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CONTENTS

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   INTRODUCTION

   REVIEW OF LITERATURE

   NEED/IMPORTANCE OF THE STUDY

   STATEMENT OF THE PROBLEM

   OBJECTIVES

   HYPOTHESES

   RESEARCH METHODOLOGY

   RESULTS & DISCUSSION

   FINDINGS

   RECOMMENDATIONS/SUGGESTIONS

   CONCLUSIONS

   SCOPE FOR FURTHER RESEARCH

   ACKNOWLEDGMENTS

   REFERENCES

   APPENDIX/ANNEXURE

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CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

JOURNAL AND OTHER ARTICLES

- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

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- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, Kurukshetra University, Kurukshetra.

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- Garg, Bhavet (2011): Towards a New Natural Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

MEASURING PRICE INSTABILITY OF PULSES IN BANGLADESH

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ABSTRACT

This study assessed price instability of pulses in Bangladesh by using time series data. For measuring the instability, it argues the "norm-price level" then the deviations from that level will be the instability but this norm-level cannot be unique because it depends on person's view. Average model, random walk model, linear trend model, exponential trend model and ARIMA (Autoregressive Integrated Moving Average) model were applied to determine the long run price instability of pulses. Average viewers had a feeling of more price instability than others. ARIMA type models showed the lowest price instability for all kinds of pulses because of the more flexibility in the ARIMA application procedure in historical simulation. Trend viewers felt less price instability than naïve viewers for the five kinds of pulses.

KEYWORDS
agriculture, instability, price, pulse.

INTRODUCTION

Productions and prices are not stable in agriculture over the time, they fluctuate yearly, monthly, weekly even day to day, and the extent of fluctuation varies from commodity to commodity depends on the characteristics (physical and also the capacity of tolerance with an adverse natural situation in the life cycle) of the commodity. Policy makers try to help the producers and consumers to reduce the impact of unstable prices through implementing some price policies and structural policies. Instability in prices is the big issues to the policy makers for the most developing countries. They have to set a certain policy for the certain crops on the basis of the extent of instability. According to Gangwar and George (1971, p.71), instability is one of the important decision parameter in development dynamics and more so in the context of agricultural production. Because price and yield instability affects area allocation of farmers to crop production enterprise. Such knowledge of instability will also be of help to the farmers in making suitable production and investment decisions, and to the financing institutions in judging the repayment capacity and risk to the farmers. Ahmed and Bernard (1989, p. 11), stabilization of prices, particularly of major food grains, is a serious concern of most developing countries.

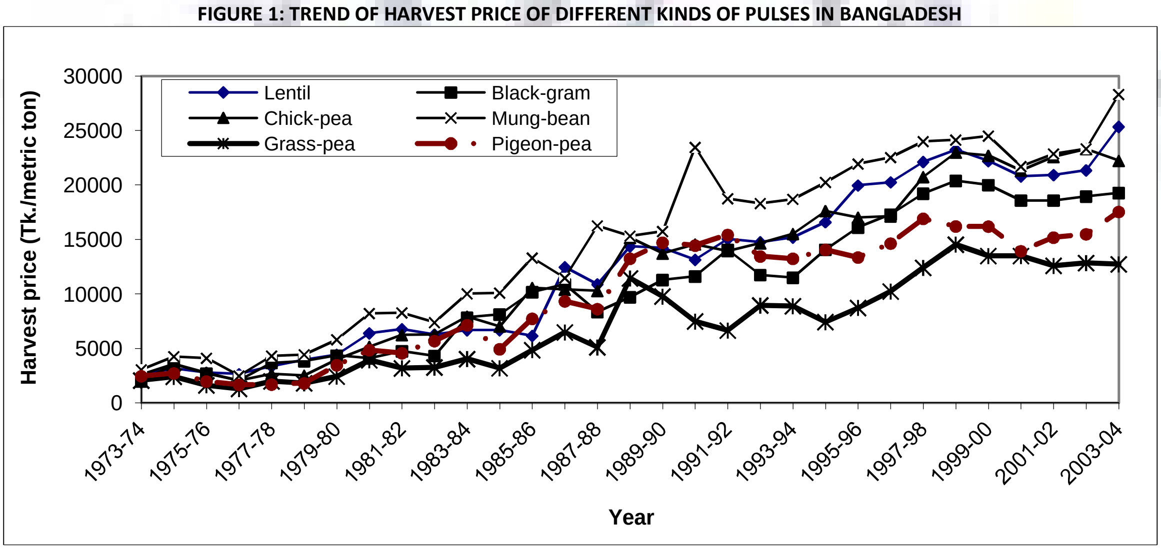
Price instability creates an uncertainty, both for producers and consumers. Farmers are handicapped in making future plans when prices are highly variable. Price uncertainty can lead to unwillingness on the part of producers to make investments. Consumers, processors, and retailers also would prefer to have more stable supplies and prices of farm commodities. Government intervention through price-support loans and guaranteed prices of producers also may serve to dampen price instability or to provide better guides for planning future production (Tomek and Robinson, 1990, p. 174). An analysis of fluctuations in price and crop output apart from growth is important for understanding the nature of crop security and income stability. Wide fluctuation in price not only affect crop output and bring about sharp fluctuations in them but also result in wide variations in disposable income of the farmers. The magnitude of fluctuations depends on the nature of crop production technology, its sensitivity to weather, economic environment, availability of material inputs and many other factors (Kaushik, 1993.p. 337). For that reason, it is an important task to measure the extent of instability in agricultural prices, so that the government can take appropriate plans to solve the high instability into a considerable range. And finally that will be helpful for the macro economic development of the country. So, the main target of this study is to apply the statistical and econometric models for measuring the instability in prices of pulses in Bangladesh.

TREND OF PRICES OF DIFFERENT KINDS OF PULSES

The tendency of prices to move up or down over a longer period of time (not concerned with one year to another) is termed as trend (Acharya and Agarwal, 1994, p. 72). Trends in agricultural prices are associated with general inflation and deflation in the economy and with factors specific to agricultural products, including changes in the tastes and preferences of consumers, increases in population and income, and technological changes in production (Tomek and Robinson, 1990, p. 165).

For instance, if we see the harvest (and wholesale) price series of different types of pulses in Bangladesh over the last 30 years, there are clearly upward drift curves with the time pass (Figure 1). Agricultural production is influenced by the so many factors in the long run such as increase in demand (or decrease), development of new technology (or constant), change of comparative advantages among the products, government policy, disease resistant of the crops etc. And these have an impact on the prices of that product.

FIGURE 1: TREND OF HARVEST PRICE OF DIFFERENT KINDS OF PULSES IN BANGLADESH



Source: Own figure, data from BBS of different yearbooks.

REVIEW OF LITERATURE

If prices remain unstable or show a high degree of instability, most activities and decisions are affected adversely and economic efficiency is reduced (Acharya and Agarwal, 1994, p. 158). For that reason, commodity market stabilization has received a great deal of attention in the literature since the first theoretical analysis of market stabilization developed by Waugh (1944), he showed that in a certain sense at least, consumers are harmed by price stability, and that they benefit from the instability of prices. Some authors criticized this conclusion also. Alam et al, 1996 estimated the nature and degree of instability in yield, production and price of agricultural crops by using the coefficient of variation. Other research works have been done on pulses by many authors, these are growth and supply response of pulses (Deshpande *et al*, 1982), identification of constraints to pulse production (Elias *et al*, 1986), growth trends in area, production and productivity of pulses (Sodhiya-Hc, 1989, Dhakal, 1993, Khan, 1998), economic analysis of growth and instability in pulses production (Jain *et al*, 1991, Sabur, 1996), marketing problems of pulses in Bangladesh (Rahman and Kashem, 1993).

Maritim (1988) conducted a study on instability of marketed output of maize in Kenya; the author used the model, which is proposed by Cuddy and Della Valle (1978) for determining the marketed output instability of maize. This method is a popular and widely used in many cases (e.g., yield, production, price, area cultivation etc.) for measuring the instability. Morgan *et al* (1994), they have measured the price variability by different way, they used the mean (or median) of the absolute value of the growth rate as a good indicator of volatility/ instability. Sarris (2000) has done a depth study on instability of world cereal (rice, wheat and maize) market. The author measured the instability in annual cereal prices and also the intra-year price variability. The author suggested constructing a model of the underlying trend price. Then instability can be defined as the deviation of the observed price from the trend.

Herrmann and Kirschke (1987), they analyzed the uncertainty on world coffee market by different ways on the basis of different views of the participants. Because, they thought that single model cannot be the representative measure of the price uncertainty. Price uncertainty/ instability is a relative thing; different people think it in different ways, so that, it is better to apply the methods that can be able to give ideas for the different viewers. I think this study has given broader aspects to the measurement of instability. They used average model, random walk model, linear trend model, exponential trend model, linear econometric model, log-linear econometric model and ARIMA model to analyze the price uncertainty (/instability) of coffee in the world market. They used root mean square error (RMSE) and the mean absolute percentage error (MAPE), which are the standard indicators to identify how a chosen model actually fits to the data. They found that the random walk model simulated the coffee prices more accurate than the average model that means the viewers of random walk model will feel less degree of uncertainty in the past than a person having an average model view. The trend model was slightly superior to the random walk model. Hence, a trend thinker will feel less degree of uncertainty in the past than a naïve viewer. Econometric model was superior to the previous four models considering the goodness of fit. Finally, they found that the ARIMA model had been fitted the data very well. It does not mean that the previous modes are not correct, all models are correct but the matter is, how a person wants to view the uncertainty in the past. The market participants who base their expectations on ARIMA models will have exposed to a relatively small degree of uncertainty in the past.

So, my observation from this review of literature section, instability is not an absolute something or it is not only involved in unique measure because as already we observed some measurements in the literature review. So, we should look it from the different points of view. For that reason, it is better to apply the different models in a same study to capture the different perceptions of the different people involved in this sector. Then we can give a comparative instability situation of different views.

OBJECTIVE OF THE STUDY

The main target of this study is to apply the statistical and econometric models for measuring the instability in prices of pulses in Bangladesh.

RESEARCH METHODOLOGY

SELECTION OF PRICES

Monthly wholesale prices of pulses were taken for the study. Policy regarding on these prices will help to the farmers directly. After that, which price will be used nominal price or real price (deflated price)? Some authors (Blandford, 1983; Ahmed and Bernard, 1989; Acharya and Agarwal, 1994; Singh and Mathur, 1994; Das, 1999; Hossain, 2005) have used nominal price and some authors (Goodwin, 1994; Alam, 1997; Sarris, 2000; Barua, 2001) have used real price in their analysis for measuring the instability. And some authors (Wahid, 1995; Begum, 2006), they have used both prices at a time. According to Tomek and Robinson (1990, p. 311), they argue that there are two reasons of deflating the nominal price; one is related to economic theory and other to statistical problems. As an economic theory, demand analysis suggests that it is appropriate to deflate if, when all prices and income increase or decrease by the same percentage, but demand remains unchanged. Deflating is not appropriate, when demand for the product changes in response to nominal prices even though real prices have not changed.

In this study, nominal price had been used for measuring the price instability. Because, this study is not like demand theory analysis, moreover, participants (i.e., farmers, traders, policymakers, and so on) who are involved in this sector, they are more concerned about the nominal price to realize the price instability, and of course, the participants, farmers they always think about the nominal price not the real price.

MEASURING THE PRICE INSTABILITY OF PULSES OVER A LONG PERIOD OF TIME

There is no any unique/definite technique as such that can only be used in measuring the instability. Because it's not an absolute something, it's a relative matter. It depends on different thinking of different participants. One can assume that the mean value of the past observations will be the base of the deviation for making the instability or fluctuation, another one can take previous year value, someone can assume the base will be the trend line (and also trend lines are different types) and so on. So, there are different types of perceptions of different persons. Coppock (1977, p. 4) stated, "Instability should not be understood to mean any deviation from a fixed level. It means excessive departure from some normal level. However, there is no way of determining a priori the meaning of excessive and normal."

AVERAGE MODEL

In this model, people expect that the future value (price) will be the average of the past values. This is the simple expectation of the persons about the future. If it does not happen then it will be said that there are some levels of fluctuation in the price in this case. This can be written as equation as follows (Herrmann and Kirschke, 1987, p. 31):

$$E[p_{n+1}] = \frac{1}{n}\sum_{t=1}^{n} p_t \quad \text{.......................................(1)}$$

where, t= 1, 2, 3, ………………………………, n time series,

p = price of pulse.

Goodness of fit is calculated to the actual price data. And the calculations are done on the basis of simulation error (e), which is expressed as

$$e_t = \hat{p}_t - p_t \quad \text{.......................................(2)}$$

where, $\hat{p}_t$ = predicted price

For assessing the goodness of fit, root mean square error (RMSE) and the mean absolute percentage error (MAPE)[1] are applied for all the five models. And these indicators are widely used in the econometric analysis. The RMS error is a measure of the deviation of the simulated variable from its time path (Pindyck and

[1] These are the important statistics for forecast evaluations. See, Makridakis, Wheelwright and McGee (pp. 43 and so on).

Rubinfeld, 1998, p. 210). Finally, the simulated error of a particular model is compared to that one of the random walk model by considering the U'[2]. The model is considered superior to such naive forecasting if U'<1(Herrmann and Kirschke, 1987, p. 32). Average model and random walk model considered as naive views.

RANDOM WALK MODEL

Another group of people, they can think that the current price will be the expected price of future period. This can be defined as follows

$$E[p_{n+1}] = P_n \quad \text{……(3)}$$

LINEAR TREND MODEL

Trend model (linear and exponential) is the group of those persons who want to deviate the actual value from the fitted trend line (they assumed this trend line is the norm-level) for considering the fluctuation of price. The linear trend model explains that the price will increase (or decrease) in the constant absolute amounts in each period of time. This model is defined as follows

$$P_t = a + bt \quad \text{……(4)}$$

EXPONENTIAL TREND MODEL

The exponential trend model explains that the price will increase (or decrease) in the constant percentage amounts in each period of time rather than constant absolute amounts (Pindyck and Rubinfeld, 1998, p. 469). This model is expressed as follows:

$$P_t = ae^{bt} \quad \text{……(5)}$$

This equation can be written as (by taking natural logarithm in both sides)

$$\ln P_t = \alpha + bt \quad \text{……(6)}$$

Where, $\alpha = \ln a$ and ln= natural logarithm, coefficient of 't' i.e., '*b*' indicates the constant percentage change if it is multiplied by 100.

AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) MODEL

Most economic time series data are non-stationary in the nature i.e., they have a tendency of upward or downward drift during the time period. In other words, non-stationary time series will have a time varying mean or a time varying variance or both. This non-stationary gives the spurious results in regressing analysis. So, it is very important to take care of this behavior in regression analysis particularly where this analysis is run for the forecasting purpose. According to Gujarati (2003, p. 798), if a time series is non-stationary, we can study behavior only for the time period under consideration. Each set of time series data will therefore be for a particular episode. As a consequence, it is not possible to generalize it to other time periods. Therefore, for the purpose of forecasting, non-stationary time series may be of little practical value.

So, we need to check the stationary of time series data before proceeding analysis. Graphical method (by plotting the original time series data), correlogram, and unit root test have been applied to identify the stationarity in the original data series of pulses. Previous data series of stationary level have been used for the analysis.

The process of ARIMA models are given below:

u-th order autoregressive [AR (u)] model-

$$p_t = \delta + \phi_1 p_{t-1} + \phi_2 p_{t-2} + \ldots\ldots + \phi_u p_{t-u} + \varepsilon_t \quad \text{……(7)}$$

v-th order moving average [MA (v)] model-

$$p_t = \mu + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots\ldots + \theta_v \varepsilon_{t-v} + \varepsilon_t \quad \text{……(8)}$$

Mixed autoregressive and moving average (ARMA) process-

Because many stationary random processes cannot be modeled as purely moving average or as purely autoregressive, since they have the qualities of both types of process (Pindyck and Rubinfeld, 1998, p. 535). The ARMA process of order (u, v) will be –

$$p_t = \phi_1 p_{t-1} + \ldots\ldots + \phi_u p_{t-u} + \delta + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \ldots\ldots + \theta_v \varepsilon_{t-v} \quad \text{……(9)}$$

RESULTS AND DISCUSSIONS

LONG RUN PRICE INSTABILITY OF LENTIL

Monthly wholesale price was converted into average annual wholesale price for the non-ARIMA models. And for the ARIMA model, monthly wholesale price was used for determining the fitted ARIMA model, after that by using the fitted model, estimated monthly wholesale prices were determined then the series were converted into estimated average annual wholesale price series, and finally the root mean square error (RMSE), mean absolute percentage error (MAPE), and U' (advantage compared with the random walk model) were calculated on the basis of estimated average annual wholesale price; these estimates indicate the goodness of fit of the model and also the level of instability (or risk). And this same procedure has been followed for all kinds of pulses.

The fitted linear trend model:

$$\hat{P}_t = 1157.55 + 100.44t \quad \text{……(4.1)}$$

t= (9.84) (10.23)

($\overline{R}^2$ =0.845, F = 104.58 and DW = 1.394)

RMSE= $\sqrt{\frac{1}{n}\sum_{t=1}^{n} e_t^2}$ and MAPE= $\frac{1}{n}\sum_{t=1}^{n}\frac{|e_t|}{p_t}$

[2] U' = $\sqrt{\frac{\sum_{t=1}^{n} e_t^2}{\sum_{t=1}^{n}(p_{t-1} - p_t)^2}}$

Where, Pt is the average annual wholesale price of lentil, t= 1, 2, 3,……….n, $\overline{R}^2$ = adjusted coefficient of determination (measures the goodness of fit of the regression equation generally), F= F-value (measures the overall significance of the estimated regression) and DW = Durbin-Watson coefficient (measures the presence of autocorrelation in the time series).

The fitted exponential trend model:

$$\ln \hat{P}_t = 1323.36 + 0.0453t \quad \text{………………………………………(4.2)}$$

t-value: (169.45) (12.79)

($\overline{R}^2$ =0.895, F= 163.54 and DW= 1.714)

Both models have fitted the data well. On the basis of above equations, other estimates are depicted in the Table 4.1. The estimates of average model, random walk model and ARIMA model are also given in the same Table.

For applying the ARIMA model, at first the data were checked whether it is stationary or non stationary. There was an upward tendency of the monthly wholesale price of lentil, the mean and variance do not seem to be time-invariant, and hence there is an indication of non-stationary. Autocorrelations were significantly different from zero, and they were gradually decreasing, that means the process is non-stationary. Partial autocorrelation function indicated that, the first difference data might have stationary because the partial autocorrelation for the first lag was highly significant then it had been dramatically dropped. After that, Dickey-Fuller (DF) test was used to test the unit root of the series. The results are given below:

Without trend model*:* $\Delta\hat{P}_t = 73.91 - 0.0275P_{t-1}$ ………………………………………(4.3)

t-value: (1.53) (-1.31)

With trend model*:* $\Delta\hat{P}_t = 185.35 - 0.161P_{t-1} + 1.51t$ ………………………………………(4.4)

t-value: (3.40) (-4.095) (3.967)

Augmented Dickey-Fuller test: $\Delta P_t = 159.37 - 0.14P_{t-1} + 1.36t - 0.09\Delta P_{t-1}$ ………………………………(4.5*)*

t-value: (2.75) (-3.310) (3.387) (-1.333)

[Critical tau (τ) values are –3.46 and –2.88 for the 1% & 5% level of significance respectively for the constant model; –3.99 and –3.43 for the 1% & 5% level of significance level for the constant with trend model]. Calculated value (in absolute term) of t for the coefficient of P_{t-1} (in equation 4.3) is less than the critical tau (τ) value, so there is a unit root, which means the data series is non-stationary. In equation (4.4), the t-value of the coefficient P_{t-1} is little bit larger than the critical tau (τ) value, so the result is different from the equation 4.3, but the augmented D-F test showed that there was a unit root, the autocorrelation function and partial autocorrelation function also indicated the idea of non-stationary. So, it can be concluded that the original data series was non-stationary. Then, it has to check that the first difference series is stationary or not.

$$\Delta\left(\Delta\hat{P}_{t-1}\right) = 15.71 - 1.17\Delta P_{t-1} \quad \text{………………………………………(4.6)}$$

t-value: (1.127) (-18.23)

Here, the calculated value (in absolute term) of t for the coefficient of ΔP_{t-1} (in equation 4.6) is much higher than the critical tau (τ) value, so the first difference of the data series was stationary. D-F test has proved that original series was not stationary but the first difference series was stationary. So, the ARIMA model had been applied for the first differenced series. Then autocorrelation function and partial autocorrelation function of the first differenced series of monthly wholesale price (because it is stationary) were used to specify the number of moving average and the number of autoregressive in the ARIMA model. And finally the diagnostic was checked for the specified model whether the residuals obtained by the used ARIMA are white noise or not[3], if it is white noise then the particular ARIMA specification is correct.

The best ARIMA specification was ARIMA (7,1,0) and only the $\Delta P_{t-1}, \Delta P_{t-6} and \Delta P_{t-7}$ lag terms (not $\Delta P_{t-2}, \Delta P_{t-3}, \Delta P_{t-4}$ and so on) were included in the model[4], because autocorrelations and partial autocorrelations were significantly different from zero for this lags, and regressed them on ΔP_t, the obtained estimates were given below:

ARIMA (7, 1, 0):

$$\Delta\hat{P}_t = 20.285 - 0.211\Delta P_{t-1} - 0.208\Delta P_{t-6} - 0.178\Delta P_{t-7} \quad \text{……………………………(4.7)}$$

t-value: (1.46) (-3.28) (-3.20) (-2.71)

($\overline{R}^2$ =0.076, F= 7.37, DW= 2.06)

The other estimates were calculated on the basis of the obtained predicted value, and the estimates were depicted in Table 1.

TABLE 1: DIFFERENT VIEWS & DIFFERENT LEVEL OF PRICE INSTABILITY OF LENTIL DURING THE PERIOD 1987 TO 2006 IN BANGLADESH

Model	RMSE (taka*/quintal)	MAPE (%)	U'
Average model	666.06	20.43	2.10
Random walk model	316.71	10.14	1.00
Linear trend model	240.28	7.97	0.78
Exponential trend model	218.80	7.20	0.71
ARIMA (7,1,0) model	58.62	1.80	0.19

*US$1= taka 67.0800 (Annual Report 2005-06, Bangladesh Bank, p. 177)

Source: Own calculation by using the data from BBS of different years.

[3] See Pindyck and Rubinfeld (1998, p.555)

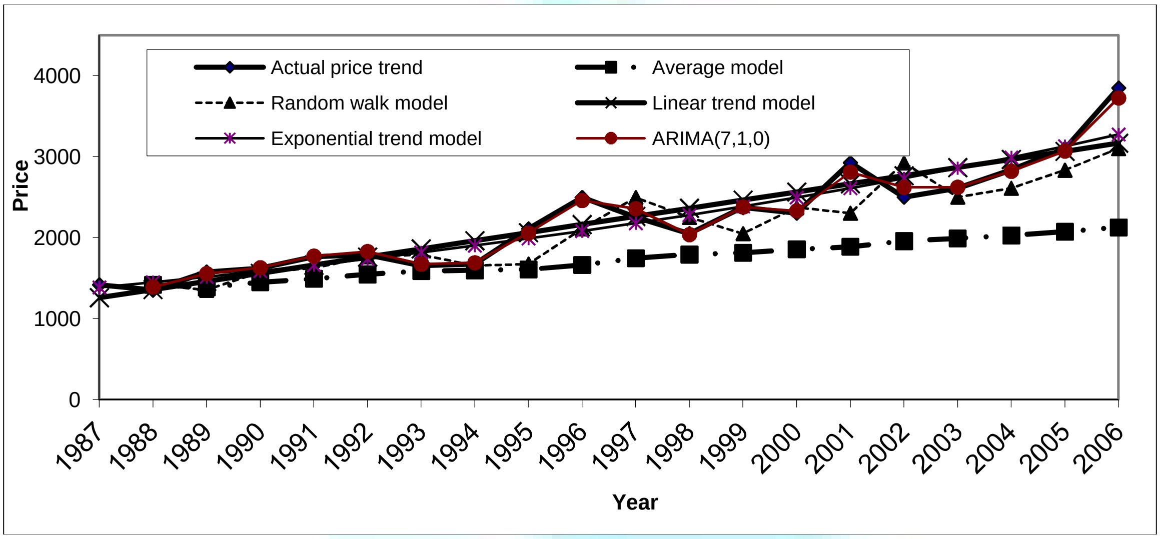
[4] See Gujarati, D.N. (1998,p. 742)

It is clear from the Table 1 that the people who think the instability from the average line, they felt more instability than other viewers for this particular data series because all of the estimates are larger for the average model than other models. Exponential model and linear trend model have shown the less instability than simple random walk model because the values of U' are less than the value of U' from the random walk model. And also the same situation was observed for the case of RMSE and MAPE. And finally, the ARIMA model had shown the lowest price instability, all estimates were found lower than other models. But it can not be justified to conclude that the average model or random walk model is not a good (or correct) model to determine the instability, because it's a perception of people's thinking from the norm-price level and that norm-price level differ from one person to another. So, all models are correct.

The average price line (Figure 1) was little bit more far than another model from the actual price line. Average viewers assumed the price fluctuations from that line which they think it as norm-price level. Linear trend line and exponential trend line was little bit more closer to actual price line than random walk model (though it is difficult to examine from the figure, but we have a numerical proof from the Table 1), for that reason they have made less instability to the trend viewers. ARIMA trend line is closest to the actual price line than another four-trend price lines. For that reason the estimates of RMSE, MAPE and U' were smallest.

The indicators of the historical simulation of price series of lentil for the ARIMA (7,1,0) model had been shown the less instability results than any other models. This model can simulate the time series more closely to the actual series. Because, analyst has more alternative choices for the selection of order for the autoregressive and moving averages to make appropriate ARIMA model, that means there are much flexibility in ARIMA selection.

FIGURE 2: COMPARING THE PREDICTED PRICE LINES OF LENTIL FOR THE DIFFERENT MODELS WITH THE ACTUAL PRICE LINE DURING THE PERIOD 1987-2006



Source: Own calculation by using the data from BBS of different years.

LONG RUN PRICE INSTABILITY OF CHICKPEA

Linear trend model:

$$\hat{P}_t = 1054.21 + 116.69t \qquad \text{.....(4.8)}$$

t-value= (7.12) (9.45)

($\bar{R}^2$ =0.823, F = 89.23 and DW = 1.385)

Exponential trend model:

$$\ln \hat{P}_t = 1248.66 + 0.0525t \qquad \text{.....(4.9)}$$

t-value= (143.45) (12.66)

($\bar{R}^2$ =0.893, F = 160.20 and DW = 1.216)

Identification of the series whether it is stationary or non-stationary:

Without trend model: $\Delta\hat{P}_t = -35.17 + 0.0232P_{t-1}$ .....(4.10)

t-value: (-1.15) (1.82)

With trend model: $\Delta\hat{P}_t = -17.09 - 0.00057P_{t-1} + 0.296t$ .....(4.11)

t-value: (-0.49) (-0.02) (1.03)

Augmented Dickey-Fuller test: $\Delta P_t = -3.96 - 0.111P_{t-1} + 0.366t + 0.067\Delta P_{t-1}$ .....(4.12)

t-value: (-0.105) (-0.365) (1.209) (0.940)

Here, sign of the coefficient of P_{t-1} (equation 4.10) is positive, so this coefficient cannot be considered for the D-F test[5]. The coefficient of P_{t-1} (equation 4.11 and 4.12) had been considered for the D-F test. Both of them proved that the series was non-stationary.

Identification of the first differenced series stationary or not:

$$\Delta\left(\Delta\hat{P}_t\right) = 16.59 - 0.927\Delta P_{t-1} \qquad \text{.....(4.13)}$$

t-value: (1.71) (-14.28)

In this case, the t-value of the coefficient ΔP_{t-1} proved the first differenced series stationary. In this way, it was found that the first differenced data of other pulses was stationary.

[5] see Gujarati, D.N. (2003, p.816)

ARIMA (5,1,5) model:

$$\Delta\hat{P}_t = 17.59 + 0.388\Delta P_{t-1} + 0.254\Delta P_{t-2} - 0.167\Delta P_{t-3} + 0.081\Delta P_{t-4} - 0.661\Delta P_{t-5}$$

t-value: (1.914) (2.633) (1.505) (-2.678) (36.42) (-12.416)

$$+0.375\varepsilon_{t-1} + 0.273\varepsilon_{t-2} - 0.131\varepsilon_{t-3} + 0.013\varepsilon_{t-4} - 0.622\varepsilon_{t-5} \quad \ldots\ldots(4.14)$$

(0.962) (1.405) (-0.658) (0.061) (-2.962)

The comparing estimates for the instability from the different models were computed and depicted on the Table 2. For the chickpea, it was found the same pattern of instability like lentil, if it is ranked on the basis of U' value then it would become average model>random walk model>linear trend model>exponential trend model>ARIMA model. Trend viewers could have less instability than the random walk and average viewers in the historical simulation.

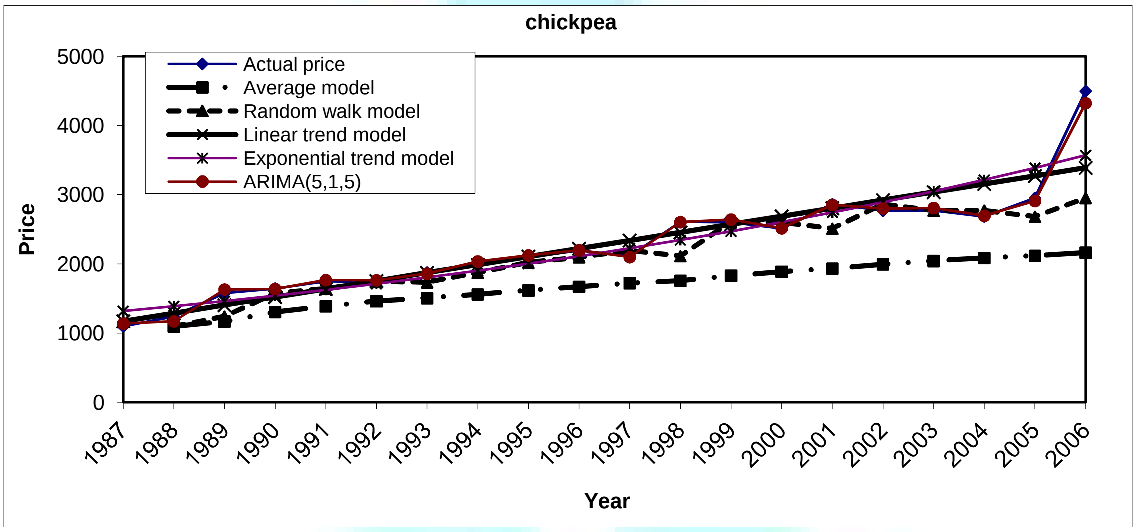
TABLE 2: DIFFERENT VIEWS & DIFFERENT LEVEL OF PRICE INSTABILITY OF CHICKPEA DURING THE PERIOD 1987 TO 2006 IN BANGLADESH

Model	RMSE (taka*/quintal)	MAPE(%)	U'
Average model	785.25	25.18	1.96
Random walk model	401.60	8.19	1.00
Linear trend model	302.20	6.75	0.77
Exponential trend model	290.69	8.49	0.74
ARIMA (5,1,5) model	49.10	1.49	0.13

*$1= taka 67.0800 (Annual Report 2005-06, Bangladesh Bank, p. 177)

Source: Own calculation by using the data from BBS of different years.

FIGURE 3: COMPARING THE PREDICTED PRICE LINES OF CHICKPEA FOR THE DIFFERENT MODELS WITH THE ACTUAL PRICE LINE DURING THE PERIOD 1987-2006



Source: Own calculation by using the data from BBS of different years.

LONG RUN PRICE INSTABILITY OF BLACK GRAM

Linear trend model:

$$\hat{P}_t = 917.60 + 88.54t \quad \ldots\ldots(4.15)$$

t-value: (5.03) (5.81)

($\bar{R}^2$ =0.652, F = 33.73 and DW = 1.015)

Exponential trend model:

$$\ln\hat{P}_t = 1073.93 + 0.0469t \quad \ldots\ldots(4.16)$$

t-value: (93.52) (7.53)

($\bar{R}^2$ =0.745, F = 56.64 and DW = 1.216)

ARIMA (0,1,11) model:

$$\Delta\hat{P}_t = 16.15 + 0.11\varepsilon_{t-1} + 0.049\varepsilon_{t-2} + 0.055\varepsilon_{t-3} + 0.070\varepsilon_{t-4} + 0.058\varepsilon_{t-5} + 0.129\varepsilon_{t-6}$$

t-value: (1.58) (1.70) (0.75) (0.85) (1.04) (0.84) (1.89)

$$-0.056\varepsilon_{t-7} + 0.030\varepsilon_{t-8} - 0.086\varepsilon_{t-9} - 0.091\varepsilon_{t-10} - 0.275\varepsilon_{t-11} \quad \ldots\ldots(4.17)$$

(-0.82) (0.44) (-1.25) (-1.32) (-3.94)

Calculated different estimates on the basis of the five models are depicted in Table 3. It is observed that the average viewers had more feelings of price instability than others. If it is ranked on the basis of RMSE or MAPE or U', it would be the same ranking in accordance with the models stated in this Table. Trend viewers would feel less instability than naïve viewers. Again the level of instability for the ARIMA participants was very low because of the special statistical features of this model. The fitted line is much closer to the actual price line (Figure 4).

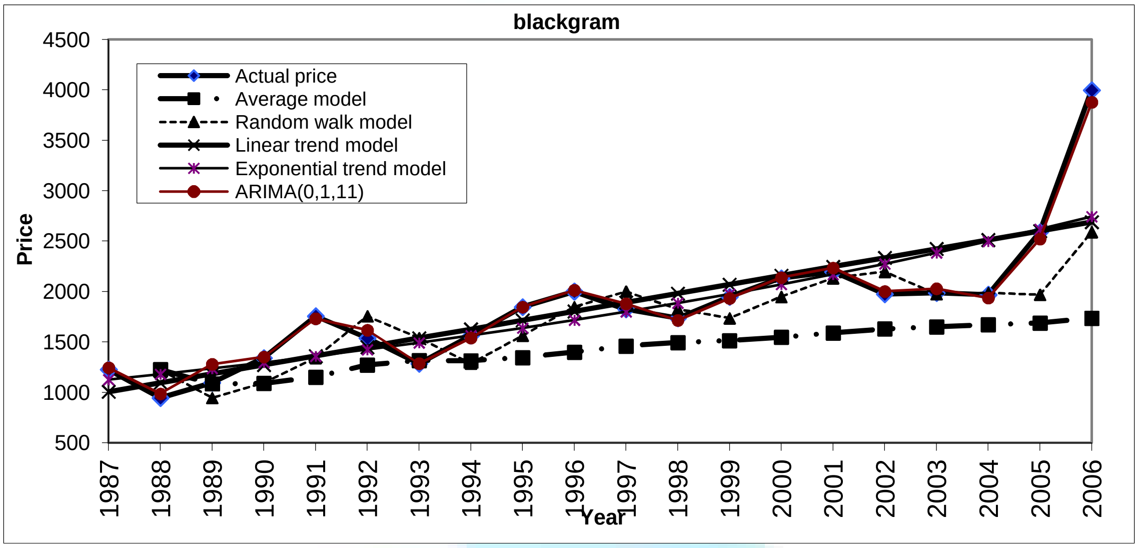
TABLE 3: DIFFERENT VIEWS OF THE PRICE INSTABILITY OF BLACK-GRAM DURING THE PERIOD 1987 TO 2006 IN BANGLADESH

Model	RMSE (taka*/quintal)	MAPE (%)	U'
Average model	673.01	22.60	1.65
Random walk model	408.09	14.17	1.00
Linear trend model	372.95	12.22	0.94
Exponential trend model	357.43	11.55	0.90
ARIMA (0,1,11) model	59.47	2.49	0.15

*$1= taka 67.0800 (Annual Report 2005-06, Bangladesh Bank, p. 177)

Source: Own calculation by using the data from BBS of different years.

FIGURE 4: COMPARING THE PREDICTED PRICE LINES OF BLACK-GRAM FOR THE DIFFERENT MODEL WITH THE ACTUAL PRICE LINE DURING THE PERIOD 1987-2006



Source: Own calculation by using the data from BBS of different years.

LONG RUN PRICE INSTABILITY OF MUNG-BEAN

Linear and exponential, both trend models had fitted the data well considering the $\overline{R}^2$ & F value and also it can be observed from the Figure 5 because the fitted lines are closer to the actual price line. The results of the all models that made a comparison of instability among the models were given in Table 4.

Linear trend model:

$$\hat{P}_t = 1349.81 + 105.05t \qquad \text{...(4.18)}$$

t-value: (8.148) (7.60)

($\overline{R}^2$ =0.749, F = 57.70 and DW = 1.184)

Exponential trend model:

$$\ln \hat{P}_t = 1504.38 + 0.0430t \qquad \text{...(4.19)}$$

t-value: (142.28) (10.03)

($\overline{R}^2$ =0.840, F = 100.59 and DW = 1.10)

ARIMA (1, 1, 0):

$$\Delta\hat{P}_t = 19.224 - 0.352\Delta P_{t-1} \qquad \text{...(4.20)}$$

t-value: (1.64) (-5.69)

($\overline{R}^2$ =0.117, F= 32.40, DW= 1.99)

To determine the predicted value for the series, the equation (4.20) can be written as-

$$\hat{P}_t = 19.224 + P_{t-1} - 0.352(P_{t-1} - P_{t-2}) \qquad \text{...(4.21)}$$

Here also the trend viewers had a less feeling of price instability of mung bean than naïve viewers because the value of U' was smaller for the trend model (Table 4). The participants of average model thinking suffered more instability than other model thinkers in the period 1987 to 2006. And there was a same sequence of the results whether it was RMSE or MAPE or U'. ARIMA model showed the lowest instability as well as for the previous pulses also.

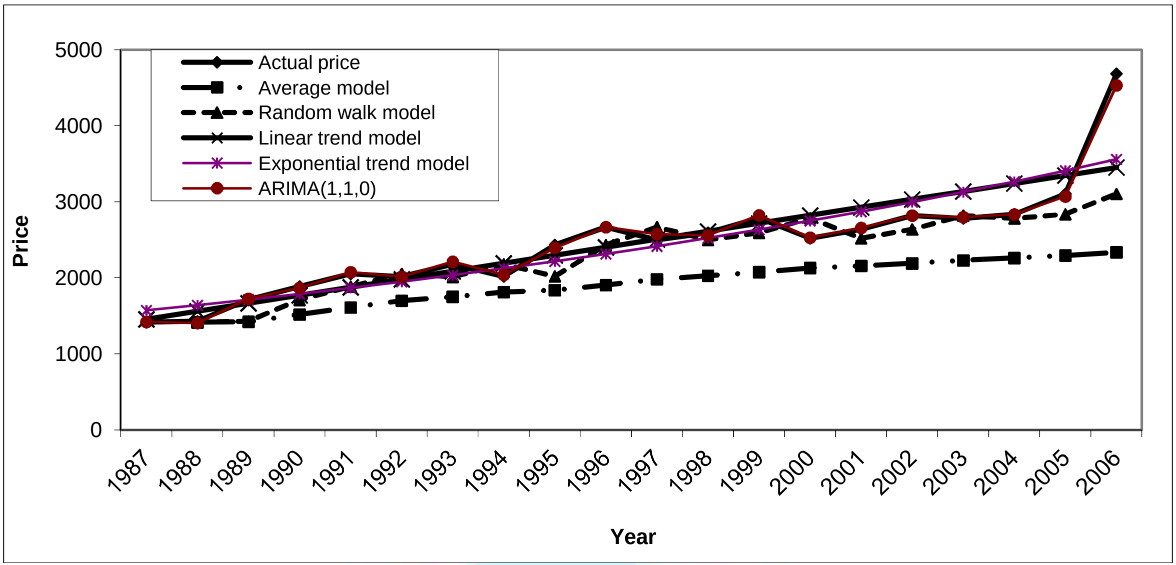
TABLE 4: DIFFERENT VIEWS OF THE PRICE INSTABILITY OF MUNG-BEAN DURING THE PERIOD 1987 TO 2006 IN BANGLADESH

Model	RMSE (taka*/quintal)	MAPE (%)	U'
Average model	738.48	20.95	1.80
Random walk model	409.54	8.57	1.00
Linear trend model	338.32	7.72	0.85
Exponential trend model	328.54	8.73	0.82
ARIMA (1,1,0) model	43.75	1.04	0.11

*$1= taka 67.0800 (Annual Report 2005-06, Bangladesh Bank, p. 177)

Source: Own calculation by using the data from BBS of different years.

FIGURE 5: COMPARING THE PREDICTED PRICE LINES OF MUNG-BEAN FOR THE DIFFERENT MODEL WITH THE ACTUAL PRICE LINE DURING THE PERIOD 1987-2006



Source: Own calculation by using the data from BBS of different years.

LONG RUN PRICE INSTABILITY OF GRASS PEA

Linear trend model:

$$\hat{P}_t = 766.73 + 35.53t \quad \text{.......(4.22)}$$

t-value: (7.66) (4.26)

($\overline{R}^2$ =0.474, F = 18.11 and DW = 1.729)

Exponential trend model:

$$\ln \hat{P}_t = 796.24 + 0.0312t \quad \text{.......(4.23)}$$

t-value: (81.24) (4.55)

($\overline{R}^2$ =0.509, F = 20.72 and DW = 2.0)

ARIMA (7,1, 7):

$$\Delta\hat{P}_t = 4.815 + 0.614\Delta P_{t-1} - 0.224\Delta P_{t-2} - 0.028\Delta P_{t-3} - 0.239\Delta P_{t-4} - 0.048\Delta P_{t-5}$$

t-value: (0.74) (7.40) (-1.53) (-0.44) (-1.68) (-0.71)

$$+0.762\Delta P_{t-6} - 0.639\Delta P_{t-7} + 0.647\varepsilon_{t-1} - 0.274\varepsilon_{t-2} + 0.046\varepsilon_{t-3} - 0.327\varepsilon_{t-4}$$

(5.50) (-17.26) (0.25) (-0.07) (0.02) (-0.57)

$$+0.056\varepsilon_{t-5} + 0.728\varepsilon_{t-6} - 0.537\varepsilon_{t-7} \quad \text{.......(4.24)}$$

(0.02) (0.33) (-0.20)

Here also the same results of sequences were observed in Table (5) as previously observed for other pulses. On the basis of U' or MAPE or RMSE, average model viewers had more feelings of instability than others. ARIMA model showed the lowest level of instability. And the linear trend viewers had an advantageous position than naïve viewers. Here one thing is noticeable that the level of instability of grass pea (whether on the basis of MAPE or U') for the average model was lowest than other pulses previously analyzed. It can be observed from the pattern of average line in Figure 6, the line was closer to actual price line than previous Figures.

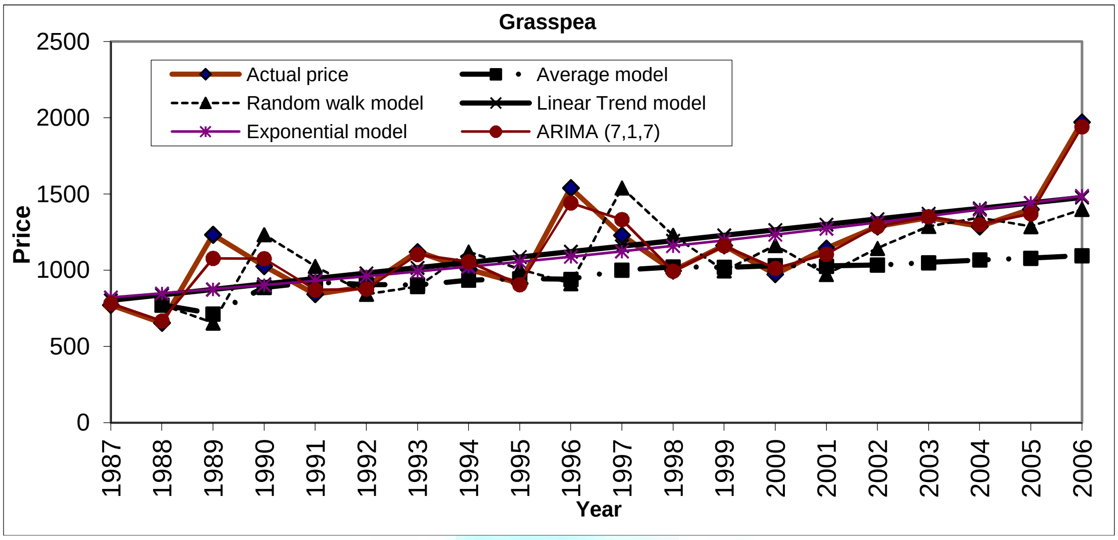
TABLE 5: DIFFERENT VIEWS OF THE PRICE INSTABILITY OF GRASS PEA DURING THE PERIOD 1987 TO 2006 IN BANGLADESH

Model	RMSE (taka*/quintal)	MAPE (%)	U'
Average model	314.84	17.30	1.12
Random walk model	281.39	18.37	1.00
Linear trend model	204.26	13.61	0.74
Exponential trend model	201.19	12.89	0.73
ARIMA (7,1,7) model	52.96	3.05	0.19

*$1= taka 67.0800 (Annual Report 2005-06, Bangladesh Bank, p. 177)

Source: Own calculation by using the data from BBS of different years.

FIGURE 6: COMPARING THE PREDICTED PRICE LINES OF GRASS PEA FOR THE DIFFERENT MODEL WITH THE ACTUAL PRICE LINE DURING THE PERIOD 1987-2006



Source: Own calculation by using the data from BBS of different years.

LONG RUN PRICE INSTABILITY OF PIGEON-PEA

Linear trend model:

$$\hat{P}_t = 1452.78 + 27.25t \quad \text{.......(4.25)}$$

t-value: (12.31) (2.63)

($\overline{R}^2$ =0.248, F = 6.94 and DW = 0.732)

Exponential trend model:

$$\ln \hat{P}_t = 1434.71 + 0.017t \quad \text{.......(4.26)}$$

t-value: (98.10) (2.62)

($\overline{R}^2$ =0.246, F = 6.87 and DW = 0.784)

ARIMA (0, 1, 1):

$$\Delta\hat{P}_t = 6.965 + 0.466\varepsilon_{t-1} \quad \text{.......(4.27)}$$

t-value: (1.364) (7.870)

The value of U' is less for the random walk model than the average and trend models (Table 6). Random walk viewers had less feeling of price instability of pigeon pea than the average & trend viewers. Linear trend and exponential trend both of them had more or less the same degree of instability. And the ARIMA model showed the lowest instability as like as previous pulses.

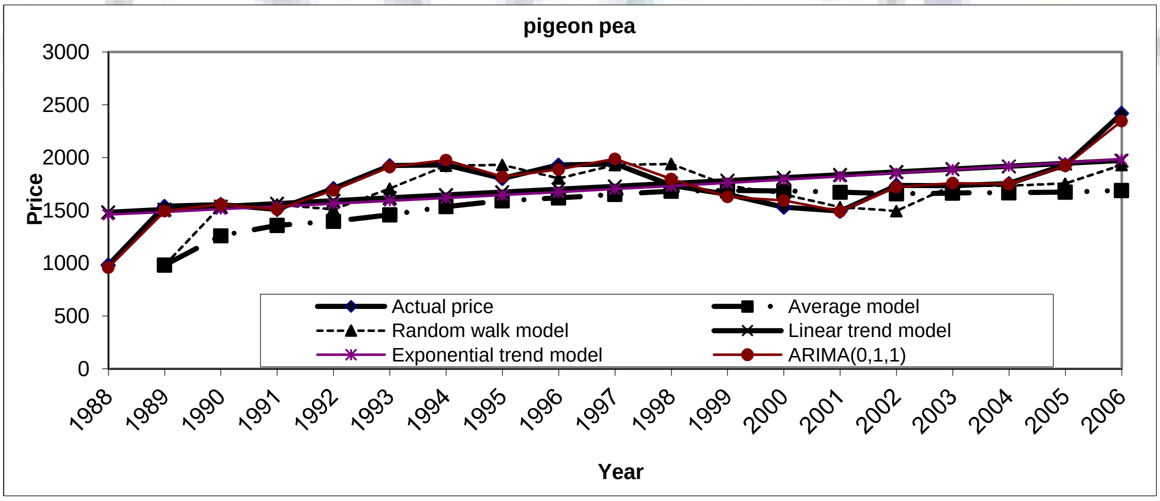
TABLE 6: DIFFERENT VIEWS OF THE PRICE INSTABILITY OF PIGEON-PEA DURING THE PERIOD 1988 TO 2006 IN BANGLADESH

Model	RMSE (taka*/quintal)	MAPE (%)	U'
Average model	315.38	13.42	1.47
Random walk model	214.08	8.31	1.00
Linear trend model	233.69	11.60	1.12
Exponential trend model	235.46	11.74	1.13
ARIMA (0,1,1) model	35.20	1.56	0.17

*$1= taka 67.0800 (Annual Report 2005-06, Bangladesh Bank, p. 177)

Source: Own calculation by using the data from BBS of different years.

FIGURE 7: COMPARING THE PREDICTED PRICE LINES OF PIGEON-PEA FOR THE DIFFERENT MODEL WITH THE ACTUAL PRICE LINE DURING THE PERIOD 1988-2006



Source: Own calculation by using the data from BBS of different years.

RANKING OF PULSES ON THE BASIS OF PRICE INSTABILITY

It was important to know that which pulse was more instable in price than others. For identifying this, at first the pulses were ranked for the each model on the basis of MAPE (MAPE higher means more instable), then the ranked was made for the overall basis. For instance, grass pea was first ranking for the four models (/viewers) and chickpea was also in the first ranking but only for one model, so grass pea was assumed in the first ranking, and so on. That means, the price instability of grass pea was highest in that period.

TABLE 7: RANKING OF PULSES ACCORDING TO THE LEVEL OF INSTABILITY MEASURED BY THE MAPE FOR THE DIFFERENT MODELS (/VIEWERS)

Ranking	Average model	Random walk model	Linear trend model	Exponential trend model	ARIMA model	**Overall**
1	Chickpea	Grass pea	Grass pea	Grass pea	Grass pea	Grass pea
2	Black gram	Black gram	Black gram	Pigeon pea	Black gram	Black gram
3	Mung-bean	Lentil	Pigeon pea	Black gram	Lentil	Lentil
4	Lentil	Mung-bean	Lentil	Mung-bean	Pigeon pea	Mung-bean
5	Grass pea	Pigeon pea	Mung-bean	Chickpea	Chickpea	Chickpea
6	Pigeon pea	Chickpea	Chickpea	Lentil	Mung-bean	Pigeon pea

N.B.: low value of the ranking indicates higher instability

Source: Own identification from the analysis

Grass pea has neurotoxin substance that is harmful for the health, if it is consumed for long term (3-4 months continuous) then it becomes the cause of lathyrism, that makes the people unable to walk (but till now it is debating also), scientist are trying to develop such varieties that contains low level of that toxin, and already they have developed some varieties. So that it cannot be a problem any more. Also they are suggesting that after soaking over night, then if it is cooked and consumed, the low possibility of getting that disease (Malek et al, 1995, p. 7). So some times, people think that consumption of grass pea is not good, then demand for grass pea decreases as a consequence price decreases, and also sometimes publicity makes them awareness in favor of grass pea consumption then the demand for grass pea increases as a result price increases. For that reason demand is fluctuating more for grass pea.

CONCLUSION

This study had been tried to give a details of instability in prices of major pulses in Bangladesh over the last two decades on the basis of different types of instability viewing. The study analyzed the data in different ways to capture the different views of instability for the different participants in this sector. Hence, the better policy alternatives can be realized to solve the particular problems from the different instability views.

Different models had been applied to assess the price instability of pulses for the different viewers. Among all the models, ARIMA type model showed the lowest price instability for all kinds of pulses because of the flexibility to application and also I would like to say, it's more about trial and error process to find out the specification that yields the better fit to the data. Trend model showed lower price instability than the naïve models most of the cases.

On the basis of overall instability, grass pea was in the first ranking that means it revealed highest price instability in the pulse sector. All kinds of viewers had a feeling of more price instability for the grass pea in the last two decades. Because of more volatility in the demand side, due to some problems of consuming grass pea on the human health. So, needs more publicity regarding the better way of consuming grass pea that can not be harmful any more and also need to develop minimum toxin contains grass pea. Lentil, grass pea, black gram, chickpea these are the important pulses on the basis of consumer preference and production as well but these were having more instability, so, the emphasis (price policy and structural policy) should be given more on these four kinds of pulses for the development of this sector.

This research was based on secondary data only, so the farm and market level primary information (regarding production problems, returns compared to other crops, marketing problems, farmers opinions, factors influencing demand and supply, etc.) were not included in this paper; so for further study regarding this subject, it will be more fruitful to include both types of data.

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