CHAPTER 4

Empirical Results and Discussions

4.1 Empirical Results

In order to estimate the Hurst exponent of the Thai rubber price, 2272 observations of daily Thai natural un-smoked rubber price from 21 April 2003 to 7 July 2014 are used. The data is obtained from TRA, as shown in Figure 4.1.

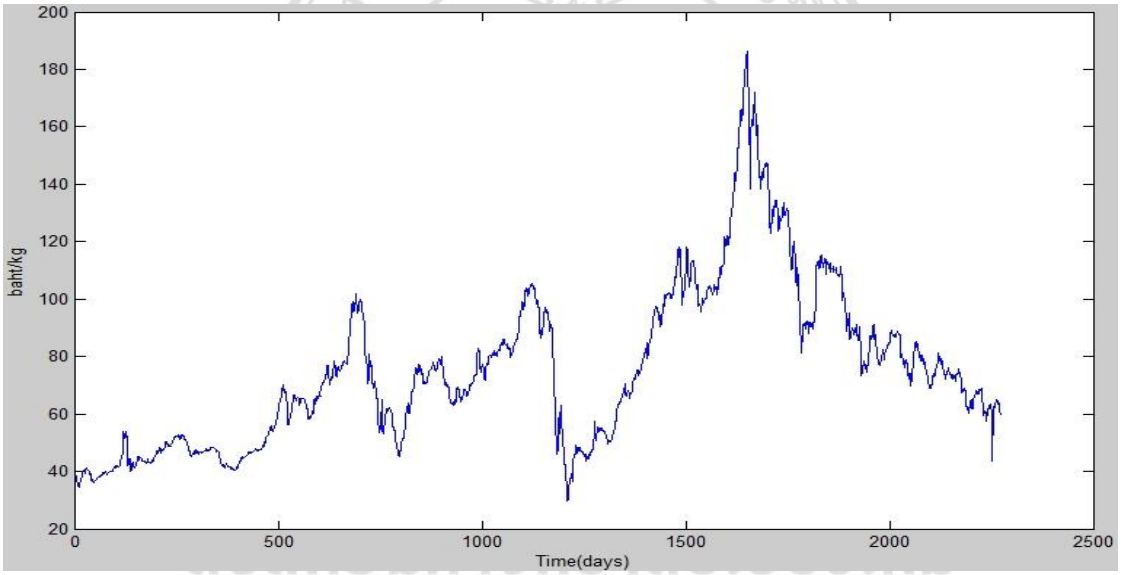


Figure 4.1: The price of the Thai natural rubber price from 2003 to 2014

Form Figure 4.1, 2772 observations of the daily Thai natural rubber price has big fluctuations. The minimum price is 29.71 Baht/kg in 2008, and the maximum price is 186.43 Baht/kg in 2011. There are both small and big fluctuations in Thai natural rubber price, according to the attributes of the Thai natural rubber price, it is very important to the investment in natural rubber market.

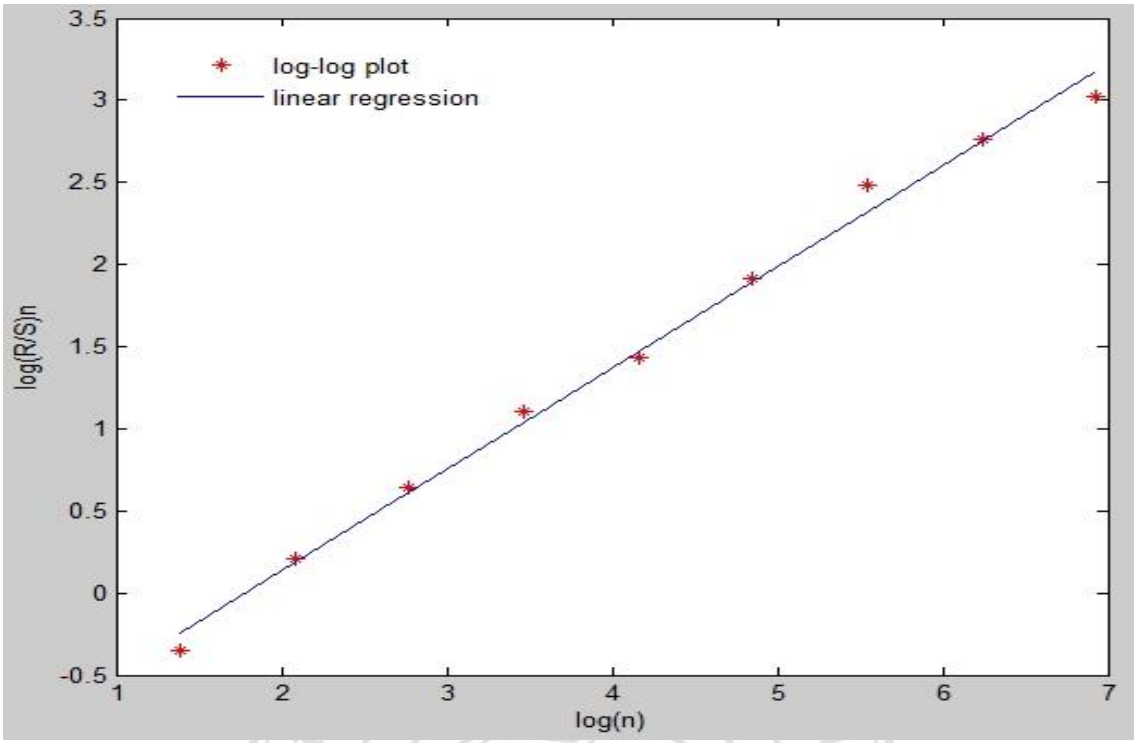


Figure 4.2: log-log plot and linear regression for Thai natural rubber price

The Hurst exponent is obtained by using the least square method and the results is $\log(R/S)_n$=-1.0959+0.6167*log(n), which is plot on Figure 4.2. On the plot, those points exhibit the obvious linearity, in a visual fashion. Hence, the Hurst exponent is the slope of the linear regression line, H=0.6167, which is larger than 0.5. The correlation coefficient CR is computed according to the obtained Hurst exponent as 0.1756. The power law exponent is 2.2334 which belongs to the case of Black noise. The determined parameters are summarized in Table 4.1.

Table 4.1: Summary of numerical results and characteristics

Commodity	***H***	***CR***	**Color Noise**
Thai Natural Rubber	0.6167	0.1756	Black (α = 2.2334)

Since the linear regression was used in this study, the confidence interval was obtained after the computing of the software Eviews. The results are showed in Table 4.2, which obtained the confidence intervals of Hurst exponent at different level.

Dependent Variable: LNR
Method: Least Squares
Date: 12/11/14 Time: 15:12
Sample: 1 9
Included observations: 9

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.095863	0.085879	-12.76049	0.0000
LNS	0.616713	0.018968	32.51354	0.0000

R-squared	0.993422	Mean dependent var	1.468975
Adjusted R-squared	0.992482	S.D. dependent var	1.174552
S.E. of regression	0.101840	Akaike info criterion	-1.537690
Sum squared resid	0.072600	Schwarz criterion	-1.493862
Log likelihood	8.919605	Hannan-Quinn criter.	-1.632270
F-statistic	1057.130	Durbin-Watson stat	1.481336
Prob(F-statistic)	0.000000		

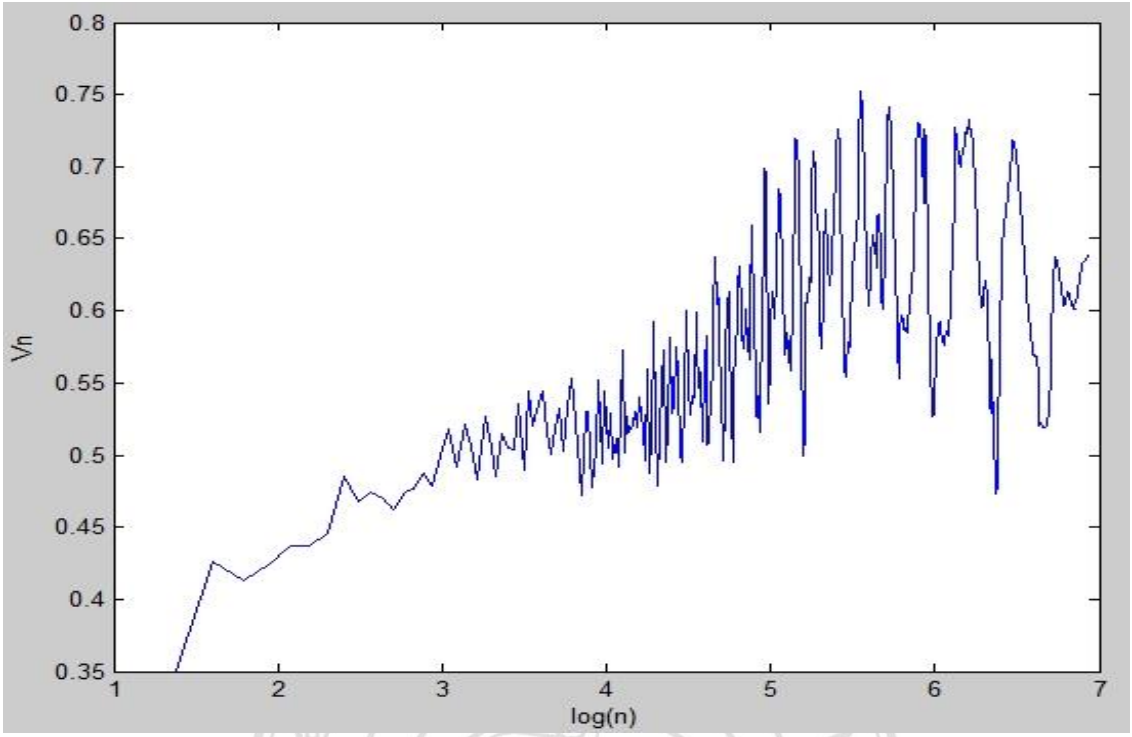
Figure 4.3: Results of Linear Regression

The Hurst exponent for the data is determined as 0.6167. The regression result is shown in Figure 4.3. The statistics of the estimation is given in Table 4.2. It is noted that the variable LNS in Figure 4.3 is the log(n) in equation (7) . In addition, the 99%-confidence interval of H is (0.5502, 0.6832); 95% confidence interval of H is (0.5718, 0.6616); and 90% confidence interval of H is (0.5807, 0.6527). As a result, Hurst exponent is greater than 0.5 at three different significant level, therefore, the estimated Hurst exponent of 0.6167 can be used for the Hurst exponent.

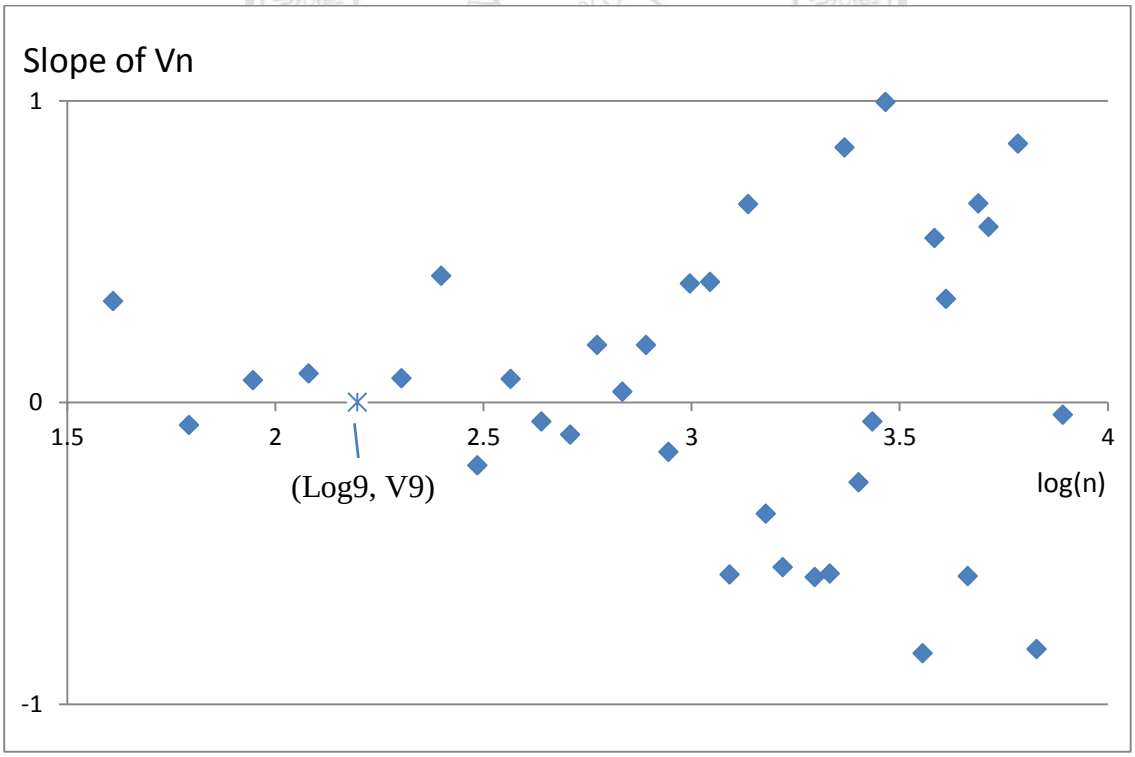
Since the Hurst exponent is greater than 0.5 at three different high level, which means the price movement belongs to a class of a persistent process with long-term memory, which implies that if here is an increase will tend to be followed by another increase.

Table 4.2: Confidence Intervals of Hurst Exponent

Level	Hurst Exponent
90%	(0.5807, 0.6527)
95%	(0.5718, 0.6616)
99%	(0.5502, 0.6832)



(a)log(n)-Vn plot



(b)log(n) and slope of Vn

Figure 4.4: Calculate the memory term of Thai natural rubber price

Moreover, after the Hurst exponent and correlation coefficient were obtained, which means that there is persistent process with long term memory in Thai natural rubber market. Thereby the memory can be determined from the log(n)-Vn diagram, when the first turning point occurs which means that the memory circulation ends. Hence, one can find the memory at the first turning point of the diagram. However, it is not strict enough to find the turning point directly from Figure 4.4 (a), so, the slope of the Vn was taken for finding the point. Therefore, Figure 4.4 (b) is plot in accordance with Figure 4.4 (a) to determine the more vigorous first turning point, technically. As results, the turning point can be found at (log9, V_9). Figure 4(b) plots the first tuning point with star sign, which is (2.1972, 0.003), the results are computed by Matlab process as attached in Appendix. The relative point on Figure 4(a) is (2.1972, 0.4371), with respective to the time scale 9. It implies that there are 9 days memories for Thai natural rubber price, which is significant to the natural rubber market investors.

4.2 Discussions

Enormous studies pay much attention to the correlations of domestic commodity price and abroad market price for anticipating. The volatilities of Thai natural rubber spot and futures returns, which clarifies the spillover effects exits in them (Chang. et al., 2011). There is no research on the fractal characteristics of Thai natural rubber price , which emphasizes the inherent properties and structures of Thai rubber. This research results thus present a new direction. The obtained fractal characteristics provide a means of speculative models to rubber investors and traders.

In accordance with the obtained Hurst exponent, the *H* value is greater than 0.5 which manifests that there is long-term memory existing in Thai natural rubber market. This allows investors to know the rubber price movements and make the positive price returns. On the other hand, Hurst exponent 0.6167 means less noisy data series show both trends and persistent in a clear way. The investors are expected to have yield positive earnings (Mandelbrot et al., 1997).

The correlation coefficient equals to 0.1756 implies the correlation between present value and future value is positive. It means that 17.56% change that the prices of future Thai natural rubber are affecting by past prices. Meanwhile, this coefficient means the strength of the long term memory can affect (Peter, 1994). The Thai natural rubber price

is thus a positive persistent process with long-term memory. The influence is not weak, which needs to take into account for the prediction application.

The black noise ($\alpha = 2.2334$) exhibits some dynamic properties of a time series (Goulielmos A., 2012):

(1) Time series follow trends of last period;

(2) Time series have memories;

(3) Time series have correlations among the observations.

The black noise occurs when there is strong economic growth or decline during a period of time, and the prices fall or increase all of a sudden. This black noise implies that a growth or declination in the past price will positively affect the future prices (Cromwell et al., 2000). Since the empirical results show that the price movement behaves close to the Black noise, the FMH can be considered valid for the Thai natural rubber price.

The Fractal Market Hypothesis (FMH) brings more confidence in long term, which could be a good information to long range investors. Different investors have different investment horizons, the long term investors can get more possibility to predict the price by Hurst exponent, correlation coefficient and long term memory. Hence, long term investors will behave more stable in capital market (Vacha L., & Vosvrda M., 2005). FMH is more general in real cases, in accordance with investors' investment horizons, it is more stable to consider the FMH to analyze the financial market.