CACAO PRODUCTION IN THE PHILIPPINES FROM 1990-2012

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ABSTRACT

Cacao (Theobroma cacao) is an important source of income for thousands of small holder farmers and could help reduce the poverty incidence in the rural areas. This paper analyzed the status of the cacao industry in the Philippines for the periods from 1990 to 2012 using a surrogate measure of data roughness through fractal dimensions. Fractal dimensions as statistical quantities are robust measures which are not easily influenced by extreme observations unlike other variance-based productivity measures of any crop. The results revealed that there is a high ruggedness in the area planted, yield and the number of fruit bearing trees in a decreasing trend. The price of cacao on the other hand is highly fragmented and is increasing every year. For 22 years, the cacao industry is technically volatile but market feasible. The observed variability can be attributed by some indicators such as climate change and the negative attitude toward producing cacao.

Keywords*: cacao production, fractal dimensions, fractal statistics*

1.0 Introduction

Cacao (*Theobroma cacao*) is an important source of income for thousands of small holder farmers in East Asia, and it has been cultivated in the Philippines since the 17th century. As a perennial crop, this has a bright potential for the farmers because this can be grown under the coconut trees. Planting cacao can be a primary or secondary source of income among farmers and this can be helpful in solving the problem of poverty.

Philippines is well placed as future supplier of cocoa beans for local, regional and international trade markets, in fact Cacao is part of the priority crop in the newly crafted Research and Development Extension Agenda and Programs of 2011, which serve as a reference for BAR in setting priorities for funding researches. Researchable areas for Cacao included: integrated pest management, package of technologies, good agricultural practices, identification of location, specific clones and drying and other post harvest technologies.

Statistics revealed that in 1990, the area planted with cacao was about 18,377 hectares, which most of these are grown in Davao, Zamboanga Peninsula, Western Visayas, North Mindanao, ARMM and Caraga. By 2006, this area had declined to less than 10,000 hectares. During the same period, reported production fell from 9,990 tons about 5,400 tons, with two thirds of the production coming from Davao Region alone. As of 2008, the estimated volume of production is 6,000 to 7,000 tons, with more than 95% used in the local market. In fact, the country has to import more than 20,000 tons of cocoa

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equivalents (main as powder and also as butter and liquor) to supply domestic confectionery, baking, beverage and chocolate and manufacturing needs (The successalliance.org/Phil.html).

The above information was being processed through the usual statistical techniques. The ruggedness or fragmentation of the time series data of the production of cacao from 1990-2012 can be best analyzed through fractal dimension. That is, the fractal dimension of the data set represents data roughness and is similar to the variance-based productivity measure but with the advantage of not being dependent on the existence of a mean (robustness against extreme observations).

2.0 Basic Concepts in Fractal Statistics

Fractal statistical analysis applies to conditions where the mean or first moment does not occur. It is also applicable to situations where smaller fluctuations overrule the larger ones. Padua (2012) recommended the use of a power law distribution which is similar to Pareto's distribution as given:

$$(1) \quad f(x) = \frac{\lambda-1}{\theta}\left(\frac{x}{\theta}\right)^{-\lambda}, \ \lambda>0, \ \theta>0, \ x \geq \theta$$

where λ defined as the fractal dimension of X and θ was the smallest (positive) value of the random variable.

The extreme likelihood estimator of λ is:

$$(2) \quad \hat{\lambda} = 1 + \frac{1}{\log(\frac{x}{\theta})}$$

so that each observation contributes to the fragmentation of the support X. Padua (2013) demonstrated that the distribution of the maximum likelihood estimators obey an exponential type of distribution so that both the mean and variance of the fractal dimensions exist. A device called fractal spectrum or $\lambda(s)$ spectrum was suggested by Padua et al., (2013) to identify locations on the support X where high data roughness or fragmentation occur and where smoothness appear to dominate. The spectrum is defined as:

$$(3) \quad \lambda(s) = 1 - \frac{\log(1-\alpha)}{\log(\frac{x}{\theta})} = 1 - \frac{\log(1-\alpha)}{s}$$

where x_a is the ath percentile of

$$x \text{ and } s = \log\left(\frac{x}{\theta}\right)$$

Deviations from smoothness indicate the big variations of the cacao production in the Philippines from 1990-2012. A test for deviation from smoothness i.e. H_0: $\lambda=1$, is suggested in the paper of Padua (2012) and the reader is referred to the paper as provided in the list of references.

3.0 Research Design and Methods

In this paper, the time series analysis of the area planted, yield, number of fruit bearing trees and the current price of cacao were considered. The data were taken from the website of the Bureau of Agricultural Statistics, Philippines.

One dimensional plot of every variable considered was constructed. The plot was then used as an input to a fractal software FRAK.OUT available as a freeware from the NET. The output is a fractal dimension for the data set. Thus, the fractal dimensions of the following were obtained: membership, assets, and liabilities,

The deviation from smoothness:

$$(4) \quad d = (\lambda - 1) \times 100\%$$

is computed for each fractal dimension. The higher the percentage deviation is, the more varied the cooperatives' performance.

Finally, we attempted to locate the areas of high fractal dimensions (more varied performance) and relatively smoother areas by computing for the fractal spectra of each data set. Graphical representations of the performance of the cacao industry on each of the variable considered were also shown as a support to the discussion of fractality.

4.0 Results and Discussions

Figures 1, 2, 3 and 4 show the one-dimensional plots of the area planted, yield, number of fruit bearing trees and the price of cacao from 1990 to 2012. This explains how the cacao industry induced ruggedness or fragmentation on the straight line interval. The roughness is also clearly shown in figs. 1a, 2a, 3a and 4a.

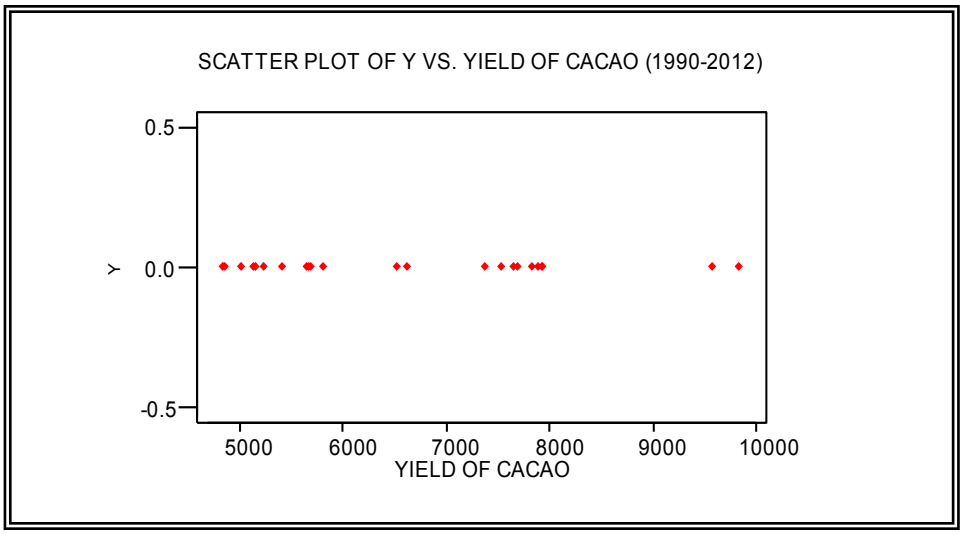

Figure 1. One-dimensional plot of yield of cacao (1990-2012)

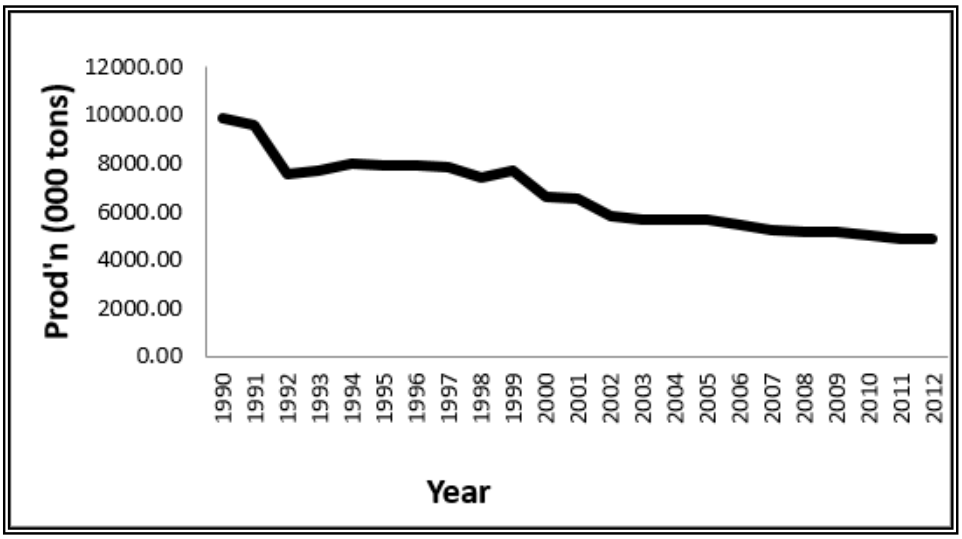

Figure 1a. Yield of cacao (1990-2012)

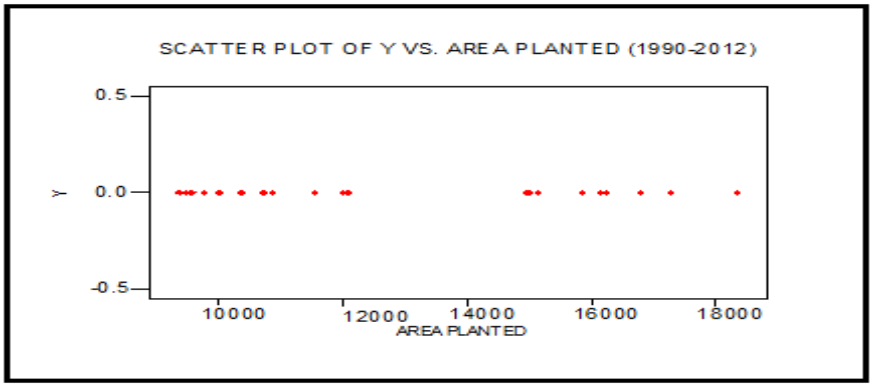

Figure 2. One-dimensional plot of area planted with cacao (1990-2012)

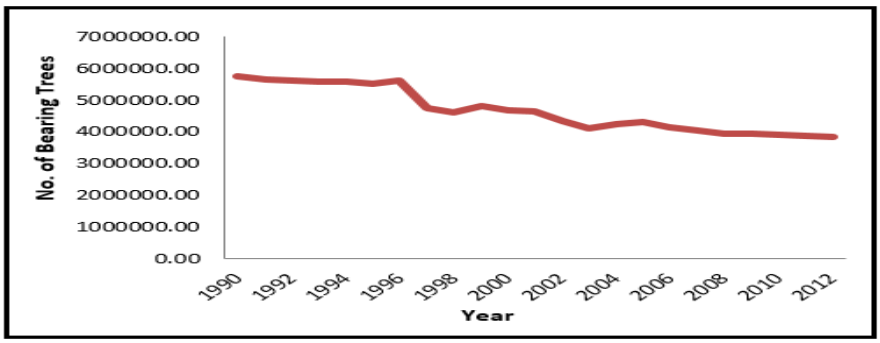

Figure 2a. Number of fruit-bearing trees of cacao (1990-2012)

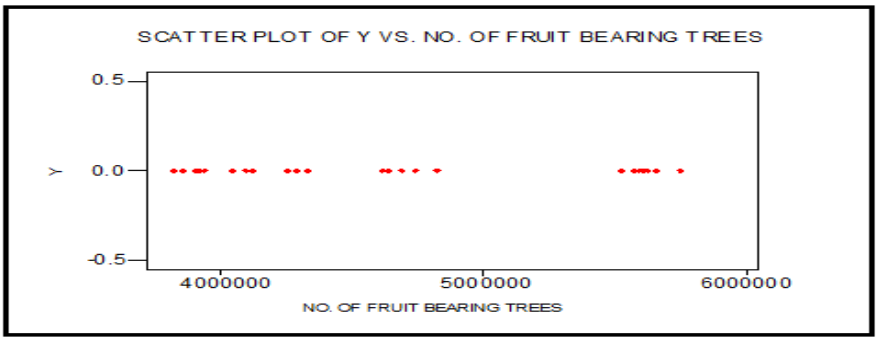

Figure 3. One-dimensional plot of number of fruit-bearing trees (1990-2012)

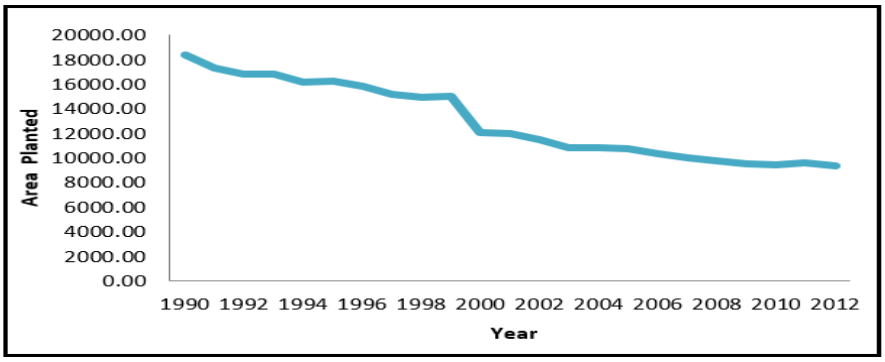

Figure 3a. Area planted with cacao (1990-2012)

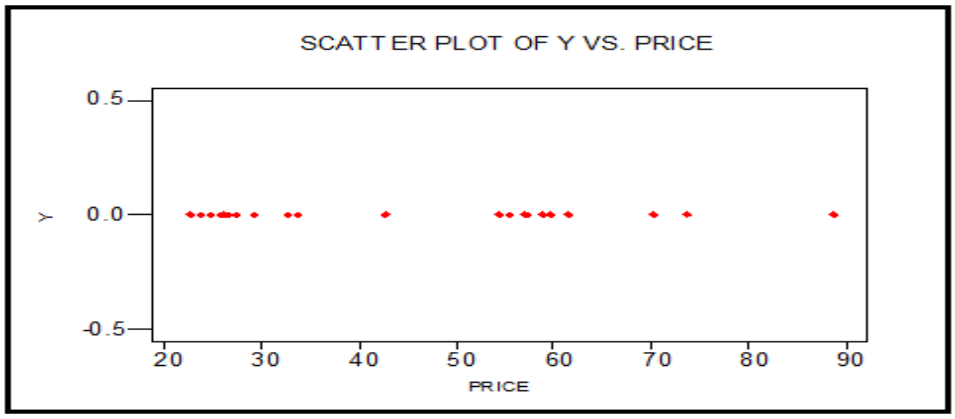

Figure 4. One-dimensional plot of the price of cacao (1990-2012)

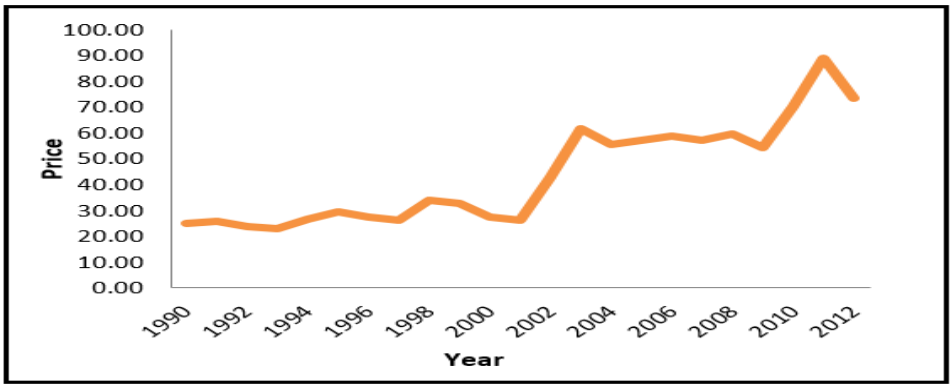

Figure 4a. Price of cacao (1990-2012)

Table 1, on the other hand, displays the fractal dimensions of the one-dimensional plots (induced roughness) as well as the deviation statistics (percentage departure from a smooth straight line).

The one-dimensional plots of the production, areas planted in hectares, number of fruit bearing trees and the price of cacao manifest the visual representation of the magnitude of cacao industry situation in the Philippines.

The degree of fragmentation (1.4534) of the area planted with cacao indicates that there are years where the increase or decrease in the area planted is minimal and there were also years where large areas of land were given up by the farmers to produce another crop. Figure 1a is a clear indicator that there is an annual drop off the cultivation area. But the variability of 45.34% indicates already a high fragmentation.

Table 1. Fractal dimension and deviation statistics for the cacao

INDICATORS	FRACTAL DIMENSION	DEVIATION STAT (%)
Yield of Cacao	1.4847	48.47
Area Planted	1.4534	45.34
No. of Fruit Bearing Trees	1.3908	39.08
Price	1.6882	68.82

The yearly decline of the area is an indication of the indifference of the farmers to produce more cacao. In addition, the lack of market information and the farmers' attitude of preferring cash crops, rather than waiting for 5 years to have a harvest, motivate them not to expand the production area. Ironically, cacao can be efficiently grown under the coconut trees. Thus, there would be a vast potential area for cacao production (Nabua and Templado, 2012).

It is also a fact that when the production area decreases, the yield would also decline. When the yield of cacao and the number of fruit bearing trees were subjected to fractal software, they were moderately rugged with fractal dimension of 1.4847 and 1.3908 respectively. The degree of ruggedness connotes that from 1990 to present, the decrease in the production and the number of fruit bearing trees are moderately fragmented as shown by its variability of 48.87%. and 39.08%. There were years which had produced more cacao and there were also years with few harvests. This scenario can be attributed by climate change and pests and diseases. Moreover, the cultural management practices of the cacao production might be weak as the farmers have low interest in planting. Despite of the promotion and encouragement by both the government and non-government organizations, the cacao industrialization, the cacao industry in the Philippines continued to slow down.

The price is the most fragmented one with a fractal dimension of 1.6882. The variability of 68.82% implies the small and large fluctuations in the price of cacao for 22 years. Despite of the significant increase in the price in 2000 and beyond, this did not motivate the farmers to even increase production.

5.0 Conclusion

There is a high ruggedness in the area planted, yield and the number of fruit bearing trees in a decreasing trend. For 22 years, the cacao industry is technically volatile but market feasible. The observed variability can be attributed by some indicators such as climate change and the negative attitude toward producing cacao.

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