KnE Life Sciences

ICSAFS Conference Proceedings
2nd International Conference on Sustainable Agriculture and Food Security:
A Comprehensive Approach
Volume 2017

Knowledge E
Engaging minds

Conference Paper

Price Volatility Analysis in Indonesian Beef Market

Intani Dewi[1], Rita Nurmalina[2], Andriyono Kilat Adhi[2], and Bernhard Brümmer[3]

[1]Bogor Agricultural University, Jl. Kumbang No. 11 Bogor 16151, Indonesia
[2]Bogor Agricultural University, Jl. Kamper Dramaga, Bogor 16680, Indonesia
[3]Georg-August University of Göttingen, Platz der Göttinger Sieben 5, 37073 Göttingen, Germany

Abstract

The Indonesian beef price movement increasing erratically and tends to be volatile in recent years. Based on the price monitoring in several production centers, there are beef price fluctuations in the consumer level across time and between provinces. This study tries to present the relationship between the beef price volatility and Indonesia's efforts to ensure food security through self-sufficiency in beef. We consider a series of consumer daily beef price from January 2006 to December 2013, with total T = 2086 observations to understand beef price volatility in Indonesia, and to analyze the impact of beef self-sufficiency program to the beef price volatility in Indonesia. Data was obtained from Ministry of Trade, Government of Indonesia and it was collected through market survey from three different markets in 33 capital provinces in Indonesia. The methodology follows GARCH model to measure the beef price volatility. The GARCH (1.1) model gives information that beef price movements are influenced by the volatility from the previous period and yesterday's variance. The volatility of beef price was driven more by its own variance rather than external shocks. GARCH (1.1) model shows that the beef price volatility will tend to be smaller and persistence in the future. Parameter of the third dummy variable in the variance equation to capture the change policy is statistically significant. It indicates that the beef self-sufficiency program may lower the beef price volatility.

Keywords: beef price, garch model, price volatility, self sufficiency.

Corresponding Author:
W. Julian
julian_witjaksono@yahoo.com

Received: 28 July 2017
Accepted: 14 September 2017
Published: 23 November 2017

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICSAFS Conference Committee.

1. Introduction

In recent years, the risks and uncertainties faced by consumers and producers due to fluctuations in food prices are likely to rise. Price fluctuations may occur in short term, per month, per week, even per day, or may occur in the long term. Food prices including beef are fluctuates. Meat as one of many agricultural commodities is also experiencing the same effect with its prices following the pattern of food prices. Food prices often fluctuate due to various factors, both natural phenomena (climate), market failures,

also distribution problem. Some strategic food price commodities within the country are increased, often fluctuate and become the spotlight in Indonesia are rice as a staple food, corn, soybeans, wheat flour, sugar, cooking oil, onions, peppers, eggs, meat and milk [1]. This causes the risks and uncertainties faced by consumers and producers due to fluctuations in food prices tend to increase.

Beef is one of food commodities from animal origin that has positive income elasticity; it means that people tend to buy more beef when their income is increasing [2]. Therefore it is also important to see the development of beef price because beef is a source of protein with increasing consumption number and has high price, beef also one of contributor to inflation in Indonesia. Indonesia became the country with the highest selling price of beef compared to some countries such as Malaysia, Singapore and Australia [3]. The Indonesian beef price movement increasing erratically and tends to be volatile in recent years. Based on data from the Ministry of Trade, the average increase in the beef price is 9 percent per year. With the highest price increase occurs in 2008 which reach 14.57% compared to the previous year, from IDR 52,841/kg to IDR 63,544/kg. Growth rates which quite high also occurs from the year 2011 to the year 2012 in the amount of 10.37% and the highest growth of 17.58% was from 2012 to 2013 with a maximum price of IDR 97,709/kg.

Very high volatility could be a major threat to food security in developing countries such as Indonesia, which is a net importer of beef. Increased volatility may increase poverty and increase the burden of government spending and worsening the national debt, thus disrupting economic stability and hamper economic growth [4]. Behind the concerns over price volatility it would appear also concerns about price levels and their relation to food security, especially for the people with low income levels. Governmental action to address this issue was launched called the Beef Self-Sufficiency Program (BSSP). The first target of BSSP was in 2005; the target was delayed into 2010 and now delayed again to 2014. Although there are delays, the government took extreme steps to reduce import quotas and empowering potential local farmers in order to develop more. This government policy main goal is to achieve food security animal origin based on local resources, by increasing population and domestic production to meet the national beef needs.

Indonesia will experience a very great beef deficit in the medium to long term if the government has not made any efforts to increase production. Great deficit in meat will further difficult the price stabilization in the country. The government needs to do a variety of urgent breakthrough efforts in the short term and medium term for the beef commodity price stability in the market, so that it can be maintained and affordable to consumer.

The government's policy of the beef self-sufficiency program, although considered to be successful in increasing the population in the country and reduce the gap between demand and supply, but the target of Indonesia to be able self-sufficient in producing beef sparked controversy because it increases the price of beef and disturb the domestic supply that makes the price volatile especially with beef cattle import reduction policy.

Complete information about the commodity prices behavior is needed not only the tendency or direction of change but also the volatility. It is important to understand the price volatility, and find out the cause and its effects on the economy in order to increase the effectiveness of the price stabilization policies and programs as well as to formulate more effective protection measures because the concept is closely related to the risks and uncertainties in decision making. Moreover, when communities are faced with price condition that are unstable and the pattern is irregular.

The Indonesian government has intervened in the beef market through many policies and one of the policies is beef self-sufficiency program. These interventions very likely influence the market performance, especially the price volatility. Therefore this study wants to find how the beef price responds to the beef self-sufficiency program. The aims of this study are to understand beef price volatility in Indonesia and to analyze the impact of beef self-sufficiency program to the beef price volatility in Indonesia. The scope of this study is the price volatility analysis to measure how volatile the price of beef at the consumer level and wants to explain one of the government programs to achieve food self-sufficiency through beef self-sufficiency program, whether or not the program affects the volatility of the beef price in the market. This study does not look beyond the effect of volatility on the marketing agents in each market chain. This paper is organized as follows; the next sections present a brief review of literature, the research methodology, analysis and results, and the conclusion of the study.

1.1. Literature Review

Volatility term refers to the unstable conditions, tend to vary and difficult to estimate. The two principal concepts for volatility are variability and uncertainty. Overall movements away from the mean refer as variability and unpredictable movement refer as uncertainty [2, 5]. We can define volatility as a measure of price fluctuation over some period of time or a prediction of a price movement over a time period. Volatility also explains the variance of data compared to their mean. Volatility is variations in economic variables over time [6]. Volatility is unobservable that refers to unexpected price changes, but still needs to be estimated [7]. Price volatility is generally associated

with a rapid price changes in each period. Some measure of volatility and risk assessment are based on the variance, standard deviation, and coefficient of variation [8]. Measuring price volatility using the standard deviation of log changes in price returns is the simplest way [9].

One of the characteristics of agricultural product prices is likely to be more volatile than the prices of other sub-sectors in the economy. There are three reasons why the agricultural prices is more volatile, they are: (1) agricultural products vary over time, because of natural causes like weather, disease, and pests, (2) low price elasticity in demand and supply, (3) production depends on time so that supply could not respond to price changes in short time [10]. This also supported by Reference [11] which highlight some characteristics of agricultural prices, namely:

1. Seasonality, some natural factors like weather, diseases and other factor could impact the farmer's expectation regarding to the cattle output, price of the cattle and input like feed needed to produce;

2. Other agricultural linkage, there are long chain in beef cattle agribusiness process, from the up-stream industry like the cattle breeder industry, medicine and feed industry before finally the cattle reared and fattened by the farmer. Farmer's yield will be distributed and processed and by the end will impact the prices of the end product;

3. Production responsiveness, small changes in supply quantity could result a large price change, it means that in short term the price elasticity of agricultural supply and demand are inelastic. If the beef price increased when stock is low, then the short term supply could not give much response to the beef price. In contrast when the beef price decreased the producer may have to postpone the sale until the price is improved.

4. Elasticity, it shows the magnitude of the agricultural commodity price fluctuation, which can be illustrated by the supply and demand curve.

Volatility of agricultural prices also influenced by political situation that happens in a country so that the price volatility can be differ over time. In the case of Indonesia, Reference [1] finds that volatility of some agricultural commodities retail prices in Indonesia is more volatile in the period after the reform in 1998 compared to the period before the reform. Interesting findings from his research is empirically proves that since the reform food prices volatility is increasing, so these conditions shows the influence of socio-economic stability of the volatility of food prices, besides that changes in trading systems and political policies also have an impact on the volatility of the price of food commodities.

In order to reduce the volatility of food prices, Indonesia requires policies that can improve the functioning of the running economic system and strengthen the country resistance in tackling a wide range of negative impacts due to the extreme food price volatility [12]. Meanwhile, Reference [13] explains some important efforts to cope with repeatable price fluctuations are: effective logistics management, marketing infrastructure improvements, improved marketing channels, improved market information, and the development of agro-industries that create added value based on form utility.

Various models have been developed in research volatility analysis. One of them is a model of Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized Autoregressive Conditional Heteroscedasticity (GARCH). ARCH-GARCH models use in agriculture including research reported in Reference [9, 14, 15]. It was found in their study that there were several factors driving volatility, namely production, consumption, stocks and speculation. They calculate volatility using logarithm of standard deviation and also GARCH model. They empirically prove that food prices become more vary [9]. Meanwhile Reference [14] reported domestic food price volatility in Greece; the purpose of their study was to determine the impact of several macroeconomic factors on volatility. They use GARCH and GARCH-X models, and their findings show that higher volatility increases uncertainty of the price in the food market. GARCH models is used to analyze the time series data of rapeseed prices, they find that rapeseed prices are sensitive to shocks and there is an increasing correlation between rapeseed and crude oil prices volatility [15].

Based on these studies, the ARCH/GARCH model is an appropriate model to analyze the price volatility using time series data. Therefore, this study was conducted using the ARCH/GARCH model to analyze the beef price volatility in Indonesia.

2. Research Methodology

This study is using secondary data to understand the volatility of beef price series in Indonesia, we consider a series of consumer daily beef price, the data used in this analysis are daily observations from January 2006 to December 2013, with total T=2086 observations. Data was obtained from Ministry of Trade, Government of Indonesia. The data was collected through market survey from three different markets in 33 capital provinces in Indonesia.

Data processing in this study is using descriptive analysis and quantitative analysis. Descriptive Analysis is used to describe the beef price volatility phenomena. Quantitative analysis is used to analyze the magnitude of beef price volatility in Indonesia using GARCH model. The Data is process using Microsoft Excel and Eviews 6. Graphic analysis of price movement conducted with a plot graph to see the time series trend.

GARCH analysis stages consist of identifying the ARCH effects, the model estimation, model evaluation and volatility measurement.

2.1. GARCH model

ARCH-GARCH modelling starts by identifying whether or not the beef prices data contains heteroskedasticity. One of ARCH effects test on beef price data can be done by observing the autocorrelation of the squared coefficient of the price data. We can say whether the data has ARCH effect when the data has autocorrelation in the squared value of beef price data and the square of beef price data is significant at the 15 first lag examined of the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) data.

There are two steps in the Estimation of ARCH-GARCH models, namely the (a) identification and determination of mean equation and (b) identification and determination step in ARCH/GARCH models.

2.2. Identification and determination of the mean equation

Determination of the mean equation is performed by following procedure Box-Jenkins method. Box-Jenkins procedure consists of several stages of stationarity test data, the determination of the tentative ARIMA model and the selection of the best ARIMA model.

In a time series analysis, stationarity is important. Therefore, prior to further analysis of the ARCH-GARCH models we have to employ the stationarity test. The stationary of each series data is needed to prevent the spurious regression in the model. Spurious regression implies that the result of the regression may not be as good or significant as they seem. If the variable has a unit root, then the data is said to be biased and data are not stationary so it is necessary for a differentiation until the data becomes stationary.

Statistically, testing the data to determine whether a series of data has been stationary or not, can be done with the unit root test. Testing the unit root tests carried out by the augmented Dickey Fuller Test approach formulated as follows:

$$\Delta X_t = \alpha + \beta X_{t-1} + \delta_t + u_t \quad (1)$$

Where $\Delta X_t = X_t - X_{t-1}$ is the difference between the value of the data series in period t to the data series in the periods $t-_1$, u_t= disturbance term and t= trend. Furthermore, the significance parameters test in the stationarity test is the same as the

t-test, but the distribution of the test statistic (t-stat) does not follow the student-t distribution instead follow Dickey-Fuller distribution.

The hypotheses of this test are:

H_0: β=o (data has a unit root or data is not stationary)

H_1: β≠o (data does not have a unit root or data is stationary)

If the null hypothesis of β = o is rejected then the conclusion is that the data series is stationary, and vice-versa.

ARIMA models tentative determination carried out on the data that has been stationer based on correlogram (ACF and PACF patterns) to determine the order of the AR (p) and the order of the MA (q) of an ARIMA (p, d, q) tentative. As for the order of d is determined based on the stationarity of data.

After some tentative ARIMA model is obtained, then the selection of the best ARIMA model. We choose the best ARIMA model by the smallest value of the Akaike Information Criteria (AIC) and Schwatrz Criterion (SC). ARIMA model selected must also meet the following criteria, namely: forecasting residuals are random, parsimonious models, parameters are estimated significantly different from zero, and stationary conditions must be fulfilled indicated by the number of AR and MA coefficients are each less than one, iteration process must convergence, and models should have a small MSE.

2.3. Identification and determination of the model

Determination of ARCH-GARCH models can be done if the residuals obtain by the mean equation contains ARCH effects. ARCH effect test using the Lagrange Multiplier test (ARCH-LM test) is based on the null hypothesis (H_0) there is no ARCH error. If the test results indicate acceptance of the null hypothesis, the data does not contain ARCH errors and do not need to be modelled with ARCH-GARCH.

For ARCH/GARCH model determination, we do some simulation models using a variety of best ARIMA model obtained. Then proceed with the estimation of the model parameters to find the coefficients of the model that best fits the data. Next step is choosing the best model from ARCH/GARCH model from some alternatives based on goodness of fit and significant coefficients using these criteria:

$$\text{Akaike Information Criterion (AIC): } AIC = \ln(MSE) + 2*K/N \quad (2)$$

$$\text{Schwartz Criterion (SC): } SC = \ln(MSE) + [K*\log(N)]/N \quad (3)$$

Where,

MSE = Mean Squared Error

K = number of estimated parameters

N = number of observations

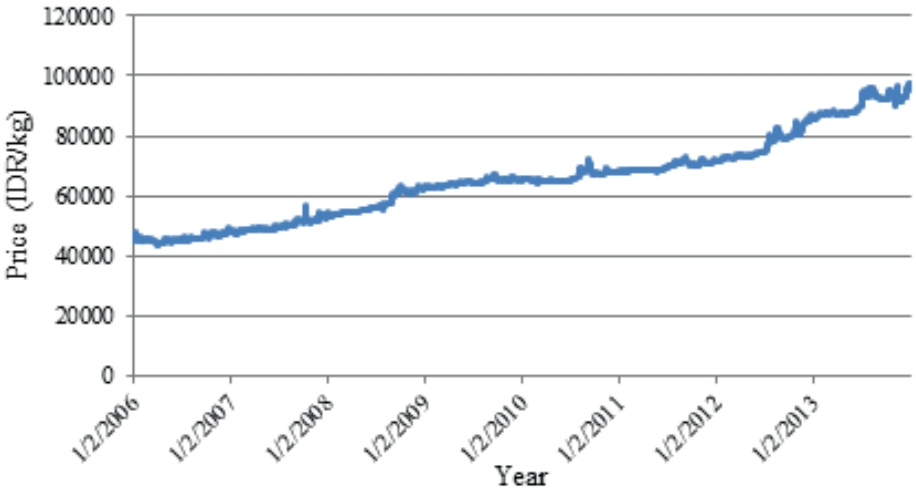

Figure 1: Daily beef price in Indonesia 2006-2013. Source: Ministry of Trade, Republic of Indonesia, 2014 [16]

AIC and SC is the standard measure of information that provides information that can find a balance between the size of the goodness of the model and the parsimony specification of the model. Good model is a model that has he smallest a value of AIC and SC. Besides that another parameter criteria in ARCH/GARCH model should have significant coefficients, the sum of the coefficients not greater than 1 ($\alpha + \beta < 1$), and the coefficients have no negative values ($\alpha_0 > 0$, $\alpha > 0$, $\beta > 0$).

3. Result and Discussion

3.1. Beef price development

We use daily data rather than monthly data because the monthly data looks very smooth and the peaks are related to Ramadhan, Idul Fitri and Idul Adha Festivals. To illustrate that we also already look at the monthly price data that if we look at the monthly frequency at the province level, we basically don't see much variation in the consumer prices probably because the data aggregate across time and so many different places. So we also try to see in province level data, and it is also very stable. It seems that the main aggregation issue comes from the temporal of the aggregation over time not so much from the aggregation over space.

Figure 1 shows the domestic daily beef price development over the past eight years. In the food crisis period in year 2007/2008, domestic beef price in Indonesia like most of agricultural commodity prices in international market, were also experiencing strong increased and reach its peak in middle 2008. This event happened due to the increase of international oil price that forced Indonesian government to also increase

Figure 2: Daily return of beef price in Indonesia 2006-2013. Source: Own calculation.

the domestic fuel price 33% from IDR 4,500 become IDR 6,500. This policy really impact beef market price, this causes feed prices to rise and transportation costs also increased. Fuel is one of important input in livestock feeding industry especially in machinery use.

The increase in the beef price has been significant in the time of the national religious festivals. At least in the last four years, the highest beef price when Ramadhan towards Idul Fitri day. This is due to the high demand and the psychological effects of Indonesian consumers who tend to buy more meat in that period as well as the expectations and behavior of traders who tend to increase prices unreasonably. In 2009, beef prices were highest during the days before Idul Fitri to Idul Fitri day and in 2010, the highest price of beef is on the days before Idul Adha festival. In 2011, beef prices were highest during the Ramadhan month. Meanwhile, the price of beef for the year 2012 continues to climb from the beginning of the year until Idul Fitri and remain at a high position after.

From the daily beef price plot illustration shows that the price of beef meat prices increased throughout the year. We can also see stronger price fluctuations in between 2006-2010. Clearly from the daily return of beef price in Figure 2 shows that in 2006-2010 there was an existence of high volatility and in the 2010-2013 periods of low volatility. This shows that the series is suitable to be analyzed using GARCH models.

Identification of ARCH effects is the first step to detect heteroscedasticity in beef price data. Identification the presence of ARCH effects performed by observing the

Table 1: Unit root test result using ADF.

Variable	t-Statistic	Prob.*
PRICE	-0.308074	0.9213
RETURN	-21.51764	0.0000 ***

Note: One, two and three asterisks indicate rejection of unit root at 10%, 5%, and 1% level of significance, respectively.
Source: Author's elaboration with data from Ministry of Trade (2014)

Table 2: ARCH LM test for ARMA model.

F-statistic	23.62084	Prob. F(15,2054)	0.0000
Obs*R-squared	304.5398	Prob. Chi-Square(15)	0.0000

Source: Author's elaboration with data from Ministry of Trade (2014)

autocorrelation coefficient squared value of the data. ARCH effect is shown by the significant autocorrelation value at first 15 lag that examined the behavior of the ACF and PACF of the data [17].

To avoid spurious regression the analyzed data should be stationary. Therefore, the first step before the ARMA model estimation is performing unit root test. Table 1 show the result of the Augmented Dickey Fuller (ADF) tests to the beef price series data. ADF test is applied to both prices in level and return, which constructed as the difference in the log price. Based on the ADF test results of stationarity, for variable price when tested at levels resulted prob value (0.9213) is greater than 5% alpha it means not stationary in levels, and therefore need to be tested on the first difference values obtained prob (0.0000) less than 5% alpha data are stationary at first price difference. It means that the beef price return is stationary.

After the data is stationary, the price can be conducted to determine the tentative ARIMA models which are based on the analysis of the behavior or pattern of Auto-correlation Function (ACF) and Partial Autocorrelation Function (PACF) for estimating parameters of AR and MA. The best ARMA model chosen has fulfilled the selection criteria which have the smallest Akaike Information Criteria value (AIC) and Schwa-trz Criterion (SC). We choose ARMA (1.1) model that fulfilled criteria required in the evaluation of the Box-Jenkins models, namely: the residuals are random, parsimonious model, parameters are estimated significantly different from zero, and the stationarity conditions are met indicated by the number of AR and MA coefficients are respectively less than one, convergence iteration process, and the model has a smaller MSE (can be seen from the value of AIC and SC).

Based on ARCH LM test results in Table 2 the estimation of ARMA model contains the heteroscedasticity problem. It is known from probability values are significant at α= 1%. So the ARMA model should be estimated with ARCH/GARCH model to overcome the heteroscedasticity problems that occur.

Table 3: Optimal parameter results.

Parameters	Without Dummy	With Dummy D1 and D2	With Dummy D1, D2 and D3
Constant (M)	0.000108 (0.0000374)***	0.0000675 (0.0000247)***	0.0000707 (0.0000315)**
D1	-	0.00045 (0.000122)***	0.000446 (0.000133)***
D2	-	0.007439 (0.000315)***	0.007518 (0.000354)***
AR (1)	0.768378 (0.043126)***	0.790552 (0.027771)***	0.782116 (0.030013)***
MA (1)	-0.885547 (0.035088)***	-0.921917 (0.018822)***	-0.914085 (0.021693)***
Constant (V)	0.000000153 (0.00000000667)***	0.000000129 (0.00000000598)***	0.000000213 (0.0000000123)***
ARCH (α)	0.053043 (0.001548)***	0.051602 (0.001549)***	0.053378 (0.001767)***
GARCH (β)	0.946393 (0.000974)***	0.948195 (0.001001)***	0.944577 (0.001170)***
D3	-	-	-0.0000000954 (0.0000000107)***
α + β	0.999436	0.999797	0.997955
Log Likelihood	8220.705	8252.075	8255.495

Note: (*) indicates a 10% significance level, (**) a 5% level and (***) a 1% level. The value in parentheses is standard errors.
Source: Author's elaboration using Eviews 6 with data from Ministry of Trade (2014)

The results of the ARCH and GARCH models are displayed in Table 3. All three models show significant autoregressive and moving average behavior in the beef return series so that the ARMA model specification is maintained for all models to keep the residuals free from the serial autocorrelation.

The parameter estimates α and β for GARCH model are significant at 1% level in all equations. The required condition of $\alpha+\beta < 1$ holds for all equations. It suggests that beef price has a high volatility persistency after shock to the price. High β coefficient indicates a strong influence of the own variance on volatility measurement development, meanwhile a low α indicates low sensitivity to external shocks to the beef market. Beef price shows a relatively smaller α than β, it can be interpreted as beef price is more sensitive to its own variance compare to the external shocks.

We suspect from visual inspection that there might be a specific effect of Ramadhan associated to beef consumption, so we introduce dummy variables. We know that certain Islamic festivals are going to affect the beef price, that's why we test some numbers of potential dummy variables. We use two different dummies in the mean equation, first is dummy 1 (D1) is during Ramadhan month and second dummy (D2) is dummy two days before Ramadhan. We find that both of them are highly significant,

Table 4: ARCH LM test for GARCH model.

F-statistic	2.032702	Prob. F(3,2078)	0.1073
Obs*R-squared	6.091967	Prob. Chi-Square(3)	0.1072

Source: Author's elaboration with data from Ministry of Trade (2014)

as we can see that the dummy variables in increased the log likelihood value, that is strong indication to keep them in the model. The result shows that both dummy variables on mean model are significant at 1 percent. Both dummy variables in the model have positive signs, for dummy 1 implies that during Ramadhan month the price is increase and for dummy 2, implies that beef price two days before Ramadhan become higher. These two dummy variables explain the expected price changes towards and during Ramadhan, not showing the beef price volatility that is unexpected.

We also add dummy 3 (D3) in the variance equation as the additional regressor to capture the change policy, we want to see whether the beef self-sufficiency policy implementation in 2010 influence the beef price volatility. From the model in table 4, the dummy 3 coefficient is negative and significant at 1 percent, so it is statistically proven that beef self-sufficiency program makes beef price volatility lower than the 2006-2009 periods. However the magnitude of the parameter in external regressor of dummy 3 is relatively small, it implies that the government policy through beef self-sufficiency program strive small impact on overall volatility development.

Based on the above considerations, we will then use the GARCH (1.1) model with D1 and D2 in the mean model and D3 as the external regressor to discuss more detail about beef price volatility in Indonesia.

Based on ARCH LM test are shown in Table 4 shows that the GARCH model estimation results is free from heteroscedasticity, we can see from its probability value that is not statistically significant. Thus we can reject H_0 in which the estimation model does not contain elements of heteroscedasticity.

GARCH (1.1) model gives information that beef price movements are influenced by the volatility from the previous period and yesterday's variance. We can say from this model that if we have relatively large price residual and variance in today's price then the next day price level will tend to be larger. ARCH coefficient in the model shows the level of beef price volatility, with value of 0.053378, which is relatively small that indicates that we have low volatility. However the value of the GARCH coefficient of 0.944577, close to unity, indicates that shocks in the variance will be persistence. Based on the model we can conclude that beef price volatility in the future will tend to be smaller and persistence.

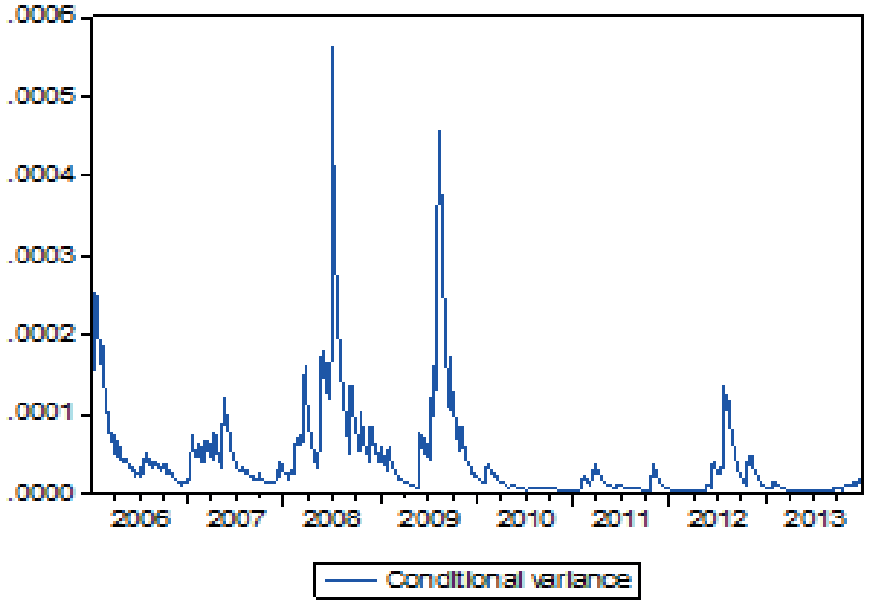

Figure 3: Conditional variance of beef price return. Source: author's elaboration.

Figure 3 shows the development of the conditional variance over the years. We can see from the figure that beef price showed higher conditional variance during 2006-2010 compare to 2010-2013. The figure shows that periods of high volatility tend to cluster. As we know from the model that this high conditional variance was driven more by its beef price own variance rather than the external shocks.

Beef supply and demand characteristics are unique; both are tend to be inelastic to price changes. Farmers as beef producer can not necessarily increase production when prices rise. Consumers also could not reduce demand when prices are rising.

Several factors are recognized as sources driving the price volatility of beef from the structure of beef supply demand and domestic policy. On the demand side, factors driving the volatility of the beef price are the increase in population, the increase in demand for beef due to changes in consumption patterns as a result of strong economic growth.

On the supply side, the problem that occurs is derived from the slow increase beef production due to low investment to increase production capacity, and for commodity beef supply reduction is mainly due to the climatic conditions and the reduction in the farming area for several major producing areas of beef cattle, and competition the designation of agricultural products to feed cattle with bio-fuel production. Beef import volume between 2004-2009 increases more than five times. Indonesia imported 11.8 thousand tons in 2004 and increased become 64.1 thousand tons in 2009 [18].

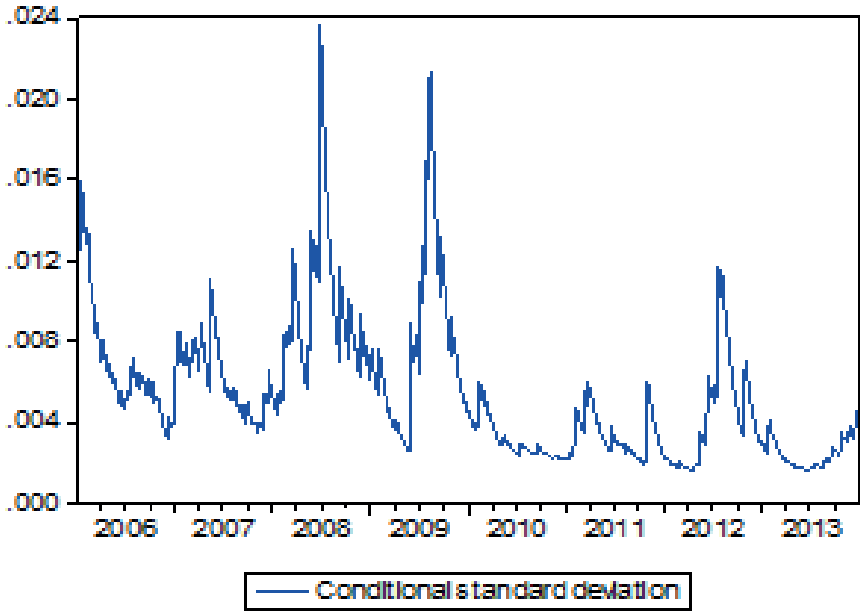

Figure 4: Conditional standard deviation of beef price return. Source: author's elaboration.

We can see from Figure 4 that the highest volatility level occur in 2008, follows by another high volatility in 2009, after that only small variation happens between 2010-2011 and become high again in 2012 although the volatility is not as high as in year 2008 and 2009. The price increase on crude oil in 2008 and the global crisis really affect international food market, not only increased beef price internationally but also beef price in Indonesia. The increase of fuel led the Indonesia government to take policy action raising the price of subsidized fuel by 33 percent on May 2008. This leads to expensive food price especially beef price, because the impact of feed cost increased and shipping costs are higher. The situation makes the availability of beef supply disrupted. Entering Ramadhan month in September makes cattle trader sells their cattle with much higher prices, which impacted the decrease in beef consumption. The high price volatility that occurred in this year makes farmers and beef producers difficult to make decisions about planning their production effectively and forced them to accept higher price risk.

Lower beef consumption continues until 2009, despite a decline in beef consumption but Indonesia still has not been able to meet the needs of domestic beef. Thus in 2009 the government issued an Application Entry Letter for cattle import up to 1 million head. Although then the import only realized approximately 700 thousand head. This makes feeder cattle and frozen beef import volume reached the highest number in 2009 compare to year 2006-2013.

The government's decision to expand the population of feeder cattle imports actually affected the price of live cattle in the country. Cattle prices dropped down as much as 25%. These conditions make the farmers restless. Not just the excess supply of feeder cattle imports but the increasing number of frozen beef also have an impact on the decreasing beef price in the country. The cause of the decline in the price of cattle is because the price of meat in the global market is going down with a fairly drastic decline in 2009. On the other hand, the purchasing power condition in the country is also decreasing at this time because it concurrent with the new academic year. Moreover, many farmers also sell their cattle because they need money to send their children to school. As a result, the supply of cattle in the market becomes excessive. The excess in beef supply follows with low consumption will make the price decrease that leads to price fluctuation in 2009.

Starting 2010, Indonesian Government employs Beef Self Sufficiency Program to support domestic beef cattle production, this effort apparently quite effective to lower the beef price volatility. Even it has managed to suppress the fluctuation of beef price changes but the program still has not been able to make the price of beef lower. As we know that typical of beef price, it is difficult to go back down again after it has increased [19]. This research shows the variability of the beef price after the policy is lower than before, but not necessarily the price level.

In 2011 Statistics Indonesia conducted beef and buffalo cattle census that resulted Figure 4. 8 million beef cattle population. This number makes the Indonesian government optimistic to make realization of the beef self-sufficiency road map by reducing import quota gradually from 30% in 2011 become 20% in 2012, next is 15% in 2013 and 10 percent in 2014. This 10 percent import quota decrease in 2012 make Indonesia suffer deficit in beef supply because there is no stock to fulfil the high demand. Thus a massive slaughter of livestock production support so that it remains able to meet the ever-increasing consumption. This has resulted an increase in price volatility significantly in 2012. Coupled with the issue of government policy that will increase the subsidized fuel price as much as 15% in 2012. This makes the price of beef increased significantly and also increased the beef price volatility.

Meanwhile 70% of Indonesian cattle farmer is small scale farmer with 1-2 cattle population, this characteristic should become the government consideration before reducing import sharply, because this type of farmer they don't sell their cattle unless they really need cash for example for their children education or wedding.

The government policy through beef self-sufficiency program is able to increase the domestic beef cattle population but not necessarily the beef production, so there is still gap between demand and supply. This cause is the price volatility still exists after the policy implemented. The conditions during the stabilization of beef supply and

beef price show that the Beef Self-Sufficiency Program in 2014 could not be achieved. Although it is declared unsuccessful but this program proved may lower beef price volatility than before the program is implemented.

3.2. Policy Implication

Since beef price driven by the dynamics of beef supply and demand, it is necessary for the government not only doing the production approach by increasing the beef cattle population through beef self-sufficiency program but also through price control policy. Another important thing is to know the national beef cattle stock with the accuracy and availability of the data that will determine the quality policy to be pursued, so that the government will be able to take control of beef distribution system through the stock mechanism in order to control prices at the consumer level.

4. Conclusion

Our study on beef price volatility shows that the volatility of beef price was driven more by its own variance rather than external shocks. GARCH (1.1) model shows that the beef price volatility will tend to be smaller and persistence in the future. Introduction of two dummy variables in the mean equation such as dummy during Ramadhan and dummy before Ramadhan which both of them are highly significant is very relevant to explain the beef price movement. That implies beef price before and during Ramadhan is higher.

Parameter of the third dummy variable as external regressor in the variance equation to capture the change policy is statistically significant to better describe the beef price observation. With negative coefficient, it is statistically proven that beef self-sufficiency program may lower beef price volatility than the 2006-2009 periods. However the magnitude of the parameter is relatively small, it implies that the government policy through beef self-sufficiency program strive small impact on overall volatility development.

Further research by adding some potential drivers such as supply and demand shocks, currency exchange rate, price of oil, using multivariate model and beef price transmission in the market would lead to a more comprehensive understanding about beef price volatility behavior.

References

[1] Sumaryanto. 2009. Analisis Volatilitas Harga Eceran Beberapa Komoditas Pangan Utama dengan Model ARCH/GARCH. *Jurnal Agro Ekonomi*, *27*(2), 135–163.

[2] Soedjana, T.D. 2011. Peningkatan Konsumsi Daging Ruminansia Kecil dalam Rangka Diversifikasi Pangan Daging Mendukung PSDSK 2014.

[3] Izzaty. 2013. Upaya Stabilisasi Harga Daging Sapi. Info Singkat Ekonomi dan Kebijkan Publik, *Vol. V, No.03/II/P3DI/Februari/2013*.

[4] FAO. 2011. Price Volatility in Food and Agricultural Markets: Policy Responses. Policy Report Including Contributions by FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI and the UN HLTF. Available online at: http://www.fao.org/fileadmin/templates/est/Volatility/Interagency_Report_to_the_G20_on_Food_Price_Volatility.pdf.

[5] Prakash, A. (Ed.). 2011. Safeguarding Food Security in Volatile Global Markets. Food and Agriculture Organization of the United Nations

[6] OECD. 2011. Price Volatility in Food and Agricultural Markets: Policy Responses, OECD Policy Report Including Contributions by FAO, IFAD, IMF,OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI and the UN HLTF. Available online at: http://www.oecd.org/tad/agricultural-trade/48152638.pdf.

[7] Brümmer, B., O. Korn, T.J. Jaghdani, A. Saucedo, and K. Schlüßler. 2013. Volatility in the After Crisis Period–A Literature Review of Recent Empirical Research, Working Paper 1, April 2013, ULYSSES project, EU 7th Framework Programme, Project 312182 KBBE.2012.1.4-05, http://www.fp7-ulysses.eu/, 46 pp.

[8] Anderson, J. R., J.L. Dillon, and J.B. Hardaker. 1977. Agricultural Decision Analysis. Iowa (US): The Iowa State University Press.

[9] Gilbert, C., and W. Morgan. 2010. Has Food Price Volatility Risen? Department of Economics Working Papers.

[10] Tangermann, S. 2011. *Policy Solutions to Agricultural Market Volatility: A Synthesis*. Issue Paper No. 33. Geneva. International Centre for Trade and Sustainable Development.

[11] Piot-Lepetit, I., and R. M'Barek. (Eds.). 2011. *Method to Analyze Agricultural Price Volatility*. Springer New York.

[12] Arifin B. 2011. Pengendalian Inflasi dan Volatilitas Harga Pangan. Kolom Pakar, Media Indonesia, Senin 7 Februari 2011. Jakarta. Available online at: www.mirror.unpad.ac.id/koran/mediaindonesia/2011-02-07/mediaindonesia_2011-02-07_012.pdf

[13] Daryanto, A. 2010. Strategi Meminimalisir Fluktuasi Harga Boiler. Jakarta. Available online at: http://www.trobos.com/show_article.php?rid=22&aid=2448

[14] Apergis, N., and A. Rezitis. 2010. Food Price Volatility and Macroeconomic Factors: Evidence from GARCH and GARCH-X Estimates, 1 February, 95–110.

[15] Busse, S., B. Brümmer, and R. Ihle. 2010. Investigating Rapeseed Price Volatilities in the Course of the Food Crisis. Paper presented at the 50st Annual Conference of the German Association of Agricultural Economists, Braunschweig, Germany, September 29–October 1, 2010.

[16] Ministry of Trade. 2014. Sistem Pemantauan Pasar Kebutuhan Pokok (SP2KP). Available online at: http://ews.kemendag.go.id/.

[17] Firdaus M. 2011. Aplikasi ekonometrika untuk Data Panel dan Time Series. Bogor (ID): Institut Pertanian Bogor.

[18] Bappenas. 2013. Rencana Pembangunan Jangka Menengah Nasional (RPJMN) Bidang Pangan dan Pertanian 2015-2019. Direktorat Pangan dan Pertanian. Ministry of National Development Planning/National Development Planning Agency.

[19] Ilham, N. 2009. Kelangkaan Produksi Daging: Indikasi dan Implikasi Kebijakannya. *Jurnal Analisis Kebijakan Pertanian. Volume 7 No. 1, Maret 2009:* 43-63.