and Australian data. He used the Error Correction Model (ECM) to correct the data that contained unit roots in both interest rate and inflation. His result showed that the movement in nominal interest rates and inflation has long run components, which are consistent with the quantity theory of money.

A study by Carmichael and Stebbing (1983) also used the US and Australian data. Instead of testing the Fisher effect, they introduced an inverted hypothesis and named it the Inverted Fisher hypothesis. Their model

accounted the effect of taxes on expected real interest rates and related the after tax real interest rate on financial assets with the expected rate of inflation. Their results showed that real interest rate varies on a point to point basis with the variation in expected inflation in the long term. It implies that the nominal rate of interest is constant in the long run.

Groenewold (1989) supported the finding reported by Carmichael and Stebbing but he argued that the result robust only in the short term in Australia at least during the sample period of 1968(II) to 1985(III).

Mishkin and Simon (1995) provided a different result than Groenewold's suggestion. Using Australian data from 1962(III) to 1993(IV), they showed that there is an indication of long run Fisher effect in Australian economy but they argued that there is no significant evidence for short run Fisher effect.

In Indonesia, a study about Fisher effect had been done by Purwanday and Suyanto (2000). He used data during first quarter 1976 to forth quarter 1993 to estimate the long run Fisher effect. For proxy nominal interest rate, he used the money market interest rates. Based on adaptive and rational expectations of inflation, his result suggested that there is no long run Fisher effect for Indonesian economy, at least during the sample period.

THE EMPIRICAL MODEL

The empirical model in this study is produced from the model suggested by Fisher (1930). According to Fisher, real interest rate is identical to the differences between nominal interest rate and the expected inflation, or can be write as:

$$r_i^{e\,o} = R_t - \dot{A}_t^e \quad (1)$$

where r_i^e is the real rate of interest, R_t is the ex ante nominal rate of interest, and $\dot{A}_t^e$ is the expected inflation rate.

From this identity, if inflationary expectation is formed by using all available information in the past, equation (1) can be rewritten as:

$$R_t = r_t^e + (\dot{A}_t^e \dot{A} \dot{A}_{t-1}, \dot{A}_{t-2}, \ldots) \quad (2)$$

Since Fisher Hypothesis argues that r_t^e is stable overtime, variation in R_t is directly explained by the change in $\dot{A}_t^e$. The model for empirical test can be formulated as follow:

$$R_t = 2_0 + 2_1 \dot{A}_t^e + 2_2 Z_t + 3/4_t \quad (3)$$

Where Z_t is the vector of other variables that may also affect the interest rate and $3/4\dot{A}_t$ is the error term. If Fisher's hypothesis hold then it would be expected that 2_1 is relatively very close to one.

The common problem in estimating equation (3) is how to model and measure the expectation of the inflation in the future (Purwandaya and Suyanto, 2000). The issues is not only how it is formulated but also what is the true functional relationship between dependent variable and explanatory ones (Peek and Wilcox, 1990). Some studies, for example Lahiri (1976) and Peek (1982), indicate several alternatives to proxy the expected inflation by using survey data. However, the similar survey data is not available in Indonesia.

For simplicity, the expected inflation in this study is expected by the actual inflation (Dornbusch et al., 2001 named this expectation as "naive expectation"). It is assumed that the inflation expected by economic agents is exactly the same with the actual inflation. This assumption arises from the used of Philips curve (Philips, 1958):

$$\dot{A} = \dot{A}^e + \mu\,(u - u^*) \quad (4)$$

Where $\dot{A}$ is the actual inflation, u is the actual unemployment rate, u* is the full-employment unemployment rate (or natural rate of unemployment), and μ is the responsive of inflation to unemployment. Equation (4) shows that if actual unemployment equals to full-employment unemployment rate, the

expected rate of inflation should be equal to the actual inflation.

Even though this assumption is too strict and hardly to apply practically, this assumption still can be used based on the argument that the inflation is stable overtime (i.e. the inflation is at the steady state). Alternative models of inflation expectation will be considered if the simple model in equation (3) contains autocorrelation.

The Ordinary Least Square (OLS) estimator with Standard Linear Model (SLM) is used to estimate equation (3). The null hypothesis in the model is whether Fisher effect hold or whether inflation have one on one relationship with interest rate (i.e. $^{2}_{1} = 1$).

DATA DESCRIPTION

Most of empirical studies on Fisher Hypothesis use the return on financial assets such as bonds and stocks or other commercial papers as the basis for data on interest rate. However, this data is not available for Indonesia. The Indonesia government does not issue bonds similar to the US or Australian Treasury Bills. The Indonesia government issues a central bank certificate (named *Sertifikat Bank Indonesia* - SBI) and a money market certificate (named *Surat Berharga Pasar Uang* - SBPU) which mainly use as money market instrument but to some degree the value of these certificate are controlled by the central bank (Purwandaya and Suyanto, 2000). Purwandaya and Suyanto suggested that the money market could be used as a proxy for the nominal interest rate based on the argument that the money market data are relatively less control by the central bank. The source of money market interest rate and inflation data is the central bank (Bank Indonesia) annual report. The data is a time series data from January 1991 to May 2002 (137 observations).

In order to attract foreign investments, the Indonesia's government instituted a free capital movement policy since 1976. In economy with free capital movements across countries, interest rate differentials among countries will have an important impact on domestic interest rate. Therefore, it is necessary to add foreign interest rates as another regressor into the model. Singapore Inter-bank offer rate (SIBOR) is used as a proxy for international interest rate. The SIBOR data is taken from Central Bank of Singapore website (http://secure.mas.gov.sg/

Table 1
Sample Statistics

Variable	Mean	Std. Deviation	Min	Max
Interest	19.24	16.26	6	77
Inflation	1.04	1.75	-1.05	12.67
SIBOR	5.02	1.29	1.88	7.06
Crisis	0.43	0.50	0	1

Source: Research Data, processed

index.cfm?id=98D056A8-1058-4FDF-B59C03A8915F48D6). A dummy variable is also included to capture the impact of economic crisis that occurred in 1997. The binary dummy variable is used for economic crisis (with 0 for data before the year 1997 and 1 for 1997 and after).

Table 1 shows the sample statistic for the variables in the model.

The interest rate has a mean value 19.24 with very high standard deviation. It is mostly because of economic crisis from the middle of 1997 to the middle of 1999. The interest rate during this period is higher than 30 percent. The highest rate of interest in the sample is 77 percent, which is happened on August 1998 (during crisis), and the lowest is 6, which is happened on December 1993 (when Indonesian Government impose deregulation in Banking sector by reduce the reserve requirement from 8 percent to 5 percent).

The average monthly inflation in Indonesia during the sample period is 1.04 percent. This number is relatively high compare to inflation in other Asian countries, such as Malaysia and Thailand. The standard deviation is also high. As in interest rate, the high variation in inflation is mostly because of economic crisis. During the crisis, the inflation rate was shooting up and reaches a peak at 12.67 percent on February 1998.

The Singapore inter-bank offer rate is lower than the interest rate of Indonesia. On the average, Singapore interest rate is 5.02 percent per year, with 1.29 standard deviation, which is lower compare to standard deviation in domestic interest rate.

THE ESTIMATION RESULT

The OLS estimate for equation (3) is given by Table 2. The coefficient of inflation 4.82 means that, other things being equals, if inflation increases by one percent the nominal interest rate will increase about 4.82 percent. To see whether the Fisher Hypothesis is hold or not (i.e. H0: $^{2}_{1}$=1 against H1: $^{2}_{1}$'"1), we need to recalculate the true value of t-statistic (note that the t-value in table 2 is under ^{2}=0) as follow:

$t = (b_1 - {}^{2}_{1}) / SE(b_1) = (4.82 - 1) / 0.58 = 6.59$

Using t-table for ±=5% and df = 133 (which is equal to 1.96), we reject null hypothesis. As implication, the Fisher hypothesis is not hold (i.e. the interest rate is not constant overtime).

If the Singapore inter-bank offer rate (SIBOR) is the correct proxy for international interest rate which has an important impact on the domestic rate,

Table 2
Interest rate equation estimated by OLS

Dependent variable: interest rate			
Variable	**Estimate**	**Standard error**	**t-ratio**
Constant	1.538999	3.994045	0.39
Inflation	4.820859	0.5807181	8.30
Sibor	1.518103	0.7601124	2.00
Crisis	11.75378	2.033641	5.78
R^2 = 0.5213	Adj-R^2 = 0.5105	F (3, 133) = 48.28	DW = 0.385702

Source: Research Data, processed

then other thing being equal, every one percent change in that rate will produce about 1.52 percent change in the nominal interest rate. The t-statistic for coefficient of SIBOR ($^{2}_{2}$) shows that null hypothesis is rejected (i.e. t-ratio = 2 > t-table = 1.96). Hence, SIBOR gives a significant effect to nominal interest rate in Indonesia.

The economic crisis also gives a positive significant effect to nominal interest rate. If inflation rate and SIBOR are constant, the nominal interest rate rises on the average 11.75 percent during the economic crisis.

Lahiri (1976) and Fama (1977) believe that OLS might give inconsistent estimate in this study because the regressor inflation could be negatively correlated with the error term ¾t in the model, due to measurement error. The expected inflation in the model in equation 3 is assumed to be equal to the actual inflation. However, in practice, it is hardly to achieve. Expected inflation will be equal to actual inflation if inflation is in the steady state. In Indonesia, inflation is mostly not stable overtime. Assumption that the expected inflation equals to actual inflation may suffer measurement error. This will lead to a negative correlation between inflation and ¾.

Another problem in using OLS estimator in the model is the estimate will contain autocorrelation. Using time series data, there is a possibility that errors are correlated their lags (Kennedy, 1989). As a result OLS estimate is inefficient. Based on DW-test in Table 2, we can see that the value of Durbin-Watson statistic (0.39) is lower than DL-value for T=137 and K=4 (which is 1.61). This implies that there is a positive autocorrelation in OLS estimate. So, the OLS estimate is not efficient anymore.

Because of those problems, we can not use OLS as estimator for the interest rate model. Other estimator should be used.

THE INSTRUMENT VARIABLE APPROACH FOR CONSISTENT ESTIMATE

To overcome the inconsistency of OLS, we can use instrument variable (IV) approach. Economists agree that the expected inflation is affected by previous inflation and previous interest rate. Hence, previous inflation and previous interest rate can be used as instrument variable for expected inflation. However, there are still debates about how many lags of inflation and lags of interest rate are used by economic agent to form their expected inflation. Some economists, for example Lahiri (1976), argue that first lag of inflation variable can be used as an instrument variable for expected inflation (this method of expectation is named adaptive expectation). Other economists, for example Fama (1977), argue that agents perform expected inflation base on the full information of previous inflation and previous interest rate. Hence we can use more than first lag of inflation rate and interest rate as instrument variables for expected inflation.

There are two instrument variable models discussed in this part. First model is using first lag of inflation as an instrument variable for expected inflation. The second model uses some lags of inflation (to achieve efficiency of estimate, 3 lags of inflation will be used) and first lag of interest rate as instrument variables for expected inflation.

Table 3 shows the result of the OLS estimator and the two instrument variable (IV) estimators (OLS estimate which is also presented in this table is in order to help readers to compare between OLS estimate and IV estimate).

The parameter of variables in IV(1) and IV(2) models provide the same sign as the OLS model. This sign is as we are expected in economic theory. Variable inflation and crisis are individually significant under ±=5%, but SIBOR is not significant individually to interest rate. The significance of variable inflation in IV (1) and IV (2) shows that

Table 3
Interest Rate Model Estimate using OLS and IV

Variable	OLS	IV(1)	IV(2)
Inflation	4.8209 (0.5807)	7.8777 (0.9354)	8.6483 (0.9419)
SIBOR	1.5181 (0.7601)	1.1992 (0.8494)	0.9227 (0.8996)
Crisis	11.7538 (2.0336)	8.9881 (2.3346)	8.6769 (2.4371)
Constant	1.5390 (3.9940)	1.1260 (4.4279)	1.6281 (4.6502)

Source: Research Data, processed

Note: numbers in the parentheses are standard error
In IV(1), instrument is first lag of inflation
In IV(2), instrument variables are first lag, second lag, and third lag of inflation and first lag of interest rate.

the instrument variables are "good" instrument for inflation.

To obtain more efficient estimate, the IV(2) estimate is more preferable than IV(1) estimate because it contains more information. The more valid instrument variables are captured in the model, the more efficient the model is.

For IV(2), we can test whether all moment condition in the model are valid or not using over-identification test. The procedure to do over-identification test, we regress residual (i.e. $e_{i,2SLS}$) on all instrument variables (inflation1, inflation2, inflation3) and exogenous variable (SIBOR and Crisis), where inflation1, inflation2 and inflation3 are first lag, second lag, and third lag of inflation, and get the R^2. Under H0, NR^2 is distributed as $Ç^2_{R-K}$, where R is all moment conditions and K is the number of parameter in the original model. The test statistic of over-identification is 6.03 while $Ç^2_3$ is 7.82. So, all moment conditions are valid.

Test statistic for "endogeneity test" based upon OLS and IV(2) is 69.75, which is larger than the critical value for F (1,132) at 5% level (H"3.85). Hence, the endogeneity problem does cause OLS to be inconsistent.

Based on the estimate in IV(2), under H0: $^21=1$, the t-statistic for inflation is 8.12 (calculated from (8.6483 - 1) / 0.9419), which is larger than t-critical at ±=5% (=1.96). Hence, Fisher hypotheses that real interest rate are constant overtime is not hold. Variable Crisis is also individually statistical significant, while SIBOR is not significant statistically.

POLICY IMPLICATION

The estimation results above provide two important things for monetary policy.

1. A real interest rate is not constant over time in the period of sample. The increasing in inflation, which leads to a monetary contraction, increases interest rate approximately equal to unity. A tight monetary is not effective because it causes high interest rate, and then crowds out private investment. As a result, there is a contraction in the economy. As a developing country, the stable economic growth is an important macroeconomic objective for

Indonesia. A monetary swing that causes a longrun unstable impact in economic growth is unfavorable. To overcome this problem, Friedman (1968) suggests a steady rate of growth in a specified monetary total to avoid instability in the economy. A steady rate of monetary growth would constitute a major improvement if the monetary authority followed a self-denying ordinance of avoiding wide swing. From the experiences of the USA and other countries, periods of relative stability in the rate of monetary growth have also been periods of relative stability in economic activity.

2. The international interest rate has no explanatory power to nominal interest rate. It implies that economic agents in Indonesia are not responsive to the difference between foreign and domestic interest rate. The free capital movement, which has been introduced by the Indonesian government since 1991, seems has no significant impact to agents' behavior in interest rate model.

CONCLUSION

Since there is an endogeneity problem in the model, OLS estimator is not longer consistent. To obtain consistent estimate, instrument variable estimate is used. There are two instrument variable models are used. First model is exactly identified instrument variable model. The first lag of inflation is used as an instrument variable for expected inflation. Second model is over-identified instrument variable model, or often called as two stage least square (2SLS) estimator.

The test of over-identification for IV(2) shows that all moment condition are valid. Hence this estimate is more efficient than IV(1) because it contains more information. Furthermore, the "endogeneity test" shows that the endogeneity problem does cause OLS estimator to be inconsistent.

Based on IV(2) model, Individual significant test for inflation shows that null hypothesis for $^{2}_{1}=1$ is rejected. Hence, there is no evidence for Fisher Hypothesis. Change in the expected inflation cause variation in the nominal interest rate more than unity.

There are two possible explanations about this finding. Firstly, this result may be partly because the change in the inflation generating processes that happened during the period of sample (Barsky, 1987). If this is the case, the unit root test might be necessary to check the stochastic data. Secondly, the inflation rate during the period of study might be not really on a steady state as it is assumed (Purwandaya adn Suyanto, 2000). The period of crisis (July 1997 to June 1999) might be the reason of unsteady in the state of inflation.

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