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RICE PRICE VOLATILITY AND ITS IMPLICATION TO FOOD SECURITY IN INDONESIA

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Abstract: *This research is mainly aimed to analyze the volatility of deflated retail price of rice in two major markets in Indonesia namely Jakarta and Surabaya for the periods of January 1984 to August 2011. It is also studied the implication of the rice price volatilities to food securities in Indonesia. Since the time series price of rice is time-varying, and the variance of deflated retail rice price was heteroskedasticity, the better model is ARCH to predict the rice price volatilities. The results of the study shows that at the wet season, the price of rice was decreased and at the slack season the price of rice was increased as shown by the sigs of parameters on the mean equations. In addition, at pre-reformation era and post-reformation era, the deflated retail rice prices were volatiles and at the period of economic crisis, the prices were very unstable. On the whole, the volatilities of the rice price in the two markets were manageable due to the successful of the State enterprice of logistic Board (BULOG) intervention in the rice markets especially in Jakarta and Surabaya markets. To reach and to maintain national food security in the future, BULOG should be given the new mandate to manage the rice price volatilities included for other strategic commodities namely corn, soybeans and sugar as before economic crisis.*

Key words: *volatility, retail rice, time varying, heteroscedasticity, ARCH model, food security.*

I. INTRODUCTION

1.1. Background

As a source of staple food, rice is also source of incomes and employment in Indonesia. Rice also has a social function to help poor people called Zakat (Charity) for muslim people. According to the Central Bureau of Statistic (CBS) rice consumption per head in Indonesia was 102.78 kg. (1981-2010) and rice farm activities contributed 2.58 percent of Gross Domestic Product (GDP) in 2008. Moreover, Swastika (2010:7) stated that most of rice, maize and soybean in Indonesia are produced by small scale farmers so called peasant. The number of peasants in Indonesia increased from 10.8 million in 1993 to 13,7 million in 2003

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and 15.6 million in 2008. Hence a price decrease of rice and other crop commodities will directly cause suffering for about 15.6 million farmers. Moreover, Ikhsan (2003) found that a 10 percent increase in the domestic rice price is associated with a one percent increase in poverty incidence. It means that rice prices stabilities are very important to producers and consumers of rice in Indonesia

1.2. Problem Identification

Out of 12 million hectares of paddy rice in Indonesia, 51 percent (6 million hectares) paddy rice is harvested at peak season during wet season in February-May, 31 percent (4 million hectares) in June-September and 16 percent (2 million hectares) in October- February (Sawit, 2010:59). Moreover, Swastika et al. (2010:2) found that on the peak harvesting season, the rice price in two markets were lower and during the dry season the price of rice were higher. In the mean time, volume of consumption per capita is relatively stable for all seasons. To stabilize the rice price in Indonesia, government assigned state enterprise (BULOG) since 1967. The role of BULOG to stabize rice price is in line with Islamic principles. With the higher prices, consumers will worse off and the produces will be better off. When the price is lower, the producers will be worse off, and the consumen will be better off. So, it is needed a fair price both for consumers and producers. Otherwise, no incentives for farmers to produce rice when the prices are lower and the rice will be scarce. Farmers will only produce rices for themselves. This situation will bring up starvation for the rest of peoples.

1.3. Research Questions

This research is aimed to analyzing and comparing retail rice price volatilities in two major markets in Indonesia namely Jakarta and Surabaya. Specifically, the aims of the research are (a) to seek appropriate prediction of retail price of rice phenomenon in two major markets in Indonesia, (b) to analyze the difference characteristic volatilities between two markets in Indonesia and (c) to analyze the pattern of price volatilities changes related to the changes of economic system since reformation era, (d) to analyze the implication of rice price volatilities to national economy.

2. LITERATURE REVIEWS

The production of food crops included rice are predominantly determined by seasons. On the wet season, rice production are plentiful and on the bad weather, the production are small. The cycles of season from wet season to dry season can create abundance and scarcity of food respectly in the country. In Indonesia, rice that produced by farmers sell to middlements and this local traders sold the rice to wholeseller traders. This kind rice marketing in Indonesia give the opportunity to these traders to be monopolist or speculator that can manipulate rice prices through hoarding of rice to get large profits.

In Indonesia, to control the rice availibilities as main stapple food over time for the societies, the government assigned a state enterprise of Logistic Board (BULOG). Before September 1998 (Pre-reformation era), BULOG defended a floor price and a ceiling price for rice to control price volatility. The instrument was a combination of domestic procurement to lift paddy prices, market operation to defend ceiling rice retail price, and import monopoly (Istiqomah 2005:2). With this instrument, BULOG was very successful in stabilizing rice price in Indonesia. However, since September 1998 (Reformation era), under structural adjustment agreements with International Monetary Fund (IMF), BULOG import monopoly was abolished and private companies were allowed to import rice. However, BULOG still accounted for around 75 percent of total rice import (Dartanto, 2010), but other strategic commodities such as corn, soybeans and sugar are no longer control by BULOG.

Since then, the economic of rice is more liberal. BULOG set the single Government Purchase Prices (GPP). This single GPP policy for medium grades of rice increase market segment for medium grades of rice. BULOG also set tariff import to stabilize rice price and control rice market through distributing cheap rice for the poors, called Raskin.

The imperfect rice market in Indonesia caused by the the presence of middlement and whole seller traders who can set the Marginal Revenue = Marginal Cost to reach maximum profit. Without the presence of perfect market in rice marketing, BULOG regulates rice price domestically through Government Purchase Price Mechanism by setting floor price for dry paddy and imposing import tariff. With this trade barriers, the volatilities of rice price in international maket was not be able to transmit to domestic market perfectly.

According to Swastika (2010:2) that the high correlation coefficient between and among market indicating the presence of high market integration in rice mainly due to two factors, namely good market chains and government market intervention through BULOG for price stabilization.

Since the last decade, risk and uncertainty faced by both consumers and producers tend to increase due to rice price fluctuation. In international market, up to year of 2003, the price of rice was low and relatively stable at $200.00 per metric ton. However, in January 2004 to December 2007, the price of rice moderately increased from $207.5 to $378. The price of rice continued to grow and reach its peak at $1015.21 per metric ton on April 2008, and went down to $577.3 in August 2011 (IMF 2012).

Since rice plays an important role to domestic economy, Indonesian people are concerned to food and retail rice price volatilities. The stabilization of food prices included rice are needed by societies since the fluctuation of food price is contributed to risk and uncertainties in food securities. The rice price volatility should be taken into account through policy decision both for production and consumption sides.

Moreover, in Indonesia, fluctuated of food retail prices mainly price of rice are always be the major public issues especially for middle and lower income levels. Malian (2004:135) stated that the price elasticity of rice in domestic with respect to rice consumption was -0.35, meaning that for every rice price increase by 10 percent will decrease the rice consumption only by 3.5 percent. Such very in-elastic rice consumption give the implication that the rice is the basic need for Indonesian people. In addition, rice consumption participation was very high which reaches 97 percent, so the domestic rice price stability is very important.

Dartanto (2010:340) found that during 1993 to 1996, the domestic rice price was less volatile compared to the world price, which was indicated by the low ratios of the standard deviation between domestic and world rice price (0,19). It is perceived that the effects of BULOG's market intervention were relatively effective. During 2001-2003, the fluctuation of domestic rice price was 1.5 times larger than that of world rice price. During 2004-2007, the fluctuation of the domestic rice price was 2.5 times larger than that of the world rice price. During 2008-2010, an increase in production, reduction in import tariff, and restricted in import policy were able to insulate the domestic price from the domestic fluctuation with respect to the world rice price.

3. RESEARCH METHODS

3.1 Concept and Definition

Volatility means unstable, tend to vary and difficult to predict. The key elements are variability and uncertainty. At least, there are three reasons to rest on the important of modeling and forecasting price volatilities. Firstly, the results of the price volatilities studies are useful for decision making concerning related to risk. Secondly, the precise results of the forecasting may be characterized by "time-varying", so the accuracy of forecasting can be obtained with modeling its variance. Thirdly, related to the second argument, it is required to formulate the appropriate forecasting model and more accurate technical forecasting.

Volatility at some point of time, can be divided into two components. The first component is that its behavioral can be predictable and the second is unpredictable. Theoretically the weigh of each component can be studied. On practice, the capability of publics and government in managing the problem concerning risk tend to concentrate at variance which can be predicted. As the results, the prediction become less accurate, especially if its fluctuation pattern changes from what they have been experienced (Sumaryanto, 2009:137).

Volatility is one of the most important concepts in the financial markets. Volatility, as measured by the standard deviation or variance of return, is often used as a crude measured of the total risk of financial assets. Many values–at-risk models for measure market risk require the estimation or forecast of a volatility parameter (Brooks, 2011:383). However, Sumaryanto (2009) stated that analysis of volatilities is not only relevant to return of financial market, but also relevant to price of commodities markets volatilities.

3.2. Research Coverage

Retailed rice price volatility analysis in this research is focused to two markets which is represented by two major cities in Indonesia namely Jakarta and Surabaya. The coverage of information needed is not only the tendency or changes, but also covering the price volatilities. Comprehensives and availabilities of information about price volatilities are useful to formulate effective decision making on managing risk and uncertainties of retail rice price.

3.3. Data Sources

This research used secondary data. Monthly retail rice price of medium quality white rice in Indonesian Rupiah (IDR) per Kg. For two markets in Indonesia during January 1984 to August 2011 are obtained from BULOG. Consumer Price Index for January 1984 to August 2011 are obtained from Central Board of Statistics (BPS).

3.4. Analysis Methods

Previously, most of forecasting method for time series data was Autoregressive (AR), Moving Average (MA), or combination of AR and MA (ARMA or ARIMA). With these methods, it will be obtained precise prediction results when the variance of the errors is constant which called homoskedastisity. However, the problem arises when these method applied to commodities market such as rice markets on which their price fluctuated tend to be clustered like capital markets or money markets. Volatility clustering describes the tendency of large changes in asset prices (of either sign) to follow large changes and small changes (of either sign) to follow small changes. In other word, the current level of volatility tend to be positively correlated with its level during the immediately preceding periods. One of the most popular approach to analyze as such condition is to applied Autoregressive Conditional Heteroscedasticity (ARCH) model (Brooks, 2010:387).

This model is intended to forecast the conditional variance. In this context, conditional variance is the variance that may change as the time goes by. In this model the dependence variables is a function of independent variable or past values of dependent variable. This model was initiated by Engle (1982) to analyze inflation volatilities in England. The more comprehensive development of this model was done by Bollerslev (1986) which called Generalized Autoregressive Conditional Heteroscedasticity (GARCH).

On this research, when homosedasticity errors assumption is not fulfilled, it will be used univariat ARCH/GARCH model. Than, the discussion will be focused on this model.

3.4.1. ARCH Model

ARCH model is employed commonly in modeling financial time series that exhibit time-variying volatility clustering, i.e. periods of swings followed by periods of relative calm (Engle, 1982). An ARCH process can be defined in a variety of contexts. Based on Bera and Higgins (1993), an ARCH is defined in terms of the distribution of the errors of a dynamic linear regression model.

Bera and Higgins showed the assumption of original ARCH model by Engle (1982) as follows:

$$\varepsilon_t \mid \Psi_{t-1} \sim N(0, h_t)$$

where

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_q \varepsilon_{t-q}^2, \tag{1}$$

The conditional variance *ht* with $\alpha_0 \geq 0$ and $\alpha_i \geq 0$, i =1,…, q, to ensure that the conditional variance is positive.

The simplest ARCH model is ARCH(1) which can be written as:

$\varepsilon_t \mid \Psi_{t-1} \sim N(0, h_t)$ where:

$$ht = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 \tag{2}$$

3.4.2. Generalized Autoregressive Conditional Heteroskedasticity (GARCH) Model

Bollerslev (1986) improved the ARCH model from the Engle's model. Bollerslev stated that the conditional variance *ht* was not only depend on lagged squared errors but also depend on lagged variance errors. He extended the conditional variance called Generalized ARCH (GARCH). The general form of GARCH model is:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_q \varepsilon_{t-q}^2 + \beta_1 h_{t-1} + \ldots + \beta_p h_{t-p}, \tag{3}$$

where the inquality restrictions are:

$\alpha_0 \geq 0$

$\alpha_i \geq 0$ for $i = 1, \ldots, q$

$\beta_i \geq 0$ for $i = 1, \ldots, p$

The simplest and most robust GARCH model is ordered p=1 dan q=1 that can be written as GARCH (1,1). The GARCH (1,1) model can be generalized to a GARCH (p,q) model- that is a model with additional lag terms, namely:

$$\varepsilon_t \mid \Psi_{t-1} \sim N(0, h_t)$$

The sum of $\alpha i + \beta i$ give the degree of persistence of volatility in the series. The closer the sum to 1, the greater is the tendency of volatility to persist for longer time. If the sum exceeds 1, it is indicative series with a tendency to meander away from mean value. The GARCH estimates have been used to identify periods of high volatility and volatility clustering (Sekhar 2005:17).

The value of αi and β_1 will influence the folatilities of variables in time series. The value of α_1 reflect as a reaction coefficient and β_1 is a persistence coefficient. When α_1 is less than β_1, the effect of the persistence coefficient will be outweight the effect of reaction coefficient It means that the effect of price volatilities will lasted for a longer time before going back to a normal condition. If, α_1 is greater than $\beta_{1,}$ the volatilities are restrained. It means that for every volatilitcase, there is a strong reaction to revise the volatility the normal condition where the volatility will not be lasted for a long time.

3.5. Distribution Assumption

Frank and Zakoian (2004) stated that unbiased estimation methods for ARCH/GARCH model is Maximum Likelihood (ML). ARCH/GARCH model can not be estimated with Ordinary Least Squares(OLS) since OLS is used to maximized R- squares. So, the estimation of regression line is not based on R-squared but it is based on Maximum likelihood. With the presence of heterocedasticity, the value of R- square will be relatively small. Usually, there are three assumptions that can be used to its estimation: (i) normal distribution (Gaussian), (ii) Student 's t-distribution, and (iii) Generalized Error Distribution (GED)with or without estimating coefficient parameters.

3.6. The Procedures of Volatility Measurement for ARCH/GARCH Methods

Like analysis with ARMA model, data that will be analyzed with ARCH/GARCH model requires the long time span of observations. Sumaryanto (2009) outlined five procedures to analyze price volatility with ARCH/GARCH model:

1. **Data Preparation:** Data preparation will cover: (i) data collection and completeness of data so that there are no missing data, (ii) smoothing stochastic behaviour through elimination of deterministic factors such as trend, seasonality and cycles. For price data, trend is eliminated by deflation. In some cases seasonality and cyclus can be also eliminated by transformation of data to logarithm.

   On this research, Consumer Price Index (CPI) is used to be a deflator using year of 1996 as a based year. Smoothing is also used to overcome the seasonality factor by introducing dummy variables "month" to the model. Since there are twelve month in a year, there are eleven dummy variables introduced. Dummy variable base is month of "December"since previous analysis concluded that the smallest coefficient variation for CPI is at that month of December.

2. **Unit Root Test:** Time series models usually contains unit root that could be spurious. To avoid spurious regression, variables which ares analyzed should be statitionary which is not contained unit root. Staticians working with time series models suggested a simple solution to the spurious regression problems by introducing first difference on variable concerned. Hence, the first step which is required to be done before developing ARMA or ARCH/GARCH model is unit root test.

   There are various methods to test the existence of unit root. On this research, it will be applied Augmented Dickey-Fuller (ADF) and Phillips-Peron to test the existence of unit root. Under the null hypothesis, if the computed absolute value of t-statistic exceeds the Mac. Kinnon DF absolute critical t-values, then one cannot reject the hypothesis that is the time series data has been stationary.

3. **ARMA Model Estimation:** When the data has been stationary, ARMA parameters can be estimated. The procedures follows Box-Jenkin methods (1976).

   Theoritically, there are few forms of ARMA model such as ARMA(p,q), ARMA(p,d,q), ARMAX which is ARMA with exogenous variables (included dummy variables), ARMA with SAR(Seasonal Autoregressive) which represent seasonal auto regressive phenomenon, ARMA with SMA (Seasonal Moving Average) that represent moving average phenomenon of which its character is seasonal, or ARMAX with SAR and SMA.

4. **Testing the Existence of ARCH:** After the most appropriate ARMA model is found, the next step is to identify the existence of ARCH by investigating ARMA residues. This can be done by Lagrange Multiplier or ARCH-LM test. If nul hypothesis (Ho) is failed to reject, it means that ARMA error is homosedastic. So that, the existence of ARCH is not significance. On the contrary, if Ho is rejected, it means that the ARMA error is heterocedastic and so that existance of ARCH is significance. It implies that, the more appropriate model is not ARMA but ARCH/ GARCH model.

5. **The estimation process of ARCH/GARCH:** The estimation process of ARCH/GARCH can not be done automatically. It needs some trials and errors to get an appropriate ARCH/GARCH model with different distribution (normal, Student,GED, Student with fixed df, GED with fixed parameters). So that, it can be obtained significant coefficient parameters which fulfil requirements (agrees with sign and magnitudes as required by an ARCH/GARCH model). It also has to satisfy DW-test and its Prob. F-test. After appropriate ARCH/GARCH model is obtained, it needs more diagnostic toward ARCH/GARCH residues namely ARCH –LM test to make sure whether the effects of ARCH still exists. If all of those requirements are satisfied, and the results of accuracy of forecasting of the model ares also satisfied, it is concluded that ARCH/GARCH models have been appropriates. The methode of estimation on this case is Maximum Likelihood (ML). On this research, computation uses the program of Eviews 6.0.

4. RESULTS AND DISCUSSIONS

4.1. Stationary Tests

The results of Root Unit Test (Table 4.1) shows that all retail rice prices in two markets in Indonesia have been stationary after one time differentiated (Dlog rice price at time t minus log rice price at time t_{-1}). Please see the results of ADF and Adj. T-statistic Phillips Peron test column which exceeds the Mac Kinnon. The stationary of retail rice prices data will be used to estimate ARMA or ARCH/GARCH model.

Table 4.1
The Results of Unit Root Test for Monthly Retail Rice Price in Five Major Markets/ Cities in Indonesia, Period of January 1984 – August 2011

Cities	*Variable*	*ADF Test*		*Philips – Peron Test*	
		t-Statistic	*Prob**	*Adjt.t-Statistic*	*Prob**
Jakarta	Log(P-rice)	-3.744068	0.0208	-3.550285	0.0358
	D(Log(P-rice))	-11.95137	0.0000	-26.07717	0.0000
Surabaya	Log(P-rice)	-3.574028	0.0336	-3.282840	0.0709
	D(Log(P-rice))	-15.13278	0.0000	-15.14434	0.0000

*Mackinnon (1996) one-sided p-values

Critical value of ADF statistics and Phillips -Peron statistics (at Level 1 percent is – 3.986026, at level 5 percent is – 3.423459 and at level 10 percent is – 3.13468).

4.2. The Results of ARMA Estimation

After the retail rice prices have been stationary, through Box-Jenkins procedures (1976), the ARMA will be called ARIMA, since the data has been differentiated for one period of time. Table 4. 2 shows the results of ARMA process. The best ARIMA model is obtained by including seasonal factors into its AR and or MA process. On this study, Dummy variables (D1, D2,------, D12) represent month of January to December respectively. DR represent for reformation era (January 1998 up to now = 1, otherwise = 0. DRAD represent Dummy variable for social unrest in relation with reformation era, October 1997-September 1998 = 1, otherwise = 0.

Table 4.2
ARMA Model for Monthly Retail Rice Price in Two Markets in Indonesia, Periods of January 1984 - August 2011

Monthly Retail P-rice (Deflated by CPI)	*ARMA Model*)*
Jakarta • d(log(p-rice))	D(Log(P-rice)) = 0.008037 + 0.37940 DRAD + 0.021639DI - 0.045267D3 - 0.040338D4 -0.031409D5 + 0.165051 AR(1) + 0.867135 SAR(11) – 0.928690 SMA(11).
Surabaya • d(log(p-rice))	D(Log(P-rice)) = 0.007777 + 0.043613 DRAD – 0.045898 D3 - 0.038722 D4 + 0.764377 AR(1) – 0.135217 AR (2) - 0.708419 SAR (11) – 0.747708 MA (1) + 0.772959 SMA (11)

*D is a time series data which has been differentiated for one period of time. All coefficient are significantly different from zero.

4.3. The Existence of ARCH

Table 4.3 shows the results of ARCH from ARMA by LM-test. To test its consistency, the existence of ARCH was tested for three different time lag. On general, if at time lag (1) Ho is rejected, there are tendency that Ho is also rejected for lag(2) and lag(3). On the other hand, if Ho can not be rejected at lag(1), then Ho also can not be rejected at lag(2) and lag(3).

Table 4.3
The Results of Lagrange Multiplier ARCH Test for ARMA Model Error for Retail Rice Prices in Five Markets in Indonesia, January 1984- August 2011

Cities	*Lag*	*F_Statistic & TR²* *(Obs*R²)*		*Prob.F (df,n)*	*Prob* $\boldsymbol{X}^2$
Jakarta	Lag (1)	F-Stat	4.482879	Prob.F (1,316)	0.035017
		TR^2	4.448148	Prob.Chi_Square (1)	0.034939
	Lag (2)	F-Stat	5.857640	Prob.F (2,314)	0.003180
		TR^2	11.40181	Prob.Chi_Square (2)	0.003343
	Lag (3)	F-Stat	3.875618	Prob.F (3,312)	0.009598
		TR^2	11.35285	Prob.Chi_Square (2)	0.009963
Surabaya	Lag (1)	F-Stat	7.414806	Prob.F (1,315)	0.006829
		TR^2	7.290278	Prob.Chi_Square (1)	0.006933
	Lag (2)	F-Stat	14.89297	Prob.F (2,313)	0.000001
		TR^2	27.45841	Prob.Chi_Square (2)	0.000001
	Lag (3)	F-Stat	9.872949	Prob.F (3,311)	0.000003
		TR^2	27.39114	Prob.Chi_Square (3)	0.000005

By observing the results of the ARCH-LM test, it can be concluded that variance of retail rice prices for all markets containts ARCH effect. So that, the forecasting model assume that the variances are heterocedasticity which suggest that the appropriate forecasting models are ARCH/GARCH. The ARIMA models are only appropriate for homocedastic variances.

4.4. Volatility of Rice Price for Two Markets in Indonesia

After investigating the distribution of log-likehood, it is known that GED with the fixed score of parameters included two markets that are Jakarta and Surabaya. To test whether the effect of ARCH is still exist, LM test for ARCH/GARCH is also conducted as shown at Table 4.4 as follows.

Table 4.4
The Results of ARCH- LM Test of Retail Rice Price for ARCH/ GARCH Model for Two Cities in Indonesia, January 1984-August 2011

Lag		*F-Statistic TR^2 and Prob. F (df n) for each lag*			
Jakarta	1	F-Statistics	1.267761	Prob.F(1,316)	0.261041
		TR^2	1.270687	Prob.Chi-Square (1)	0.259638
	2	F-Statistics	1.695351	Prob.F(2,314)	0.845210
		TR^2	3.386529	Prob.Chi-Square (2)	0.883918
	3	F-Statistics	1.163271	Prob.F(3,312)	0.323890
		TR^2	3.495456	Prob.Chi-Square (3)	0.321352
Surabaya	1	F-Statistics	0.400991	Prob.F(1,315) Prob.	0. 0.527038
		TR^2	0.403024	Chi-Square (1)	0.525532
	2	F-Statistics	0.260344	Prob.F(2,313)	0.770953
		TR^2	0524806	Prob.Chi-Square (2)	0.769201
	3	F-Statistics	0.387949	Prob.F(3,311)	0.761762
		TR^2	1.174420	Prob.Chi-Square (3)	0.759146

Since all of F-Statistic and Observed R^2 (TR^2) are not significant from zero, the ARCH/GARCH model are appropriates. Furthermore, based on the results of ARCH-LM test, the accuracy level of forecasting, AIC and SBC criterion, the sign and magnitude of coefficient parameters, it is concluded that Jakarta and Surabaya market which are located in Java have ARCH(1) model.

Dummy reformation (DR) was dropped from each mean equation since it does not significantly determine the rice price in each rice market. This caused by the fact that agricultural reformation has been started since the issuance of Agricultural Law number 12/1992 which give the right to the farmers to grow any commodities they want to. This Law has liberalized agricultural activities in Indonesia. As a result, in 1994, self sufficiency in rice was no longer existed, and bring about that DR was not significant in equation model.

The discussion of the results of this research will be focused on *mean equations* and *variane equations. The mean equation* will deal with the changes of independence variables toward dependence variables. On the other hand, the variance equations will show the behaviour of variables concerned such as the behaviour of rice prices.

4.4.1. Mean Equations

1. **Jakarta Market:** Table 4.5 shows that on the peak harvest time in wet season in (February-May), the price of rice at Jakarta market was decreased which was reflected by the negative signs and significance of dummy months of D3 (March), D4 (April) and D5 (May). The positive sign of Dummy month of D1 (January) shows the lack of supply of rice at that month (slack season) which causes rice price to increase significantly. The positive sign and significance of DRAD shows that the rice price increase significantly as an impact of Indonesian crisis in 1997-1998. Consequently, in 1998 and 1999 Indonesia imported 2.89 and 4.7 million metric tons of rice respectively (Kementrian Pertanian, 2011). The AR(1) shows that the rice price level in the Jakarta market was determined by the rice price level at lag 1. The SAR(11) and SMA(11) shows that the pattern of yearly cyclus of the rice price.

Table 4.5
Mean Equation for Jakarta Market

D(LogP-rice)	*Coefficient*	*z-Statistic*	*Prob.*
Constant	0.003685	1.426728	0.0153
D1	0.017983	3.195409	0.0014
D3	-0.028827	-40317469	0.0000
D4	-0.034904	-40207080	0.0000
D5	-0.019141	-207388328	0.0062
DRAD	0.060365	5.885987	.00000
AR (1)	0.116854	1.905956	0.0567
SAR (11)	-0.843763	-35.92204	0.0000
SMA (1)	0.936078	96.07068	0.0000

Note: Log like hood = 608.7061 (distribution of GED with fixed parameter at 1.5) DW = 1.992143, AIC = -3.747373, SBC = -3.617539

2. **Surabaya Market:** Table 4.6 shows that on the peak harvest time in wet season (February-May), the Surabaya rice prices was decreased which is reflected by the negative signs and significance of dummy months of D3 (March), and D4 (April). The positive sign and significance of DRAD of dummy variable shows that the rice price increase significantly as the impact of Indonesian crises (Octobre 1997 – Septembre 1998).

The AR(1) shows that the rice price level in Surabaya market was determined by the price level at lag 1. The AR(2) shows that the rice price level in the Surabaya market was determined by the price level at lag 2 in the opposite direction. The SAR(11) and SMA(11) shows that the pattern of yearly cyclus of the rice price. The MA(1) shows that the price level in Surabaya was determined by the average of the last month of rice price.

Table 4.6
Mean Equation for Surabaya Market

D(LogP-rice)	*Coefficient*	*z-Statistic*	*Prob.*
Constant	0.004311	2.123322	0.0337
D3	-0.037941	-5.225729	0.0000
D4	-0.025926	-3.252325	0.0011
DRAD	0.071158	9.736386	0.0000
AR (1)	0.727469	3.703399	0.0000
AR (2)	-0.137185	-2.090328	0.0366
SAR (11)	-0.644682	-3.853547	0.0001
MA (1)	-0.663919	-3.295773	0.0010
SMA (11)	0.685151	4.264236	0.0000

Note: Log like hood = 621.9639 (distribution of GED with fixed pamameter at 1. 5). DW = 2.020178, AIC = -3.842540, SBC = -3.712406

4.4.2. Variance Equations

1. **Jakarta Market:** Variance equations for Jakarta markets is ARCH(1), as shown by the following table.

Table 4.7
Variance Equations for Jakarta Markets in Indonesia

Variance	*Coefficient*	*z-statistic*	*Prob.*
C	0,000913	8.347821	0.0000
ARCH (1)	0,430550	3.242874	0.0012
GARH (1)	–	–	–

The coefficient of α_1 for Jakarta market was less than one. This ARCH(1) exhibits time varying volatility clustering, i.e. periods of swings followed by periods of relative calm. This means that after experiencing of price volatilities for some period of time, it will be followed shortly by normal price level.

2. **Surabaya Market:** Variance equations for Surabaya markets is also ARCH(1), as shown by the following table.

Table 4.8
Variance Equations for Surabaya Markets in Indonesia

Variance	*Coefficient*	*z-statistic*	*Prob.*
C	0.000986	14.94319	0.0000
ARCH (1)	0.210516	3.309607	0.0009
GARH (1)	–	–	–

Variance equations as shown by Table 4.8 for Surabaya markets is also ARCH(1). The coefficient of α_1 for Surabaya is less than one. This ARCH(1) exhibits time varying volatility clustering, of which periods of volatility followed by relatively stable prices. This means that after price swings was followed by normal prices.

4.5. Price Behaviour at Pre-Reformation and Post-Reformation Era

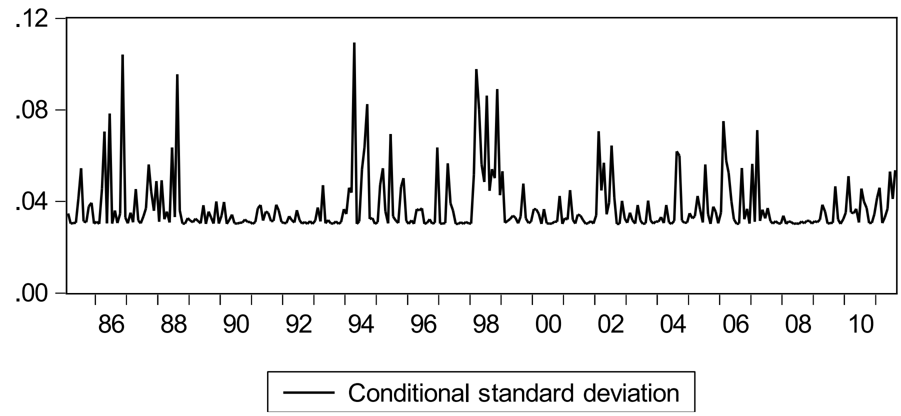
At pre-reformation era and post-reformation era, the rice price in Jakarta and Surabaya were volatiles, as shown by average conditional standard deviation (CSD) of deflated retail price of January 1984–August 1998, and period of Septembre 1998 and to August 2011. The CSD for Jakarta was 3.71 percent and for Surabaya was 3.59 percent for period of January 1984- August 1998. For the period of Septembre 1998 – August 2011 was 3.69 percent for Jakarta and 3.47 percent for Surabaya. On the period of economic crisis (April 1997-September 1998), the CSD went up to 5.17 percent for Jakarta and 5.31 percent for Surabaya. These Volatilities are shown on the following table.

Table 4.9
Volatifities (CSD) of Retail Rice Price in Jakarta and Surabaya Market in Indonesia.

No	*Market*	*Pre Era Reformation (Jan 1984- August 1998)*	*Post Era Reformation (1 Sept 98-August 2011)*	*Economic Crisis (Oct 1997– Sept 1998)*
1.	Jakarta	0.0371	0.0369	0.0517
2.	Surabaya	0.0359	0.0347	0.0531

This agrees with CSD for retail rice price in Jakarta, 1984-2011, as follows.

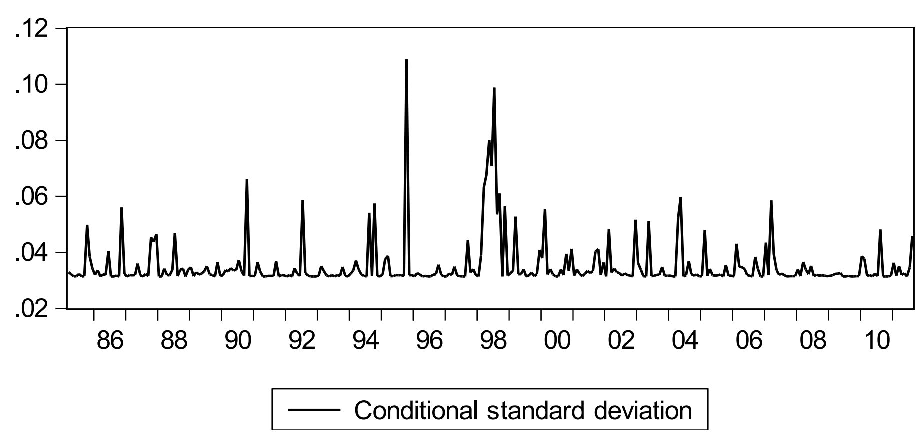
Figure 1: Conditional standard deviation for Retail Rice Price of Medium Qualities in Jakarta, January 1984 – August 2011



For the Jakarta market, Figure 1 illustrates the volatilities of rice price per month which agree with the CSD of retailed rice price at Table 4.9, of which CSD accounted based on whole years. Figure 1 also shows that after rice prices raised always followed by normal prices.

For the Surabaya market, Figure 2 illustrates the volatilities of rice price per month which also agree with the CSD of retailed rice price at Table 4.9. Figure 2 also shows that after rice prices raised always followed by normal prices.

Figure 2: Conditional standard deviation for Retail Rice Price of Medium Qualities in Surabaya, January 1984 – August 2011



2.5. Policy Implication of Rice Price Volatilities to Food Securities

In the last several years, rice production in Indonesia is difficult to be predicted caused by global warming which frequently bring up El-Nino incidence. Budhi and Mimin Aminah (2010:58) stated that the global warming cause domestic productivity of rice will be decreased by 18.6-31.4 percent, corn 9.6-17.6 percent and soybean 13.8-24.2 percent in 2050. Hence, there is a tendency that the rice price both in domestict and in the world market will likely higher in the future.

Since international market rice price was also volatile, it is very risky to be dependent on international rice market. To reach and to maintain food security in the future included other strategic commodities namely corn, soybeans and sugar, Indonesia has to be self suffeciency in rice and increase domestic rice stocks in sufficient amounts to protect Indonesian people from hunger. The rice stocks which is managed by BULOG can be used to control the rice price volatilities. Another problem arising from world trade market is that the world rice market is a thin market. Departemen Pertanian (2009) reported that there was only 30 million metric ton of rice traded in the world market out of 435 million metric ton of world rice production in 2009, which is very sensitive to demand changes.

To increase domestic rice supplies, it needs extensificasion program through constructing new paddy fields since the growth of rice productivities in Indonesia has been very low since the last decade (1.04 %).

In addition, Government needs to protect land conversion from agriculture to non-agriculture uses in the future. For the last decade, about 1.5 million hectares of of agricultural land has been conversed to non-agricultural uses. This conversion will threaten food production mainly rice production.

4. CONCLUSIONS AND RECOMMENDATIONS

The results of this research show that the more appropriate model to make forecasting of retail rice price in Jakarta and Surabaya market are ARCH model and not ARIMA model since the variance of error terms were heterocedasticities.

The very unstable price of rice in all markets was on period of economic crisis in October 1997-September 1998, as indicated by the highest spikes of CSD values compared to other period.

The presence of economic crisis in that time impacted seriously to all retail rice price in two major markets.

The behaviour price changes in Jakarta and Surabaya markets almost has the similarities in mean equations. The changes in rice price in two markets caused mainly by the harvest time and yearly routine cycles of. On the peak harvest time the prices went down caused by supply glut and in the slack harvest time the price went up caused by lack of supply. Auto Regressive (AR), Seasonal Auto Regressive (SAR) and Seasonal Moving Averages (SMA) also contributed to rice price changes in all markets. Dummy for economic crisis (DRAD) also significantly caused rice price changes in all markets in Indonesia.

From variance equation's perspectives, Jakarta and Surabaya markets have ARCH(1) model. These implicate that the rice price volatilities in Jakarta and Surabaya are easier to bring back to normal situation after price shocks as shown by the value of α on variance equations which less than one which shown by Figure 1 and Figure 2 of CSD. The reasons are that BULOG plays important roles to bring back the rice price volatilities to normal conditions.

The contribution of this research is how to improve the effectiveness of price stabilization policies for retail rice price for each two markets in Indonesia. Since BULOG was very effective in controlling rice price volatilities and rice availabilities and other strategic commodities namely corn, soybeans and sugar in Indonesia, it is suggested that BULOG should be given new mandates to revitalize it's institution and to protect domestic producers and consumers of food commodities in Indonesia through market operations.

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