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***Research Article***

# Forecasting volatility of quality for wheat soya blend products in the statistical model of ARCH

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## Abstract

Present work has explored the impact of type of food products on testing for ARCH effects and on the estimation of ARCH models for food products analysis data. Our sample comprises physiochemical and microbial analysis data for food products. In our analysis the different value for different variables of parameters of the ARCH-LM test; the lags are 1. The corresponding p-value is >0.05, which is very high. So we have no difficulty to accept the null hypothesis of no ARCH error in the analysis series. The parameters of Wheat Soya Blend (WSB) analysis are insignificant that means no ARCH effects of the models. The estimation results are given in the table 3 shows that the values of Dickey–Fuller (DF) test for all variables p-value<0.05 at 5%, level of significance except Sugar (as sucrose) (%) and Standard Plate Count (cfu/g) which implies that the variables series is stationary. An outcome of DF test confirms that the physiochemical analysis variables series is stationary. Our results revealed that the ARCH model satisfactorily explains volatility and is the most appropriate model for explaining volatility in the series under analysis.

**Keywords:** Physiochemical and Microbial analysis; ARCH effects; Forecasted to Volatility; Dickey–Fuller test.

## Introduction

Fortified Blended Foods (FBFs) are blends of partially precooked and milled cereals, soya, beans, pulses fortified with micronutrients (vitamins and minerals). Special formulations may contain vegetable oil or milk powder. Corn Soya Blend (CSB) is the main blended food distributed by WFP but Wheat Soya Blend (WSB) is also sometimes used.

FBFs are designed to provide protein supplements. In food assistance programs to prevent and address nutritional deficiencies. They are generally used in WFP Supplementary Feeding and Mother and Child Health programs. Also, to provide extra micronutrients to complement the general ration. Usually mixed with water and cooked as a porridge [1].

Wheat Soya Blend is a product preferred for young children aged 6 months – 2 years. The product is to be used as a complement to breastfeeding. The product is not a breast-milk replacer. Super Cereal *plus* is prepared from heat treated wheat and de-hulled soya beans, sugar, dried skim milk, refined soya bean oil, vitamins and minerals. If Super Cereal *plus*- Wheat Soya Blend is consumed as a porridge or gruel, it should be prepared by mixing an appropriate proportion of flour and clean water (i.e. 50g of Super Cereal *plus*- Wheat Soya Blend with 250 g of water) followed by a boiling time at simmering point from five to ten minutes.

Super Cereal *plus*- Wheat Soya Blend shall be manufactured from fresh wheat grain and soy beans of good quality, free from foreign materials, substances hazardous to health, excessive moisture, insect damage and fungal contamination and shall comply with all relevant national food laws and standards. Sugar, dried milk powder and soya bean oil shall be of optimal food quality and meet the Codex standards for these commodities [2].

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The analysis of chemical analysis data has received considerable attention in the literature over the last 20 years. Several models have been suggested for capturing special features of this data and most of these models have the property that the conditional variance (or the conditional scaling) depends on the past. One of the best known and most often used is the autoregressive conditionally heteroscedastic (ARCH) process introduced by [3]. The theoretical results on ARCH and related properties have played a special role in empirical work in the analysis of data on rates, prices and in inflation rate data to mention but a few [4].

This first model is Autoregressive Conditional Heteroskedasticity (ARCH) which was early introduced in the [3], it aimed to capture the conditional variance that is why it became the most popular way of describing the unique feature. Later on, for making this model better [5,6] put forward, independently of each other, a generalization of this model, called Generalized ARCH (GARCH). And this model have been certificated not only to catch volatility clustering but also to contain fat tails from the volatility data. These are common features about the financial data. Even though the GARCH model is already the extension of the ARCH model, it still has some drawbacks. The main point is that the GARCH model is symmetric, so it has a poor performance in reflecting the asymmetry. Because a fact on an interesting feature of financial volatility data is that bad news seems to have a more significant effect on the fluctuation compared to good ones. In other words, positive and negative information generate different degrees of influence to the changes of financial data. So this asymmetric phenomenon is leverage effect. Considering the stock data, it always exist a strong negative correlation between the current return and the future conditional variance. That is why some advanced GARCH model will be introduced later. Such as exponential-GARCH model, [7] and GJR-GARCH model, [8], are proposed. Except these models, there still have many other extension GARCH models, such as TGARCH model-threshold ARCH-attributed to [8,9], FIGARCH model-introduced by [10] IGARCH model-proposed by [11,12].

The overall objective of the study is to model economic aspects of food production and analysis systems, understanding physiochemical analysis report and concern stakeholder awareness for food products. Specifically the study will pursue the following objectives: (i) to describe the physiochemical analysis of characteristics of food products; (ii) establish the determinants of food decision to accept in food products distinguishing between the fully-accepted food and unaccepted; (iii) elicit producer risk preferences and empirically analyze producer sources of risk and risk management strategies; (iv) explore consumer or stakeholder awareness, perceptions and attitudes regarding food products; and (v) identify the factors that affect the consumer‘s preference and consumption of food products. The outcome of which will help make policy recommendations that have an implication on technology adoption, increase smallholders capacity to bear risk and enable government and other role players have a clear understanding of consumers’ food purchase decisions.

## Materials and methods

### *Data*

The Wheat Soya Blend (WSB) products 36 analysed observations were collected from from Institute of Food Science and Technology (IFST), BCSIR, Dhaka over the year 2007 to 2012 by Single Stage Cluster Sampling method [13]. Data collection methods were non-participant observation of organization included in the study. Archival research included hard-copy issues of reports of analytical documents.

### *Methodology*

*Auto-regressive Conditional Heteoskedastic Model (ARCH) model*

ARCH (Auto-regressive Conditional Heteoskedastic) Model is the first and the basic model in stochastic variance modeling and is proposed by [3]. The key point of this model is that it already changes the assumption of the variation in the error terms from constant $Var(\varepsilon_t) = \sigma^2$ to be a random sequence which depended on the past residuals ($\{\varepsilon_1 \dots \varepsilon_{t-1}\}$). That is to say, this model has changed the restriction from homoscedastic to be heteroscedasticity. This breakthrough is explained by [14]. And this is an accurate change to reflect the volatility data's features. Let $\varepsilon_t$ as a random variable that has a

 

mean and a variance conditionally on the information set $I_{t-1}$.

*Residual Test/ARCH LM test*

This is a Lagrange multiplier (LM) tests for autoregressive conditional hetroskedasticity (ARCH) in the residuals. The test statistic is computed by an auxiliary regression as follows.

$$P_t = \alpha_1 P_{t-1} + u_t \Rightarrow u_t = P_t - \alpha_1 P_{t-1}$$

To test the null hypothesis that there is no ARCH up to order q in the residuals, the following regression is run.

$$u_t^2 = \lambda_0 + \left( \sum_{s=1}^{q} \lambda_s u_{t-s}^2 \right) + v_t$$

Where $u_t$ is the residual. This is a regression of the squared residuals on a constant and lagged squared residuals up to order q. The null hypothesis is that, $\lambda_s$=0 in the absence of ARCH components.

In a sample of T residuals under the null hypothesis of no ARCH errors, the LM test statistic equals number of observations*R-square ($TR^2$). The test statistic $TR^2$ follows Chi ($\chi^2$)-distribution with q (lag length) degrees of freedom. If $TR^2$ calculated is greater than the chi-square table value ($TR^2$ critical), reject the null hypothesis in favour of the alternate hypothesis. Hence there is ARCH effect in the GARCH model [15].

*Unit root test*

In the case of time series analysis, unit root tests are important. Unit root tests help to identify the stationarity and non-stationarity of time series data used for the study. A stationary time series has three basic properties. First, it has a finite mean. This means that a stationary series fluctuates around a constant long run mean. Second, a stationary time series has a finite variance. This means that variance is time invariant and third, a stationary time series has a finite (auto) covariance. This reflects that theoretical autocorrelation decay fast as lag length increases. Regressions run on non-stationary time Series produce a spurious relationship. Hence, to avoid a spurious relationship, there is a need to perform a unit root test on variables [16].

Dickey – Fuller (DF) has been widely used to check the stationarity and presence of unit root of a process. The Dickey – Fuller test is valid only for AR(1). We use the DF test when the residual are not auto correlated. Dickey – Fuller considered the estimation of the parameter α from the models.

1. $y_t = \alpha y_{t-1} + e_t$ (pure random walk)
2. $y_t = \mu + \alpha y_{t-1} + e_t$ (drift + random walk)
3. $y_t = \mu + bt + \alpha y_{t-1} + e_t$ (drift + linear trend)

It assumes that $y_0$=0 and $e_t \sim$i.i.d $(0, \sigma^2)$

The null and alternative hypotheses are:

$H_0$: α=1 (α(z)=0 has a unit root)

$H_1$: |α |<1 (α(z)=0 has root outside unit circle) [17], [18]. Using non-stationary time series data in financial models produces unreliable and spurious results and leads to poor understanding and forecasting [19].

## Results and discussion

### *Preliminary analysis of the data*

The method for simplifying and organizing data is to construct a frequency distribution. Frequency distribution of preliminary analysis of the data presented in Table 1 indicates that only Fat (%), Vitamin A (IU/100g) and Iron (mg/100g) contains are reasonably unacceptable range were compared to the standard value prescribed by World Food Programme (WFP), Dhaka [20].

### *Descriptive Statistics of Wheat Soya Blend*

Statistics are a set of tools for obtaining insight into a psychological phenomenon. Descriptive statistics summarise the data, making clear any trends, patterns etc. which may be lurking within them; they consist of visual displays such as graphs and summary statistics such as means [21].

The descriptive statistics as mean, standard deviation, minimum and maximum value for physiochemical analysis of Wheat Soya Blend (WSB) are displayed in Table 2. Here, we observed that only Moisture, % are comparatively low standard deviation (SD<2). So we conclude that physiochemical analysis of Wheat Soya Blend (WSB) were high standard deviation except moisture value.

Table 1. Frequency distribution results for Wheat Soya Blend

| Proximate Variable | | Frequency | Percentage |
|---|---|---|---|
| Moisture (%) | | | |
| | Acceptable Range | 34 | 100.0 |
| | Not Acceptable Range | 0 | 0.0 |
| Protein (%) | | | |
| | Acceptable Range | 30 | 93.8 |
| | Not Acceptable Range | 2 | 6.3 |
| Fat (%) | | | |
| | Acceptable Range | 16 | 47.1 |
| | Not Acceptable Range | 18 | 52.9 |
| Total Carbohydrate (%) | | | |
| | Acceptable Range | 31 | 100.0 |
| | Not Acceptable Range | 0 | 0.0 |
| Sugar (as sucrose) (%) | | | |
| | Acceptable Range | 29 | 96.7 |
| | Not Acceptable Range | 1 | 3.3 |
| Vitamin A (IU/100g) | | | |
| | Acceptable Range | 0 | 0.0 |
| | Not Acceptable Range | 27 | 100.0 |
| Iron (mg/100g) | | | |
| | Acceptable Range | 10 | 37.0 |
| | Not Acceptable Range | 17 | 63.0 |
| Standard Plate Count (cfu/g) | | | |
| | Acceptable Range | 25 | 89.3 |
| | Not Acceptable Range | 3 | 10.7 |
| Total Coliform (MPN/g) | | | |
| | Acceptable Range | 23 | 17.9 |
| | Not Acceptable Range | 5 | 82.1 |
| Escherichia Coli (MPN/g) | | | |
| | Acceptable Range | 22 | 84.6 |
| | Not Acceptable Range | 4 | 15.4 |

### *ARCH-LM test*

To detect the presence of ARCH effect in the mean equation of Wheat Soya Blend (WSB), we use the ARCH-LM (Lagrange multiplier) test. In our analysis the different value for different variables of above parameters of the ARCH-LM test; the lags value are 1. The corresponding p-value is >0.05, which is very high. So we have no difficulty to accept the null hypothesis of no ARCH error in the analysis series. The parameters of Wheat Soya Blend (WSB) analysis are insignificant that means no ARCH effects of the models. The estimation results are given in the Table 3 shows that the values of Dickey-Fuller (DF) test for all variables p-value <0.05 at 5%, level of significance except Sugar (as sucrose) (%) and Standard Plate Count (cfu/g) which implies that the variables series is stationary. An outcome of DF test confirms that the physiochemical analysis variables series is stationary.

### *Time-Varying Volatility and ARCH Models*

The presence of extreme spikes in our analysis of Wheat Soya Blend (WSB) products is a bad characteristic of food products. Figure 1 shows the conditional variance of Moisture content over the period January 2008 to July 2010. It is noticeable in the figure above that the first-differenced time series of Moisture content of Wheat Soya Blend (WSB) products are not so volatile. The results indicate that the variance almost stable among 2008 to 2010 and in spike behaviour in January 2010. However, volatility in deviations is very low in this time period.

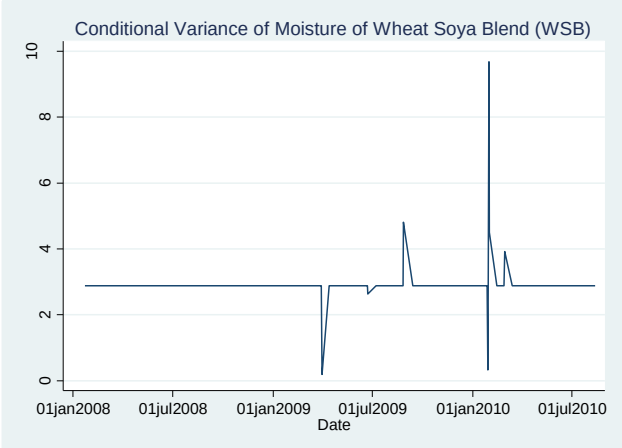


Figure 1. Moisture content of Wheat Soya Blend (WSB) products for the Period January 2008 to July 2010

Figure 2 shows the conditional variance of Protein content over the period January 2008 to July 2010. It is noticeable in the figure above that the first-differenced time series of Protein content of Wheat Soya Blend (WSB) products are not so volatile. The results indicate that the variance almost stable among 2008 to 2010 and in spike behaviour in January 2010. However,

 

volatility in deviations is very low in this time period.

Table 2. Descriptive Statistics results for proximate analysis of Wheat Soya Blend

| Proximate Variables | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| Moisture (%) | 0.69 | 8.82 | 3.857 | 1.771 |
| Protein (%) | 8.35 | 20.30 | 16.970 | 2.362 |
| Fat (%) | 3.54 | 20.66 | 6.457 | 2.995 |
| Sugar (as sucrose) (%) | 9.87 | 18.88 | 13.321 | 2.161 |
| Total Carbohydrate (%) | 65.48 | 73.70 | 69.061 | 2.170 |
| Vitamin A (IU/100g) | 293.00 | 4281.00 | 1229.852 | 716.271 |
| Iron (mg/100g) | 6.17 | 22.61 | 12.203 | 3.984 |
| Standard Plate Count (cfu/g) | 0.00 | $5.60e^{+06}$ | $2.20e^{+05}$ | $1.06e^{+06}$ |
| Total Coliform (MPN/g) | 0.00 | 240.01 | 41.750 | 81.379 |
| E. Coli (MPN/g) | 0.00 | 240.00 | 11.192 | 47.017 |

Table 3. ARCH-LM and DF test analysis results of physiochemical analysis parameter of Wheat Soya Blend

| Variable | LM test for autoregressive conditional heteroskedasticity (ARCH) | | Dickey-Fuller test for unit root | |
|---|---|---|---|---|
| | Chi-square Statistic | p-value | Test Statistic, Z(t) | p-value |
| Moisture (%) | 1.289 | 0.256 | -4.715 | 0.0001 |
| Protein (%) | 0.212 | 0.645 | -4.433 | 0.0003 |
| Fat (%) | 1.373 | 0.241 | -3.407 | 0.0107 |
| Sugar (as sucrose) (%) | 0.085 | 0.771 | -2.639 | 0.0851 |
| Total Carbohydrate (%) | 0.574 | 0.449 | -4.493 | 0.0002 |
| Vitamin A (IU/100g) | 0.008 | 0.927 | -3.655 | 0.0048 |
| Iron (mg/100g) | 0.687 | 0.407 | -2.915 | 0.0436 |
| Standard Plate Count (cfu/g) | 2.435 | 0.119 | 0.959 | 0.9938 |
| Total Coliform (MPN/g) | 1.948 | 0.163 | -3.856 | 0.0024 |
| E. Coli (MPN/g) | 0.058 | 0.810 | -4.458 | 0.0002 |

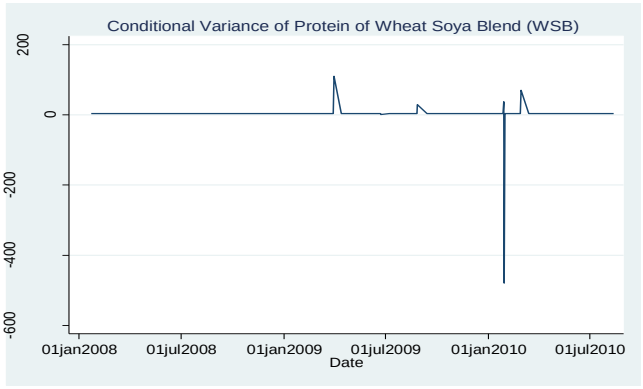


Figure 2. Protein content of Wheat Soya Blend (WSB) products for the Period January 2008 to July 2010

Figure 3 shows the conditional variance of Fat content over the period January 2008 to July 2010. It is noticeable in the figure above that the first-differenced time series of Fat content of Wheat Soya Blend (WSB) products are not so volatile. The results indicate that the variance almost stable among 2008 to 2010 and in spike behaviour in January 2009-2010. However, volatility in deviations is very low in this time period.

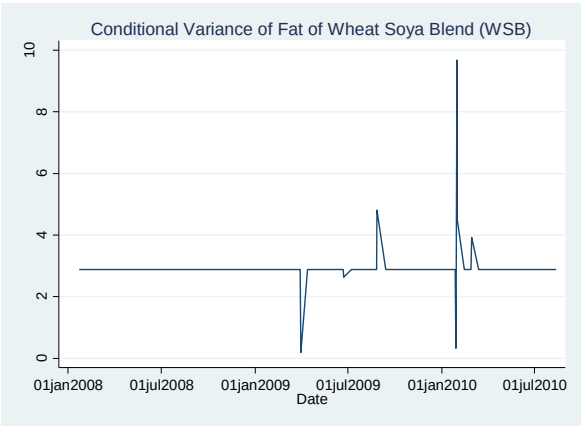


Figure 3. Fat content of Wheat Soya Blend products for the Period January 2008 to July 2010

Figure 4 shows the conditional variance of Iron content over the period January 2008 to July 2010. It is noticeable in the figure above that the first-differenced time series of Iron content of Wheat Soya Blend (WSB) products

 

are not so volatile. The results indicate that the variance almost stable among 2008 to 2010 and in spike behaviour in January 2009-2010. However, volatility in deviations is very low in this time period.

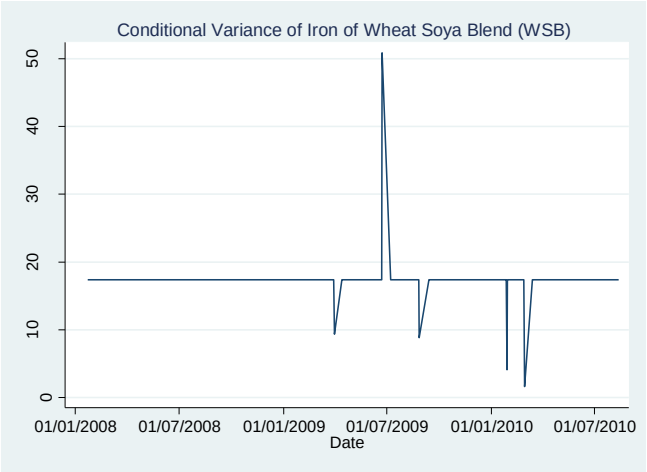


Figure 4. Iron content of Wheat Soya Blend products for the Period January 2008 to July 2010

The results of figure 1 to 4 indicate that the volatility in the Chemical Analysis of Wheat Soya Blend (WSB) exhibits the low or stable of volatility in this time period.

## Conclusions

The present work was attempted to study the volatility in the quality of food products. The data used for analysis were observations for the period of 2007 to 2011. Empirical results showed that ARCH model can adequately describe the quality of food products. We use ARCH-LM test to test whether there is any further ARCH error in both series. The test results of some parameters in food products show that there is there is an ARCH error in the analysis series. Time-Varying Volatility indicate that the volatility in the Chemical Analysis of Wheat Soya Blend (WSB) exhibits the low or stable of volatility in this time period. The results suggest that the volatility in the quality of food products exhibits the persistence of volatility behavior. Our results revealed that the ARCH model satisfactorily explains volatility and is the most appropriate model for explaining volatility in the series under analysis. Government mechanism should continuously monitor the food products quality in Bangladesh on a regular basis for necessary analysis of the contents of food products. For this purpose regular sample analysis data should be collected and necessary statistical analysis should be done. Partnerships with relevant academic and research institutions to investigate and to generate information and data. This relevant organization should maintain a data bank of food products produced in our country for further statistical analysis.

## Conflicts of interest

Authors declare no conflict of interest.

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