

## Vegetable Price Fluctuation in Albania: A Nonlinear Model for Its Study

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### Abstract

The change in price of agricultural products and their fluctuations has a major effect on our everyday life and on the development of the society in several aspects. During the recent years, there has been an obvious priority of economic analysis based on nonlinear dynamical models. Cobweb model, despite being simple in its organization, gives valuable explanations about the cyclic tendency of the market, which accounts for the immense interest taken into the improvement of the model. In this article a vegetable price analysis is conducted and the nonlinear cobweb model has also been added in order to provide a theoretical basis for price control. All the data gathered and assumptions made refer to the application of model in Albania.

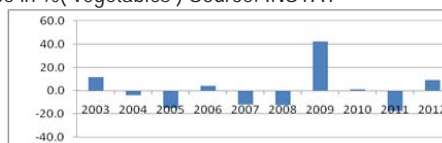
**Keywords:** cobweb model, price fluctuation, vegetable price, stability

### 1. Introduction

In the recent years, the characteristics and structures of economy have significantly changed and the prices have evaluated in a complex and rather chaotic way. Nowadays agriculture plays an important part in the development of Albanian economy. According to the Office of World Bank in Tirana and to the Ministry of Agriculture, agriculture accounts for as much as 21% of inner gross production, 16.8 % of macro indicator and 58% of employment in the country.

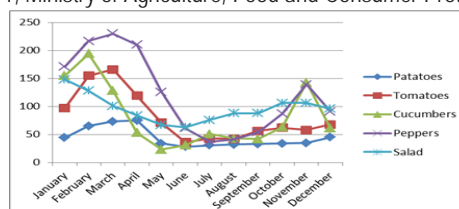
INSTAT (2013) divulges that the Price Index of vegetables has experienced major changes for time period of 2003-2013. The annual change has been compared to the previous year change. During March 2013, the data from Ministry of Agriculture reveals that there are price fluctuations for vegetables in a national and local rate, which may reach the figure of 35% when assessing certain products. The following graphs illustrate fluctuations and growth in vegetable prices.

**Figure 1.** Index of consumption price in % (vegetables) Source: INSTAT

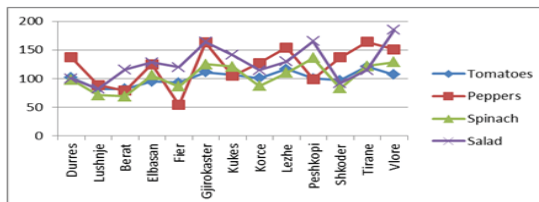


Price fluctuations are observed not only in country rate, but also for the same product in different areas. This is primarily explained with reference to geographical position and differing climate conditions.

**Figure 2.** Vegetable prices for 2011, Ministry of Agriculture, Food and Consumer Protection



**Figure 3.** Vegetable prices for different areas, Ministry of Agriculture, Food and Consumer Protection



## 2. Literature Review

The situation above is not only characteristic of Albanian economy and agriculture. Many researchers worldwide have conducted a number of studies to discover the main causes of these fluctuations, which have a tendency of growth, based on data from different countries. Zhang (1997) for instance, highlights the fact that the growth and instability of prices has two main indicating sources: the cost of production changes and the market circulation becomes broader. Xu (2012) assumes that apart from the increasing production cost, inner production of a certain country becomes insufficient.

The price fluctuations has eventually turned into a major concern for researchers who among the reasons mentioned above also list indicators such as: the growing cycle of vegetables, agriculture costs, unorganized production in big farms, external insecure conditions, use of substitute goods, government policies etc.

The further scenario aims to expand the view point of the way how price fluctuations occurred. The market, affected by external interventions, makes prices deviate from the equilibrium price. As time passes, this moves and fluctuations become even bigger and the equilibrium price develops divergence tendency. Suoping (2006) assesses that the production price of the previous year is fundamental in the production of current year. The Cobweb model has primarily been introduced by Moore to analyze the cyclic behavior of agriculture markets and is one of the first dynamical models in economy. Since 1917 Moore (Moore, 1917) had shown that the current price of agricultural product has been determined by production, whereas the production of the upcoming year is determined by the previous year's prices. Perhaps the easiest approach to a recursive model is the two-dimensional "cobweb diagram" discussed by Ezekiel (1938), which somehow aims to generalize the easy cobweb model. The conclusive study by Ezekiel was preceded by three studies conducted in the year 1930. Ricci, an Italian Tinbergen, originally from Holland, and Schult, all touched upon the actual theorem a little but discussed its most important features. These attempts were further followed by Chiarella (1988), who constructed the nonlinear model.

Economic models demonstrate several examples of cobweb chaos. Hommes and some other authors use linear function of demand with nonlinear function of supply. The nonlinear cobweb explains different fluctuations observed in real economic data (Hommes, 1994).

### 2.1 Model

The three cases of studies of the linear model combine the equilibrium theory with that of elasticity, drawing upon the demand and supply law to fathom into the reasons of price variations and their impact of previous year prices on the next production cycle.

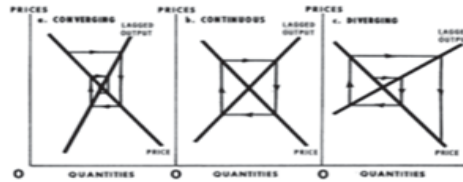
A simple illustration of the model is given by Marshall in his landmark work "Principles of Economics". The curve labelled "price" shows how current prices are related to current production. Both price and production may be calculated as deviations from their respective time trends. The curve labelled "lagged output" shows how current output is related to past prices. Specifically, output here is lagged one period after price. If output in the first period is  $q_1$ , the price is  $p_1$ . This leads to an output of  $q_2$  and a price of  $p_2$  in the second period, and so on.

Therefore, a high price in period 1 would initiate a series of future changes in both output and prices. The Cobweb model shown in the first graph, is said to converge; which means that the fluctuations of price and production tend to go smaller and smaller towards an equilibrium point.

Contrary to this model, there are cases where the Cobweb model diverges, as illustrated in the third graph in the Figure4; that is, in that case price and production fluctuation would get larger and larger as time goes on. Unless a new force prevents it, this Cobweb model will "explode". This is illustrated in the second graph at Figure 4 In this case the

lagged-output line is flatter than the price line.

Figure 4. The linear cases



The Cobweb model has two main advantages. The first is its dynamism and the latter is its recurrence.

Nevertheless, applying this model is highly difficult because of the following restrictions:

- Production is based completely upon price and in the case of pure competition.
- The time of production requires at least a full period.
- Price is decided assuming that it depends on ----- offer.

The restrictions in its use have actually improved the model by substituting linear model with nonlinear one.

By using the dynamic Cobweb model with adaptive expectations, several conclusions can be drawn about the dynamic behavior such as stability, bifurcations, and chaos. Bärbel Finkenstädt and Peter Kuhbier (1996) present the model with nonlinear function of demand.

Let's assume that offer is a linear function given by:

$$S(P_t^*) = a + bP_t^* \text{ per } P_t^* > \max\left(0, \frac{-a}{b}\right); b > 0 \quad (1)$$

Demand is a nonlinear function with elasticity constant:

$$D(P_t) = \frac{c}{P_t} \text{ per } P_t > 0; c > 0 \quad (2)$$

Market clearance requires

$$S(P_t^*) = D(P_t) \quad (3)$$

The predicted price for the period is a linear combination of predicted expectation and accomplished price

$$P_t^e = (1 - \theta)P_{t-1}^e + \theta P_{t-1} \quad , \quad 0 < \theta < 1 \quad (4)$$

Where  $\theta$  is the expectation coefficient. By substituting at (3) and using (4), we find a first order difference equation, by which we can determine the price in each period.

$$P_t = F(P_{t-1}) = \frac{cP_{t-1}}{\theta b P_{t-1}^e + a\theta P_{t-1} + c(1-\theta)} \quad (5)$$

We can transform price, demand and quantity without change in the dynamic model:

$$p_t = \frac{b}{|a|} P_t, p_t^* = \frac{b}{|a|} P_t^* \text{ and}$$

$$S(P_t^*) = |a|s(p_t^*)D(P_t^*) = |a|d(p_t)$$

As a result the function of supply is given by:

$$s(p_t^*) = \frac{a}{|a|} + p_t^* \text{ per } p_t^* > \max(0, -\text{sign}(a)). \quad (6)$$

The relation of demand can be found as:

$$d(p_t) = \frac{c}{a^2 p_t} \quad (7)$$

Basing on equation (4) the price serving as a regulating mechanism is:

$$p_t = f(p_{t-1}) = \frac{\frac{cb}{a^2} p_{t-1}}{\theta b p_{t-1}^2 + \theta \frac{a}{|a|} p_{t-1} + (1-\theta) \frac{cb}{a^2}} \quad (8)$$

Marking  $d = \frac{cb}{a^2} > 0$  (8) represents in this case

$$p_t = f(p_{t-1}) = \frac{d p_{t-1}}{\theta b p_{t-1}^2 + \theta \frac{a}{|a|} p_{t-1} + d(1-\theta)} \quad (9)$$

The equation is a difference equation of first order.

## 2.2 Sensitiveness analysis

The study of dynamic behavior at (9) is complex. Taking into consideration that the expectation parameter is a "knob setting" and that price is positive, the denominator will be positive a  $\geq 0$ , or if a  $< 0$  then  $4d > \frac{\theta}{1-\theta}$  (10)

The only maximum of (9) is

$$p_{max} = \sqrt{\frac{d(1-\theta)}{\theta}} \text{ and has two fixed points } p = 0 \text{ and } \bar{p} = -\frac{1}{2} \frac{a}{|a|} + \sqrt{d + \frac{1}{4}}$$

The behavior of equilibrium price depends on the value of function derivate in its fixed point.

The first derivate of (9) is :

$$f'(p_{t-1}) = \frac{-d\theta p_{t-1}^2 + d^2(1-\theta)}{(\theta p_{t-1}^2 + \theta \frac{1}{|a|} p_{t-1} + d(1-\theta))^2} \quad (11)$$

If  $|f'(p_{t-1})| < 1$  the fixed point is the only stability point and the prices converge toward equilibrium price  $\bar{p}$ .

The first price is not fixed if

$$f'(p_{t-1}) < -1 \quad (12)$$

This inequality is satisfies if

$$\frac{a\theta}{|a|d} \bar{p} < 2(\theta - 1) < 0 \quad (13)$$

In the case when a  $< 0$ ,  $\bar{p}$  will not be stable under the condition

$$\frac{\theta}{1-\theta} > \frac{2d}{\frac{1}{2} + \sqrt{d + \frac{1}{4}}} \quad (14)$$

Let's analyze the dynamic behavior at (9) by taking:

$$a = -1, b = 1.5, c = 0.6 \text{ Thus } d = \frac{c^2}{a^2} = 0.9$$

Equation (9) will take the form

$$p_t = f(p_{t-1}) = \frac{0.9p_{t-1}}{\theta 1.5p_{t-1}^2 + \theta p_{t-1} + 0.9(1-\theta)}$$

Condition (10) is satisfied if:

$$\theta < \frac{4d}{1+4d} = 0.782608 = \theta_{fin}$$

The intercept of graph with the line under 45° angle is:

$$\bar{p} = \frac{1}{2} + \sqrt{0.9 + \frac{1}{4}} = 1.572380$$

This will be the only stable price of equilibrium until  $\theta_1 = 0.782608$  which is taken exactly when

$f'(p_{t-1}) = -1$  and the periodic point is indifferent. If we apply  $f(f(p_{t-1}))$  we will have two fixed points and bifurcation appears, but this will not be in our focus.

### 3. Proposals and Strategy

Different natural factors in agriculture dictate small fluctuations in production, but what we consider important is the determination of tendency to go toward equilibrium price. In the projection of prices and quantity of production with reference to next year, economists have to study the trends in variables: population and productivity. Cobweb model creates the opportunity of studying by taking into consideration the real prices of previous periods. In this way, the assumptions indicate that production is not only increased because the price in one period has exceeded the equilibrium price.

Tendency of prices in market should be analyzed and later on rational decisions should be taken on the quantity of production. A considerable obstacle is the lack of infrastructure and marketing. The improvement of circulation, chain of supermarkets, distribution logistics, by providing efficient transport would result in the reduction of vegetable price.

The increase in production price does not allow the increase of profit, thus the agricultural market should be constructed by using scientific and efficient methods. The increase of life standard leads to higher demand for vegetables. Since vegetables are seasonal and alternative, corresponding strategies should be undertaken to differentiate products.

To create and system of standard quality and to promote as well as abound the production of organic vegetables. Priority should be given to inner production rather than import, while boosting the production base security so that it could be healthy and organic.

The registration of brand products creates the opportunity of not only good sales, but also market broadening in European Union countries.

Farms' expansion by small producers cooperation creates the conditions so that organized production can resist better to market dangers and failures. This should also be supported by the government.

As agricultural sector contributes to as much as 53% to the GDP (European Commission, 2007) agriculture holds the status of prioritized sector in supporting policies by the government and yet there are a number of obstacles relating to the ability for creating pure and growing competition.

Data from indicators of development from World Bank show that for 2007 direct support has been approximately 7 million Euros and Albanian government has raised budget funds for agribusiness and subsidies. Three years after 2007, this contribution is estimated almost 3 million dollars. However, what remains crucial is that these funds go for the modernization and efficiency in the production of agricultural goods.

It would be necessary to create a webpage for marketing and online service not only in Albania, but also in region, integrating, in this way, in a common regional market.

#### 4. Conclusions

In this paper, based on data from the Ministry of Agriculture, a considerable fluctuation in vegetable prices was ascertained. In the second part Cobweb model was presented, which facilitates the study of tendency and convergence of prices by allowing to build strategies.

The third part gives some opinions and proposals which might affect the decreasing and stability of agricultural goods prices. Long-term predictions, sales, prices, production, consumption, expenses etc., require different programs. To accomplish this more improved recursive models should be used. Cobweb method might be one of the most means not only in practical prediction, but also in real economic theories. As far as Albania is concerned, guaranteed economic growth will certainly create the necessary opportunities for established development in accordance with common policies of the European Union.

#### References

- Agarwal, PR (2000). *Difference Equations and Inequalities*. New York: Marcel Dekker.
- Champsaur, P, Drèze, J & Henry, C (1977). *Stability Theorems with Economic Applications*. *Econometrica*, 45, 2, 273-294.
- Coddington, AE & Levinson, N (1955). *Theory of Ordinary Differential Equations*. New York: McGraw-Hill.
- Elaydi, S (2005). *An Introduction to Difference Equations*. New York: Springer.
- Ezekiel, M (1938). The Cobweb Theorem. *Quart. J. Econ.* 52, 255-280
- European Commission (2007). *Report on Albania*. Brussels.
- Finkenstädt, B & Kuhbier, P (1992). *Chaotic dynamics in agricultural markets*. Springer. 37, 1, 73-96.
- Hommes, CH (1994). Dynamics of the cobweb model with adaptive expectations and nonlinear supply and demand. *Journal of Economic Behavior & Organization*. 24, 3, 315–335.
- Lucas, ER (1986). Adaptive behavior and economic theory. *Journal of Business*. 59, 4, 401–426.
- Ministry of Agriculture (2013). *Food and Consumer Protection. Statistical Yearbook*.
- Moore, H, (1914). *Economic cycles: Their law and cause*. New York: MacMillan.
- Neusser, K (2008). *Difference Equations for Economists* [Online] Available: [http://www.vwl.unibe.ch/studies/3107\\_e/DifferenceEquations.pdf](http://www.vwl.unibe.ch/studies/3107_e/DifferenceEquations.pdf)
- Robbin, JW (1971). A Structural Stability Theorem. *The Annals of Mathematics*. 94, 3, 447-493.
- Ricci, U, (1930). Die "Synthetische Ökonomie" von Henry Ludwell Moore. *Zeitschrift für Nationalökonomie*. 1, 649-668.
- INSTAT (2013). *Statistical Institute. (Instituti i Statistikave)*: [www.instat.gov.al](http://www.instat.gov.al), Albania
- Suoping, L & Linong, W (2006). Analysis of China Vegetables Supply on the Price of Reaction. *Journal of Agro-technical Economics*, 5, 59-62.
- Taylor, BJ (1980). Aggregate demand and staggered contracts. *Journal of Political Economy*, 88, 1–23.
- Tinbergen, J, (1930). Bestimmung und Deutung von Angebotskurven, Ein Beispiel. *Zeitschrift für Nationalökonomie*. 1, 669-679.
- Woodford, M (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press, New Jersey: Princeton.
- Ximing, Z (1997). The Rising 'Vegetable Prices and Its Comprehensive Management China Price' 4, 19-20.

