CHAPTER V
DATA ANALYSIS AND INTERPRETATION

5.1. Description of data

This research applies secondary data that is collected from literatures, governmental and international agencies as well as from private organizations. Those are International Financial Statistics, Central Bureau Statistics of Indonesia (CBSI), some related reports and other publications. Meanwhile, the research uses annually time series data for the period between 1980 and 2003. In discussing econometric techniques, a sophisticated and user-friendly statistical package, Eviews, is used to minimize errors in processing data.

To avoid from misinterpretation, again, it is necessary to make variables obvious. These annual data pertain to Indonesia for the period 1980 to 2003:[7]

- ***C***, consumption for NR or industrial businesses absorption of NR
- ***PNR***, price of NR
- ***GDP***, total real GDP
- ***PSR***, (world) price of synthetic rubber (SR)
- ***D***, dummy variable, "1" if $C_t > 100$, or closed to 100, and "0" if otherwise

5.2. Externalities Identification

By referring to the raw data in appendix A.2, the actual data of C (the absorption of NR) has no pattern in trend since it fluctuates from year to year. The values grow up and down. There can be externalities affecting the fluctuation of

[7] See variable definition in section 3.2.

the demand. For this reason, dummy variable are included into the model as dependent variable (D_t).

Rubber market is influenced by many externalities. The supply of natural rubber is conducted by the nature meaning that the harvest time allows the quantity supplied to peak. The other factors are like government policy which encourages the export will influence the local market of natural rubber, devaluation (which Indonesia have experience in 1983 and 1986), buffer stock strategy imposed by seller countries, etc. When the buffer stock is released into the market, the supply is overwhelmed with the commodity and Indonesia will hard to sell abroad. Finally, the domestic consumption is increase.

5.3. Choosing the Proper Model

The results of OLS multiple regression model shows that *DW*-stat is clearly greater than R^2 (1.8016 > 0.6397) meaning that the data is not spurious. Therefore, it does not need to use the error correct model (ECM).[8]

5.3.1. Unit Root Test

In the case of $\boldsymbol{PNR_t}$ (price of NR), the result is that the three different forms of DF test (excluded the *random walk*) obtain estimated $|\tau|$ exceeding the MacKinnon critical tau value at any level of significant (1, 5 and 10%). It means the null hypothesis that $\delta = 0$ is rejected, in which case the time series of $\boldsymbol{PNR_t}$ is ***stationary*** in original level. For instance,

[8] See appendix A-4

$$\Delta PNR_t = -0.0378\, PNR_{t-1}$$
$$t = \quad (-0.7646) \qquad R^2 = 0.024 \qquad d = 2.40$$
MacKinnon critical t values are – 2.67; – 1.957; – 1.623 for 1, 5, and 10% respectively.

$$\Delta PNR_t = -0.7616\, PNR_{t-1} + 17.16$$
$$t = \quad (-3.6325) \quad (3.5174) \qquad R^2 = 0.3858 \qquad d = 1.762$$
MacKinnon critical t values are – 3.75; – 2.997; – 2.638 for 1, 5, and 10% respectively.

$$\Delta PNR_t = -0.8519\, PNR_{t-1} + 0.1956\, t + 16.87$$
$$t = \quad (-3.9384) \quad (1.3491)\ (3.5224) \qquad R^2 = 0.4371 \qquad d = 1.771$$
MacKinnon critical t values are – 4.417; – 3.622; – 3.25 for 1, 5, and 10% respectively.

(5.1)

In similar way, it is estimated that time series of C_t , GDP_t and PSR_t, respectively, are nonstationary where their estimated $|\tau|$ are statistically insignificant at all 1, 5, and 10% levels of significant.

However, C_t, GDP_t ***and*** PSR_t are ***Stationary*** in the ***1st Difference***.[9]

5.3.2. Cointegrating Regression Durbin-Watson (CRDW) Test

$$GDP_t = -0.5091 + 0.0029\, PSR_t$$
$$R^2 = 0.1388 \qquad d = 0.1785 \qquad \textbf{(5.2)}$$

The 1, 5, and 10 percent critical values to test the hypothesis that the true d = 0 are 0.511, 0.386, and 0.322, respectively. Thus, the computed d value is smaller than critical value. Therefore, the null hypothesis of cointegration is rejected at any 1, 5, and 10 percent level of significant.[10]

To sum up, based on CRDW tests, it is found that between GDP_t and PSR_t are not cointegrated. Since the two variables may not have meaningful relationship in economic, the result of CRDW test might be true. These situations exemplify non spurious regression and hence it supports the preceding finding in

[9] See Appendix A-11 to A-13
[10] See Appendix A-14

the OLS multiple regression model that the data is not spurious, which is indicated by $d = 1.8016$ exceeding $R^2 = 0.6398$. (See appendix A-4)

Unit root test finds that the data available is not spurious but faces weak stationary. To recognize the weak nonstationary, this study applies PAM model. Hence, it is necessary to make a lag of dependent variable as the independent variable—that is C_{t-1} (the absorption of NR in the previous year).

PAM and adaptive expectation, the rationalization of the *Koyck* model, in appearance, are indistinguishable but actually they are very different. The following are reasons why the study is related to PAM model:

A. The study discusses about domestic firm's consumption for NR as input used in their production process. The firms are concerned about managing its level of inventories. A firm that does not have the optional amount of the raw material on hand, the natural rubber, will face two costs: the forgone profit from having too much or too little inventory and the cost of adjusting the current level of inventory to the optimal one (the *opportunity cost*). The adjustment may require finding a buyer for the current excess and or obtaining new storage facilities (considering NR is imperishable commodity, the latter is possible). Producers need a given number of NR stock. To minimize costs, the adjustment to the optimal level of stock should be gradual and, hence, there are changes in stock to increase or decrease the existing one. Therefore, in the consumption example Y^* represents a desired expenditure level in consuming NR. The mechanism of how the producers adjust the level of inventory follows the derivation of PAM model.

B. For reason in point A, the study postulates the PAM model of $Y^*_t = \beta_0 + \beta_1 X_t + u_t$, (rather than the adaptive expectation model of $Y_t = \beta_0 + \beta_1 X_t^* + u_t$), where the permanent or long-run dependent variables, Y^*, is a function of the current or observed X. In other words, this study considers $C^*_t = \beta_0 + \beta_1 PNR + \beta_2 GDP + \beta_3 PSR + u_t$ and in this context of demand, Y^* represents the desired quantity to be supplied or the desired acreage to be farmed. It thus determines: how promising the Indonesian natural rubber in domestic market is, and the future growth of Indonesian NR and firms producing NR goods.

C. The adaptive expectation is restricted in one explanatory variable to make it consistent with the *Koyck* model. The rationalization result of adaptive expectation with more than one X's (for example, $Y_t = \beta_0 + \beta_1 X_1^*_t + \beta_2 X_{2t} + u_t$) will not as consistent as it is in PAM model. In other words, it does not produce the common form of $Y_t = \alpha_0 + \alpha_1 X_{1t} + \alpha\beta_2 X_{2t} + \alpha_3 Y_{t-1} + v_t$.

5.4. Choosing Between Linear and Log-Linear Regression Model

Choosing between linear and log-linear regression model is essential in empirical analysis. From the results of *MWD test*, there is not an exact proper choice because Z_1 and Z_2 are both insignificant meaning that it may choose the linear or log-linear model. However, the latter is more appropriate to test the hypotheses since the variables are estimated significant.[11] Therefore, this study will apply the partial adjustment model (PAM) in log form. The estimated equation formulated as follows:[12]

[11] See appendix A-6
[12] See appendix A-5

$$\widehat{\ln C_t} = -1.0972 \ln PNR_t - 0.3799 \ln GDP_t + 1.2177 \ln PSR_t + 0.8544\, D_t + 0.3028 \ln C_{t-1} - 2.3184$$

se	=	(0.4394)	(0.1625)	(0.5751)	(0.1362)	(0.1119)	(3.6539)
t-stat	=	(-2.4970)	(-2.3379)	(2.1175)	(6.2745)	(2.7048)	(-0.6345)
Prob.	=	(0.0231)	(0.0319)	(0.0493)	(0.0000)	(0.0150)	(0.5342)

$R^2 = 0.8126$ DW stat = 2.3965 F-statistic = 14.7464

Adj $R^2 = 0.7575$ df = 18 **(5.3)**

5.5. Statistical Hypotheses Testing

Test of significance approach, one-tail and two-tail tests, is a procedure by which samples results are used to verify the truth or falsity of a null hypothesis. The objective of this test is to know the relationship between independent and dependent variables individually.

A. Test of Variable lnPNR_t, Price of Natural Rubber (NR).

The regression estimates $\beta_1\delta = -1.0972$, se $(\beta_1\delta) = 0.4394$, t-statistic = -2.4970, and df = (23-5) = 18. If it assumes $\alpha = 5$ percent at one-tail test, $t_\alpha = -1.734$ and then H_0: $\beta_1\delta = 0$ and H_1: $\beta_1\delta < 0$, hence

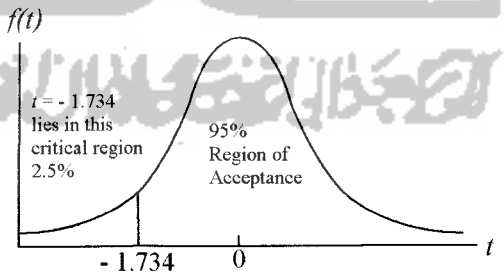

Figure 5.1.The 95% Confidence interval for t(18df)

As shown diagrammatically in figure 5.1, the observed t-statistic clearly lies in the critical region, $|t| > t_{\alpha/2,\text{df}}$. Hence, the conclusion is that t-value is statistically significant and the null hypothesis may be rejected. It

means, individually, price of NR does statistically influence consumption for Indonesian NR.

B. Test of Variable ln GDP_t, total real GDP

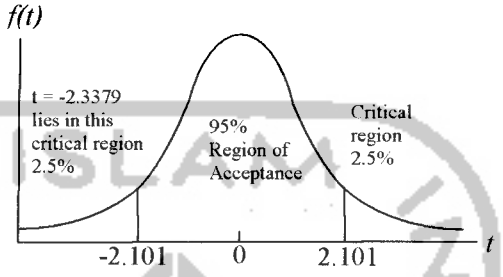

Figure 5.2 The 95% Confidence interval for t(18df)

If it assumes α = 5 percent at two-tail test, t-statistic of $\beta_2\delta$ = -2.3379; $t_{\alpha/2}$ = 2.101 and H_0: $\beta_2\delta = 0$ and H_1: $\beta_2\delta \neq 0$, the observed t-value lies in the critical region 2.5% or $|t| > t_{\alpha/2,df}$. Thus, it is statistically significant and the null hypothesis is rejected. It means, individually, Indonesian total real GDP does influence consumption for Indonesian NR.

C. Test of Variable ln PSR_t, Price of Synthetic Rubber (SR)

The test procedure is the same as before, t-statistic $\beta_3\delta$ = 2.1175. If H_0: $\beta_3\delta = 0$ and H_1: $\beta_3\delta \neq 0$, then the two-tail test are shown as follows:

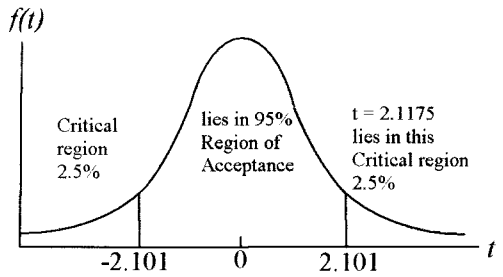

Figure 5.3 The 95% Confidence interval for t(18df)

As seen in figure 5.3, the observed t-value lies in the critical region or $|t| > t_{\alpha/2,\text{df}}$. Thus, it is statistically significant and the null hypothesis is rejected. It means, individually, the variable price of synthetic rubber does influence consumption for Indonesian NR.

D. Test of Variable D_t, Dummy Variable

As a rule of thumb that two-tail significant of ρ value is extremely small, closed to zero, it may be concluded that this dummy variable is statistically significant. In other words, there is statistically significantly differential intercept coefficient that tells how much the value of intercept of those who received the dummy value 1 differs from the intercept coefficient of the benchmark category.

E. Test of Variable $\ln C_{t-1}$, consumption for NR at previous year

The regression obtains the t-statistic of $(1-\delta)$ = 2.7048, and df = 18. Assuming α = 5 percent at two-tail test, $t_{\alpha/2}$ = 2.101. H_0: $(1-\delta) = 0$ and H_1: $(1-\delta) \neq 0$, then

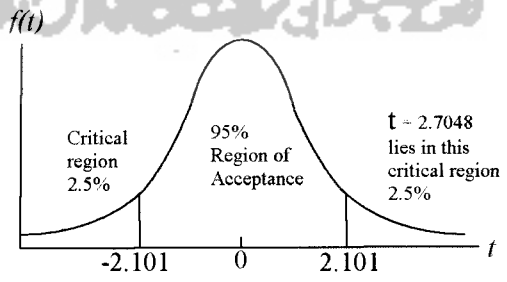

Figure 5.4 The 95% Confidence interval for t(18df)

As shown diagrammatically in figure 5.4., the observed t-statistic clearly lies in the 2.5% critical region and $|t| > t_{\alpha/2,\text{df}}$. The conclusion is that t-

value is statistically significant and the null hypothesis is rejected. It means, individually, the variable consumption for NR at previous year (lagged one), does influence consumption for Indonesian NR.

5.6. F-Statistic Testing

Testing the overall significance of a regression in terms of R^2 can use F-test as an alternative to test the eq. 5.3. To test the hypothesis of

$$H_0: \beta_1\delta = \beta_2\delta = \beta_3\delta = \beta_4\delta = (1-\delta) = 0$$

versus

H_1: Not all slope coefficients are simultaneously zero

then, as the regression result, that F-statistic is equal to 14.414 while the critical $F_{\alpha\,(k-1,n-k)}$ value is equal to 2.93, at $\alpha = 5\%$; (k-1) = 4; and (n-k) = 18, it is obtained

$$F > F_{\alpha\,(k-1,n-k)} = 14.4140 > 2.93$$

therefore, that H_0 may be rejected and that the five regressors (PNR_t; GDP_t; PSR_t; D_t; and C_{t-1}) statistically significantly have the joint impact on the absorption of industries producing NR goods.

5.7. Partial Adjustment Model (PAM)

The regression result in the equation 5.3,

$$\widehat{\ln C_t} = -1.0972\ \ln PNR_t - 0.3799\ \ln GDP_t + 1.2177\ \ln PSR_t + 0.8544\ D_t + 0.3028\ \ln C_{t-1} - 2.3184 \qquad \textbf{(5.3)}$$

represents the *short-run equation* of the absorption of industrial business producing in Indonesian market because the total number of NR demanded may

not necessarily be equal to total number demanded in the long-run. It will be estimated *the long-run equation* by simply dividing the short-run through by δ and drop the $\ln C_{t-1}$ term, and the result are:

$$\ln C_t = -1.5738 \ln PNR_t - 0.5449 \ln GDP_t + 1.7466 \ln PSR_t + 1.2255 D_t - 3.3253 \quad \textbf{(5.4)}$$

As it is presented, the finding long-run estimators is substantially greater (in absolute terms) than the corresponding short-run one.

5.7.1. The Short-Run Domestic Absorption of NR, 1980-2003

The size of R^2 is estimated 0.8126. It means that about 81 percent of the variation in absorption of NR in Indonesian market is explained by PNR_t GDP_t; PSR_t D_t and C_{t-1} (See variables definition in the data description above). It is a fairly high value considering that the maximum value of R^2 can at most be 1.

Referring to the equation 5.3., the estimated equation shows that the ***short run price elasticity*** ***(ln*PNR)*** coefficient has the correct sign—negative relationship—and it is statistically significant. The elasticity of C (demand for NR) relative to PNR (price of NR) is estimated 1.0972, in absolute. It suggests that if the price goes up by 1 percent, on average, the demand or absorption of NR is decreased by about 1.10 percent, ceteris paribus. Thus, the absorption is very responsive to changes in price since NR has an "elastic" price when the elasticity is greater than 1. These

support our subjective description in previous chapter, that obviously NR is commodity that has ready substitutes.[13]

The ***short-run income elasticity*** (**ln*GDP***) coefficient is surprisingly negative, and statistically it is not different from zero. The elasticity of *C* in relation to *GDP* is about 0.3799, in absolute. It suggests that if total real GDP goes up by 1 percent, on average, the consumption for NR will reduced by about 0.38 percent, ceteris paribus. Since the consumption goes down as total real GDP increases, it can be said that natural rubber is *inferior* commodity in local market.

The relationship between natural and synthetic rubber is indeed ***substitutes*** when the ***short-run cross-elasticity*** coefficient is more than zero. It is indicated by the finding coefficient 1.2177 on the variable of synthetic rubber price (**ln*PSR***) meaning that a 1 percent increase in price of synthetic rubber affects a decrease in the demand for NR for about 1.2 percent, other things being held constant.

In the case of variable ***D***, dummy variable, it is statistically significant that there is a differential intercept coefficient for those who received the dummy value 1 as much as 0.8544 and those are equal to – 1.4640. These indicate the externalities affecting total amount of the demand for NR in Indonesian market.

[13] Businesses switch to synthetic rubber substitution product and more SR enters Indonesian market. This is in contradiction with the world rubber consumption, which is switching to natural rubber.

Rubber market is influenced by many externalities. The supply of natural rubber is conducted by the nature, government policy, buffer stock strategy, etc. Referring to the data for total consumption, those are so fluctuated. For the period 1980-1984 (excluded 1981), domestic demand for NR were below the average because mostly NR was export. As the price of oil increase, international market substitutes synthetic rubber (SR) with NR. Moreover, the 28% of rupiah devaluation on September 1983 made factor of production so costly to the industrialist. Then, in 1985-1986 a rapid growth in domestic tyre industry has made the demand for NR to increase. For period 1987-1991, a sharp decrease in oil price in 1986 and, again, the 45% of rupiah devaluation have made domestic price of NR exceeds the international price and, consequently, domestic market was sluggish. In 1992-1996 the absorption of NR grows significantly as Indonesian economy wealthier. After that, the economic crisis in the 1997 destroys the economy and shocking every business. However, not until 2000, NR market backs on the track and the demand rises exceeding the average level. In fact, there are so many externalities (it might be in thousand) affecting the fluctuation of the absorption of NR.

The adjustment coefficient is $\delta = (1 - 0.3026) = 0.6974$ (from the coefficient of ln C_{t-1}), suggesting that in any given period consumers, businesses, only adjust their consumption about 70% of the way toward its desired or long run level, ceteris paribus. In other words, the adjustment is very quick.

When the size of constant is converted to the original form (the antilog of – 2.3184), it obtains 0.0984 meaning that the contribution of factors not included in this model is only 0.0984 tonne (or equal to 98.4 Kg) of the total average 112.75 tonne. Therefore, mostly the size of domestic consumption for NR comes from the three factors plus dummy variable (*PNR*, *GDP*, *PSR*, and *D*).

5.7.2. The Long-Run Domestic Absorption of NR, 1980-2003

The long-run price elasticity of demand for NR is substantially greater (in absolute terms) than the corresponding short-run elasticity, which is also true of the income elasticity of demand for NR and the cross-elasticity demand of both commodity natural and synthetics rubber.

Returning to eq. (5.4) the estimated ***long-run price elasticity*** (**ln*PNR***) coefficient shows that the elasticity of *C* (absorption of NR) relative to *PNR* (price of NR) is 1.5738, in absolute. In other words, in the long run, a 1 percent increase in price makes the absorption to decrease by totally about 1.57 percent, ceteris paribus. It is, thus, greater than the corresponding short-run elasticity and the price elasticity is elastic.

In addition, the ***long-run income elasticity*** (**ln*GDP***) coefficient shows that the elasticity of *C* relative to *GDP*, is about 0.5449, in absolute. It suggests that in the equilibrium a 1 percent increase in the real GDP reduces the businesses' consumption ultimately by about 0.54 percent, ceteris paribus and in fact, natural rubber is still inferior.

Due to the substitutes-relationship between natural and synthetic rubber, in the long-run, consumers tend to reduce their absorption of NR as much as 1.75 percent for every 1 percent increase in price of the related good price, SR. ceteris paribus. The coefficient indicates a substitution relationship between the two commodities.

In the case of variable ***D***, in the long-run those who received the dummy value "1" have differential intercept value of 1.2255 and it is equal to –2.0998.

In the long-run, the contribution of factors not included in this model is only 0.0360 tonne (or equal to 36 Kg) of the total average 112.75 tonne. Therefore, mostly the size of domestic demand for NR comes from the five factors (*PNR, GDP, PSR, D, and* C_{t-1}).

5.8. Testing Violation of Classical Assumption

5.8.1. Detecting Autocorrelation

Note that the estimated Durbin-Watson *d* is 2.4078, which is close to 2 , suggesting that the ***Breusch-Godfrey*** test is considered better to detect autocorrelation in autoregressive models. Furthermore, the result of autocorrelation test shows that the t-stat value, $(n-j)\ R^2$, does not exceed the critical chi-square value for the 5% level of significance (1.3212 < 5.99) and the null-hypothesis of no serial correlation may be accepted. In other words, ***there is no autocorrelation*** in the error term in this model.[14]

[14] See appendix A-8

5.8.2. Detection of Heteroscedasticity

An important assumption of the classical linear regression model is that the disturbance u_t(s) appearing in the population regression function are homoscedasticity. However, the method of Glejser test will be applied to detect whether this present regression containing heteroscedasticity or not. Glejser suggests regressing the ln $|u_t|$ on the X variables that is thought to be closely associated with σ_t^2. The results of the Glejser test are as follows:

$$\widehat{\ln |u_t|} = -1.8590 \ln PNR_t - 0.4611 \ln GDP_t + 0.7212 \ln PSR_t - 0.0355 \ln C_{t-1} + 3.1872$$

se =	(1.6435)	(0.6182)	(2.2207)	(0.4231)	(13.94)
t =	(-1.1311)	(-0.7458)	(0.3248)	(-0.0840)	(0.2286)

$R^2 = 0.0756$ $\quad t_{\alpha/2,df} = 2.093$ with $\alpha = 5\%$ and df = 19 **(5.3)**

The regression results of all computed t value are statistically significant, each $|t| < t_{\alpha/2,df}$ in two-tail test. Obviously, there is no relationship between the absolute value of the residuals and the regressors. It might be concluded that ***there is no heteroscedasticity*** in the regression. Meanwhile, the Goldfeld-Quant tests also reach the same conclusion concerning this heteroscedasticity.[15]

5.8.3. The Detection of Specification Error

As shown in the appendix A-4, the Ramsey's RESET test results the F-test is insignificant at 5 % level of significance. The value of about 1.1806 is lower than $F_{\alpha\ (k-1,n-k)}$ (of about 2.71) where (k-1) = 7; and (n-k) = 15. It means the hypothesis

[15] See appendix A-7 and A-9

that the model is mis-specified is rejected. In other words, ***the model does not commit the specification errors***.[16]

5.9. The Granger Causality Test

Null Hypothesis:	F-Statistic	Decision
ln PNR_t does not Granger Cause *ln Ct*	2.9535	Sig.
ln C_t does not Granger Cause ln PNR_t	0.5963	NS
ln GDP_t does not Granger Cause ln C_t	1.6710	NS
ln C_t does not Granger Cause ln GDP_t	0.6965	NS
ln PSR_t does not Granger Cause ln C_t	6.2562	Sig.
ln C_t does not Granger Cause ln PSR_t	0.6201	NS

The result of Granger causality test, which is shown in the table 1.1, suggests that apart from $PNR_t \rightarrow C_t$ and $PSR_t \rightarrow C_t$, for the period between 1980 and 2003, at the lag (6) and 18df, there is no bilateral causality of consumption for NR against its explanatory variables, PNR_t GDP_t and PSR_t, since there are statistically insignificant at 5 percent level of significance ($F < F_{\alpha/2\ df}$). However, PNR_t may cause C_t and PSR_t may cause C_t even not for the opposite.[17]

[16] See Appendix A-4
[17] See Appendix A-10