Original Research Article
EVALUATING TEMPORAL PRICE BEHAVIOUR OF RICE IN BANGLADESH

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ABSTRACT

Aims: The agriculture sector in Bangladesh is predominantly centered on rice production and it is the staple food. High prices of rice can affect the consumers adversely. This study aimed to analyze the annual price dynamics of rice in Bangladesh.
Study design: The study was based on secondary time series data of prices of different category of rice at wholesale and retail level. Both nominal and deflated prices were sued to analyze for achieving the objectives of the study.
Place and duration of study: Secondary time series data of price for different category of rice from country as a whole from 1991 to 2021 were used to assess its annual price behavior.
Methodology: Descriptive statistics were employed to assess the annual price fluctuations, while linear regression analysis was used to evaluate the annual price trends.
Results: The analysis revealed significant variations in the annual wholesale and retail prices of rice (both fine and coarse). Notably, coarse rice exhibited greater price fluctuations compared to fine rice in both wholesale and retail markets. Price fluctuation at retail level for fine rice is greater than the wholesale level but in case of coarse rice, price fluctuation at retail level is lower than wholesale level. The study further found that the wholesale price trend for fine rice increased more sharply than that of coarse rice, a pattern that was also reflected in retail prices.
Conclusion: The study indicates that over the study period, the price of fine rice experienced a more pronounced fluctuate and increase compared to coarse rice.

Keywords: Temporal, Price Behaviour, Rice, Bangladesh

1. INTRODUCTION

Agriculture has been the mainstay of Bangladesh economy, contributing 13.38% to the gross domestic product (GDP) and generating employment for about 41% of the total labour force [10,15,13]. Rice is the staple food of about 169 million people in Bangladesh [20]. It accounts for over 70% of the country's total calorie intake, with per capita consumption averaging around 181.3kg per year, making it one of the highest in the world [17, 21]. More than three-fourths of the country's total cropped land is devoted to rice production, contributing more than 83 percent of the total cereal food supply [4, 12]. Rice is grown on about 11 million hectares which has remained almost stable over the past three decades in Bangladesh. About 75% of the total cropped area and over 80% of the total irrigated area is devoted to rice [15, 12]. Total rice production in Bangladesh was about 10.59 million tons in the year 1971 when the country's population was only about 7.88 million. However, the country is now producing more than three times to feed her 170 million people [3]. Rice is cultivated in Bangladesh throughout the year as Aus, Aman or Boro. Aman (broadcast and transplanted) is generally cultivated in December-January, Boro in March-May and Aus in July-August

cropping season. Among these cropping's Aman is most important and occupied about 48% of the paddy cultivated land in 2020-2021. Boro is an important paddy which shares about 41% total paddy production. The rest 11% of the land is occupied by Aus [3].

The price of rice remains a sensitive factor for producers, consumers and policy makers. At the village level, it affects poor consumers who derive the major proportion of calorie intake from rice (70 % in 2009). It also matters to producers, for whom rice cultivation is increasingly a commercial activity and often accounts for a large share of total annual household income [16].

Price movements have a dominant impact on farmers' decision-making and resource allocation behaviour. Apart from guiding production and marketing decisions, prices govern the optimal allocation of resources among competing uses. Therefore, price stabilization is of significant importance to the whole economy. As both the land and financial resources are limited to the farmers, they always suffer in decision and risk. If it were possible to inform them about the future trend of market prices of respective crops before production, the scarce resources would be allocated in an optimal way. Area allocation is influenced by the previous year's price of crops. Therefore, it is important to know the average price fluctuation over the periods. Then government can take stabilization programs for the economy considering price volatilities. Crops have swings in annual production because planned production varies with changing expectations about returns and because yields are sensitive to weather condition, diseases, and pests. Since the derived demands for many crops at the farm level are price inelastic, year-to-year shifts in production result in price fluctuations that are larger in percentage terms than the change in production [18].

Farmers in Bangladesh, particularly smallholder farmers, were adversely affected by low paddy prices. They proposed two policy options for rice procurement in Bangladesh. First, when the paddy price is low and does not cover farmers' production cost per unit, the government can purchase paddy directly from farmers to provide necessary price support. Second, when the paddy price is high, the government can purchase rice from the market through open tender to build or replenish public food grain stocks [2]. The price fluctuation of rice was caused due to improper management and syndication among the channel members, which leads a situation where a farmer sells paddy at a lower price in contrast a consumer, buys rice paying a high price. Furthermore, seasonal productivity and natural calamities expand the gap between demand and supply of rice [11]. Both nominal and real price fluctuation of rice of different seasons in Bangladesh also has been examined [7].

A study was [8] empirically analyzed the factors affecting rice production, consumption, and prices using fixed effects model estimation of an unbalanced panel data of fifteen rice-producing regions from 2003 to 2020. The study utilized a vector autoregressive (VAR) approach on time series data of rice self-sufficiency, production, consumption, and prices from 1998 to 2020 to explore and understand the dynamics of the relationship between the variables. The volatility of food prices is of prime policy interest, as it can impact the prosperity of farmers, consumers, agribusiness, exporters, importers, and indirect effects on incomes and employment in many other sectors [5,19,6]. The ARCH-GARCH and the VAR/VECM models were applied to examine the dynamics and factors influencing price volatility in the domestic rice market of Tanzania. The results of the price volatility analysis showed that the volatility of rice

prices tends to be low and persistent over the long run. This is supported by the estimation results of factors affecting price volatility, which showed that supply variables play an important role in the short and long run in influencing rice price volatility. The prices in the producing regions (large surplus areas) turned out to be more volatile than the prices in the main consuming regions (large deficit areas) [9].

The current paper is discussed about the trend of price escalation of rice and also discussed about the annual price variation of rice. If the impact of annual price variation of rice can be reduced then it will be easy to ensure appropriate margin for the farmers as well as reasonable price for the consumers. Although, the government has been attempting for a long time to minimize the annual price variations of through open market sales to limit price increases, targeting food distribution to poor households, providing emergency relief after natural disasters and procuring paddy to support producers' prices and incomes. If the year-to-year prices changes and the impact of seasonal price variation are reduced, then the government can ensure food for every household at reasonable price and the stability of price of rice will be ensured. In this connection, authors evaluated annual price behavior of rice in Bangladesh.

2. material and methods

2.1 Data and Time

This study was fully dependent on secondary data. Bangladesh Bureau of Statistics (BBS), (1991-2021) was the main sources of data. Average market price of rice was deflated using consumer price index (CPI) of the base year 2005-2006 in order to obtain the real price. Annual average wholesale and retail price of rice (fine and coarse) were used for analyzing the yearly price fluctuation and trend of those varieties of rice. Secondary time series data of wholesale and retail price of rice (fine and coarse) 31 years were used for measuring the annual price variation.

2.2 Measuring the annual price fluctuation of rice

Annual wholesale price of rice have been used to measure the annual price fluctuation. Deflated prices (real price) of rice also have been used to estimate the annual price fluctuation to observe which one more fluctuate. In this case, nominal prices of rice have been converted into real prices by dividing the consumer price index (cpi general, base year 2005- 2006) and multiplied by 100.

Annual price fluctuation (%) =

Where,

P_t =price of current year

P_{t-1}= price of previous year

2.3 Measuring the annual price trend of rice

Analysis of trend component in annual series of prices involves ascertaining the general direction of the movement of prices over a period of several years. The general direction should be such that movements in one or two years away from this direction have the tendency to return in subsequent years. The trend is generally expressed in terms of a straight line [1]. Price trend for wholesale price of rice for both nominal and real price have been assessed in this study. This method of getting the trend in series

of annual prices involves estimating the coefficients α and ß in the following linear functional form:

$Y_t = \alpha + \beta T_t + \mu_t$
Where,
Y_t = Price (annual wholesale and retail price of rice) during the year t.
T_t = Serial number assigned to the t^{th} year,
μ_t = random disturbance term with usual assumptions, and
α= Intercept
ß is coefficient to be estimated.

3. results and discussion

3.1 Annual Wholesale Price Variation of Fine Rice

Secondary time series data of wholesale price of fine rice for 31 years were used for measuring the annual price variation of fine rice. Annual price fluctuation was measured for nominal price only. Annual nominal price fluctuation was measured by subtracting each year's price from the current year's price and expressing it in percentage. Table 1 shows important attributes of yearly wholesale price fluctuation. Price of fine rice fluctuation occurred between "-9.95% to 28.59%". The highest decreasing rate of price fluctuation (-9.95 %) happened in 2000 that mean price became 9.95 percent lower this year than the previous year on the other hand the highest increasing rate of price fluctuation (28.59%) occurred in 2008 that means price became 28.59 per cent higher in this year than the previous year. An increasing rate of price fluctuation occurred most of the years (19 out of 30) (Figure 1).The data indicates that the prices of rice in Bangladesh have been highly volatile, with significant fluctuations both upwards and downwards. The high standard deviation and CV suggest that these price changes are not consistent, making it difficult to predict future price movements. The market shows signs of instability, likely influenced by various external factors such as supply chain disruptions, seasonal variations, or economic conditions. The figure visually complements the table, providing a clearer picture of the erratic nature of fine rice price fluctuations over the years. This combination of data and visual representation underscores the unpredictability and volatility in the fine rice market.

Table 1. Important attributes of yearly wholesale price fluctuation of fine rice

Items	Fluctuation (%)
Maximum	28.59
Minimum	-9.95
Range	38.55
Standard deviation	10.64
Mean	5.92
CV (%)	179.83

Fig. 1. Year to year nominal wholesale price fluctuation (%) of fine rice

3.2 Annual Wholesale Price Variation of Coarse Rice

Secondary time series data of wholesale price of fine rice for 31 years were used for measuring the annual price variation of coarse rice. Annual price fluctuation was measured for nominal price only. Annual nominal price fluctuation was measured by subtracting each year's price from the current year's price and expressing it in percentage. Table 2 shows the important attributes of annual wholesale price variation of coarse rice. Price of coarse rice fluctuation occurred between "-15.22% to 41.38%". The highest decreasing rate of price fluctuation (-15.22 %) happened in 2012 that mean price became 15.22 percent lower this year than the previous year on the other hand the highest increasing rate of price fluctuation (41.38%) occurred in 2011 that means price became 41.38 per cent higher in this year than the previous year. An increasing rate of price fluctuation occurred most of the years (20 out of 30) (Figure 2). Highest increasing rate of price fluctuation and decreasing rate of price fluctuation occurred respectively year 2011 and 2012 (Figure 2). The table suggests that the coarse rice market is even more volatile than the fine rice market, with larger swings in prices both upwards and downwards. The high standard deviation and CV reflect a highly unstable market, making price predictions challenging. The figure visually emphasizes the high volatility and unpredictability captured in the table. The combination of the data and visual representation underscores the significant price instability in the coarse rice market, even more pronounced than in the fine rice market.

Table 2. Important attributes of yearly price fluctuation of coarse rice

Item	Fluctuation (%)
Maximum	41.38
Minimum	-15.22
Range	56.60
Standard deviation	14.87
Mean	5.85
CV (%)	254.34

Fig. 2. Year to year nominal wholesale price fluctuation of coarse rice

Over the 30 years, annual price variation between the nominal wholesale price fluctuation of fine rice and coarse rice was compared by using the coefficient of variation (CV) and it was observed that the CV was higher in case of nominal wholesale price fluctuation of coarse rice than the nominal price fluctuation of fine rice. Range of wholesale price fluctuation is also higher in case of coarse rice than fine rice. Therefore, it can be concluded that annual wholesale price fluctuation is higher for coarse rice than fine rice. From figure 3, it can be concluded that in the case of a

positive rate of fluctuations, the rate fluctuation is higher in the case of nominal wholesale price of coarse rice than the fluctuation of fine rice. In the case of a negative rate of fluctuations, the rate of fluctuation is higher also in the case of wholesale price of coarse rice than the fine rice. Although both fine and coarse rice have similar average yearly price increases, coarse rice is far more prone to extreme and unpredictable price changes, making it a less stable market commodity compared to fine rice.

Fig. 3. Comparison between wholesale price fluctuation of fine rice and coarse rice

3.3 Annual Retail Price Variation of Fine Rice

Table 3 shows some of the important attributes of annual price variation of fine rice. Price of fine rice fluctuation occurred between "-31.49% to 47.91%". The highest decreasing rate of price fluctuation (-31.49 %) happened in 2010 that means price became 31.49 percent lower this year than the previous year on the other hand the highest increasing rate of price fluctuation (47.91%) occurred in 2009 that means price became 47.91 percent higher in this year than the previous year. An increasing rate of price fluctuation occurred most of the years (22 out of 30) (Figure 4). Highest increasing rate of price fluctuation and decreasing rate of price fluctuation occurred respectively year 2009 and 2010 (Figure 4). Retail prices for fine rice in Bangladesh are highly volatile, with significant year-to-year changes. The large range, high standard deviation, and very high CV all suggest that consumers face considerable unpredictability in rice prices, making it difficult to anticipate price trends. The figure visually confirms the high volatility of retail prices for fine rice as described in the table. Consumers have experienced substantial and unpredictable price changes, with significant upward and downward fluctuations over the years. The combination of the data and visual trends underscores the instability and unpredictability in the retail market for fine rice in Bangladesh.

Table 3. Important attributes of yearly price fluctuation of fine rice

Item	Fluctuation (%)
Maximum	47.91
Minimum	-31.49
Range	79.39
Standard deviation	14.26
Mean	6.46
CV (%)	220.78

Figure 4: Year to year nominal retail price fluctuation of fine rice

3.4 Annual Retail Price Variation of Coarse Rice

Table 4 shows some of the important attributes of annual price variation of coarse rice.

Price of coarse rice fluctuation occurred between “-17.63% to 45.84%”. The highest decreasing rate of price fluctuation (-17.63%) happened in 2017 that means price became 17.63 percent lower this year than the previous year on the other hand the highest increasing rate of price fluctuation (45.84%) occurred in 2008 that means price became 45.84 percent higher in this year than the previous year. An increasing rate of price fluctuation occurred most of the years (22 out of 30) (Figure 5). The retail prices for coarse rice in Bangladesh are highly volatile, with significant fluctuations from year to year. The large range, high standard deviation, and very high CV all suggest a highly unstable market, making price trends difficult to predict for consumers. The figure visually complements the data in the table, confirming the high volatility of retail prices for coarse rice. Consumers have faced substantial and unpredictable price changes, with both significant increases and decreases over the years. This highlights the instability and unpredictability in the retail market for coarse rice in Bangladesh, similar to that observed for fine rice but with its own unique pattern of fluctuations.

Table 4. Important attributes of yearly price fluctuation of coarse rice

Item	Fluctuation
Maximum	45.84
Minimum	-17.63
Range	63.47
Standard deviation	15.14
Mean	6.58
CV (%)	229.95

Fig. 5. Year to year nominal retail price fluctuation of coarse rice

Based on the comparison of retail price fluctuation of fine rice and coarse rice over the period from 1991 to 2021 as presented in Figure 6, the following observations can be made:

Maximum retail price fluctuation: The maximum retail price fluctuation for fine rice (47.91 %) was slightly higher than that of coarse rice (45.84 %), indicating that there were times when the price of fine rice was higher than that of coarse rice.

Minimum retail price fluctuation: The minimum retail price fluctuation for fine rice (-31.49 %) was lower than that of coarse rice (-17.63 %), indicating that there were times when the price of fine rice was lower than that of coarse rice. Coefficient of variation of retail price fluctuation: The coefficient of variation of retail price fluctuation for fine rice (220.78%) was slightly lower than that of coarse rice (229.95%), indicating that the relative variation in the price of fine rice was slightly lower than that of coarse rice over the period.

Fine rice shows greater overall volatility with a higher maximum price increase, a much larger minimum price drop, and a wider range. However, coarse rice displays slightly higher variability and inconsistency, as reflected by the standard deviation and CV. While both rice types have similar average price increases, coarse rice has slightly more variable and unpredictable year-to-year price behavior. Fine rice tends to have

more extreme price fluctuations, especially on the downside, whereas coarse rice, though less extreme, is slightly more erratic in its year-to-year price movements. Fine rice appears more volatile with larger extremes, while coarse rice shows slightly more unpredictability in its retail price changes (Figure 6).

Overall, while there were some slight differences in the retail price fluctuation between fine rice and coarse rice over the period, they were generally similar. However, the wider range of fluctuations in the price of fine rice suggests that it may be more volatile than coarse rice.

Fig. 6. Comparison between retail price fluctuation of fine rice and coarse rice

3.5 Annual Price Trend of Rice

This section is about possible systematic upward (or downward) movements in economic variables. These are sometimes called deterministic trends [18]. Analysis of trend component in annual price series of prices involves ascertaining the general direction of the movement of prices over several years. The trend generally expressed in terms of a straight line [1]. Trend lines are made by connecting two or more price highs or price lows with a straight line. The slope of the trend line indicates the trend. When prices cross the trend line, a change in trend is indicated. Here, the annual wholesale and retail price of rice have been used to analyze the price trend.

3.5.1.1 Wholesale price trend of fine rice

The results of trend analysis for the nominal wholesale price of fine rice for the period 1990-1991 to 2020-2021 are shown in table 5. It is found from the table, that the model fits the data very well because the r-square value is high (90 percent). It can be concluded from the table, that the wholesale price of fine rice has been increased on average TK 187 per quintal per year over the period significantly.

Table 5. Regression results of the nominal wholesale price trend of fine rice

Items	Coefficient	t-value	p-value
Constant	-372161.76	-16.19	00
Time	187.07	16.33	00
R-square (%)		90	

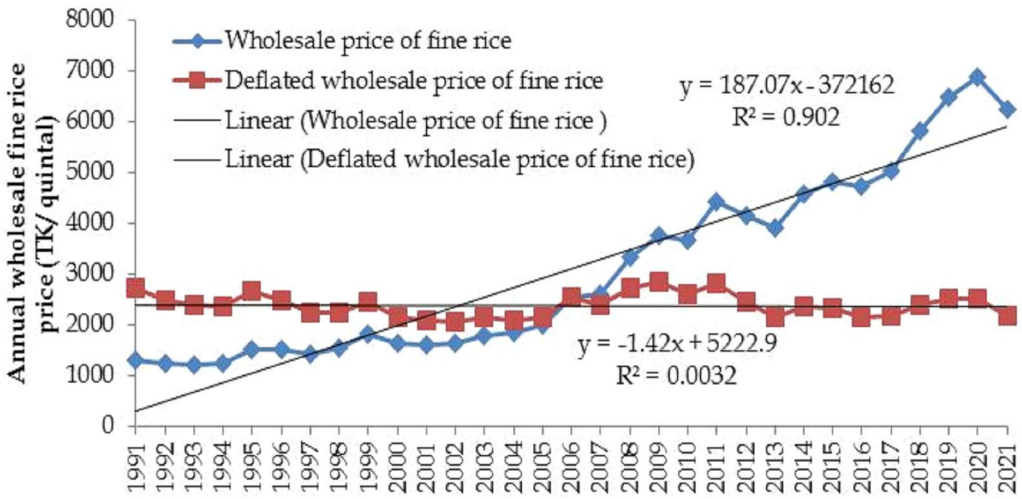

Fig. 7. Nominal and deflated wholesale price trend for fine rice

From the Figure 7 it can be observed that upward trend for nominal price and a downward trend for deflated price of wholesale price for fine rice. It can be concluded from the figure, that the deflated wholesale price of fine rice has been decreased on average TK 1.42 per quintal per year over the period.

3.5.1.2 Wholesale price trend of coarse rice

From Table 6 it is found, that the model fits the data very well because the r-square value is high (85 percent). It can be concluded from the table, that the wholesale price of coarse rice has been increased on average Tk. 121 per quintal per year over the period significantly.

Table 6. Regression results of the nominal wholesale price trend of coarse rice

Items	Coefficient	t-value	p-value
Constant	-240600.16	-12.75	0.00
Time	121.03	12.87	0.00
R-square (%)		85	

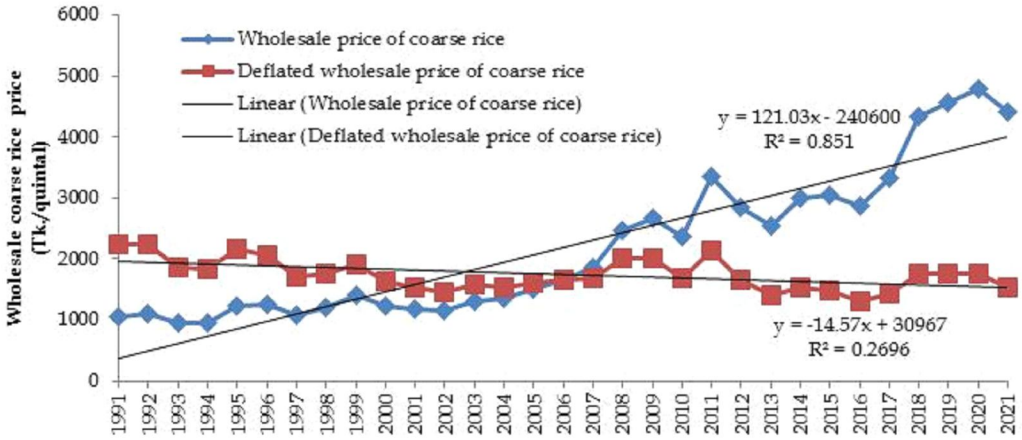

Fig. 8. Nominal and deflated wholesale price trend of coarse rice

From the Figure 8 we can see that upward trend for nominal price and a downward trend for deflated price of wholesale price for coarse rice. It can be concluded from the figure, that the wholesale price of coarse rice has been increased on average Tk. 121 per quintal per year over the period and deflated price has been decreased on an average Tk. 14.57 per quintal per year over the period.

3.5.1.3 Difference between wholesale price trend of fine rice and coarse rice

From Table 5 and 6 it can be explained that annual wholesale price trend of fine rice has been increased on an average Tk. 187.07 per quintal per year is greater than the annual wholesale price trend of coarse rice which has been increased on an average Tk. 121.03 per quintal per year over the period.

3.5.2.1 Retail price trend of fine rice

The results of trend analysis for the nominal retail price of fine rice for the period 1990-1991 to 2020-2021 are shown in Table 7. It is found from the table, that the model fits the data very well because the r-square value is high (91 percent). It can be concluded from the table, that the retail price of fine rice has been increased on average 196 per quintal per year over the period. In addition, the coefficient is statistically significant.

Table 7. Regression results of the nominal retail price trend of fine rice

Items	Coefficient	t-value	p-value
Constant	-391187.6	-17.56	0.00
Time	196.77	17.72	0.00
R-square (%)		91	

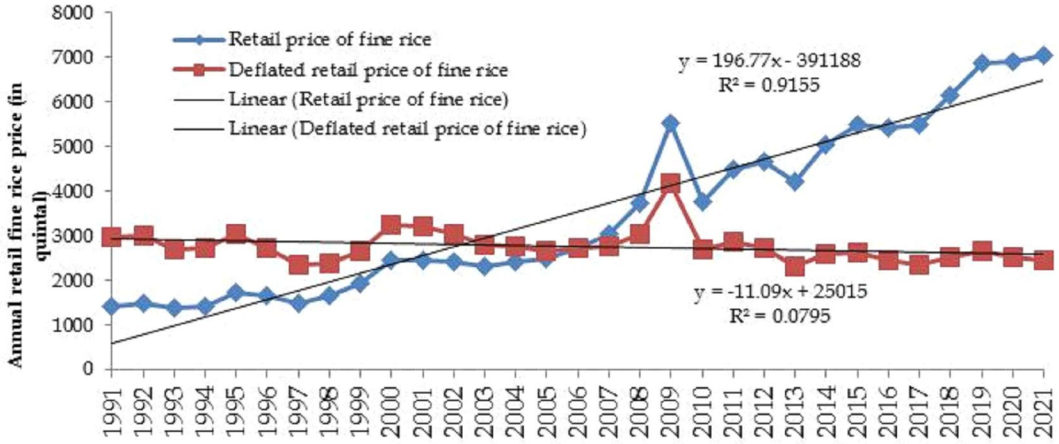

Fig. 9. Nominal and deflated retail price for fine rice

From figure 9, it can be observed that retail nominal price trend of fine rice is upward and a downward trend line is observed from the deflated price of fine rice. It can be concluded from the figure, that the retail price of fine rice has been increased on average Tk. 196 per quintal per year over the period. Moreover, deflated price of fine rice has been decreased on an average Tk. 11.09 per quintal per year over the period.

3.5.2.2 Retail price trend of coarse rice

From Table 8 it is found, that the model fits the data very well because the r-square value is high (84 percent). It can be concluded from the table, that the retail price of coarse rice has been increased on average 152 per quintal per year over the period. In addition, the coefficient is statistically significant. The model explains a substantial portion of the variability in prices, as indicated by the high R-square value.

Table 8. Regression results of the nominal retail price trend of coarse rice

Items	Coefficient	t-value	p-value
Constant	-304173.86	-12.41	0.00
Time	152.90	12.52	0.00
R-square (%)		84	

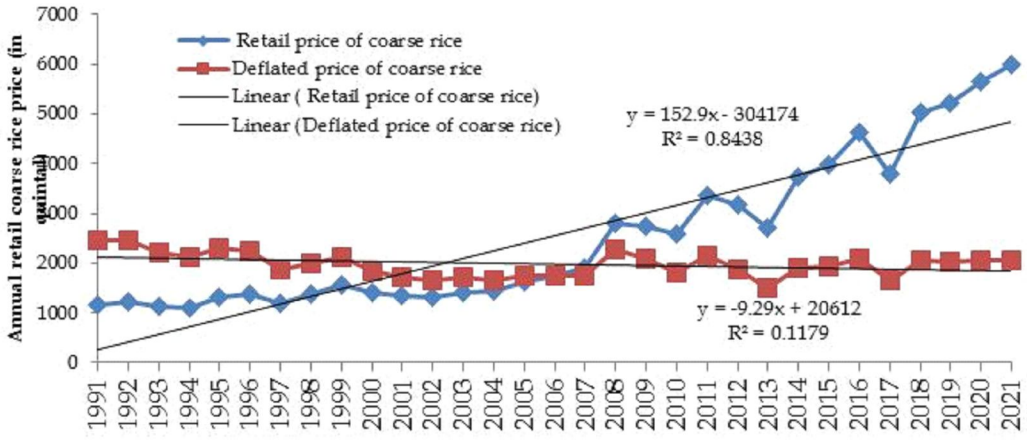

Fig. 10. Nominal and deflated retail price of coarse rice

From figure 10, we can see that retail nominal price trend of coarse rice is upward and a downward trend line is observed from the deflated price of fine rice. It can be explained from the figure that nominal price trend of coarse rice has been increased Tk. 152.9 per quintal per year over the period and deflated price trend has been decreased Tk. 9.29 per quintal per year over the period.

3.5.2.3 Difference between annual retail price trend of fine rice and coarse rice

From Table 7 and 8 it can be explained annual retail price trend of fine rice has been increased on an average Tk. 196.77 per quintal per year is greater than the annual retail price trend of coarse rice, which has been increased on an average Tk. 152.9 per quintal per year over the period.

4. CONCLUSION

Both fine and coarse rice markets are highly volatile, with significant fluctuations observed in wholesale and retail prices. The coefficient of variation and the range of price changes suggest that coarse rice is a less stable commodity, with more unpredictable price movements. Coarse rice tends to have more significant price swings, both upward and downward. The market for rice in Bangladesh shows signs of instability, influenced by various external factors such as economic conditions, supply chain disruptions, and seasonal variations. Regression analysis of price trends indicates that both fine and coarse rice have experienced significant upward trends in nominal prices over the study period. The annual increases are more pronounced for fine rice, which rises by an average of Tk. 196 per quintal, compared to Tk. 152.90 for coarse rice. These trends highlight the persistent inflationary pressures affecting the rice market in Bangladesh, emphasizing the need for strategic interventions to stabilize prices and protect consumers. Despite the volatility, there is a clear upward trend in the nominal prices of rice, reflecting long-term price increases. The findings highlight the challenges faced by consumers and stakeholders in managing price risks in the rice market, underscoring the need for better market interventions, enhanced supply chain management, and policy measures aimed at reducing price volatility and forecasting methods to stabilize prices and ensure food security. Future research should explore the underlying factors driving these price variations, including supply chain disruptions,

climatic impacts, and shifts in consumer demand, to develop robust strategies for ensuring food security and market stability in the rice sector. Furthermore, for getting in-depth insights into the price fluctuation of rice market and making robust policy implications, we need to study the seasonal price fluctuations of different category of rice at wholesale and retail marketing stage also.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that a generative AI technology such as Large Language Models (ChatGPT) has been used during the writing or editing of manuscripts.

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