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THE VOLATILITY PROCESSES IN INDONESIA'S DEMAND FOR NARROW MONEY

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Abstract

There were two purposes of this research. The first purpose was to test and search the volatility processes by using ARCH/GARCH methodology in Indonesia's demand for narrow money estimation, which was approached by error correction modeling (ECM). The empirical evidences had shown that the estimation of Indonesia's demand for narrow money contained the volatility processes (GARCH processes).

The second purpose was to prove that the estimation of ECM, which contained the GARCH processes, had the better abilities for prediction than its benchmark. For this purpose, the research compared the predictive powers of Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Parentage Error (MAPE). However, the empirical evidences supported the second purpose.

Keywords*: error correction modeling (ECM), volatility processes, ARCH, GARCH, narrow money.*

INTRODUCTION

Money has important role to modern economic activities and attracts the interest of economic agents, such as household, firm, government, central bank, and monetary authority. Households and firms concern to know the aggregate money movements to form their expectation of inflation. Central bank and monetary authority put a great attention on the aggregate money movements due to their need pursuing appropriate monetary policies.

The theories of demand for money explain, why the economic agents hold money. These theories predict a negative relation between money demanded and interest rate. However, during the financial crisis, Indonesia for example, the market interest rate rises up to about 65-70% but the aggregate money also rises. This phenomenon cannot be explained by the conventional theories of demand for aggregate money.

When an economy is facing uncertainty, the economic agents would do their economic activities not only based on fundamental considerations but also risk or volatility and the credibility of policies from economic authorities, especially in financial and monetary sectors. Hence, these considerations will be included in their expectations. Thus, to have better estimated model of the demand for aggregate money, the central bank also should estimate the volatility or the risk of their expectations.

Most empirical studies in the demand for aggregate money apply time-series variables. The focus of most macro-econometric time-series until two decades ago, centered on the first moment or conditional mean equation, with any temporal dependencies in the higher order moments treated as a nuisance. Hence, time-series analysis is related to time-series properties and its problems, especially non-stationary variables and spurious regression problems. Moreover, recent advances in time-series analysis are conducting the procedures for estimating long run and short-run relationships between non-stationary variables. One such procedure, which has become widespread in economic literatures, is the use of dynamic specification with an error correction modeling (ECM).

Economists and econometricians recognized the ECM since Davidson et al. (1978) on UK's consumption function was published. The favorable performance of ECM relative to the traditional model has inspired other researchers to use the ECM approach, especially on the demand for aggregate money analyses (Sriram, 2001). However, the increased importance played by risk and uncertainty considerations in modern economic theory particularly in the theories of the demand for aggregate money has necessitated the development of new econometric time-series techniques that allow for the modeling of time-varying variances and co-variances as called Autoregressive of Conditional Heteroscedasticity (ARCH) (Engle, 1982).

The importance of ARCH or volatility model is to know the risks (variances) of an estimated model in any given time of observation. It implies that if there is an estimated model containing non-constant variances but these variances are forced to be constant, the estimated model will be not well behaved. Moreover, if such estimated model is based on an economic policy, it will be misleading policy.

The ARCH models were introduced by Engle (1982) and generalized as GARCH (Generalized ARCH) by Bollerslev (1986). These models are widely used in various branches of econometrics, especially in financial time-series analysis (Engle, 2001; Engle and Patton, 2001). Bollerslev, Chou, and Kroner (1992) and Bollerslev, Engle, and Nelson (1994) provided the recent surveys of theories and empirical studies of ARCH models.

This research will still focus the analysis on first moment, but it searches for second moment. These purposes could be achieved by using ARCH methodology of Engle (1982). Hence the study will compare the results and chose the best estimation between the estimated models. This purpose could be achieved by using predictive powers of Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Parentage Error (MAPE).

PREVIOUS EMPIRICAL STUDIES

There are so many empirical studies of the demand for money in international and national perspectives. Laidler (1993) had presented the early empirical studies of demand for money, especially in United Kingdom and United States. Sriram (2001) provided the empirical evidences in industrial and developing countries. His presentation was based on the publications in 1990s to 2000s which they used co-integration and error correction mechanisms as the methods.

There were so many studies on Indonesia's financial sector in the last three decades. During the 1970s to 1980s, most of the analyses used only a simple dynamic specification, typically the partial adjustment model (for examples: Aghevli, 1977; Boediono, 1979, 1985; Nasution, 1983; Parikh, Boot, and Sundrum, 1985, Insukindro, 1993). Hence, in 1990s to early 2000s, the empirical studies moved to co-integration and error correction mechanisms.

Price and Insukindro (1994) specified the currency and demand deposit as the functions of real income, real domestic interest rate, real foreign interest rate, and deregulation dummy variables for quarterly samples, 1969:1-1987.4. They used ARCH test by including one lag for non-heteroscedasticity test and found out no ARCH effect in their estimated equations. Hence, Insukindro (1998) also provided the similar specification and results of the demand for currency by using sampling period of 1987:1 to 1997:4.

Doriyanto (1999) specified the demand for currency by depending on real income, real interest rate, exchange rate, and inflation rate for monthly sampling period, 1988:01-1999:03. He also used ARCH test by including one lag and indicated no ARCH effects in the estimated equation. Meanwhile, Saleh and Pasaribu (2001) analyzed the broad money as a function of real income, nominal interest and general price index for 1976:1-1991:4, quarterly. The test by including four lags resulted that there were no ARCH effects or volatility processes.

The reasons for those results can be described as follows. (1) Those estimations have been correctly specified and do not have high fluctuation in the sampling distribution. In other words, there are no high uncertainties or crisis effects to the samples, even there are, but not long enough. (2) The ARCH test by including only one lag may be failed because the ARCH effects could exist in higher order.

DATA

The main source of data is International Financial Statistics (IFS) of International Monetary Fund (IMF), CD-ROM version. This study uses the data for nominal narrow money (line 34) as NM, and gross domestic product (line 99b) as nominal income, GDP. All data are divided by consumer price index (line 64) as P, to get the real values. The data for interest rate use the data of line 60 and it is subtracted by inflation rate of the consumer price index to get the real rate of interest, RIR. All variables are transformed into natural logarithms except the real rate of interest. An additional source for interest rate data comes from Bulletin of Statistics and Finance from Bank Indonesia.

This study uses the sampling periods during 1970–2001, quarterly. The data have been available on quarterly data except for GDP. The GDP data only in yearly and should be transformed into quarterly. For this purpose, the study uses linear interpolation method that is proposed by Insukindro (1993:142). Finally, all calculations in this research use econometric software, EViews 3.0.

METHODOLOGY

There had been strong evidence of co-integration between real money balance, real income, and real interest rate in the case of Indonesia. For instances, Insukindro (1993, 1998), Price and Insukindro (1994), Dekle and Pradhan (1997), Saleh and Pasaribu (2001) reported the co-integration among those variables. Thus, the co-integrating equation in this study can be specified as,

$$nmr_t = \mu + \alpha_1 gdpr_t + \alpha_2 rir_t + u_t \qquad \textbf{(1)}$$
$$\alpha_1 > 0 \qquad \alpha_2 < 0$$

where: *nmr* is the real of Indonesian narrow money, *gdpr* is real income, *rir* is real interest rate, *u* is error terms, and *t* is time.

Next, it can be described how co-integrated non-stationary variables can be used to formulate and estimate a model with an error correction mechanism. The fact that variables are co-integrated implies that there is adjustment process, which prevents the errors in the long-run relationship becoming larger and larger. Engel and Granger (1987) have shown that any co-integrated series have an error correction representation. Based on Engle and Granger (1987), general ECM of the Indonesia's demand for aggregate money function can be formulated as following equation (Insukindro, 1993, 1998; Thomas, 1997):

$$\Delta nmr_t = \gamma_1 \Delta gdpr_t + \gamma_2 \Delta rir_t + \gamma_3 u_{t-1} + \varepsilon_t \qquad \textbf{(2)}$$

where: Δ denotes first difference and $-1 < \gamma_3 < 0$ (Hendry, 1997). The coefficient γ_3 is known error correction terms (ECT) because it represents the speed of adjustment from short-run to long-run or equilibrium. Equation (2) explains that the changes on demand for narrow money are depended by the changes of real income, real interest rate, and error correction term.

However, the equation (2) can be estimated two different ways. The first is to estimate (2) using a two-staged procedure involving estimation of (1) and then utilizing the residuals to estimate (2). However, the residuals of (1) are not well behaved and hence, invalidate the use of standard t-statistics and F-statistics. The second alternative and, in fact, the preferred one is based on Donowitz and Elbadawi (Insukrindo, 1993).

$$\Delta nmr_t = c_0 + c_1 \Delta gdpr_t + c_2 \Delta rir_t + c_3 nmr_{t-1} + c_4 gdpr_{t-1} + c_5 rir_{t-1} + \varepsilon_t \quad (3)$$

where, $c_0 = \gamma_3(-\mu)$; $c_1 = \gamma_1$; $c_2 = \gamma_2$; $c_3 = \gamma_3$; $c_4 = \gamma_3(\alpha_1)$; $c_5 = \gamma_3(\alpha_2)$.

Equation (3) can be estimated directly by a consistent estimator of OLS method. Its residuals are likely to be free of autocorrelation and heteroscedasticity, rendering validity to correct critical values. Furthermore, all the short-term and long-term coefficients can easily be recovered. The coefficients, c_1 and c_2 explain the short-run effects of real income and interest on the demand for aggregate money. The long-run coefficients of real income and rate of interest are easy to calculate. For example, to calculate the long-run effect of real income and rate of interest use the formula of ($\alpha_1 = c_4/ -c_3$) and ($\alpha_2 = c_5/ -c_3$), respectively.

Generally, economists and econometricians use the basic version of least squares to estimate a conditional mean model such as equation (2) or equation (3). This estimation assumes that the equation's estimated variance is constant for given point of estimation. However, if there is a given circumstance, such as economic crisis, the estimated equation may produce a non-constant variance. It means that the assumption of homoscedasticity is violated.

As far as ARCH/GARCH effect concern, it will have to provide two distinct specifications, one for the conditional mean and one for the conditional variance. Thus, the general specification of the Indonesia's demand for narrow money can be modeled as following equations,

$$\Delta nmr_t = c_0 + c_1 \Delta gdpr_t + c_2 \Delta rir_t + c_3 nmr_{t-1} + c_4 gdpr_{t-1} + c_5 rir_{t-1} + \varepsilon_t \quad (4)$$

$$\varepsilon_t \sim (0, \sigma_\varepsilon^2)$$
$$\sigma^2_t = \phi_0 + \sum_{i=1}^{p} \phi_i \varepsilon^2_{t-i} + \sum_{j=1}^{q} \varphi_j \sigma^2_{t-j} \quad (5)$$

where: σ^2_t is the one-period ahead forecast variance based on past information, it is called the conditional variance. The conditional variance equation specified in (5) is a function of three terms: (i) the mean, ϕ_0, (ii) news about volatility from the previous period, measured as the lag of the squared residual from the mean equation, ε^2_{t-p} (ARCH terms), and (iii) last period's forecast variance, σ^2_{t-j} (GARCH terms).

If ϕ_i and φ_j are statistically equal to zero but ϕ_0 is significant, then the variance is constant. In the other hand, if ϕ_I and φ_j are significant, the variance is not constant indicating the volatility process existence. This study will use Schwarz Information Criterion (SIC) to set the optimal *p* and *q*. Moreover, each ϕ_i, $\varphi_j > 0$ and sum of ϕ_i and $\varphi_j \leq 1$ for i, j ≥ 1 should be satisfied for the model not to be explosive and to guarantee positive variances. If φ_i and/or ϕ_j have negative values, they will not have economic meaning.

If $\phi_i + \varphi_j$ are more than one, the conditional co-variances are non-stationary (Bollerslev, 1986). In the other hand, if $\phi_i + \varphi_j < 1$ then the conditional co-variances are stationary. Finally, if $\phi_i + \varphi_j$ are more than one or equal to one, the shocks are persistence or accumulation. However, with the inclusion of one period lag value of volume in the equation this condition may fail, despite it will be tested empirically.

The sign of the innovation may influence the volatility in addition to its magnitude. There are number of ways to parameterize this idea, one of which is the Threshold GARCH (or TARCH) model. This model was proposed by Glosten *et al* (1993) and Zakoian (1994) and was motivated by the EGARCH model of Nelson (1991). The specification for the conditional variance becomes,

$$\sigma^2_t = \phi_0 + \sum_{i=1}^{p} \phi_i \varepsilon^2_{t-i} + \lambda \varepsilon^2_{t-1} d_{t-1} + \sum_{j=1}^{q} \varphi_j \sigma^2_{t-p} \quad (6)$$

where $d_t = 1$ if $\varepsilon_t < 0$, and $d_t = 0$ if otherwise. In this model, $\varepsilon_t < 0$, and $\varepsilon_t > 0$ have differential effects on the conditional variance. The $\varepsilon_t < 0$ have an impact of ϕ_i, while $\varepsilon_t > 0$ have an impact of $\phi_i + \varphi_j$. If $\lambda \neq 0$ or if it is significant, there is asymmetric information. Those models can be estimated via maximum likelihood once a distributions of the innovations, ε_t, has been specified. A commonly employed assumption is that the innovations are normal distribution (Gaussian). Bollerslev and Wooldridge (1992) had proven that maximum likelihood can estimate the GARCH model assuming Gaussian errors were consistent even if the true distribution of innovations is not Gaussian. The usual standard errors of estimators were both consistent when the assumption of Gaussianity of the errors was violated. Bollerslev and Wooldridge had provided a method for obtaining consistent estimation of those.

EMPIRICAL EVIDENCE

The empirical analysis begins from the unit root and co-integration tests. The aim here is simply to show that the variables are integrated of the same order or not. The sampling distribution of OLS estimator is not well behaved if the disturbance is non-stationary. If a unit root present, it is essential to first difference the variables, thereby eliminating the unit root and achieving stationarity before attempting to estimate the model.

For this purpose, the research uses the methods of Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and Phillips-Perron (PP) (1988). The research uses Schwarz Information Criterion (SIC) to select suitable lag lengths of ADF test, while Newey-West method suggests four lags as truncation lags of PP test. The results of ADF and PP for unit root tests are reported in Table 1.

Table 1.
The Dickey-Fuller and Phillips-Perron Tests for Unit Root

Variables	Level Data		First Difference Data	
	T-ADF	T-PP	T-ADF	T-PP
nmr	-3.054 (1)	-2.962	-6.258*** (1)	-9.384***
gdpr	-1.429 (1)	-1.683	-3.008*** (3)	-9.472***
rir	-3.980** (1)	-3.923**	-9.109*** (1)	-13.393***

Note: the values in parentheses are optimal lags and asterisks indicate levels of significant at 5% (**) and 1% (***).

Table 2.
The Co-integrating Equation

$$nmr_t = -1.857 + 1.090\, gdpr_t - 0.723\, rir_t$$
$$(-9.339)^{***} \quad (58.732)^{***} \quad (-5.254)^{***}$$

Adjusted-R^2 = 0.991,
F-statistic = 6841.039 [0.000],
CRDW = 0.535***,
N (number of observations) = 128.

Table 3.
The Co-integrating Test

$$\Delta u_t = -0.374\, u_{t-1} - 0.003\, \Delta u_{t-1} + 0.235\, \Delta u_{t-2} + 0.030\, \Delta u_{t-3} + 0.214\, \Delta u_{t-4}$$
$$(-4.402)^{***} \quad (-0.035) \quad (2.552)^{**} \quad (0.332) \quad (2.360)^{**}$$
$$+ 0.085\, \Delta u_{t-5}$$
$$(0.959)$$

Adjusted-R^2 = 0.204,
SIC = -3.072,
ADF (optimal lag bases on SIC) = - 4.402***,
LM(1, 4, 8) = {0.000 [1.000], 1.611 [0.807], 11.555 [0.172]}
N (number of observations) = 122.

Table 4.
The Estimated Equation of ECM

$$\Delta nmr_t = -0.373 + 0.766\, \Delta gdpr_t - 0.003\, \Delta rir_t - 0.242\, nmr_{t-1} + 0.257\, gdpr_{t-1}$$
$$(-3.350)^{***} \quad (4.618)^{***} \quad (-2.671)^{***} \quad (-4.072)^{***} \quad (4.041)^{***}$$
$$- 0.129\, rir_{t-1}$$
$$(-1.731)^{*}$$

Adjusted-R^2 = 0.312,
F-statistic = 12.450 [0.000],
DW-statistic = 2.024,
LM(1,4, 8) = {0.070 [0.791], 7.127 [0.129], 10.443 [0.235]},
ARCH(1, 4, 8) = {0,197 [0.657], **8.052 [0.090**], 13.189 [0.106]},
JB-statistic = 1.275 [0.529],
RESET(1) = **10.821 [0.001]**,
N = 127.

Note: An asterisk indicates level of significant at 10% (*).

Note that the ADF and PP tests are performed with time trend and constant in level data but without them in first difference data. As is shown in Table 1, there are different conclusions relating to the tests. Except real interest rate, all variables are non-stationary series in level. Moreover, all variables become stationary series in first difference data.

Having established the unit root tests, the study moves onto examining the associated co-integration and error correction mechanisms that describe long run and short-run dynamics. The co-integrating equation and its test can be explained in Table 2 and 3, while the estimated ECM of Indonesia's demand for narrow money is presented in Table 4.

The values in parentheses are t-statistics that based on robust standard error of Newey-West (1987) Heteroscedasticity and Auto-correlation Consistent (HAC) Covariance with truncation lags = 4. The asterisks indicate that the estimated coefficients are significant at 1% critical level. Following this result, the study moves to co-integration test based on Dickey-Fuller test for residual series on estimated equation from Table 2. The investigation for optimal lag length produces the optimal lags equal to five lags as presented in Table 3.

The results in Table 2 and 3 show that CRDW statistic and ADF t-statistic indicate there is a co-integrating regression. These empirical results base on unit root test of ADF and CRDW test that indicate the significant statistics at 1% and 5% critical levels, respectively. Although the individual variables have different order of integration, the linear combination of those variables still produces stationary residuals (Harris, 1995: 80). Hence, the regression such estimated equation in Table 2 can be called as a co-integration regression and its co-integrating parameters are 1.090 of income and –0.723 of real rate of interest. Having a co-integration regression, the study continues to its estimated ECM. The estimation can be expressed in Table 4.

LM is a serial correlation test, ARCH is ARCH test, JB-statistic is normality test, and RESET (1) test is a functional form test of squared function while those in brackets denote p-values. This study uses Lagrange Multiplier (LM) for serial correlation test, ARCH-LM test for non-heteroscedasticity, and Jarque-Bera (JB)-statistic for normality of residual of estimated equation. The results show that there are no serial correlation, no heteroscedasticities, and the distribution of residuals is normal. However, there is still functional form problem according to RESET test.

The one and three asterisks indicate that the estimated coefficients are significant at 10% and 1% critical levels. Thus, in the short-run, real income and real rate of interest have significant impacts to the Indonesia's demand for narrow money, at 1% critical levels. The elasticity of real income and the impact of real rate of interest become 0.766 and –0.333. In the long-run, the elasticity of real income and the impact of real rate of interest to the demand for narrow money are 1.062 and –0.532, respectively.

Both LM test of serial correlation and JB test of normal distribution produce insignificant values. In the other hand, the ARCH test indicates a significant value at 10% critical level, marginally. RESET test indicates that the squared functional is significant. The significant statistics of the last two tests indicate that there are volatility processes in estimated equation. Although the estimated equation produces all significant variables but it is not well behave because ARCH effects are forced to be constant. Thus, the estimated equation such as the equation in Table 4 should be modeled as GARCH/ARCH specification and estimates it by maximum likelihood method.

THE VOLATILITY PROCESSES

The estimation of model (3) by using OLS, assumes that the variance of its residuals is constant. However this assumption has been violated by the significant statistics of ARCH test as presented in Table 4. In this particular situation, estimating Indonesia's demand for narrow money by the general model (4) and (5) could be useful because the ARCH effects are allowed in the models. Hence, these models can be estimated via maximum likelihood method. This method produces the suitable estimation of ECM with GARCH processes as presented in following table.

Table 5.
The Estimated ECM with GARCH Processes

$$\Delta nmr_t = -0.271 + 0.758\,\Delta gdpr_t - 0.279\,\Delta rir_t - 0.212\,nmr_{t-1} + 0.220\,gdpr_{t-1}$$
$$(-2.412)^{**} \quad (5.259)^{***} \quad (-2.164)^{**} \quad (-4.304)^{***} \quad (4.056)^{***}$$
$$-\,0.098\,rir_{t-1}$$
$$(-1.548)$$
$$\sigma^2_t = 0.0004 + 0.208\,\varepsilon^2_{t-1} + 0.645\,\sigma^2_{t-1}$$
$$(0.995) \quad (2.118)^{**} \quad (2.895)^{***}$$

Adjusted-R^2 = 0.289,
F-statistic = 7.408,
DW-statistic = 2.035,
Q(4)-statistics of residuals = 5.476 [0.242],
Q(4)-statistics of squared residuals = 3.331 [0.504],
JB-statistic = 0.065 [0.968],
ARCH(4) = 3.002 [0.557],
SIC = -2.983.

Table 6.
The Estimated ECM with TARCH Processes

$$\Delta nmr_t = -0.279 + 0.761\,\Delta gdpr_t - 0.280\,\Delta rir_t - 0.215\,nmr_{t-1} + 0.224\,gdpr_{t-1}$$
$$(-2.470)^{**} \quad (5.265)^{***} \quad (-2.204)^{**} \quad (-4.368)^{***} \quad (4.120)^{***}$$
$$-\,0.101\,rir_{t-1}$$
$$(-1.585)$$
$$\sigma^2_t = 0.0003 + 0.186\,\varepsilon^2_{t-1} + 0.030\,\varepsilon^2_{t-1}\,d_{t-1} + 0.659\,\sigma^2_{t-1}$$
$$(0.998) \quad (1.744)^{*} \quad (0.215) \quad (3.097)^{***}$$

Adjusted-R^2 = 0.284,
F-statistic = 6.541,
DW-statistic = 2.030,
Q(4)-statistics of residuals = 5.515 [0.238],
Q(4)-statistics of squared residuals = 3.170 [0.530],
JB-statistic = 0.067 [0.967],
ARCH(4) = 2.844 [0.584],
SIC = -2.944.

The values in parentheses of variance equation are t-statistics, which based on Bollerslev-Wooldrige (1992) robust standard errors and covariance. The maximum ARCH and GARCH terms are based on SIC. This method produces GARCH(1,1) as the suitable estimation. Next, the study goes to its associate TARCH. As mentioned previous section, the sign of the innovation might influence the volatility in addition to its magnitude. One way to parameterize this idea is by Threshold GARCH (or TARCH) model. This method produces mean and variance equations as presented in Table 6.

The maximum ARCH and GARCH terms are also based on SIC and produces TARCH(1,1) as the suitable estimation. To select the better empirical estimation between GARCH(1,1) and TARCH(1,1), the study also uses the SIC criterion. GARCH(1,1) produces SIC = -2,983 meanwhile the TARCH(1,1) provides SIC = -2,944. Finally, this research chooses GARCH(1,1) as the better empirical estimation.

Evaluating the empirical estimation of GARCH(1,1), the research uses residual test based on Correlogram–Q-statistics of the standardized residuals. The test uses four lags to be included, and produces Q-statistics equal to 5.476 [p-value = 0.242] that it is not significant. Thus, it can make a conclusion that the mean equation is correctly specified.

The study also had to test of residual based on correlogram squared residuals for remaining ARCH in the variance equation and to check the specification of the variance equation. If the variance equation is correctly specified, all Q-statistics should not be significant. The test statistics is 3.331 [p-value = 0.504] by including four lags. Again, it is not significant, so the variance equation is also in correctly specified.

The ARCH-LM test carries out Lagrange multiplier tests to test whether the standardized residuals exhibit additional ARCH. If the test statistics is not significant, the variance equation is correctly specified and do not need additional ARCH terms. The ARCH-LM test also has no significant value by including four lag test, ARCH-LM(4)=3.002 [p-value=0.557]. It implies that there is no ARCH left in the standardized residuals.

In the short-run of conditional mean equation, real income and real rate of interest still have significant impacts to demand for Indonesian narrow money, at 1% and 5% critical levels. The elasticity of real income and the impact of real rate of interest to demand for money are corrected to be 0.758 and –0.279, respectively. These values are not quite difference than its benchmark (the estimated equation in Table 4), 0.766 and –0.333. In the long-run, the elasticity of real income and the impact of real rate of interest to demand for money have corrected to be 1.038 and –0.462, respectively. This results also not quite difference than its benchmark, 1.062 and –0.532.

In variance equation, the ARCH(1) and GARCH(1) terms also have significant values at least 5% and 1% critical levels, respectively. The results indicate that the volatility of the Indonesia's demand for narrow money in the short-run is not quite persistent with the sum of ARCH(1) and GARCH(1) equal to 0.853. However, the estimated equation still has stationary covariance. Thus the model is still well behaved in variance specification.

THE FORECASTING ABILITY

In this section, the study compares the dynamic forecasting abilities between the estimated equations in Table 4 and 5. The comparisons are based on predictive powers of root mean squares error (RMSE), mean absolute error (MAE), and mean absolute percentage error (MAPE). The results are presented in Table 7, Figure 1 and 2.

Table 7.
The Comparisons of Predictive Powers
Between The Estimated Equations in Table 4 and 5

Predictive Powers	The Equation in Table 4	The Equation in Table 5
RMSE	0.049576	0.049556
MAE	0.039338	0.039230
MAPE	138.0436	135.1769

Figure 1.
Dynamic Forecasts of The Equation in Table 5

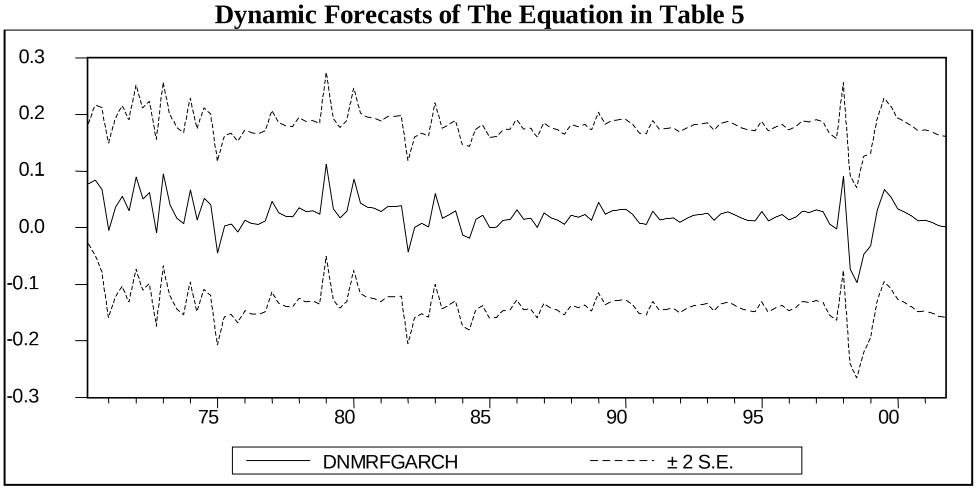


Figure 2.
Dynamic Forecasts of The Equation in Table 6

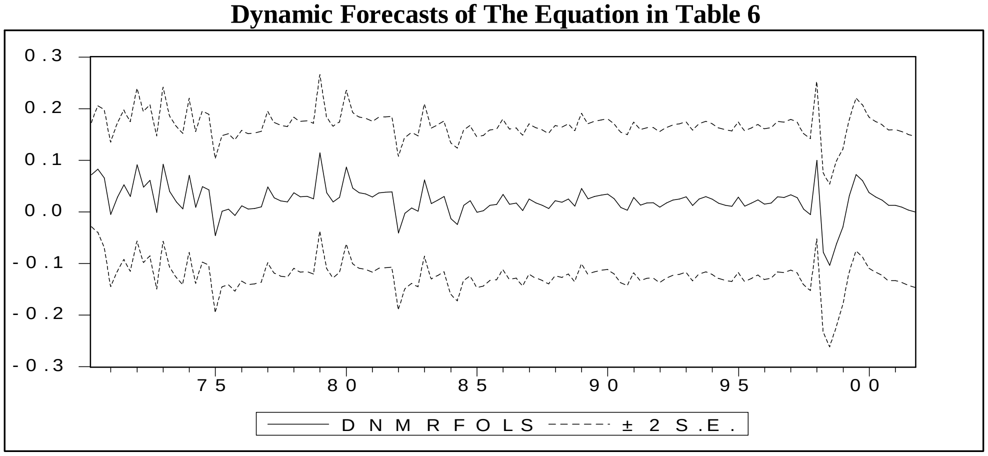
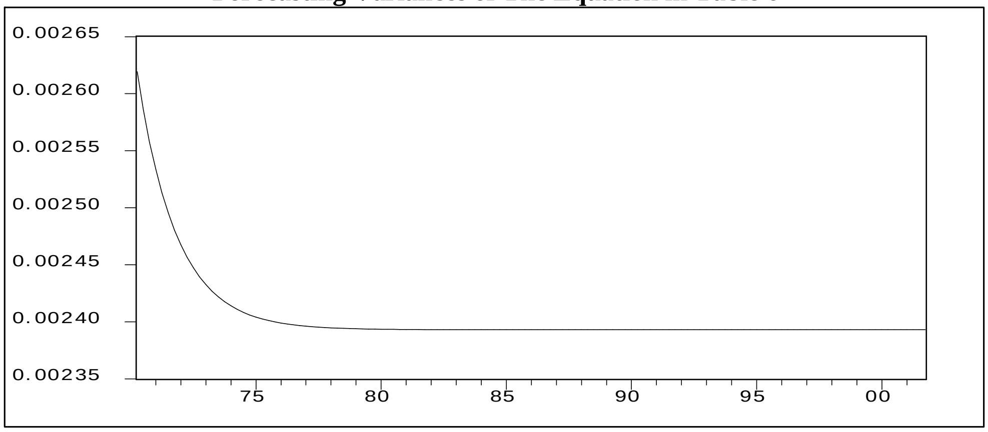


Figure 3.
Forecasting Variances of The Equation in Table 6



The table shows that the RMSE, MAE and MAPE of dynamic forecasts from the estimated equation in Table 4 are larger than the estimated equation in Table 5. Moreover, the RMSE, MAE, and MAPE values from dynamic forecasts of the estimated equation in Table 5 are 0.049556, 0.39230, and 135.1769 while its benchmark produces 0.049576, 0.039338, and 138.0436, respectively. The smaller values indicate the better prediction. Thus, the estimated equation in Table 5 is the best equation to predict actual values of Indonesia's demand for narrow money.

Beside the dynamic forecasts of its mean, the estimated equation in Table 5 also produces the dynamic forecasting values of its variances as plotted in Figure 3. The figure shows that the forecasting values of the variances are negative downward from 1970 to 1975. However, it seems to be stable from 1976 to 2001.

CONCLUSION AND POLICY IMPLICATION

Most empirical studies of demand for money in Indonesia focus on first moment (mean) rather than second moment (variance). Moreover, those studies were developed by error correction mechanism in their conditional mean equation. However, this research focuses the analysis of Indonesia's demand for narrow money not only in mean expectation but also in variance expectation.

The conditional mean equation was also developed by error correction mechanism in this study, but allowed the conditional variance by ARCH methodology. This research had proved that volatility processes (were developed by ARCH processes) followed the error correction model estimation. The results had seen that the ECM model with volatility processes has more predictive than ECM with constant variance to forecast the Indonesia's demand for narrow money.

There are policy implications relating to the findings in this research. *First*, the volatility processes should be included in order to have better estimation of Indonesia's demand for narrow money. It implies that in any given estimation of Indonesia's demand for narrow money, the central bank still has a risk (forecast variance). Thus, the central bank should consider the estimated volatilities or conditional variances in order to using the appropriate monetary policy to reach monetary targets. In economic terms the volatility processes can be assumed as the risks of expectation when the central bank forecasts the growth of Indonesia's demand for narrow money at given estimation. Moreover, the risk can be calculated and may differ for each given observation over the sample periods.

Technically, if the dynamic forecast of the growth of Indonesia's demand for narrow money in the first quarter of 1998 is 0.09% while the actual value is 0.8%, the variance is 0.006. It differs if the point of estimation is the third quarter of 2000. The growth of Indonesia's demand for narrow money is 0.02% when the actual value is 0.3% and then the variance is 0.002.

Second, it is simply to show that there is still risk to central bank to reach the aggregate monetary targets, especially in the estimation of the Indonesia's demand for narrow money. It is very useful if the central bank also sets the risks of every monetary policy they have. If the risk of every target is set up too, the central bank will know which of the several monetary policies is the best.

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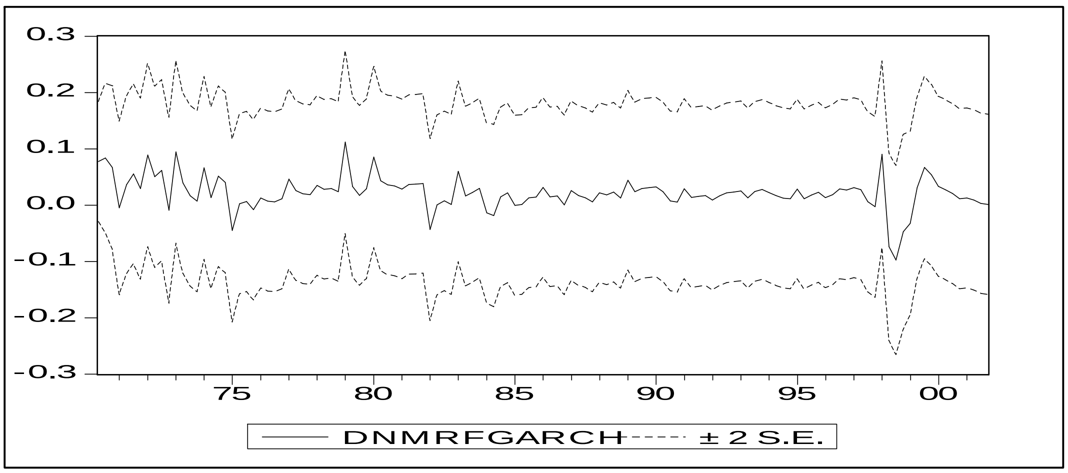

Figure 1. Dynamic Forecasts of The Equation in Table 5

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