Exploring the Nexus between Domestic Consumption of Milled Rice (DCM) and the Gross Domestic Product (GDP) of Bangladesh

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Abstract

Using annual data from 1960 to 2014, the aim of the current investigation is to evaluate the link between Bangladesh's GDP and domestic consumption of milled rice (DCM). In this study, the Kwiatkowski-Phillips-Schmidt-Shin (KPSS), Augmented Dickey-Fuller (ADF), Elliott-Rothenberg-Stock (ERS), and Phillips-Perron (PP) tests were implemented to observe the stationarity of the variables. Next, the causal link is established using the Granger causality (GC) test, and the long-term association between the study's variables is evaluated using the Johansen cointegration test. The GC test indicates that there is bidirectional causation, the Johansen co-integration test indicates that there is no long-term association between the variables, and there is no unit root between the variables, according to the experimental results of the stationary test. Therefore, the domestic consumption of milled rice (DCM) and GDP do not cointegrate over the long run.

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1. Introduction

The most accurate way to assess a nation's economy is to look at its GDP (gross domestic product). It is the entire monetary worth of all the commodities and services generated during a certain time period by all individuals and businesses, both domestic and international. A country's economic health can be known by GDP. It can be calculated on the basis of production, spending and income of a country and the personal consumption expenditures, government expenditures and investments are three major components of calculating GDP based on spending method. GDP measures the economic expanding and contraction along with standard of living of a nation. It bears many implications for the policy makers, government and economic analyst who make economic decisions and it helps the investors to manage their portfolios by providing them with guidance about the economic condition. Proper measures are taken in the period of economic boom and recession through the measurement of GDP. Domestic consumption implies the consumption of goods and services in the country where they are produced and it is the important component of Gross Domestic product (GDP) either expenditure method or production method of calculating GDP is used. Around 50% of people worldwide consider rice to be their primary source of nutrition, and the majority of rice is produced as milled rice. White rice that has had its husk, bran, and germ removed is known as milled rice. This improves the rice's taste, texture, and appearance while extending its shelf life and preventing spoiling. This increases the rice's shelf life and prevents spoilage while also enhancing its flavor, texture, and appearance. After milling, the rice is polished to produce a seed that is dazzling, white, and shiny. According to World Atlas, 78 percent of the world's rice consumption in 2009 was for human consumption (worldatlas.com). Although the demand for rice has grown dramatically in Africa, Latin America, and the Middle East, Asian countries still supply the majority of the rice that is consumed globally. The top 10 rice-producing nations in the world are Bangladesh, India, Burma, Thailand, Vietnam, the Philippines, Indonesia, Cambodia, China, and Pakistan. Since rice accounts for the bulk of the nation's food supply, rice cultivation is crucial to Bangladesh's economy. The cultivation of rice is the primary industry on 70% of the country's land. Currently, it is the fourth-largest rice producer in the world. As a result, rice cultivation significantly contributes to Bangladesh's GDP (http://ricepedia.org/bangladesh). The purpose of this study is to ascertain how domestic milled rice consumption and Bangladesh's GDP are related (DCM). The relationship between domestic consumption of milled rice (DCM) in Bangladesh and GDP is important since it has an impact on the country's short- and long-term economic plans. The current study employs a bi-variate data structure using the gross domestic product (GDP) and domestic consumption of milled rice to capture the dynamic interactions between the variables under consideration (DCM). Including the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test developed by Kwiatkowski et al (1992), this study employs four empirical tests. When looking for a unit root, the Elliott-Rothenberg-Stock (ERS) test by Elliott et al. (1996) offers many additional (nonparametric) techniques for adjusting for serial correlation. It is called the Augmented Dickey-Fuller (ADF) test after Dickey and Fuller (ADF) test. The Granger causality (GC) test, which was initially established by Granger in 1969, is utilized in this study to ascertain if GDP affects DCM or vice versa. The next step is to find long-run equilibrium relations between the study's variables using the Johansen cointegration technique (Johansen and Juselius, 1990; Johansen, 1988). The paper is divided into five sections. The literature review is discussed in Section 2 of the study. The study's methodology is outlined in Section 3. The data and empirical findings are discussed in Section 4. The discussion of conclusions, ideas, and future work marked the end of Section 5.

2. Literature review

Domestic consumption of milled rice (DCM) and gross domestic product (GDP) are two important components of an economy, particularly in nations where rice production contributes the most to GDP. This result is in line with the results of other research that examined the connection between GDP and consumption. For instance, Hasanur et al. (2021), conducted research on the empirical association between energy consumption and industrialization in Bangladesh. The GC test and the Johansen co-integration test were implemented in the study to ascertain the relationship between the variables. The long-run relationship in this process was seen in the Johansen co-integration estimation. Industrialization and power usage were shown to be causally related in both directions. Mizanur and Hidetoshi led the research project titled "Causality Analysis between the Energy Consumption and Economic Growth in South Asia: An Evidence from Bangladesh" in 2021. From 1971 through 2016, utilizing the unit root and GC tests. This study discovered that Bangladesh's GDP is growing faster due to increased energy usage. Electricity consumption and GDP nexus in Bangladesh: a time series analysis for the years 1971–2014 were examined by Sima and Mohammed in 2019. This research uses the "Bound Test" method of Autoregressive Distributed Lag (ARDL) to conduct its inquiry. The empirical findings demonstrated a short-term, unidirectional causal relationship between per capita real GDP and electricity consumption. Lamia et al. (2018) studied Bangladeshi Reports on Foreign Direct Investment and Renewable Energy Consumption. The study used the Granger causality test, the Phillips-Perron (PP), the Augmented Dickey Fuller (ADF), and the Johansen's cointegration test. The Granger causality test revealed a two-way relationship between the variables, and the long-term cointegration of the variables was proved using the Johansen cointegration test. An investigation of the connection between India's electricity energy consumption and GDP was conducted by Asit & Devtosh in 2015. The connection was found using KPSS tests, the two-step Engle-Granger method, and the Granger causality/Block exogeneity Wald test. Granger causality/Block exogeneity, non-stationarity at level, and stationary at initial difference were found using KPSS tests. The Wald test revealed that both the short- and long-term effects of electricity energy consumption on economic growth were favorable. Using yearly data for the years 1986 to 2015, Guvenek et al. (2017) investigated the connection between Natural Gas Consumption and Economic Growth in Turkey. The association was established using both the Granger causality test and the ADF unit root test. Granger causality analysis revealed that there is neither a direct causal relationship between economic growth and natural gas use nor a causal relationship between the two. Kaplan et al. (2011) looked at the relationship between energy usage and economic growth for Turkey between 1971 and 2006. They employed a Vector Autoregression (VAR) model to discover the connection. The results indicated a two-way causal link between energy usage and economic development as well as cointegration between the two variables. In other words, growing energy use directly affects economic expansion, which in turn drives more energy use. Razzaqi and Sherbaz (2010) carried a research to examine the dynamic relationship between energy consumption and economic growth in the D8 countries. There is a short- and long-term relationship between energy consumption and economic development in every country, according to data obtained using the VAR Granger Causality, Johansen Cointegration, and Vector Error Correction Model (VECM). With the exception of Indonesia, where there was demonstrated non-causation between the two variables in the short term, the results for all of the D8 nations revealed either uni- or bi-directional causality in the long as well as short periods. In order to better understand the dynamics of the relationship between real consumption spending and economic growth in India from 1950–1951 to 2008–2009, Mishra (2011) conducted a

research. He used a variety of tests, such as Unit Root, Johansen Cointegration, and Granger Causality, to analyze the findings. The results of the cointegration test conducted using Johansen's methodology revealed a cointegration between the GDP and private final consumption expenditures (PCE). The causality test showed a long-term, unidirectional causal relationship between real private consumption spending and economic growth. However, the Granger causality test showed that there is no immediate cause and effect link between them. Between 1971 and 2004, Belloumi (2009) examined the relationship between Tunisia's per capita gross domestic output (PCGDP) and per capita energy consumption (PCEC).

According to empirical results of the Granger causality test, there is a long-term bi-directional causal link between the two series as well as a short-term unidirectional causation from energy to GDP. Accordingly, disruptions to the energy supply will have a negative effect on GDP. This shows that energy is a limiting factor for GDP development in Tunisia. Soni et al. (2013) employed cointegration and causality analysis to assess sustainability and security in the Indian energy sector. The study considered the GDP and energy consumption data over the previous three decades (1981–2011). They used Granger causality (GC), the unit root test, cointegration, and error-correcting approaches (ECM). The Granger causality (GC) test results confirmed the presence of a unidirectional causal relationship connecting economic development and power consumption. When cointegration is utilized, it is observed that two variables had co-integrations of order 1. Chontanawate et al. (2006) evaluated the relationship between energy and GDP for 30 OECD and 78 non-OECD countries using a uniform data collection and methodology. Although the difference is not as great as the causality from energy to GDP, the results showed that the causality from GDP to energy consumption is more common in the OECD/developed countries than the non-OECD/developing countries, with 57 percent of OECD countries finding it compared to 47 percent of non-OECD countries and 56 percent and 51 percent for the high and mid dev. Nguyen (2015) examined the Dynamics between real consumption and economic growth in Bangladesh using annual information on the country's private consumption and real GDP from 1980 to 2014. He employed VAR and the Granger causality test to establish the connection. The estimated findings suggest that real GDP and real consumption in Bangladesh have a bidirectional Granger causal connection, suggesting that real GDP and real consumption have mutually reinforcing effects. Masuduzzaman (2013) discovered a connection between economic growth and electricity use in Bangladesh between 1981 and 2011. The findings of the Granger causality (GC) test and the Johansen co-integration test revealed that all the variables have been combined into a single co-integrating vector and that there is a short-run, unidirectional causal relationship between consumption of electricity and economic growth, investment in electricity and economic growth, and consumption of electricity and goods and services related to electricity. Using yearly time series data from the years 1973 to 2010, Islam (2014) examined the short- and long-term relationships between economic growth and education in Bangladesh. To ascertain the result, the Unit Root and Cointegration Test, Granger Causality Test, and Error Correction Modeling method were used. The findings of the Augmented Dickey-Fuller test indicate that economic growth and the cost of schooling as a whole are both integrated on the order of two since neither variable is stationary at the level nor non-stationary at the second difference. The conclusions that there is a statistically significant positive correlation between educational spending and economic development were supported by the Granger causality test. Amin (2011) utilized the Granger causality (GC) test and the Johansen cointegration model to investigate whether consumer spending is an outcome of economic activity or a driver of economic development. The World Development Indicators, which were maintained by the World Bank between 1976 and 2009,

provided the data for all of the variables. The study's findings revealed a protracted, unidirectional causal relationship between economic expansion and consumer spending. The cited literature demonstrates that numerous studies have examined the relationships between various consumption variables, such as natural gas consumption, energy consumption, electricity consumption, consumption expenditure, in comparison with GDP and economic growth, using the stationarity test, Granger causality test, Vector Auto Regression (VAR) method, and Johansen co-integration model to determine various short run and long run relationships. There is, however, less research analyzing the connection between domestic consumption of milled rice and GDP. As a result, given that rice is one of Bangladesh's key agricultural crops, this study is being done to ascertain how domestic consumption of milled rice and GDP are related.

3. Methodology
The unit root tests (i.e., PP, ADF, ERS, and KPSS) utilized in this study's empirical techniques include information on the stationarity characteristics of the variables under investigation. The second step is the Granger causality test, which is used to ascertain whether there is a causal connection between the variables. The long-term connection between the variables is then examined using the Johansen cointegration test. E-views 8econometric software was used to obtain this result.

Unit root test
To demonstrate the stationarity of the variables, unit root tests are used. Four unit root tests are utilized in this analysis, including:

The Augmented Dickey-Fuller (ADF) test was developed by Dickey and Fuller, which shows that this statistic does not follow the traditional t-distribution, provides asymptotic results, and assumes critical values for different tests and sample sizes under the null hypothesis of unit root (1981). The ADF test assumes that the sequence follows an AR procedure and includes delayed alteration terms of the dependent variable to generate a parametric adjustment for higher-order correlation.

IN 1988, Phillips and Perron created the **Phillips-Perron (PP) test**, offers a nonparametric method of sequential correlation control while seeking for a unit root.

The Elliott-Rothenberg-Stock (ERS) test was developed by Elliott et al (1996). The PP technique builds the non-augmented DF test equation and adjusts the coefficient's -ratio in order to avoid serial correlation impacting the test statistic's asymptotic distribution.

Granger causality test
In this study, the Granger causality test, developed by Granger (1969), was employed to examine the connection between GDP and milled rice consumption. One may assess causality from Granger's point of view by using F-tests to see if lagged information on a variable Y supplies any statistically significant information on a variable X in the presence of lagged X. "Y does not Granger-cause X," unless otherwise indicated. Although Granger causality does not by itself imply causality in the way that the word is most generally used, it does evaluate information content and precedence.

Johansen cointegration test
The third phase involves identifying long-run equilibrium relationships between variables using the Johansen cointegration approach (Johansen, 1988; Johansen and Juselius, 1990) given in an equation. Additionally, the amount of delays needed in each series was chosen using the Schwarz information criteria after using maximum eigenvalue and trace tests to discover cointegration relationships.

4. Data and Empirical Results
4.1 Data
The data set applied in this study was annual data on logarithm of the domestic consumption of milled rice (*ldcm)* and real Gross domestic product (*lgdp*) of Bangladesh from 1960 to 2014; the data sets were accomplished from indexmundi http://www.indexmundi.com/agriculture/?country=bd) and FRED (https://fred.stlouisfed.org/series/RGDPNABDA666NRUG) accessed in May 2017. A detailed description of the statistical data is exhibited in Table 1.

Table 1. Descriptive statistics

Variables	Means	Standard deviation	Variables (logarithms)	Means	Standard deviation
dcm	187017	7988.019	ldcm	9.752399	0.407857
gdp	178162.9	120014.3	lgdp	11.90167	0.597617

Notes dcm stands for domestic consumption of milled rice, gdp stands for Gross domestic product of Bangladesh. *ldcm* represents logarithm of domestic consumption of milled rice and *lgdp* stands for logarithm gross domestic product.

Figure 1 exhibits log domestic consumption of milled rice*(ldcm*) andlog Gross domestic product (*lgdp*) of Bangladesh in vertical axis and the number of year from 1960 to 2014 is depicted in horizontal axis. The domestic consumption represents downward trend until 1962, then obtainan upward trend with some fluctuation up to 2014.The gross domestic product shows upward trend until 1970 then become downward as like as 1961and again it gained upward trend up to2014.
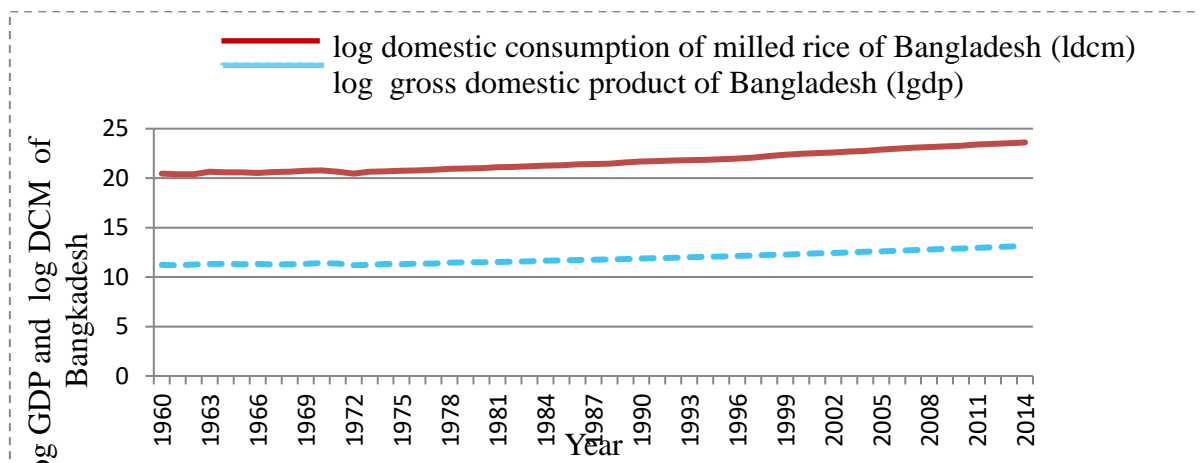

Figure: 1

4.2 Empirical Results
Table 2. Unit root test results of two variables

Variables	Test	Level	First difference	Details
ldcm	ADF	0.240710*	-9.863210***	SIC, Int
ldcm	ADF	-3.072290	-9.910882***	SIC, Int, Tr
ldcm	PP	1.330805*	-11.29596***	NW, B, Int
ldcm	PP	-2.957522	-22.88713***	NW, B, Int, Tr
ldcm	KPSS	0.876075	0.346658***	NW, B, Int
ldcm	KPSS	0.228925	0.213399**	NW, B, Int, Tr
ldcm	ERS	131.7520	1.180153***	SIC, SOLS, Int,
ldcm	ERS	11.68084	3.871278***	SIC. SOLS, Int, Tr
lgdp	ADF	3.631904	-1.780525	SIC, Int
lgdp	ADF	-1.2024147*	-7.234100***	SIC, Int, Tr
lgdp	PP	4.444470	-6.169769***	NW, B, Int
lgdp	PP	-0.974723*	-9.835990***	NW, B, Int, Tr
lgdp	KPSS	0.858874	0.958499	NW, B, Int
lgdp	KPSS	0.253210	0.363943	NW, B, Int, Tr
lgdp	ERS	1117.338	16.60432	SIC, SOLS, Int,
lgdp	ERS	216.2814	1.970425***	SIC. SOLS, Int, Tr

*Notes: ldcm*exihibits*log domestic consumption of milled rice and *lgdp* implies log Gross domestic product.*

SIC is Schwartz Information Criterion, Tr is linear trend, Int is Intercept, B is Bartlettkernel, SOLS is Spectral OLS, NW is Newey-West bandwith choice.
*, ** and *** represent that variables are stationary at 10 per cent, 5 per cent , and 1 per cent significant levels, respectively.

4.2.1 Stationarity Test
This study used a variety of unit root tests to determine the stationarity of the data, including the ADF, ERS, KPSS, PP, and ERS tests (proposed by Dickey and Fuller in 1981). With the exception of ADF and ERS tests in lgdp, where stationary is rejected considering intercept while KPSS tests show non stationary considering both intercept and trend intercept in lgdp, these four unit root tests demonstrate that the variables, the log domestic consumption of milled rice (ldcm) and gross domestic product (lgdp), are stationary in their first difference. The KPSS and ERS tests demonstrate that ldcm and lgdp are non-stationary in the level when intercept and intercept trend are taken into consideration.The test, ADF and PP, however, demonstrates that the ldcm is non stationary when trend intercept is taken into account but stationary in the level when simply the intercept is taken into account.
The variable lgdp is non-stationary in the level for the ADF and PP tests when only the intercept is taken into account, but stationary when the trend intercept is taken into account. When considering the aforementioned facts, it is thought that variables remain stationary at their initial difference.

Table 3: Individual Granger causality (GC) test results in Bangladesh

Dependent variable	Sources of causation (independent variables)	
	ldcm	*lgdp*
3.1*ldcm*	-	4.33953**(0.0423) ←
3.2*lgdp*	17.0346***(0.0001) ←	-

Here,*ldcm*and *lgdp*indicate log domestic consumption of milled rice and log gross domestic productof Bangladesh respectively.

4.2.2 Granger causality test

Table 3represents the individual Granger causality tests between GDP and DCM here DCM indicates domestic consumption of milled rice and GDP means gross domestic product of Bangladesh. Null hypothesis of non-causality between domestic consumption of milled rice (DCM) and Gross domestic product (GDP) is rejected at 5% level of significance critical value 0.05 is greater than P value (0.0423 and 0.0001) meaning that causality is present. Row 3.1 of table 3shows that real GDP Granger cause domestic consumption of milled rice (DCM).It indicates that real GDP has a predictive power to forecast DCM. Row (3.2) shows that DCM Granger cause GDP meaning that DCM plays a role in forecasting GDP. Thus the GC results reported indicate a bidirectional causality between GDP and DCM. This implies that real Gross domestic product and domestic consumption of milled rice are interconnected and may very well serve as complements to each other which in turn suggest that the policy regarding domestic consumption of milled rice and Gross domestic product of Bangladesh should be considered carefully. The table mentions that an increase in GDP may contribute to DCM, while a reduction in GDP may adversely affect DCM and vice versa.

Johansen cointegration test between DCM and GDP.

Table 4: Unrestricted Cointegration Rank Test (Trace)

Number of cointegration	Eigen value	Trace	5% Critical value	p-value
At most 1	0.023343	1.251829	3.841466	0.2632
None	0.191344	12.50806	15.49471	0.1341

Table 4.1: Unrestricted Cointegration Rank Test (Max-Eigen value)

Number of cointegration	Eigen value	Max-eigen statistic	5% Critical value	p-value
At most 1	0.023343	1.251829	3.841466	0.2632
None	0.191344	11.25623	14.26460	0.1418

4.2.3 Johansen cointegration test

Table 4 demonstrates that the null hypothesis between domestic milled rice consumption (DCM) and Bangladesh's GDP is accepted at the 5% level of significance in the trace test since the critical value (15.49471) is higher than the trace value (12.50806). According to Table 4.1, the rank test's critical value (14.26460) is higher than the maximum Eigen value (11.25623), and as a result, the null hypothesis—that there is no cointegration between the variables—is likewise accepted. This finding suggests that domestic consumption of milled rice (DCM) and Bangladesh's GDP do not have a long-term relationship. Since solely domestic consumption of milled rice (DCM) has no bearing on Bangladesh's Gross Domestic Product (GDP), consumption of other crops like potatoes, wheat, maize, and so on helps to raise GDP.

5. Conclusion, Suggestions and Future work
5.1 Conclusion

Investigating the relationship between Bangladesh's GDP and domestic milled rice consumption was the main goal of this study (DCM). This study focused on GDP and domestic consumption of milled rice (DCM) from 1960 to 2014. The ADF, KPSS, PP, and ERS tests, the Granger causality test, and the Johansen cointegration test were among the stationary tests used to look into the relationship. The actual data demonstrate that there is no unit root in accordance with the stationarity test, proving that both variables have changed over time.

Results of the Granger causality test show a two-way causal relationship between the variables, showing how variations in Gross Domestic Product (GDP) affect domestic consumption of milled rice (DCM). This affects GDP in a manner similar to how domestic milled rice consumption varies (GDP). The Johansen cointegration test shows that there is no evidence of long-run cointegration between the variables. The maximum consumption of milled rice is reliant on how much of its production is included in Bangladesh's Gross Domestic Product (GDP), as is evident from our discussion above. Furthermore, rice production is a significant contributor to Bangladesh's food security.

5.2 Suggestions

Since there is a bidirectional relationship between DCM and GDP, Government should give attention on much production of other crops like potato and wheat to remove the excessive dependency on rice consumption. Total production of rice should be increased by proper cultivation considering weather, fertilizers, irrigation and other related factors with cultivation. GDP should be calculated accurately through proper keeping of rice production records by Bangladesh Bureau of Statistics (BBS) along with expenditure method of GDP calculation. Government should take steps for effective monitoring to ensure proper record keeping of BBS. Budgets on agricultural research should be increased for more production. Central management information system should be established to maintain the information of production and consumption. Investment on much employment should be made to increase domestic consumption that will contribute to increase the volume of GDP. Illegal entrance of foreign products should be reduced through effective monitoring of crop market and enforcing the law properly. Government should provide subsidies to the producer of crops.

5.3 Future work

This study tried attentively to determine the nexus between domestic consumption of milled rice (DCM) and Gross domestic product (GDP) of Bangladesh. Only three tests—the Unit Root Test, the Granger Causality Test, and the Johansen Cointegration Test—were used to look at the relationship between the variables. Unobserved components (UC), Vector Error Correction Model (VECM), Panel Vector Error Correction Model, and Auto Regressive Integrated Moving Average (ARIMA) models can be used to advance this type of study work. The researcher may utilize a multivariate technique that includes other factors to ascertain the link. Furthermore, research projects may be conducted based on a variety of nations, as opposed to this study, which focused primarily on Bangladesh.

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