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Bogor, April 2016

Intani Dewi
H351120311
SUMMARY

INTANI DEWI. Price Volatility Analysis in Indonesian Beef Market. Supervised by RITA NURALINA, ANDRIYONO KILAT ADHI and BERNHARD BRÜMMER.

Agricultural product prices always fluctuate over time. The Indonesian beef price movement is 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. The beef price volatility is a risk factor that must be faced and will affect the decision making. 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). 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 needs of the national beef.

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 meat will further difficult the price stabilization in the country. 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. Therefore it is interesting to see how the beef price responds to the import reduction policy through beef self-sufficiency program and how it is affecting the beef price volatility.

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. This study is using secondary data to understand the volatility of beef price series in Indonesia, the data used in this analysis are daily observations from January 2006 to December 2013, with total 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.

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, 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 beef price is increasing 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.

GARCH (1.1) model gives information that beef price movements are influenced by the volatility from the previous period and yesterday 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. Based on the model we can conclude that beef price volatility in the future will tend to be smaller and persistence. Parameter of the 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.

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 at balance proportion. In relation to price stabilization, it is important that Indonesian government should develop an effective and efficient beef supply chain, this can be done by improving the market mechanisms, transportation and infrastructure for distributing beef cattle from production areas to consumption areas. Due to low production and high demand of beef the government should be more flexible in relation to food policy in order to make faster response to any situations such as hold sufficient beef stock in the storage in Ramadhan, Idul Fitri festival and other big celebration day in Indonesia.

Keywords: beef, garch, price volatility
RINGKASAN

INTANI DEWI. Analisis Volatilitas Harga di Pasar Daging Sapi Indonesia. Dibimbing oleh RITA NURMALINA, ANDRIYONO KILAT ADHI dan BERNHARD BRÜMMER.


Indonesia akan mengalami defisit daging sapi yang sangat besar pada jangka panjang menengah jika pemerintah tidak membuat suatu usaha untuk meningkatkan produksi. Defisit daging sapi yang tinggi akan menyulitkan stabilisasi harga di dalam negeri. Studi ini mencoba untuk menampilkan hubungan antara volatilitas harga daging sapi dan usaha pemerintah Indonesia untuk menjamin ketahanan pangan melalui program swasembada daging sapi. Oleh karena itu sangat menarik untuk melihat bagaimana harga daging sapi merespon terhadap kebijakan pengurangan impor melalui program swasembada daging sapi dan bagaimana hal tersebut akan mempengaruhi volatilitas harga daging sapi.


Kami tahu bahwa festival Islam tertentu akan mempengaruhi harga daging sapi, itu sebabnya kami menguji beberapa variabel dummy potensial. Kami menggunakan dua dummy yang berbeda dalam persamaan mean, pertama adalah dummy 1 (D1) selama bulan Ramadhan dan dummy kedua (D2) adalah dummy dua hari sebelum Ramadhan. Kami menemukan bahwa keduanya sangat signifikan, seperti yang dapat kita lihat bahwa variabel dummy meningkatkan nilai log likelihood. Hasil penelitian menunjukkan bahwa kedua variabel dummy pada model model signifikan pada taraf alfa 1 persen. Kedua variabel dummy dalam model memiliki tanda positif, untuk D1 menyiratkan bahwa selama bulan Ramadhan harga daging sapi meningkat dan untuk D2 menyiratkan bahwa harga daging sapi dua hari sebelum Ramadhan menjadi lebih tinggi. Kedua variabel dummy menjelaskan perubahan harga yang diharapkan selama Ramadhan, tidak menunjukkan volatilitas harga daging sapi yang tak terduga.
Kami juga menambahkan dummy 3 (D3) dalam persamaan varians sebagai regressor tambahan untuk menangkap perubahan kebijakan, kami ingin melihat apakah implementasi kebijakan swasembada daging sapi pada tahun 2010 berpengaruh terhadap volatilitas harga daging sapi. D3 memiliki nilai koefisien yang negatif dan signifikan pada taraf alfa 1 persen, sehingga secara statistik terbukti bahwa program swasembada daging sapi dapat membuat volatilitas harga daging sapi lebih rendah dari periode 2006-2009. Namun besarnya parameter di regressor eksternal dummy 3 relatif kecil, hal ini menunjukkan bahwa kebijakan pemerintah melalui program swasembada daging sapi berdampak kecil pada pengembangan volatilitas harga keseluruhan. Berdasarkan pertimbangan di atas, maka kami akan menggunakan GARCH (1,1) model dengan D1 dan D2 dalam model mean dan D3 sebagai regressor eksternal untuk membahas lebih detail tentang volatilitas harga daging sapi di Indonesia.

Model GARCH (1,1) memberikan informasi bahwa pergerakan harga daging sapi dipengaruhi oleh volatilitas dari harga periode sebelumnya dan variasi hari kemarin. Dapat dikatakan dari model tersebut bahwa jika kita memiliki residual harga yang cukup besar dan variasi dari harga hari ini maka tingkat harga esok hari akan cenderung lebih tinggi. Berdasarkan model juga dapat kami simpulkan bahwa volatilitas harga daging sapi di masa yang akan datang akan cenderung lebih kecil dan persisten. Parameter dari variabel dummy pada persamaan varians untuk menangkap perubahan kebijakan signifikan secara statistik. Hal ini mengindikasikan bahwa program swasembada daging sapi dapat membuat volatilitas harga daging sapi lebih kecil. Harga daging sapi didorong oleh dinamika pasokan daging sapi dan permintaan oleh karena itu pemerintah sebaiknya tidak hanya melakukan pendekatan produksi dengan meningkatkan populasi sapi potong melalui sapi program swasembada tetapi juga melalui kebijakan pengendalian harga. Pemerintah Indonesia harus membuat rantai pasok daging sapi yang efektif dan efisien, hal ini hanya bisa dilakukan dengan mengembangkan mekanisme pasar, transportasi dan infrastruktur untuk mendistribusikan ternak sapi potong dari daerah produksi ke daerah konsumsi. Kebijakan yang dibuat pemerintah harus lebih fleksibel untuk produksi daging sapi yang rendah dan permintaan yang tinggi, seperti mengadakan stok persediaan pada bulan-bulan tertentu disaat harga daging sapi sedang tinggi seperti saat Ramadhan, Idul Fitri dan juga hari besar keagamaan lainnya di Indonesia.

Kata kunci: daging sapi, garch, volatilitas harga
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PRICE VOLATILITY ANALYSIS
IN INDONESIAN BEEF MARKET

INTANI DEWI

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Bogor, April 2016

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Bogor Agricultural University

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LIST OF ABBREVIATIONS

APFINDO : Asosiasi Produsen Daging dan Feedlot Indonesia (Indonesian Meat Producers and Feedlot Association)
ARCH : Autoregressive Conditional Heteroskedasticity
ASPIDI : Asosiasi Pengusaha Importir daging Indonesia (Indonesian Meat Importer Association)
BAPPENAS : Badan Perencanaan Pembangunan Nasional (National Development Planning Agency)
BSSP : Beef Self-Sufficiency Program
BULOG : Badan Urusan Logistik (National Logistics Agency)
DGLAH : Directorate General of Livestock and Animal Health
FAO : Food and Agriculture Organization
GARCH : Generalised Autoregressive Conditional Heteroskedasticity
NAMPA : National Meat Processor Association
OECD : Organisation for Economic Cooperation and Development
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Hak Cipta Milik IPB (Institut Pertanian Bogor)
1 INTRODUCTION

Background

In recent years, the risks and uncertainties faced by consumers and producers due to fluctuations in food prices are likely to rise. The increase begins in 2004 and reached its peak at the end of 2007 to the summer of 2008. 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 price are fluctuates. Food prices often fluctuate due to various factors, both natural phenomena (climate), market failures, also distribution problem. The existence of price fluctuation is a risk faced by producers and also consumers. We can see the fluctuations in food prices and world meat prices from 1990 through 2014 in Figure 1.

Figure 1 World food and meat price index 1990-2014
Source: FAO 2014

We can see in Figure 1 that the food prices from 1990 to 2000 are relatively stable and have been increasing since 2004 and a peak surges in 2008 due to the economic crisis that hit the world. Once it decreased until it finally rose again in 2011. Meat as one of many agricultural commodities is also experiencing the same effect with its prices following the pattern of food prices. As we can see, the economic crisis in 2007/2008 and 2011/2012 affected the price of meat, this is indicated in the figure where the two highest peaks occurred in 2008 and 2012.

Within the county some strategic food price commodities also increased, food commodities whose prices often fluctuate and become the spotlight in Indonesia are rice as staple food, corn, soybeans, wheat flour, sugar, cooking oil, onions, pepper, eggs, meat and milk (Sumaryanto 2009). This cause the risks and uncertainties faced by consumers and producers due to fluctuations in food prices.
Related to food consumption pattern of the Indonesian people, over this time the government's biggest concern focused on the retail price of rice as a staple food, wheat flour, palm oil, sugar, chili and red onion. But along with the increase in population, economic growth, and better education in Indonesia, there is changing dietary pattern in the middle income people. Their concern in healthy food is increasing and they add more proteins in their meal, such as: egg, chicken, beef and milk. 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 (Soedjana 2011). 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 (Izzaty 2013).

The price increase is influenced by various factors, including closely related to the increase in demand, which reduced the amount of supply, as well as import and beef prices prevailing in the international market. The increase in demand commodity beef is very significant due to national religious festivals such as Ramadhan, Idul Fitri, and Idul Adha which will potentially increase the price, especially if it is not corresponded with sufficient supply. Besides the beef shortage which triggered from the high demand and low supply, another thing that causing high beef price in Indonesia is the distribution process from beef production center to the consumption center.

The Indonesian beef price movement increasing erratically and tends to be volatile in recent years. This can be seen from figure 2, which shows the development of beef prices over the last eight years which always rises every year. 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 14.37 percent compared to the previous year, from Rp 52,841/kg to Rp 63,544/kg. Growth rates which quite high also occurs from the year 2011 to the year 2012 in the amount of 10.37 percent and the highest growth of 17.58 percent was from 2012 to 2013 with a maximum price of Rp 97,709/kg.

Nationally, the beef prices situation in 2012 (until September 2012) is gradually increased from the beginning of January and begin to experience a surge in July 2012 (before Ramadhan), which reached 3.36 percent from Rp 74,393/kg to Rp 76,895/kg and in August 2012 rise again 3.78 percent from Rp 76,895/g to Rp 79,800/kg. Based on the price monitoring in several production centers, there are beef price fluctuations in the consumer level across time and between provinces. The largest price fluctuations over time occurred in 2012.

Various stakeholders such as government, beef cattle farmers, feedlotter, beef importers, beef traders, beef processing industry and beef consumer interest in stable beef prices. For the government, the stabilization of the price of beef could prevent national unrest in social, politics and economy. Meanwhile to beef cattle farmers, feedlotter, beef importers, beef traders, beef processing industry, the beef price volatility is a risk factor that must be faced and will affect the decision making. On the other side beef price stabilization also important for the consumer. Beef price stabilization will have direct influence to the household
expenditure. The impact will be significantly affect poor households and small scale farmers who are acting as net buyers.

![Beef Price Development](image)

**Figure 2 Beef price development 2006-2013**

*Source: Ministry of Trade 2014*

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 (FAO 2011).

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 needs of the national beef.

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 meat will further dificult 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 by consumer purchasing power.

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.

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. Therefore, it is interesting to see how the beef price responds to the import reduction policy through beef self-sufficiency program and how it is affecting the beef price volatility.

Problem Statement

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. Thus the research questions of this study are:
1. How volatile is beef price in Indonesia?
2. Is Beef Self Sufficiency Program influence beef price volatility?

Research Objectives

Following the research questions, the objectives of this research are:
1. To understand beef price volatility in Indonesia.
2. To analyze the impact of beef self-sufficiency program to the beef price volatility in Indonesia.

Study Limitation

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.

Organization of Study

The organization of this study is structured as follows. Chapter 1 is the introduction that describes the background of this study, the study problems, the study objectives, the scope of study, and the organizations of study. Chapter 2 describes the overview of Indonesian beef market which includes beef production, consumption and import, government policies on beef trade, and beef market
chain. Chapter 3 explains the literature reviews about theory and the framework of this study. Chapter 4 details the methods of this study. Chapter 5 presents the result and discussion. Chapter 6 concludes this study with conclusion, policy implications, and recommendations based on this study.

2 BEEF MARKET OVERVIEW IN INDONESIA

Production, Consumption and Import

Beef cattle in Indonesia spread throughout many provinces, but its concentration vary by region. Based on the data from Statistics Indonesia that were obtained from 33 provinces, the distribution of livestock population is mostly concentrated in Java. The biggest herd number is in East Java which accounted for more than 5 million of cattle, followed by Central Java, and South Sulawesi. The rest are spread in other provinces.

Based on the island, 50.68 percent of beef cattle population is in Java Island, 18.38 in the island of Sumatera, 14.18 percent in Bali and East Nusa Tenggara, 12.08 in Sulawesi island, 2.95 percent in Borneo, and 1.75 in the Moluccas and Papua (Statistics Indonesia 2013).

Figure 3 Beef cattle population in Indonesia 2000-2013

Source: Directorate General of Livestock and Animal Health 2014

Figure 3 shows that beef cattle population is increasing over time. Beef cattle population is continuously increasing in year 2003-2012 with the average increase of 6.78 percent per head, especially since the Beef Self-sufficiency Program 2014 enforce in 2010. However, dramatic reduction of beef imports in 2012 and 2013 leads to massive beef cattle slaughtering in Indonesia in order to address the growing demand for beef. As a consequence, beef cattle population reduced drastically from 15.98 million heads in 2012 become 12.69 million heads in 2013.
Based on data obtained from Directorate General of Livestock and Animal Health (2014) that is illustrated in figure 4, the number of domestic beef production fluctuated between 2003 and 2009. It increased up to 19.2 percent from to 2005-2006 but experienced a decline in 2007 by 18.8. This reduction was temporary, as the beef production showed an upward trend until 2012 with 9.1% average growth rate. A slightly decrease in 2013 were due to the impact of import restriction and massive domestic cattle slaughter in 2012-2013.

![Beef Production in Indonesia (Ton)](image)

**Figure 4** Beef production in Indonesia 2000-2013  
*Source: Directorate General of Livestock and Animal Health 2014*

Sources of national beef production are coming from: (1) local cattle, namely beef cattle, dairy cattle, and culled dairy cows, which are mostly beef cattle; and (2) Cattle feeder (feeder steer) imported from Australia and fattened in Indonesia for about 100 days. The demand of the national beef cattle met from local production, imported cattle and imported beef (Ministry of Agriculture 2012, Bappenas 2013).

The increase in beef production hampered by the slow growth of beef cattle population as a result of: (1) commercial breeding business less profitable thus it is only done by small-scale farmers as sideline just for savings; (2) the grazing land availability in the eastern region of Indonesia continues to decrease due to residential used and others; and (3) slaughtering productive beef cattle that are very difficult to control so that the born calves growth decreased (Bappenas 2013).

Data show that on aggregate Indonesia is a net importer of livestock products, including beef products that tend to increase yearly. This condition illustrates the lack of supply nationwide. Domestic beef cattle production is fail to meet consumption needs in Indonesia so that the level of dependence on imports is still very high. Contributions beef to the needs of the national meat by 23% and expected to be continue to increase (Directorate General of Livestock Services 2009). The beef consumption rate is increasing up to 4% while the beef cattle
production growth is increasing by only 2%, so clearly there is a gap between the supply and demand that creates shortage in beef.

![Beef Consumption in Indonesia (Kg/Capita/Years)](image)

**Figure 5** Beef consumption in Indonesia 2002-2012

*Source: Directorate General of Livestock and Animal Health 2014*

Since 2009 beef consumption in Indonesia is increasing and in the future beef consumption will continue to increase due to the population growth with an average of 1.49 percent per year, the increase in real income per capita of an average of 12.9 percent per year (Statistics Indonesia 2013), the image of the product (prestige), taste, as well as the growth of the beef processing industry and tourism industry (hotels and restaurants). We can see from figure 5 that beef consumption decreased sharply in 2006 due to government policies that raise the price of fuel in the end of 2005 is causing high inflation thereby reducing the purchasing power of the beef.

Beef consumption distribution is not spreading evenly in every province. In Indonesia there are different levels of meat consumption by community from one region to another. People in the western part of Indonesia (Sumatra and Java) have a high level of beef consumption, while in eastern part of Indonesia where a large numbers of cattle population spread, people has comparably low consumption level. Potential excess of beef cattle population is quite large that makes it difficult to be distributed to Java and Sumatra, which still needs large additional supply. Due to logistic constraints, especially cattle transportation system which is still inadequate in the end will affect the high price when they arrive in the hands of consumers.

Indonesia’s beef exports are very small, and export cattle did not even exist. The Indonesian import volume development of beef and beef cattle during 2006-2013 is shown in figure 5. Indonesia imported beef in the form of meat, edible offal and feeder cattle for fattening.

Imports of feeder cattle mainly are from Australia while imports of beef are from different countries of the world. Over the last 20 years Indonesian imports beef from Australia with a share of 50.54 percent per year, followed by
New Zealand, USA, other Asia and Singapore with a share of 33.39 percent, 7.99 percent, 3.77 percent, and 2.89 percent. In addition, Indonesia also imported from European countries, Canada and other countries (Ardiyati, 2012). But Indonesia stops importing beef from USA since the country affected with food and mouth disease.

Ardiyati (2012) also writes Australia and New Zealand are two main exporting countries of imported beef in Indonesia. Besides giving the largest share, the development of Indonesia’s imports from these two countries is fairly high respectively 44.75 percent and 43.68 percent each year. This can occur partly due to relatively close distance and well-developed trade relations. Thus the prices tend to be cheaper.

Yati (1993) states that the price of beef imported from New Zealand and Australia are relatively 50 percent cheaper than the price per kilogram of beef from USA and the Netherlands, while the Japanese beef is 380 percent more expensive per kilogram, compared with beef imports from Australia and New Zealand.

Figure 6 shows that imported beef and beef cattle is increasing between 2006 and 2009 and starts to decrease since 2010. The amount of imported beef and cattle is decreasing because of the government has set the Beef Self-Sufficiency Program in 2010 that aims to reduce imports. Beef import quota restrictions setting in year 2010 makes the amount of imported beef and cattle decreased more sharply. In 2013, the beef imports volume slightly increase because there is a shortage of supply of beef in the country as a result of the drastic decrease in the volume of imports of feeder cattle (Bappenas 2013). This policy is expected to drives local farmers to increase the amount of their cattle. This is consistent with the Government policy that targeted beef self-sufficiency by 2014 as stated in the Regulation of the Minister of Agriculture No. 19/Permentan/OT.140/2/2010.

Imports of beef and feeder cattle was originally intended only to support and meet the needs of the growing beef demand in in the country amount.
However, in some areas it turns beef and feeder cattle imports this would potentially disrupt the local beef cattle agribusiness. Imported beef prices are relatively cheaper than the local beef because of the harvest management, production resource management of beef cattle in the exporting countries are more efficient resulting in lower production costs compared with beef cattle business in Indonesia. At the same time due to the increasing demand for meat, local productive cows illegal slaughter is also continue to occur and cause a national replacement stock diminishing and the long-term will inhibit the growth of local cattle population in the country.

Policies on Beef Trade

**Beef Self Sufficiency Program**

The concept of beef self-sufficiency is the fulfillment of the public consumption of beef from domestic resources by 90%, so 10% is left to import cattle and meat. But the concept is not the application of the "quota" policy but with the intention to increase domestic production to reach 90%. Increased domestic production will be followed by other policies that are technically and economically, which includes operational measures to increase population and the production and exploration of tariffs and steps of the SPS (Sanitary Phytosanitary) application (DGLAH 2011).

Beef self-sufficiency plan already started in 1999/2000 due to concerns over the low growth livestock cattle and increasing trend of beef consumption that follows the increase of per capita income resulting high beef imports. However, the realization on the 2000 plan is only by giving soft loan credits for the farmer to raise their cattle without up with a structured, systematic program formulation and targets.

According to the Regulation of the Minister of Agriculture No. 19/Permentan/ OT.140/2/2010 concerning the General Guidelines for Beef Self-Sufficiency Program 2014, this program is a joint determination and became one of the main program from the Ministry of Agriculture concerning the efforts to achieve food security based on domestic animal livestock resources, especially beef cattle. Self-sufficiency in beef has long been desired by the public so that dependence on imported cattle and beef both decreased by developing the potential resources in the country.

It clearly states in the Regulation of the Minister of Agriculture No. 19 year 2010 that the beef self-sufficiency program will obtain some advantages and value added, namely: (1) increasing the income and welfare of farmers; (2) additional absorption of new workers; (3) foreign exchange savings; (4) optimizing the utilization of local cattle; and (5) increasing the supply of beef that is Safe, Healthy, Whole and Halal (SHWH) for the community so that tranquility is guaranteed.

Conceptually Ashari et al. (2012) implies that the purpose of the beef self-sufficiency program are to increase population and to improve the quality of beef cattle as well as increased production of beef which is assured safe, healthy, intact, halal and sustainable. The beef self-sufficiency program is announced for the third time in 2014 as the government has proclaimed, it is an improvement
from the previous beef self-sufficiency program in 2005 and the beef self-sufficiency acceleration program in 2010, which both are failed to achieve.


1. **Pre 2000**
   The government provides credit loans to help small farmers with fattening and breeding cattle.

2. **Plan of 2000**
   The first beef self-sufficiency program was initiated to be realized in 2005 with the name of Beef Sufficiency Program (BSP). But this program is not successfully realized due to limited supply chain, land shortage for breeding and production. The program lasts from year 2000 to year 2005, but the program did not achieve the desired target because at that time the program is too characterized by discourse, seminars and workshops without being followed by concrete measures both policy and technical activities.

3. **Plan of 2005**
   Target of achieving beef self-sufficiency 2005 pushed back into the year 2010, with three main objectives, namely the increase in beef cattle population, decrease in feeder cattle imports and increase local beef cuts (Ilham 2006). Between 2005 and 2007 there was a vacuum in the program while the figure for the importation of both cattle and beef increased continuously. As a result, the central government re-launched a program called Accelerated Beef Self-Sufficiency Program (ABSSP) between 2008 and 2010.

   The program has had concrete steps but has not been supported by adequate funding so that the program failed and import figures of cows and beef increases. This program is not successful due to low productivity and high calf mortality rate. Indonesia's dependence on the imports reach 25%, accounted from 600 thousand heads of feeder cattle and 100 thousand tons beef per year on average (DGLAH 2011). The peak was in 2009 where the import exceeded to 720 thousand cattle and 120 thousand tons beef. The overall import value of cattle and beef are equivalent to nearly 1.5 million heads. To compare, the cattle’s slaughtering in various abattoirs in Indonesia around 2.4 million heads a year. It means that more than 60% of the slaughtering in Indonesia has been dominated by imported cattle.

4. **Plan of 2010**
   In 2010 the Minister of Agriculture later reformed the Beef Self-sufficiency Program (BSSP) that expected to be achieved in 2014. Because of the two previous programs in 2005 and 2010 failed to achieve its goals and objectives, the self-sufficiency target launched back in to be realized in 2014. Therefore, Beef Self-sufficiency Program 2014 implemented in 2010 is updating the concept of a variety of aspects, including the program, implementing organizations, supporting documents, and funding. The government also added the program of beef self-sufficiency from the programs before, including the development of commercial cattle farming, improving supply chain and make the import quota program. The program has been equipped with a blueprint and roadmap as well as various measures to undergo the road map and has been supported by adequate funding.
Beef self-sufficiency program was declared unsuccessful because of the failure to achieve three main objectives of the program. Moreover, Yusdja et al. (2004) discussed that there are five reasons of the failure, they are: 1) program policies which formulated are not accompanied by a detailed operational plan, 2) programs are made top-down and a small scale compared with the objectives to be achieved, 3) generalized strategy in implementing the program without consideration about the uneven population region, but more oriented to the competitive commodity, 4) implementation of programs do not allow for evaluation of the impact of the program implemented, 5) programs are not clearly have an impact on the growth of the national population. Ashari et al. (2012) also adds that during the 2000-2005 periods the implementing organization is not formed, so that the implementation of activities is unclear and unfocused. While in the period 2005-2010, the executive is the technical team but non-operational.

The government's policy is intended to reduce the import of beef either in the form of frozen meat, beef cattle or edible offal in the hope of encouraging growth in domestic beef production and the added value of livestock subsector also create jobs. Beef self-sufficiency can be achieved if domestic beef production can meet at least 90 percent of the total national beef. Self-sufficiency is defined as 90% - 95% of beef consumption from domestic production with imports is 5% - 10%.

Tariff and Import Quota

In order to give protection to local farmers it is necessary to impose tariff on imports of beef and live cattle. There are two different types of tariff implies for beef and for beef cattle. The government implied 5% import tariff since 1999 until today for beef and for the edible offal which turned out to be equated with type of meat. However the government imposed 0% tariff for breeding cattle and feeder cattle. Cattle imports required for breeding business and produce feeder cattle, thus imposed tariff 0%. Import tariff feeder cattle also charged an entrance fee of 0%, this is possible because the fattening activities will provide added value and create jobs.

The import quota policy imposed to support the achievement of beef self-sufficiency. Thus, frozen beef and live cattle import is restricted since 2010. The establishment of import quota also leads to problem because the government is less accurate in calculating the amount of meat for domestic consumption, processing industry and others, and the ability of local cattle to provide beef. The administration of larger quotas causing local cattle prices fall in 2008-2009, while granting smaller quota causing beef prices to rose sharply as it did in 2010-2012.

Import restriction policy of the Australian feeder cattle and beef imports have caused the supply of beef in the country became increasingly scarce so that the price of beef lifted. The increase in fuel prices, Ramadan and Eid festivals also raised prices so beef prices continue to climb and difficult to go back down. These conditions cause the movement on the livestock policy authority from the Ministry of Agriculture to the Ministry of Commerce.

This change was marked by the publication of the Decree of the Minister of Trade No. 699 / M-DAG / KEP / 7/2013 on strengthening the beef price on July 18, 2013. The essence of the decision is by opening beef imports in sufficient quantity to maintain the availability of beef and price stabilization.
National Beef Price Control Policy

The government, through the Ministry of Trade removes the limited import quota system and replaced it with a reference price mechanism. Minister Decree No. 46 / M_DAG / PER / 8/2013 has been established on 30 August 2013 on the terms of import and export of Animals and Animal Products. One article which leads to controversy is Article 14 verse 2 about the reference price to stabilize prices. Price reference is reference price of sales at the retail level set by the beef prices monitoring team established by the Ministry of Commerce. The effort is to regulate the import mechanism of animals and animal products by using the reference price. Import will be automatically done if domestic prices exceed 15 percent of the reference price. It also Give permission to the government to appoint a National Logistics Agency (BULOG) to import animals and animal products, as long as the imported beef is distributed to the retail market.

Beef imports trading activities carried by BULOG is to stabilize the price of beef in the country. In this beef trade, BULOG bought beef imported from Australia according to Import Letter of Approval from the Ministry of Trade which required by beef importers who purchase or import beef in Indonesia. Procurement by BULOG is currently concentrated to fulfill the beef stock in Jakarta and West Java. The stock of imported beef is saved in cold storage in Jakarta that is near from BULOG’s beef sales area. Locations of the distribution are including areas of Jakarta, Depok, Bogor, Tangerang, Bekasi and Bandung. Besides, BULOG through BULOGMart also distributes beef imports through cheap market, bazaar, weekly market and an exhibition of food products, which are sold by retailers.

BULOG beef imports selling mechanism to maintain price stabilization in the beef market are (BULOG 2013):
1. Sales in strategic markets both traditional markets and modern markets;
2. Provide Freezer by BULOGMart to be distributed to the village, Cooperative and houses;
3. Selling through Association and Distributor;
4. Direct Selling by renting a stall in strategic markets.

BULOG’s activities conduct so far is keeping the floor prices for grain, particularly the cost of price stabilization, rice allocation to the poor, and management of food stocks. Although the focus of BULOG previously only on a single commodity, namely rice, but BULOG actually also have experience in terms of stabilizing and multi-commodity supply management in the era of the 1980s until the early 1990s, before finally BULOG limited authority.

The appointment of BULOG as a price stabilizer of meat is to give permission to import frozen beef from Australia, accounted for 3000 tons in the year 2013, divided into two delivery mechanisms, 800 tones by air and 2200 tones by sea. Furthermore, BULOG will conduct market operations to stabilize the price of beef by cooperating with meat retailers who are members of the association, as well as selling directly to traders at the market stalls. The price that will apply by BULOG ranged from Rp70000 to Rp80000 / kg (Permana, 2013).

BULOG’s beef import as much as 3000 tones with the aim of lowering the beef price is not significantly able to lower beef prices yet. Recent regulation published on September 26 year 2013, No. 57 / M-DAG / PER / 8/2013 as an
amendment to the Regulation Decree No. 46 / M-DAG / PER / 8/2013. The amendment is highlighting chapter 18 which stated the role changes of BULOG, so that its authority to distribute to retail market is eliminated.

**Beef Market Chain**

In general, beef supply chain in Indonesia consists of: farmers, middleman, cattle market place, wholesaler, butcher or small scale trader, slaughter house and consumers. It can be divides into domestic beef cattle, imported beef cattle and imported frozen meat.

Figure 7 illustrate the domestic cattle supply chain. The farmers sell their cattle to the middleman or village collector and in Indonesian term called “Blantik” or they also can sell it to the nearest cattle market place. Furthermore, the cattle are sold to wholesalers or to beef butcher (traders who buy live cattle and cut it by themself to be sell). Large cattle traders sell cattle to other areas, including Jakarta, Bogor, Depok, Tangerang, Bekasi and even beef from cattle production centers in east Indonesia (East Nusa Tenggara, West Nusa Tenggara, Bali) sold to Borneo.
Cattles slaughtered by butcher in either public owned or private owned slaughter house, or in individual slaughtering place. The beef cuts from this process consist of various meat part, offal (intestines, liver, lung, heart, etc.), head, tail, skin and feet. These beef cuts and its edible offal will be purchased by beef retailers who will then sell them in traditional market, with various types of buyers such as household consumers, restaurant/food stalls, and meatball seller.

We can see the illustration of the imported beef cattle and imported beef supply chain from figure 8. Feeder cattle purchased from Australian by beef cattle companies (feedlotter) are incorporated into APFINDO (Indonesian Meat Producers and Feedlot Association) and importers in Indonesia. In a relatively short time, thousands of cattle brought to the port of the port of Panjang (Lampung), Tanjung Priok (Jakarta), Cilacap (Central Java) and Tanjung Perak (Surabaya).

The number of imported beef must be approved by the Ministry of Agriculture. According to government regulations, the weight of the imported cattle should not be more than 350 kg/head for fattening period of 90-100 days in Indonesia, thus, it has an effect in economic terms by creating added value in the form of increase in the weight of the meat, employment, utilization of transport services, utilization of industrial waste for feed, and others (RPJMN 2013). However, in urgent circumstances to meet the needs of the domestic market, the
weight of the imported cattle could exceed the provisions and can be directly slaughtered after arriving in Indonesia. Feedlot companies and importer cut their own beef cattle and they also sell it to the public slaughter house or private slaughter house.

Cattle slaughtered at the slaughter house owned by the feedlotter company can directly distribute to supermarkets, hotels and restaurants. While other retailers who is selling in the traditional market usually buy beef from the public slaughter house or private slaughter house, which will be sold to the meatball seller, food sellers and household consumers.

Figure 9 illustrates the imported beef supply chain. Imported beef from Australia, New Zealand, and other countries are usually in the form of frozen beef meat (including offal, liver, heart, tail, etc.). They are purchased by the company member of Indonesian Meat Importer Association (ASPIDI).

Imported frozen meat is directly sold to the meat processing industry which joined NAMPA (National Meat Processor Association), supermarkets, hotels, and agents. It is not allowed to be sold to the traditional market. The quality of the meat sold to the processing industry generally is second class, while the first class (prime cut) being sold to the luxury hotels and supermarkets. Processed meat that produced by the processing industry are: sausage, smoked beef, burgers, and others. Processed products are then sold to supermarkets. Supermarkets sell fresh meat to the restaurant/catering, and sell processed products to consumers. Agents selling beef imports meat (including offal, liver, heart, tail, etc.) to the restaurant / catering.
3 FRAMEWORK

The underlying theories and concepts of this study are addressed in this chapter. However these explanations were not aimed to prove how the theories and concepts work in detail, but to indicate the relevancy of this empirical study to the theories and concepts.

Theoretical Framework

Price Volatility: Concept and Measurement

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 (Prakash 2011 and Sumaryanto 2009).

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. According to OECD (2011) volatility is variations in economic variables over time. Brümmer et al. (2013a) described that volatility is unobservable that refers to unexpected price changes, but still needs to be estimated.

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 (Anderson et al. 1977). Measuring price volatility using the standard deviation of log changes in price returns is the simplest way (Gilbert and Morgan 2010).

There are two types of measurement that is frequently used in calculating price volatility, they are:

1. Realized volatility, this calculation is based on the historical or observed movements from an economic variable like agricultural prices in the past that reflects the determination of supply and demand factor (Tothova 2011).
2. Implicit volatility, this measurement wants to know the volatility of an asset in the future that shows the responsiveness of the commodity price to current market conditions (Tothova 2011).

Drivers of Price Volatility

Prices of agricultural commodity are often random, that can lead to risk and uncertainty into the process of projecting and modeling the market. There are many available methods to analyze price volatility, but agricultural commodity prices cannot be analyzed as financial price volatility because of agricultural commodity price has its own characteristic (Piot-Lepetit and M’Barek 2011). Furthermore Piot-Lepetit (2011) mentioned that price volatility is an important factor that reflects the risk on product availability, especially in perishable agricultural products which have inelastic demand and uncertainty in production.

According to Brümmer et al. (2013a; 2013b) based on summarize from recent empirical research, there are several main drivers that influenced price volatility, they are:

1. Supply, short run supply shocks play a role for increasing price volatility.
2. Demand, increasing trend of middle class in developing countries, including Indonesia, which increases the consumption of meat as dietary pattern changes.

3. Storage, in the periods of low stocks, with high demand the stock availability of stock seems to be decreasing higher price volatility.

4. Oil Prices, there are direct effect of increased oil prices on production processes in agriculture, especially for the use of machinery and transportation.

5. Macroeconomic factor, macro policies have a substantial impact on the stability of a whole economy that will affect the agricultural price volatility.

6. Specific policies, government policies concerning the control of the market price, import restriction policy affects price volatility.

ARCH and GARCH Models

Modeling of time series data is generally done by using the assumption that constant residual variance (homoscedastic). But in reality there are many of the time series data that have non constant residual variance (heteroskedastic), especially for the time series data in economics. That is why the time series models with homoscedastic could not be used.

ARCH (Autoregressive Conditional Heteroscedasticity) is a model that takes into account the presence of heteroskedasticity in time series of data analysis. The primary principles of modeling autoregressive conditional heteroscedasticity (ARCH) was originated by Engle (1982) which is used to model the residual variance that depends on the square of the residual in the previous period in autoregression. The model was applied to analyze the behavior of inflation in the United Kingdom in the period 1958:2-1977:2. The equation used is first order autoregression and estimated using ARCH models. In the paper, Engle explains that the the time series data model with high volatility are likely to contain the problem of heteroscedasticity.

Bollerslev (1986) complete ARCH models developed by Engle (1982), but in the same analytical framework. This is done by inserting the residual elements of the past and the residual variance in the autoregressive equation. The model is called the Generalized Autoregressive Conditional Heteroscedasticity (GARCH). Using data on United State of America inflation with autoregressive equation, Bollerslev try reevaluate ARCH inflation model of Engle. The results show that by incorporating elements of the residual variance in the regression equation produces better than ARCH models (Bollerslev 1986).

Volatility based on GARCH (p, g) the model assumed that the variance and fluctuations of data is affected by a number of p data from previous fluctuations and q data from previous volatility. In general, this model as autoregression (AR) and moving average (MA), that looks the relationship of random variables with the random variables in the period before.

In ARCH models, the residual variance of time series data is not only influenced by the independent variable, but also influenced by the residual value of the variables studied. ARCH (1) model can be represented as:

$$\sigma_t^2 = \sigma_0 + \alpha_1 \epsilon_{t-1}^2$$

(1)
Where: $Y_t$ is dependent variable, $X$ is independent variable, $\varepsilon$ is residual/error, $\sigma_t^2$ is residual variance and $\alpha_1 \varepsilon_{t-1}^2$ is the ARCH component.

Residual variance has two components, they are constant and residual from the previous period. That is why the ARCH model called the conditional model, when recent period influenced by the previous period. In reality, conditions that often happens that this mean is very dependent on the volatility of the past few periods (conditional mean) or the current variance depends on the volatility of some of the previous period. This raises the number of parameters in the conditional mean or the conditional variance to be estimated. Estimating these parameters is difficult with accurate precision. To overcome these problems, the team Bollerslev (1986) developed a GARCH model.

GARCH model is an improvement on ARCH model is actually a further elaboration of ARCH models that have conditional information. Along with the increasing lag ($p$) are estimated on ARCH models, it will be more difficult to estimate a parameter because the likelihood function will be very flat or in other word the estimator precision is less. Because of that GARCH models usually recommended to estimate volatility. GARCH models allow the calculation of time-varying volatility (time varying volatility) and volatility clustering, as well as an extremely flexible model and perform well with reasonable restrictions on the coefficients and using only a few parameters. The simplest GARCH model called GARCH (1.1) can be written as follow:

$$
\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \tag{2}
$$

From the equation (2) above, we can tell that GARCH model assume today’s conditional variance from error ($\sigma_t^2$) consist of three parts, they are: (1) constant variance, $\alpha_0$, (2) volatility from previous period which is measured as lag from mean residual quadrat from previous period or we can call it ARCH term, $\varepsilon_{t-1}^2$, and (3) variance forecast of previous period or GARCH term, $\sigma_{t-1}^2$. Thus we can say that $\alpha_1$ is a parameter that describes the effect of stochastic deviations in the previous period on the conditional variance, and $\beta_1$ is the influence of the variance of previous period on current variance.

In order to make the above equation possible to estimate there are two restrictions to fulfill, they are: (1) all the variances must be positive ($\alpha_0 > 0$, $\alpha_1 > 0$, $\beta_1 > 0$) and the sum of all weights must be smaller than 1 ($\alpha_1 + \beta_1 < 1$). This number shows the persistence degree of volatility in time series data. Piot-Lepetit (2011) describes that if the sum of $\alpha_1 + \beta_1$ is close to 1, it means that the greater of the volatility tendency to persist for long time, and if the sum of $\alpha_1 + \beta_1$ is greater than 1, there is an indication that the data series exploded with a tendency to meander away from the mean value.

**Previous Study**

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 according to Tangermann (2011) 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. This also supported by Piot-Lepetit and M’Barek (2011) 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, Sumaryanto (2009) 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.

The government has a major role in setting policy that able to overcome the price volatility on agricultural commodities problem. OECD-FAO (2011) explains that a coherent policy is needed as an effort to reduce volatility and restrict its negative impacts. The policy consist of: (1) mitigate volatility through increased market transparency, improvement of global and national information as well as increased surveillance system of the market outlook, and (2) the management of volatility through the social security mechanism to help consumers who are most vulnerable when the price food increase. One important factor that can influence the success of the government’s policies efforts to overcome price fluctuation is the knowledge of the volatility pattern.

Arifin (2011) explains that 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. Meanwhile, Daryanto (2010) 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
and GARCH models have been used in several studies in various fields like finance and agriculture.

ARCH-GARCH models are used in agriculture including research conducted by: Gilbert & Morgan (2010), Apergis & Rezitis (2011), and Busse et al. (2010). Gilbert & Morgan (2010) found in their study that there are several factors driving volatility, namely production, consumption, stocks, and speculation. They calculate volatility using the logarithm of standard deviation and also a GARCH model. They empirically prove that food prices become more variable. Meanwhile, Apergis & Rezitis (2011) study about 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 in the price of the food market. Busse et al. (2010) use GARCH models 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.

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

Operational Framework

Beef is one commodity which has a big influence on the nutrition improvement of the community in Indonesia, especially animal protein that is needed in human development because it is closely related to physical health and development of human intelligence. In line with the addition of the population, economic growth and a better level of education in Indonesia, the demand and the level of consumption of beef shows increasing annual trend.

Household incomes improvement shift the consumption patterns of the middle class that makes beef consumption increased but not followed by an increase in domestic beef production. Domestic beef production growth is lower than the growth in beef consumption which can lead to fluctuations in the price of beef. If the beef supply is high then the price will be low, otherwise if the supply is low, then the price will increase (ceteris paribus). The high beef price is because of the limited supply in response to demand.

Since 2010, the Indonesian government policy tries to achieve self-sufficiency in beef which is targeted to be achieved in 2014, in response to high domestic demand for beef. Domestic beef demand has been met from domestic production plus imports. Beef self-sufficiency program has a target to meet domestic demand of 90-95% through domestic production with imports only about 5-10%. Therefore, over the last 5 years since 2010, the government tried to reduce imports. The objective of self-sufficiency of beef in addition to reducing dependence on imported beef from other countries, it is also to improve the beef productivity from local farmers in the country so as to improve their welfare.

Beef self-sufficiency program is experiencing a lot of criticism and debate from many parties, whether it will lead to increased beef price volatility in the short term. Considering the goal of beef self-sufficiency program, it is interesting to know whether the beef self-sufficiency program affects price volatility.
4 RESEARCH METHODOLOGY

This chapter provides information about the data and methodology of the research. The first section of this chapter describes about the data description: the type of data, sources of data, and so forth. Second it continuous with the method analysis while the rests describe about the data processing along with steps and all operations conducted.

Data Description

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 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 and Data Analysis Method

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.

Price Volatility Analysis

GARCH Model

We do further volatility analysis using ARCH/GARCH models. The stages of volatility analysis using ARCH/GARCH models are: identification of ARCH effects, model estimation and model evaluation.

1. ARCH effect identification

ARCH-GARCH modeling starts by identifying whether the beef prices data contains heteroskedasticity or not. 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.

2. Model Estimation

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.

A. 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.

1) Unit Root Test

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:
\[ \Delta X_t = \alpha + \beta X_{t-1} + \delta_t + u_t \]

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 \( t=t\)-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) do not follow the student-\( t \) distribution instead follow Dickey-Fuller distribution.

The hypotheses of this test are:

- \( H_0: \beta = 0 \) (data has a unit root or data is not stationary)
- \( H_1: \beta \neq 0 \) (data does not have a unit root or data is stationary)

If the null hypothesis of \( \beta = 0 \) is rejected then the conclusion is that the data series is stationary, and vice-versa.

2) Determination of ARMA/ARIMA model

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 Akaikie Information Criteria (AIC) and Schwartz 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.

B. 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.

1) ARCH effect test

ARCH effect test using the Lagrange Multiplier test (ARCH-LM test) is based on the null hypothesis \( (H_0) \) there is no ARCH errors. If the test results indicate acceptance of the null hypothesis, the data does not contain ARCH errors and do not need to be modeled with ARCH-GARCH.

2) 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:

(a) Akaike Information Criterion (AIC)

\[
\text{AIC} = \ln (\text{MSE}) + 2K/N
\]

(b) Schwartz Criterion (SC)

\[
\text{SC} = \ln (\text{MSE}) + \frac{K\log (N)}{N}
\]

Where,

\( \text{MSE} = \) Mean Squared Error

\( K = \) number of estimated parameters

\( N = \) number of observations
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 the smallest 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 (α + β < 1), and the coefficients have no negative values (α0 > 0, α > 0, β > 0).

3. Model Evaluation

Evaluation of the model is done by checking the adequacy of the model so that the model obtained is sufficient. If the model is not adequate, then go back to the step of identification to get a better model. Diagnosis is done by analyzing the model residuals standardized, include:

1) Normality test

Residual normality test was conducted to test whether the residual normally spread. Normality of residuals examined from the Jarque-Bera test, which measures the difference between skewness and kurtosis of the normal distribution of the data, and the variance size. The hypotheses of this test are:

H0: Residual normally spread
H1: Residual not normally spread

The Value of the Jarque-Bera test statistic (JB) is obtained by the formula:

\[ JB = N-K/6 \left( S^2 + 1/4 \left( k-3 \right)^2 \right) \]

Where,

- S = skewness
- K = kurtosis
- k = number of estimated coefficients
- N = number of observations

Decision criteria JB test is: Reject H0 if JB > χ²(2) (α) or reject H0 if P (χ²(2) > JB) is less than α=0.05 and vice versa.

2) Ljung-Box test

Ljung-Box test is to detect the serial correlation. GARCH models show a good performance if it can eliminate the existing autocorrelation in the data, that is, if the residuals are random (white noise). The test is performed by examining the autocorrelation coefficient of squared residuals.

The null hypothesis to be tested:

\[ H_0: \rho_1 = \rho_2 = \cdots = \rho_K = 0 \]

The test statistic formula:

\[ Q = n(n+2) \sum_{k=1}^{K} (n-k)^{-1} \hat{\rho}_k^2 \]

where K = the maximum lag length

n = the number of observations

\( \hat{\rho}_k \) = sACF at lag k

If Q > \χ²table, reject H0. This means that the autocorrelation exists in residuals.
3) ARCH effect test for heteroskedasticity

We do the ARCH effect test to see whether there are still ARCH effects in the GARCH model chosen. The existence of ARCH effects can be detected through the Lagrange Multiplier test (ARCH-LM).

Flow chart to estimate GARCH model is shown in Figure 11:

Preestimation Analysis:
1. Data preparation
2. Change beef prices into first difference
3. Unit Root test
4. Test for correlation
5. ARCH effect test

Parameter Estimation:
1. Estimate the parameters using GARCH model without dummy variable
2. Estimate the parameters using GARCH model with dummy variables (Dummy 1 and Dummy 2)
3. Estimate the parameters using GARCH model with dummy variables (Dummy 1, Dummy 2 and Dummy 3)

Model Evaluation:
1. Model fit diagnostic test to residuals

Figure 11  Flowchart estimation process for GARCH model

This research is design to be able to understand what factors that creates beef price volatility and when it is usually happened. In this thesis we will use three dummy variables, the choices of these dummy variables are based on visual inspection from the beef daily prices and we know that certain Islamic festivals are going to affect the beef price, that’s why we test some numbers of potential dummy variables, in this case they are dummy 1 (D1) is during Ramadhan month and dummy 2 (D2) is dummy two days before Ramadhan which will be tested in the mean equation. We also add dummy (D3) as the additional regressor to capture the change policy of the implementation of Beef Self Sufficiency Program and it will be tested in the variance equation of the GARCH model.
We will use a dummy matrix containing 1 and 0, where 1 represents two days before Ramadhan festival for D1 and a whole month of Ramadhan for D2 in every year from January 2006 until December 2013. As for D3, 1 represents time after the beef self-sufficiency program runs since 2010-2013 and 0 represents before the program 2006-2010.

5 RESULT AND DISCUSSION

Result

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. We can see from figure 2 and the monthly price return in appendix 1 that the prices don’t hold as volatile series.

Figure 12 Daily beef price in Indonesia 2006-2013
Source: Ministry of Trade, Republic of Indonesia

Figure 12 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. The beef price growth from 2007-2008 is 14.57, this is increasing significantly from the
previous year (see table 1). This event happened due to the increase of international oil price that forced Indonesian government to also increase the domestic fuel price 33% from Rp. 4500 become Rp. 6500. 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 13 show that in 2006-2010 there is existence of high volatility and in the 2010-2013 periods of low volatility. The return plot in figure 13 shows that the series is suitable to be analyzed using GARCH models.

![Figure 13 Daily return of beef price in Indonesia 2006-2013](source: Own calculation)

Table 1 provides information on the mean of data, skewness, and kurtosis. On overall, the beef price return series have mean and median near to zero with standard deviation of 0.006. Skewness coefficient is a measure of the slope is greater than zero which indicates the variable data have the right to a skewed distribution means the data tends to accumulate at a low value. The price at level has an asymmetrical distribution with a long tail to the right (positive skewness),
meanwhile price at return has long tail to the left (negative skewness). The kurtosis value is more than three, it means that the data distribution has a denser tail than the normal distribution. Kurtosis value greater than three is also the first sign of heteroscedasticity. Based on the normality test, the value of Jarque-Bera probability from all variables have a smaller probability value of alpha 5%, it means that the data is not spreading normally.

### Table 1 Descriptive statistics of beef price

<table>
<thead>
<tr>
<th></th>
<th>BEEF_PRICE</th>
<th>LN_PRICE</th>
<th>RETURN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>65158.510</td>
<td>11.062</td>
<td>0.000</td>
</tr>
<tr>
<td>Median</td>
<td>65142.640</td>
<td>11.084</td>
<td>0.000</td>
</tr>
<tr>
<td>Maximum</td>
<td>97709.000</td>
<td>11.490</td>
<td>0.046</td>
</tr>
<tr>
<td>Minimum</td>
<td>43679.360</td>
<td>10.685</td>
<td>-0.086</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>13789.160</td>
<td>0.212</td>
<td>0.006</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.382</td>
<td>0.000</td>
<td>-1.158</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.419</td>
<td>2.154</td>
<td>32.230</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>111.992</td>
<td>87.067</td>
<td>104607.300</td>
</tr>
<tr>
<td>Probability</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

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

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 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 (Firdaus, 2011). We can see from appendix 5 that the data is significant in the first 36 lags. This indicates that there is ARCH effect in the data.

### Table 2 Unit root test result using ADF

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRICE</td>
<td>-0.308074</td>
<td>0.9213</td>
</tr>
<tr>
<td>RETURN</td>
<td>-21.51764</td>
<td>0.0000 ***</td>
</tr>
</tbody>
</table>

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)

To avoid spurious regression the analyzed data should be stationer. Therefore, the first step before the ARMA model estimation is performing unit root test. Table 2 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 Autocorrelation 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 Schwatrz 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). The results of ARMA model is in appendix 6 and appendix 7.

<table>
<thead>
<tr>
<th>Table 3 ARCH LM test for ARMA model</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
</tr>
<tr>
<td>Prob. F(15,2054)</td>
</tr>
<tr>
<td>Obs*R-squared</td>
</tr>
<tr>
<td>Prob. Chi-Square(15)</td>
</tr>
</tbody>
</table>

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

Based on ARCH LM test results in table 3 the estimation of ARMA model contains the heteroscedasticity problem. It is known from probability values are significant at $\alpha = 1\%$. So the ARMA model should be estimated with ARCH/GARCH model to overcome the heteroscedasticity problems that occur.

The results of the ARCH and GARCH models are displayed in table 4. 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 $\alpha$ and $\beta$ for GARCH model are significant at 1 percent 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 $\beta$ coefficient indicates a strong influence of the own variance on volatility measurement development, meanwhile a low $\alpha$ indicates low sensitivity to external shocks to the beef market. Beef price shows a relatively smaller $\alpha$ than $\beta$, 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, 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 beef price is increasing 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.

Table 4 Optimal parameter results

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

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

The optimal results of GARCH estimations are shown in table 4. The result yield from GARCH model with 1 external regressor D3 to capture the Beef Self Sufficiency Program Policy:
\[ \sigma_t^2 = 0.0000000213 + 0.053378 \varepsilon_{t-1}^2 + 0.944577 \sigma_{t-1}^2 - 0.0000000954 D3 \]

(0.000000123)***  (0.001767)***  (0.001170)***  (0.0000000107)***

Log Likelihood = 8255.495

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 and significant that indicates that we have low volatility. However the value of the GARCH coefficient of 0.944577, it is large close to unity and also significant, 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. The sum of the coefficient \( \alpha_1 + \beta_1 \) is close to 1 (0.997955), which supports the presence of a strong ARCH and GARCH effect, it means that the greater of the volatility tendency to persist for longtime. Since the dummy variable in the variance equation D3 is negative and significant (-0.0000000954)*** it shows us that the government policy through beef self-sufficiency program has small impact on beef price volatility. Based on the model we can conclude that beef price volatility in the future will tend to be smaller and persistence.

Table 5 ARCH LM test for GARCH model

<table>
<thead>
<tr>
<th>F-statistic</th>
<th>2.032702</th>
<th>Prob. F(3,2078)</th>
<th>0.1073</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obs*R-squared</td>
<td>6.091967</td>
<td>Prob. Chi-Square(3)</td>
<td>0.1072</td>
</tr>
</tbody>
</table>

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

Based on ARCH LM test are shown in table 5 shows that the GARCH model estimation results in Table 4 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.

![Conditional variance](image)

Figure 14 Conditional variance of beef price return
Source: author’s elaboration
Figure 14 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 compared 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.

**Discussion**

Several factors are recognized as sources driving the price volatility of beef from the structure of beef supply demand and domestic policy. According to Brümmer et al. (2013a; 2013b) and Tothova (2011) based on summarize from recent empirical research, there are some factors that influencing price volatility, they are: (1) supply, (2) demand, (3) storage and stock, (4) oil prices, and (5) specific policies. In order to gain more comprehensive understanding about these main drivers to beef price volatility, we will related these drivers to the state of beef agribusiness in Indonesia.

**Supply**

Volatility represents an important risk factor of supply, especially in agricultural product such as beef. On the supply side short run supply shocks play a role for increasing price volatility. The problem that occurs is derived from the slow increase of beef production due to low investment to increase production capacity, and for beef commodity 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.

An important characteristic of meat supply response of beef is the possibility of a negative short-run producer price elasticity response. Beef supply and demand characteristics are unique, both are tend to be inelastic to price changes. Commodities that has inelastic beef demand tend to be more volatile (Tothova 2011). Farmers as beef producer can not necessarily increase production when prices rise. Consumers also could not reduce demand when prices are rising. This is because beef cattle act as capital and consumption good. Beef cattle as livestock saving owned by 97% of small farmers in Indonesia that can act as price leader because the will keep their cattle unless they need cash for school or wedding. It means that if the price of beef increases and farmers as producers expect this increase to be permanent they may decide to retain a larger females in the cattle herd instead of slaughtering them at a time (Piot-Lepetit and M’Barek 2011). An increase in beef price volatility implies higher uncertainty about the future prices.

**Demand**

On the demand side, factors driving the volatility of the beef price are income and population growth, the increase in demand for beef due to increasing trend of middle class in developing countries, including Indonesia, which increases the consumption of meat as dietary pattern changes as a result of strong economic growth. The role of westernisation of diets might additionally increase
these shifts in the aggregate of supply and demand. The increasing move toward higher meat shares will lead to an increasing competition between food and feed in major agricultural products.

Because of the low beef population and beef production in Indonesia, the beef farmers cannot provide beef to meet the high beef demand. This situation makes the beef price rise and leads to higher consumer expenditure on beef. It will make the reduction of income allocation for other needs such as education and health. If the beef price increases continuously and volatile, the welfare of society can reduce and add more burden for them.

**Storage and stock**

Most of agricultural products traded on international markets like beef are storable. As the stocks of beef fall, it is expected that the volatility in the prices would increase. If stocks are low, then the dependence on current production in order to meet short-term consumption demands would be likely to rise. Any further shocks to yields could therefore have a more dramatic effect on prices. Since the stocking outs are likely to occur at high prices, while low prices increase the demand for storage, phases of increased volatility for storable commodities are likely to coincide with high prices.

Beef farmers in Indonesia do not have stocks to anticipate increasing beef demand shocks in certain months such as Ramadhan and Idul Fitri festival which might worsen the volatile prices. Government policies regarding the situation, first is to permit the import of frozen beef and beef cattle to be fattened from Australia or New Zealand as the nearest beef exporter countries. Second is to give BULOG the role to become stock buffer by doing market operation, which can help holding beef stocks to reduce the beef price fluctuations. The third one is to make investment in genetics and feeding technology to increase beef cattle production in Indonesia.

![Figure 15](image)

**Figure 15** Conditional standard deviation of beef price return

Source: author’s elaboration

The Indonesian government employs the beef self-sufficiency program as one of policy to increase beef stock holding by increasing domestic beef population. In order to achieve this goal, starting 2010 the government enacted...
regulations to support domestic beef production. This policy seems to be quite effective in lowering the beef price volatility (Figure 15). However, the impact of this policy is very small to overall volatility development as indicated by very low parameter of dummy 3 in our model.

**Oil prices**

There are direct effect of increased oil prices on production processes in agriculture, especially for the use of machinery and transportation. 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. Beef import volume between 2004-2009 increases more than five times. Indonesia imported 11.8 thousand tones in 2004 and increased become 64.1 thousand tones in 2009 (Bappenas 2013).

**Specific policies**

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 percent. 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.

Government policies concerning the control of the market price, import restriction policy affects price volatility. 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 (Ilham 2009). This research shows the variability of the beef price after the policy is lower than before, but not necessarily the price level. We can see from figure 15 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.

In 2011 Statistics Indonesia conducted beef and buffalo cattle census that resulted figure 14.8 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 percent in 2011 become 20 percent in 2012, next is 15 percent 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 fulfill 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 increased the subsidized fuel price as much as 15 percent in 2012. This makes the price of beef increased significantly and also increased the beef price volatility. Meanwhile 97 percent of Indonesian cattle farmer is small scale farmer with 3-4 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 to make beef price volatility is lower than before the program is implemented.

6 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

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 the 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.

**Recommendations**

The challenge of food supply through the production of agricultural commodities in the future will be increasingly difficult. Therefore, building a database and socio economic analysis should be performed. Maintaining sufficient level of beef stock is very important to keep beef market stable, but it is not enough to give big impact in reducing beef price volatility. 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 at balance proportion.

In relation to price stabillization, it is important that Indonesian government should develop an effective and efficient beef supply chain, this can be done by improving the market mechanisms, transportation and infrastructure for distributing beef cattle from production areas to consumption areas. Due to low production and high demand of beef the government should be more flexible in relation to food policy in order to make faster response to any situations such as hold sufficient beef stock in the storage in Ramadhan, Idul Fitri festival and other big celebration day in Indonesia. Government polices regarding the situation, first is to permit import frozen beef and beef cattle to be fattened from Australia or New Zealand as the nearest beef exporter countries. Second is to give BULOG the role to become stock buffer by doing market operation, which can help holding beef stocks to reduce the beef price fluctuations. The third one is to make investment in genetics and feeding technology to increase beef cattle production in Indonesia.
REFERENCES


Appendix 1: Graph of monthly beef price return

Appendix 2: ARCH effect test for monthly beef price

<table>
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<tr>
<th>Heteroskedasticity Test: ARCH</th>
<th>F-statistic</th>
<th>Obs*R-squared</th>
<th>Prob. F(1,169)</th>
<th>Prob. Chi Square(1)</th>
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<tbody>
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<td></td>
<td>1.249729</td>
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**Appendix 3 ARCH effect test for monthly beef price**

Null Hypothesis: Y has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic based on SIC, MAXLAG=25)

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<thead>
<tr>
<th></th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
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<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-0.308074</td>
<td>0.9213</td>
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</table>

Test critical values:
- 1% level: -3.433297
- 5% level: -2.862728
- 10% level: -2.567449


**Augmented Dickey-Fuller Test Equation**

Dependent Variable: D(Y)
Method: Least Squares
Date: 01/28/15   Time: 23:00
Sample (adjusted): 1/12/2006 12/31/2013
Included observations: 2079 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
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<td>-0.084086</td>
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<td>D(Y(-6))</td>
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R-squared: 0.102705
Adjusted R-squared: 0.099237
S.E. of regression: 336.5232
Akaike info criterion: 2.34E+08
Schwarz criterion: -15042.47
Hannan-Quinn criter.: 29.61659
Durbin-Watson stat: 0.000000
Log likelihood: 11.31246
Akaike info criterion: 14.47953
Schwarz criterion: 14.503955
Hannan-Quinn criter.: 14.48848
Durbin-Watson stat: 1.997353
Appendix 4 Unit root test result in daily return beef price

Null Hypothesis: R has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic based on SIC, MAXLAG=25)

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<td>-21.51764</td>
<td>0.0000</td>
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Test critical values:
- 1% level: -3.433297
- 5% level: -2.862728
- 10% level: -2.567449


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(R)
Method: Least Squares
Date: 01/28/15   Time: 23:00
Sample (adjusted): 1/12/2006 12/31/2013
Included observations: 2079 after adjustments

<table>
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R-squared: 0.638441
Adjusted R-squared: 0.637219
S.E. of regression: 0.006103
S.D. dependent var: 0.010132
Akaike info criterion: -7.356345
Schwarz criterion: -7.334644
Hannan-Quinn criter.: -7.348393
Durbin-Watson stat: 1.999564
Prob(F-statistic): 0.000000

Probabilities and test statistics for unit root tests.
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Apendix 6 ARMA (1.1) model output estimation

Dependent Variable: R  
Method: Least Squares  
Date: 01/29/15   Time: 15:28  
Sample (adjusted): 1/04/2006 12/31/2013  
Included observations: 2085 after adjustments  
Convergence achieved after 6 iterations  
MA Backcast: 1/03/2006

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R-squared: 0.093710  
Adjusted R-squared: 0.092839  
S.E. of regression: 0.006250  
Akaike info criterion: -7.311020  
Sum squared resid: 0.081329  
Schwarz criterion: -7.302901  
Log likelihood: 7624.738  
Hannan-Quinn criter.: -7.308045  
F-statistic: 107.6386  
Durbin-Watson stat: 1.996705  
Prob(F-statistic): 0.000000

Inverted AR Roots: .52  
Inverted MA Roots: .80
Appendix 7 ARMA (1.1) model output estimation with two dummy variables

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<td>D2</td>
<td>0.009004</td>
<td>0.001381</td>
<td>6.521819</td>
<td>0.0000</td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.536933</td>
<td>0.035210</td>
<td>15.24938</td>
<td>0.0000</td>
</tr>
<tr>
<td>MA(1)</td>
<td>-0.829414</td>
<td>0.023477</td>
<td>-35.32925</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared: 0.117099
Adjusted R-squared: 0.115401
S.E. of regression: 0.006172
Sum of squared resid: 0.079230
Log likelihood: 7651.996
Prob(F-statistic): 0.000000

Inverted AR Roots: .54
Inverted MA Roots: .83
Appendix 8 ARCH LM test after ARMA estimation
Heteroskedasticity Test: ARCH

<table>
<thead>
<tr>
<th>F-statistic</th>
<th>23.62084</th>
<th>Prob. F(15,2054)</th>
<th>0.0000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obs^R-squared</td>
<td>304.5398</td>
<td>Prob. Chi-Square(15)</td>
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Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/29/15   Time: 16:08
Sample (adjusted): 1/25/2006 12/31/2013
Included observations: 2070 after adjustments

<table>
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<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
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<tbody>
<tr>
<td>C</td>
<td>1.58E-05</td>
<td>3.99E-06</td>
<td>3.975326</td>
<td>0.0001</td>
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<td>RESID^2(-1)</td>
<td>0.322796</td>
<td>0.022062</td>
<td>14.63103</td>
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<tr>
<td>RESID^2(-2)</td>
<td>0.041477</td>
<td>0.023172</td>
<td>1.789952</td>
<td>0.0736</td>
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<tr>
<td>RESID^2(-3)</td>
<td>-0.007823</td>
<td>0.023150</td>
<td>-0.337927</td>
<td>0.7355</td>
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<tr>
<td>RESID^2(-4)</td>
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<td>0.023146</td>
<td>0.529519</td>
<td>0.5965</td>
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<tr>
<td>RESID^2(-5)</td>
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<td>0.023122</td>
<td>-0.364443</td>
<td>0.7156</td>
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<tr>
<td>RESID^2(-6)</td>
<td>-0.015547</td>
<td>0.023102</td>
<td>-0.672962</td>
<td>0.5010</td>
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<tr>
<td>RESID^2(-7)</td>
<td>0.143176</td>
<td>0.023001</td>
<td>6.224870</td>
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<td>RESID^2(-8)</td>
<td>-0.021627</td>
<td>0.023194</td>
<td>-0.932412</td>
<td>0.3512</td>
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<tr>
<td>RESID^2(-9)</td>
<td>-0.028734</td>
<td>0.022949</td>
<td>-1.252118</td>
<td>0.2107</td>
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<tr>
<td>RESID^2(-10)</td>
<td>0.014464</td>
<td>0.022635</td>
<td>0.639004</td>
<td>0.5229</td>
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<tr>
<td>RESID^2(-11)</td>
<td>0.014578</td>
<td>0.022598</td>
<td>0.645091</td>
<td>0.5189</td>
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<tr>
<td>RESID^2(-12)</td>
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<td>0.022581</td>
<td>0.064556</td>
<td>0.9485</td>
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<tr>
<td>RESID^2(-13)</td>
<td>0.057365</td>
<td>0.022580</td>
<td>2.540551</td>
<td>0.0111</td>
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<tr>
<td>RESID^2(-14)</td>
<td>0.032022</td>
<td>0.022605</td>
<td>1.416579</td>
<td>0.1568</td>
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<tr>
<td>RESID^2(-15)</td>
<td>0.000829</td>
<td>0.021512</td>
<td>0.038551</td>
<td>0.9693</td>
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</table>

R-squared 0.147121  Mean dependent var 3.64E-05
Adjusted R-squared 0.140892  S.D. dependent var 0.000174
S.E. of regression 0.000162  Akaike info criterion -14.61627
Sum squared resid 5.36E-05  Schwarz criterion -14.57271
Log likelihood 15143.84  Hannan-Quinn criter. -14.60031
F-statistic 23.62084  Durbin-Watson stat 1.999298
Prob(F-statistic) 0.000000
Appendix 9 GARCH (1,1) model output estimation without dummy variables

Dependent Variable: R
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 01/29/15 Time: 15:38
Sample (adjusted): 1/04/2006 12/31/2013
Included observations: 2085 after adjustments
Convergence achieved after 111 iterations
MA Backcast: 1/03/2006
Presample variance: backcast (parameter = 0.7)
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.000108</td>
<td>3.74E-05</td>
<td>2.893462</td>
<td>0.0038</td>
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<td>AR(1)</td>
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<td>0.043126</td>
<td>17.81693</td>
<td>0.0000</td>
</tr>
<tr>
<td>MA(1)</td>
<td>-0.885547</td>
<td>0.035088</td>
<td>-25.23768</td>
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</table>

Variance Equation

<table>
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<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESID(-1)^2</td>
<td>0.053043</td>
<td>0.001548</td>
<td>34.26480</td>
<td>0.0000</td>
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<tr>
<td>GARCH(-1)</td>
<td>0.946393</td>
<td>0.000974</td>
<td>971.5268</td>
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</tr>
</tbody>
</table>

R-squared: 0.064716
Adjusted R-squared: 0.062467
S.E. of regression: 0.006354
Sum squared resid: 0.083931
Log likelihood: 8220.705
F-statistic: 28.77091
Prob(F-statistic): 0.000000

Inverted AR Roots: 0.77
Inverted MA Roots: 0.89
Apendix 10 GARCH (1,1) model output estimation with two dummy variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>6.75E-05</td>
<td>2.47E-05</td>
<td>2.739933</td>
<td>0.0061</td>
</tr>
<tr>
<td>D1</td>
<td>0.000450</td>
<td>0.000122</td>
<td>3.696108</td>
<td>0.0002</td>
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<tr>
<td>D2</td>
<td>0.007439</td>
<td>0.000315</td>
<td>23.58950</td>
<td>0.0000</td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.790552</td>
<td>0.027771</td>
<td>28.46660</td>
<td>0.0000</td>
</tr>
<tr>
<td>MA(1)</td>
<td>-0.921917</td>
<td>0.018822</td>
<td>-48.98048</td>
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</tbody>
</table>

Variance Equation

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.29E-07</td>
<td>5.98E-09</td>
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<tr>
<td>RESID(-1)^2</td>
<td>0.051602</td>
<td>0.001549</td>
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<tr>
<td>GARCH(-1)</td>
<td>0.948195</td>
<td>0.001001</td>
<td>947.7021</td>
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</tr>
</tbody>
</table>

R-squared: 0.086880  Mean dependent var: 0.000217
Adjusted R-squared: 0.083803  S.D. dependent var: 0.006562
S.E. of regression: 0.006281  Akaike info criterion: -7.907986
Sum squared resid: 0.081942  Schwarz criterion: -7.886336
Log likelihood: 8252.075  Hannan-Quinn criter.: -7.900053
F-statistic: 28.23135  Durbin-Watson stat: 2.281894
Prob(F-statistic): 0.000000

Inverted AR Roots: .79
Inverted MA Roots: .92
### Appendix 11 GARCH (1,1) model output estimation with external regressor

**Dependent Variable:** R  
**Method:** ML - ARCH (Marquardt) - Normal distribution  
**Date:** 01/29/15  **Time:** 15:42  
**Sample (adjusted):** 1/04/2006 12/31/2013  
**Included observations:** 2085 after adjustments  
**Convergence achieved after 103 iterations**  
**MA Backcast:** 1/03/2006  
**Presample variance:** backcast (parameter = 0.7)  
**GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1) + C(9)*D3**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
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<td>3.15E-05</td>
<td>2.244366</td>
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</tr>
<tr>
<td>D1</td>
<td>0.000446</td>
<td>0.000133</td>
<td>3.361421</td>
<td>0.0008</td>
</tr>
<tr>
<td>D2</td>
<td>0.007518</td>
<td>0.000354</td>
<td>21.21127</td>
<td>0.0000</td>
</tr>
<tr>
<td>AR(1)</td>
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<td>0.030013</td>
<td>26.05942</td>
<td>0.0000</td>
</tr>
<tr>
<td>MA(1)</td>
<td>-0.914085</td>
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<td>-42.13686</td>
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</table>

**Variance Equation**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1.23E-08</td>
<td>17.31287</td>
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<tr>
<td>RESID(-1)^2</td>
<td>0.053378</td>
<td>0.001767</td>
<td>30.21206</td>
<td>0.0000</td>
</tr>
<tr>
<td>GARCH(-1)</td>
<td>0.944577</td>
<td>0.001170</td>
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<td>0.0000</td>
</tr>
<tr>
<td>D3</td>
<td>-9.54E-08</td>
<td>1.07E-08</td>
<td>-8.928238</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**R-squared** | 0.087329     | Mean dependent var | 0.000217  
**Adjusted R-squared** | 0.083812     | S. D. dependent var | 0.006562  
**S.E. of regression** | 0.006281     | Akaike info criterion | -7.910307  
**Sum squared resid** | 0.053378     | Schwarz criteria | -7.885950  
**Log likelihood** | 8255.495     | Hannan-Quinn criter. | -7.901382  
**F-statistic** | 24.83035     | Durbin-Watson stat | 2.281280  
**Prob(F-statistic)** | 0.000000     |                   |        

**Inverted AR Roots** | .78         
**Inverted MA Roots** | .91         

---

1. Ilustrasi Dilihat dari Undang-Undang  
2. Dilihat menggunakan dan memperoleh atau seluruh karya tulis dalam bentuk oppu dengan terkait IPB.
Apendix 12 ARCH LM test after GARCH estimation
Heteroskedasticity Test: ARCH

<table>
<thead>
<tr>
<th>F-statistic</th>
<th>2.032702</th>
<th>Prob. F(3,2078)</th>
<th>0.1073</th>
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</thead>
<tbody>
<tr>
<td>Obs*R-squared</td>
<td>6.091967</td>
<td>Prob. Chi-Square(3)</td>
<td>0.1072</td>
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</tbody>
</table>

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 01/29/15  Time: 16:06
Sample (adjusted): 1/09/2006 12/31/2013
Included observations: 2082 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
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<tbody>
<tr>
<td>C</td>
<td>0.953589</td>
<td>0.109993</td>
<td>8.669513</td>
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<tr>
<td>WGT_RESID^2(-1)</td>
<td>0.053007</td>
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<tr>
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<td>0.003123</td>
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<td>0.021936</td>
<td>-0.451084</td>
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</tbody>
</table>

R-squared | Mean dependent var | 0.002926 | 0.999812 |
Adjusted R-squared | S.D. dependent var | 0.001487 | 4.736311 |
S.E. of regression | Akaike info criterion | 4.732789 | 5.948826 |
Sum squared resid | Schwarz criterion | 46545.74 | 5.959664 |
Log likelihood | Hannan-Quinn criter. | -6188.728 | 5.952797 |
F-statistic | Durbin-Watson stat | 2.032702 | 2.000166 |
Prob(F-statistic) |                 | 0.107283 |        |
Appendix 13 Residual plots

Appendix 14 Standardized residual plots
### Correlogram of standardized residual

- **Date:** 01/29/15  
- **Time:** 16:03  
- **Sample:** 1/04/2006 12/31/2013  
- **Included observations:** 2085

- **Q-statistic probabilities adjusted for 2 ARMA term(s)**

<table>
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<th>Autocorrelation</th>
<th>Partial Correlation</th>
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<th>PAC</th>
<th>Q-Stat</th>
<th>Prob</th>
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<tr>
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<tr>
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<td>28.956</td>
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<td>-0.016</td>
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</table>
Appendix 16 Normality test of residual

Appendix 17 ARCH LM test after GARCH estimation

Heteroskedasticity Test: ARCH

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 02/02/15   Time: 20:09
Sample (adjusted): 1/18/2006 12/31/2013
Included observations: 2075 after adjustments

<table>
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<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
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R-squared            0.004558  Mean dependent var 0.995681
Adjusted R-squared   -0.000265  S.D. dependent var 4.741555
S.E. of regression   4.742183  Akaike info criterion 5.956159
Sum squared resid    46415.86  Schwarz criterion 5.986046
Log likelihood       -6168.515  Hannan-Quinn criter. 5.967113
F-statistic          0.945003  Durbin-Watson stat 2.000069
Prob(F-statistic)    0.490296
BIOGRAPHY

The author was born in Bogor, September 14, 1983. She is the first of two children from Mr. Djaelani and Mrs. Ami Nurrachmi. She is married with Galih Sudrajat and has one child named Sultan Al Farizy. The author grew up and study from elementary school until senior high school in Bogor, West Java. She finished her senior high school in SMAN 1 Bogor, West Java. She continued her study in Bogor Agricultural University with major Social Economics and Animal Husbandry Industry and graduated as the Bachelor of Animal Science in 2006.

After finished her Bachelor study, since 2006 author worked in Diploma Program Bogor Agricultural University as a lecturer. Then she continued her master in year 2012 on International Joint Degree Program between the Magister Science of Agribusiness, Graduate School of Bogor Agricultural University Indonesia and the International Agribusiness and Rural Development, Sustainable International Agriculture, Georg-August Goettingen University Germany with sponsorship from the Directorate General of Higher Education, The Ministry of National Education Republic of Indonesia.