

CHAPTER IV

DATA COLLECTING AND PROCESSING

4.1 Data Collecting

4.1.1 Logam Mulia Business Unit

Logam mulia business unit by PT Aneka Tambang (Persero) Tbk located in Jl. Pemuda - Jl. Raya Bekasi KM.18. Pulogadung, Jakarta is one of refining gold and silver in Indonesia. It has the recognition of London Bullion Market Associates (LBMA) and included in Good Delivery List of acceptable refiners of gold bars since January 1, 1999.

The company was founded by RT Braakensiek, a gold merchant around 1930 who started his business by refining gold scrap in certain locations of work. In 1937 he settled his business on Jalan Gajah Mada 84, Jakarta and began to refine gold from Bengkulu and Cikotok gold mine besides gold scrap.

In the year 1949 this private enterprise turned into a legal entity called NV Essaieur en Affinage Bedrijf v/h RT Braakensiek. In 1957 the company was taken over by Bank Industri Negara and changed its name into PT Logam Mulia (Logam Mulia Ltd). Then on January 1, 1961 under PP No.281/1961, became a state owned company named PN Logam Mulia. On December 31, 1974 in accordance with PP No.320/1974 it became one of production units PT Aneka Tambang named Unit Pengolahan dan Pemurnian Logam Mulia (Precious Metal

Refinery) and since April, 1979 the plant was then relocated to Pulogadung in East Jakarta.

Logam Mulia main business recently depends on dore bullion's supplies from several national mining companies and pongkor gold mine business unit. The maximum production capacity of Logam Mulia itself actually around 60 tons of gold and 250 tons of silver per year. But from that maximum capacity, now we only use about 60% of it and still try to increase due to the upcoming opening of new gold mines or traditional mines.

The main product of Logam Mulia is cast bars, minted bars, dinar and dirham coins and industrial products i.e needle test, silver granules, silver nitrate etc.

4.1.2 Logam Mulia Gold Flagship Product

99.99% pure gold standard is the raw material for 14 to 24 carats gold jewelry in which the levels are equivalent to the gold content. Mixing metal for the Gold Jewelry is silver and copper. Gold with a slightly reddish appearance is the dominant of copper while the yellowish appearance is dominant of silver. There is a certificate of assurance while investing in precious metal gold and can be traded anywhere.

For the consistency of long-term growth, the experts repeatedly urged the investors to diversify their investment into gold. Gold has produced many other types of investments for long-term investment category, and this is a classical protection to against inflation, holding value in the instability fluctuations of money.

Purchasing Precious Metals Gold, meaning we have invested a sum of money which the value will continue to be strengthened from time to time. When investing in the stock market plagued by uncertainty due to the inflated stock value or plummeted, gold remains strong as a solid investment tools because the value of gold does not depend on the success or failure of a firm or industry. Gold is an asset that determines its own merits. It is real, portable, can be availed anytime and anywhere.

For those varieties of advantages, Logam Mulia presents the precious gold with the weight and guaranteed content, as well as 99,99% gold purity. Gold is flexible and accepted throughout the world without need to be examined more, because it has been bundled by the LBMA Certificate (London Bullion Market Association). Gold Bullion by LM is available in gold casting, and minting. The physical appearance of casting bar will be defined below:

Table 4.1 Dimensions of Casting Bar

weight (gram)	thickness (mm)	dimension
12500 (400 troy oz)	42	238 x 78
1000	8.85	118 x 53.7
250	3.11	83.3 x 50

While the minted bars is:

Table 4.2 Dimensions of Minted Bars

weight (gram)	length (mm)	dimension
100	3.73	50 x 30
50	2.53	42.5 x 25.5
25	2.07	33.3 x 20
10	1.22	27.5 x 16.5
5	1.09	20.5 x 12.3

4	0.83	20.5 x 12.3
3	1.03	16.7 x 10
2.5	0.83	16.7 x 10
2	0.75	15.6 x 9.4
1	0.51	13 x 7.8

4.1.3 Gold Calculation for Rupiah

The troy ounce (ozt) is a unit of imperial measure. Currently this is the most common unit used to gauge the weight of precious metals. The troy ounce is part of the troy weights system derived from the Roman monetary system. The Romans used bronze bars of varying weights as currency. An *aes grave* weighed equal to 1 pound. One twelfth of an *aes grave* was called an *uncia*, or "ounce". One troy ounce defined as exactly $0.0311034768 \text{ kg} = 31.1934768 \text{ gr}$.

Since Indonesia use Rupiah for the national currency, it needs to convert the price from dollar into rupiah, which is:

$$\text{Rp / gram} = \frac{\text{loco price}}{31.103} \times \text{rate US dollar}$$

For example:

$$\text{Loco price} = 1400 \text{ USD per troy ounce}$$

$$\text{USD rate} = \text{Rp.8700,-}$$

Therefore price in rupiahs per grams will be:

$$\text{Rp / gram} = \frac{1400}{31.103} \times 8700$$

$$= \text{Rp.391.639,87 / gram}$$

4.1.4 Data Collecting

This research use secondary data obtained from Logam Mulia. Gold price in a specified period is used as data representing a time series situation. Defined:

State 1 = increasing price

State 2 = decreasing price

United States recession, the shift in crude price, new academic term in July, government policy are some example of causative factors. In this case the Indonesian crude price and new academic term are used as the factors. Actual gold price data per gram (in Rupiahs) and Indonesian Crude price year 2008, 2009 and 2010 are shown in Table 4.3.

Table 4.3 Gold and Indonesian Crude Price in year 2008-2010

Month	Actual Gold Price (Rp/gr)	ICP (US\$/barrel)
Jan-08	250000	92.09
Feb-08	298000	94.64
Mar-08	308500	103.11
Apr-08	315000	109.30
May-08	320000	124.67
Jun-08	292000	132.36
Jul-08	285500	134.96
Aug-08	295500	135.56
Sep-08	308500	99.06
Oct-08	283500	70.66
Nov-08	335000	72.32
Dec-08	350500	52.45
Jan-09	330500	61.89
Feb-09	367000	65.10
Mar-09	346500	43.95
Apr-09	330000	40.62
May-09	310000	57.86
Jun-09	319000	68.91
Jul-09	311500	64.85
Aug-09	309000	72.47

Sep-09	319500	67.07
Oct-09	334500	72.53
Nov-09	375500	77.08
Dec-09	350000	75.58
Jan-10	338500	77.29
Feb-10	380500	74.01
Mar-10	320500	78.67
Apr-10	368000	85.48
May-10	400500	86.96
Jun-10	407500	70.22
Jul-10	387500	73.74
Aug-10	362000	75.94
Sep-10	410500	76.76
Oct-10	391500	72.26
Nov-10	439500	80.07
Dec-10	422000	91.37

Thus the graph of actual gold price will be:

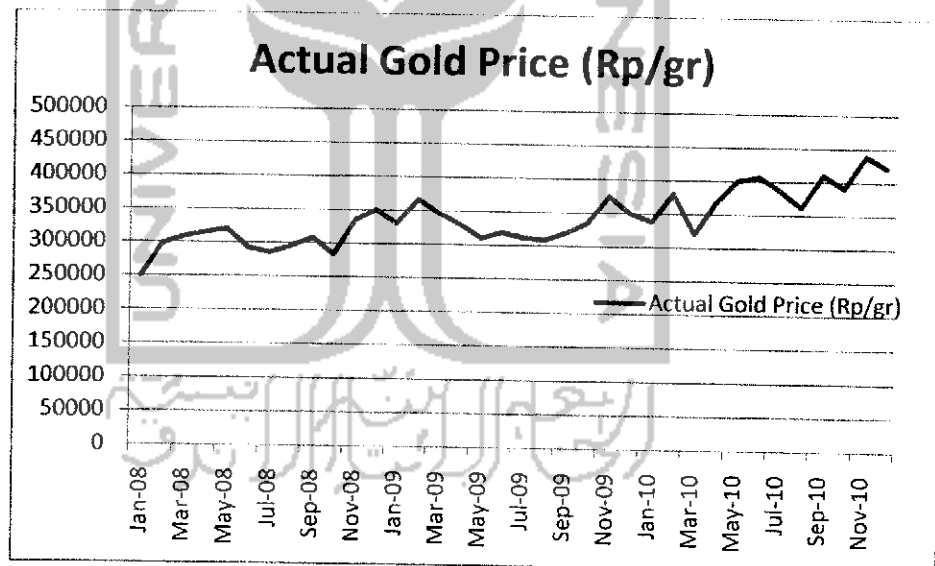


Figure 4.1 Actual Gold graph

and the graph of crude price will be:

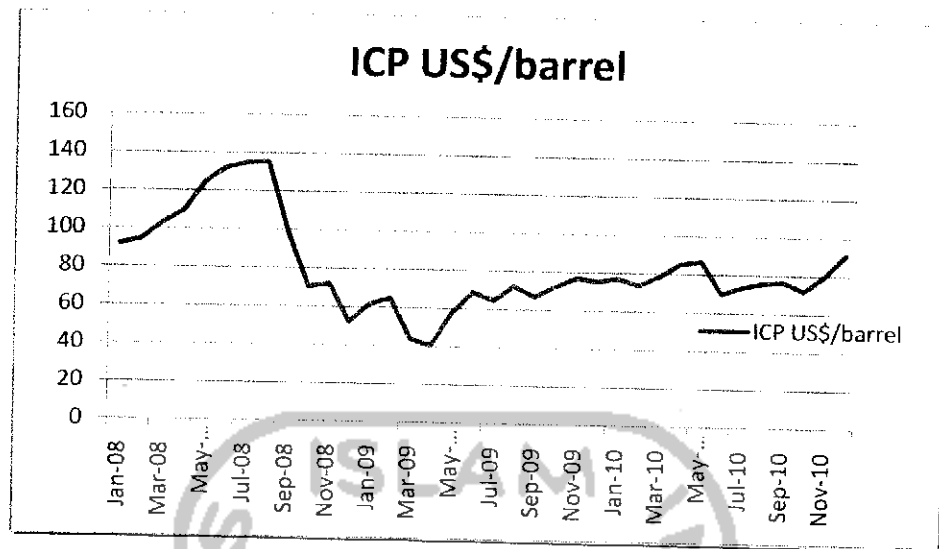


Figure 4.2 Indonesian Crude Price Graph

4.2 Data Processing

4.2.1 Model Selection

Since the relationship between X_k and Y_k are determined by equation 3.1, based on the assumption that the cause of the incident gold price are not observed, resulting that X_k hidden under observation data Y_k . So, a pair of $\{ X_k , Y_k \}$ is Hidden Markov Model. Based on previous chapter, there are three models on Hidden Markov. Second model with discrete time and continuous observation is characterized by several parameters including the transition probability matrix, expectation and variance. The causative factor of gold price is assumed as a state (discrete) that not observed directly and has the properties of Markov chains. Gold price in a specified period is used as data representing a continuous observation. Therefore second model which is Hidden markov model with discrete time and continuous observation is being used. There are 36 observation sequences at January 2008 – December 2010. Y_k are estimated with \hat{Y}_k . This estimated value is expected to accost the actual value.

4.2.2 Algorithm Selection

Estimation is being done using algorithms described in Equation 3.11 to 3.25 in chapter III. Set $N = 2$, $T = 36$ and data input $\{Y_k\}$ as same as data table.

Parameters tested based on the simulation model includes:

1. A Parameter (transition probability matrix) sized 2×2
2. C Parameter shaped vector 2×1
3. σ Parameter shaped vector 2×1

Set the value of A , C and σ :

$$A_{ij} = \begin{pmatrix} 10/20 & 10/20 \\ 9/15 & 6/15 \end{pmatrix} \quad C_1 = \begin{pmatrix} 1400 \\ 1200 \end{pmatrix} \quad \sigma_1 = \begin{pmatrix} 150 \\ 200 \end{pmatrix}$$

$$C_2 = \begin{pmatrix} 2200 \\ 1500 \end{pmatrix} \quad \sigma_2 = \begin{pmatrix} 300 \\ 250 \end{pmatrix}$$

4.2.3 Data Processing

Thus the state of every month described in table 4.4 as follow:

Table 4.4 State in every month

Month	Price (Rp/gr)	State
January 2008	250000	1
February 2008	298000	1
March 2008	308500	1
April 2008	315000	1
May 2008	320000	1
June 2008	292000	2
July 2008	285500	2
August 2008	295500	1
September 2008	308500	1
October 2008	283500	2
November 2008	335000	1
December 2008	350500	1

January 2009	320500	2
February 2009	367000	1
March 2009	346500	2
April 2009	330000	2
May 2009	310000	2
June 2009	315000	1
July 2009	319500	2
August 2009	309000	2
September 2009	319500	1
October 2009	354500	1
November 2009	385500	1
December 2009	350000	2
January 2010	338500	2
February 2010	380500	1
March 2010	320500	2
April 2010	368000	1
May 2010	400500	1
June 2010	397500	2
July 2010	347500	2
August 2010	362000	1
September 2010	410500	1
October 2010	391500	2
November 2010	439500	1
December 2010	422000	2

And the state transition described in table 4.5 as follow:

Month	Price (Rp/gr)	State	Transition
January 2008	250000	1	
February 2008	298000	1	1-1
March 2008	308500	1	1-1
April 2008	315000	1	1-1
May 2008	320000	1	1-1
June 2008	292000	2	1-2
July 2008	285500	2	2-2
August 2008	295500	1	2-1
September 2008	308500	1	1-1
October 2008	283500	2	1-2
November 2008	335000	1	2-1
December 2008	350500	1	1-1

January 2009	320500	2	1-2
February 2009	367000	1	2-1
March 2009	346500	2	1-2
April 2009	330000	2	2-2
May 2009	310000	2	2-2
June 2009	315000	1	2-1
July 2009	311500	2	1-2
August 2009	309000	2	2-2
September 2009	319500	1	2-1
October 2009	354500	1	1-1
November 2009	385500	1	1-1
December 2009	350000	2	1-2
January 2010	338500	2	2-2
February 2010	380500	1	2-1
March 2010	320500	2	1-2
April 2010	368000	1	2-1
May 2010	400500	1	1-1
June 2010	397500	2	1-2
July 2010	347500	2	2-2
August 2010	362000	1	2-1
September 2010	410500	1	1-1
October 2010	391500	2	1-2
November 2010	439500	1	2-1
December 2010	422000	2	1-2

In the same algorithm on chapter III, the trials for predetermined parameter was conducted using Matlab® and the results are presented in table 4.6 :

a. Simulation of $A - C_t - \sigma_t$

Table 4. 6 Simulation Result of $A - C_t - \sigma_t$

Month	Actual Price (Rp/gr)	Simulation Price (Rp/gr)	Galat (%)
January 2008	250000	235500	5.8
February 2008	298000	280000	6.4
March 2008	308500	297000	3.6
April 2008	315000	299500	4.9
May 2008	320000	329000	-2.8

June 2008	292000	290500	0.5
July 2008	285500	287000	-0.6
August 2008	295500	280500	5.1
September 2008	308500	300500	2.5
October 2008	283500	269000	5.2
November 2008	335000	310000	7.4
December 2008	350500	345500	1.6
January 2009	320500	335000	-4.4
February 2009	367000	360500	1.6
March 2009	346500	320000	7.6
April 2009	330000	345000	-4.1
May 2009	310000	319000	-3.5
June 2009	315000	323500	-2.7
July 2009	311500	321500	-3.6
August 2009	309000	310000	-0.5
September 2009	319500	325500	-2.0
October 2009	354500	375000	-6.0
November 2009	385500	380000	1.3
December 2009	350000	361500	-2.5
January 2010	338500	322000	4.9
February 2010	380500	361000	5.2
March 2010	320500	346000	-7.9
April 2010	368000	369500	-0.5
May 2010	400500	387000	3.5
June 2010	397500	370500	6.7
July 2010	347500	358000	-2.6
August 2010	362000	368000	-1.8
September 2010	410500	399500	2.7
October 2010	391500	401000	-2.4
November 2010	439500	420500	4.4
December 2010	422000	415000	1.8

Total percentage error of this simulation is 2.25%. Thus the comparison graph between actual and $A - C_I - \sigma_I$ simulation will be described in figure 4.3 :

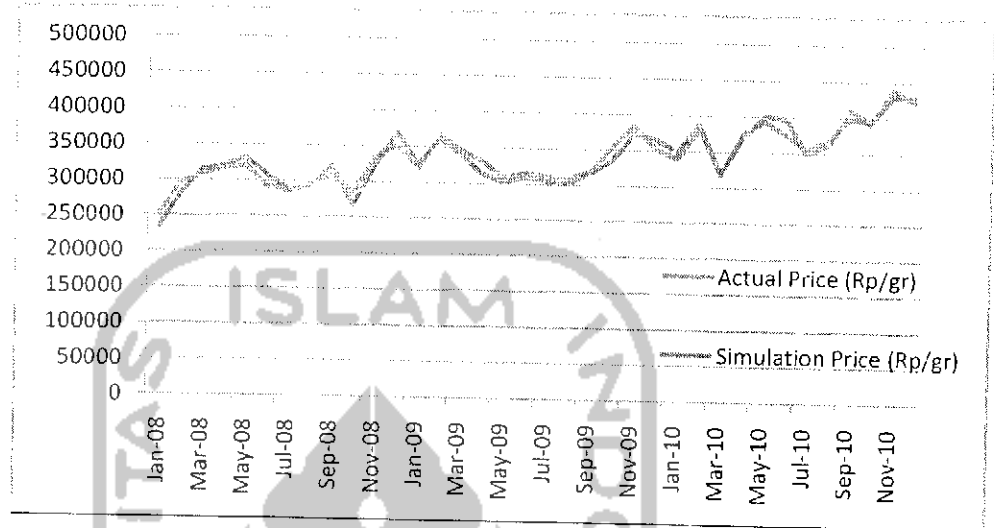


Figure 4.3 Actual vs Simulation of $A - C_1 - \sigma_1$

b. Simulation of $A - C_1 - \sigma_2$

Table 4. 7 Simulation Result of $A - C_1 - \sigma_2$

Month	Actual Price (Rp/gr)	Simulation Price (Rp/gr)	Galat (%)
January 2008	250000	245000	2.0
February 2008	298000	287500	3.4
March 2008	308500	285000	7.5
April 2008	315000	321000	-1.9
May 2008	320000	330000	-3.1
June 2008	292000	288500	1.2
July 2008	285500	280500	1.8
August 2008	295500	292500	1.0
September 2008	308500	311500	-1.0
October 2008	283500	274000	3.1
November 2008	335000	315500	5.8
December 2008	350500	340000	3.1
January 2009	320500	340000	-6.2
February 2009	367000	361500	1.3
March 2009	346500	321000	7.3
April 2009	330000	319000	3.6
May 2009	310000	320000	-4.0
June 2009	315000	321500	-2.1
July 2009	311500	316000	-1.9
August 2009	309000	305000	1.3

September 2009	319500	338000	-5.9
October 2009	354500	365000	-3.2
November 2009	385500	370000	3.7
December 2009	350000	360500	-2.3
January 2010	338500	332000	1.9
February 2010	380500	374500	1.6
March 2010	320500	318000	0.9
April 2010	368000	373500	-1.6
May 2010	400500	405500	-1.1
June 2010	397500	370500	6.7
July 2010	347500	375000	-7.6
August 2010	362000	361000	0.5
September 2010	410500	399500	2.7
October 2010	391500	381000	2.8
November 2010	439500	422500	3.9
December 2010	422000	430000	-2.0

Total percentage error of this simulation is 2.22%. Thus the comparison graph between actual and simulation of $A - C_2 - \sigma_2$ described in figure 4.4:

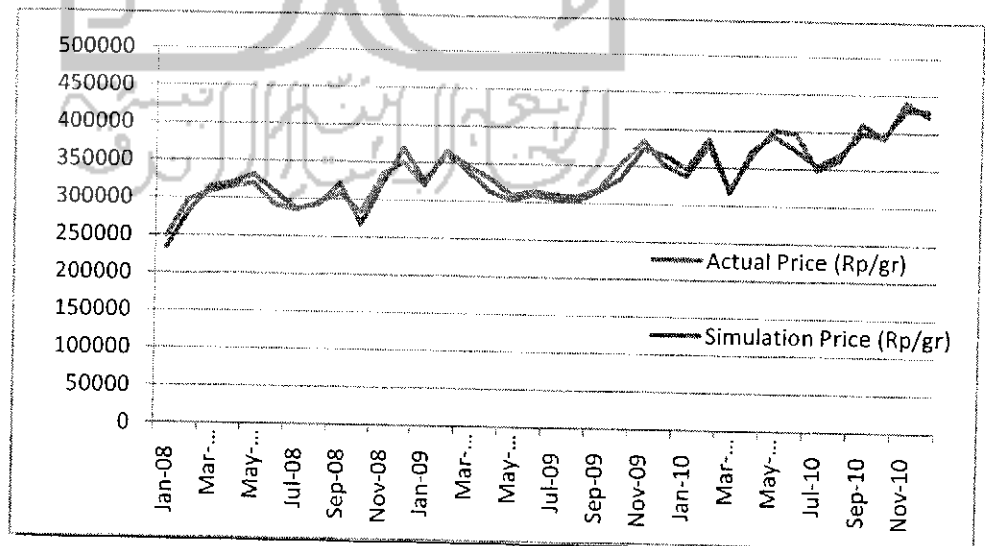


Figure 4.4 Actual vs Simulation of $A - C_1 - \sigma_2$

c. Simulation of $A - C_2 - \sigma_1$ Table 4. 8 Simulation Result of $A - C_2 - \sigma_1$

Month	Actual Price (Rp/gr)	Simulation Price (Rp/gr)	Galat (%)
Jan-08	250000	269500	-7.8
Feb-08	298000	290000	3.2
Mar-08	308500	292500	5.2
Apr-08	315000	312000	0.9
May-08	320000	334000	-4.4
Jun-08	292000	288500	1.2
Jul-08	285500	292000	-2.4
Aug-08	295500	283500	4.0
Sep-08	308500	320500	-3.9
Oct-08	283500	265000	6.6
Nov-08	335000	319500	4.6
Dec-08	350500	364500	-3.8
Jan-09	320500	334000	-4.3
Feb-09	367000	372500	-1.7
Mar-09	346500	330500	4.6
Apr-09	330000	341000	-3.0
May-09	310000	314000	-1.8
Jun-09	315000	323500	-2.7
Jul-09	311500	318500	-2.6
Aug-09	309000	311000	-0.6
Sep-09	319500	321500	-0.7
Oct-09	354500	369000	-4.3
Nov-09	385500	375000	2.4
Dec-09	350000	350500	0.5
Jan-10	338500	331000	2.3
Feb-10	380500	388500	-2.1
Mar-10	320500	318500	0.6
Apr-10	368000	348500	5.2
May-10	400500	407500	-1.6
Jun-10	397500	384500	3.2
Jul-10	347500	352000	-1.0
Aug-10	362000	373000	-3.0
Sep-10	410500	399500	2.7
Oct-10	391500	389500	0.6

Nov-10	439500	417500	5.1
Dec-10	422000	413500	2.1

Total percentage error of this simulation is 2.96%. Thus the comparison graph between actual and simulation of $A - C_1 - \sigma_2$ described in figure 4.5:

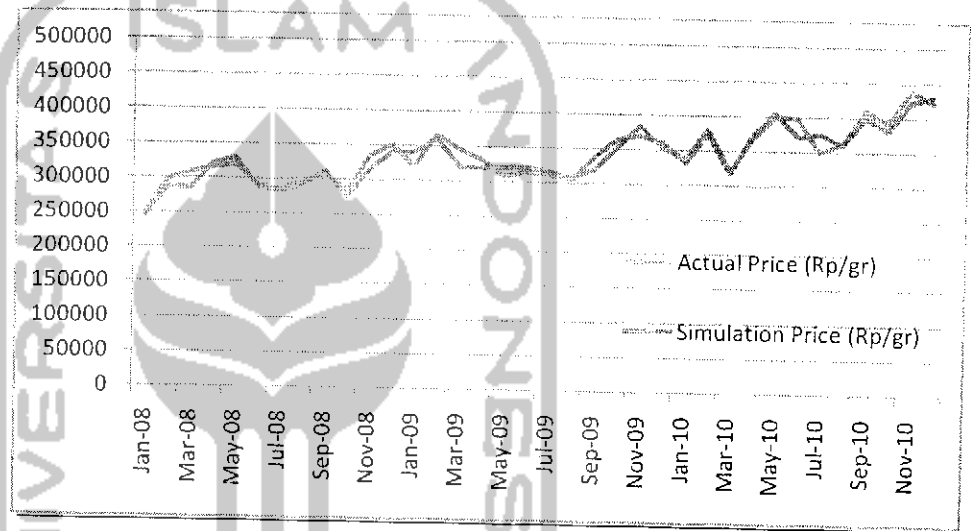


Figure 4.5 Actual vs Simulation of $A - C_2 - \sigma_1$

d. Simulation of $A - C_2 - \sigma_2$

Table 4.9 Simulation Result of $A - C_2 - \sigma_2$

Month	Actual Price (Rp/gr)	Simulation Price (Rp/gr)	Galat (%)
Jan-08	250000	234500	6.7
Feb-08	298000	281500	5.5
Mar-08	308500	315000	-2.0
Apr-08	315000	320500	-1.7
May-08	320000	331500	-3.5
Jun-08	292000	308500	-5.6
Jul-08	285500	287000	-0.6
Aug-08	295500	292500	1.1
Sep-08	308500	321500	-4.2
Oct-08	283500	266500	6.0
Nov-08	335000	323000	3.6

Dec-08	350500	369500	-5.3
Jan-09	320500	325000	-1.5
Feb-09	367000	362500	1.0
Mar-09	346500	339000	2.1
Apr-09	330000	313500	5.3
May-09	310000	302500	2.0
Jun-09	315000	309500	1.8
Jul-09	311500	305000	1.8
Aug-09	309000	302000	2.1
Sep-09	319500	316500	0.9
Oct-09	354500	334000	5.6
Nov-09	385500	373500	2.9
Dec-09	350000	365500	-3.6
Jan-10	338500	348000	-2.8
Feb-10	380500	388000	-2.0
Mar-10	320500	317500	0.9
Apr-10	368000	374500	-1.8
May-10	400500	393000	2.0
Jun-10	397500	374500	5.7
Jul-10	347500	354000	-1.5
Aug-10	362000	369000	-1.9
Sep-10	410500	397500	3.2
Oct-10	391500	394000	-0.7
Nov-10	439500	429500	2.3
Dec-10	422000	429000	-1.6

Total percentage error of this simulation is 2.8%. Thus the comparison graph between actual and simulation of $A - C_2 - \sigma_2$ described in figure 4.6:

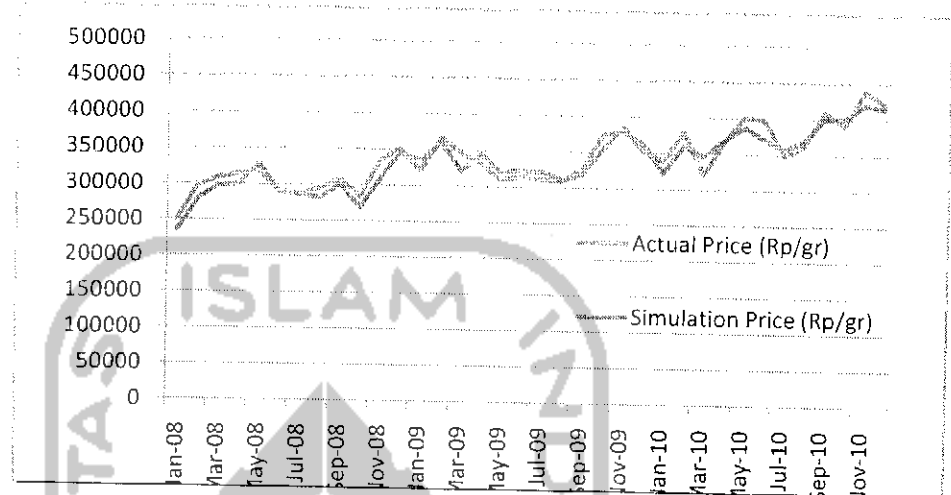


Figure 4.6 Actual vs Simulation of $A - C_2 - \sigma_2$

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