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Estimation of selected factors affecting rice imports in Sri Lanka

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Abstract

For ensuring the price stability and food security in Sri Lanka, it is important to estimate the drivers of the import rice demand, as rice is the main diet of majority of the Sri Lankans. The purpose of the study was to estimate the impact of the exchange rate, inflation rate, production, and gross domestic product (GDP) on rice imports in Sri Lanka during the period of 1990 to 2023 while finding the existence of short and long run relationships between the dependent and independent variables. In this study, the log transformed data were used for improving the linearity among the dependent and independent variables and for boosting the validity of the models. Autoregressive distributed lags (ARDL) model was employed to find out the long and short run relationships among the variables. The findings imply that GDP positively impacts rice import demand while production negatively affects it in both the short and long run. During the study period, exchange rate and inflation rate impacts were not significant. The diagnostic tests of restricted error correction model (RECM) and unrestricted error correction model (UECM) further verify the reliability of the fitted models. The high predictive accuracy of the ARDL model, confirmed by a low mean absolute scaled error (MASE) of 9.40 % and mean absolute percentage error (MAPE) of 3.59 %, suggests that domestic production and GDP are the primary, significant drivers of rice import demand. This study will help policymakers, government, and other related parties to get ideas about the economic environment for managing and stabilizing the domestic agriculture while ensuring food security effectively.

Keywords: ARDL, exchange rate, GDP, inflation rate, rice imports

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Introduction

Rice is the staple food of most Sri Lankans, with an annual per capita consumption of approximately 100 kilograms (Department of Census and Statistics, 2020). More than 30% of the total labour force is directly or indirectly involved in the rice sector (Dhanapala, 2007). However, domestic rice production has struggled to keep up with rising population and demand, resulting in a greater dependency on rice imports (Abeysekera et al., 2016).

Rice is a fundamental component of the diet not only in Sri Lanka but all over the world (Samaranayake et al, 2017). China is the biggest rice producing country before India, Indonesia, Bangladesh, Vietnam, Thailand, Myanmar, The Philippines, Japan, and Brazil (Garofalo et al., 2021). Sri Lanka primarily imports rice from India, Pakistan, United States and China according to world bank data.

Sri Lanka importing rice becomes a threat to the local market because the demand for imported rice is higher than the local market due to the huge difference in the prices (Senanayake et al., 2016). This mostly happens because of climate changes, shortage of fertilizer, sudden disasters, and impactful government policy changes (Perera et al., 2021). With the decrease in the local rice supply, consumers are more focused on buying the cheaper rice due to the economic problems currently running in Sri Lanka. The population growth, quantity of rice production, GDP, consumer price index, and foreign exchange rate are some of the major facts that affect the rice market (Kularathne et al., 2024; Rajakaruna, 2017). With the ups and downs, the supply and demand for local rice are changing, which makes way for importing rice. Addressing this problem is important for Sri Lanka to achieve self-sufficiency in rice.

This research was designed to find how selected factors (exchange rate, rice production, GDP, inflation rate) affect the import of rice in Sri Lanka, with the goal of identifying solutions for stabilizing domestic prices and ensuring reliable market supply. This study fills an important gap in previous studies related to Sri Lankan rice imports by including four essential elements that were often disregarded in prior research works. To account for variations in the price of imports, the exchange rate was taken into consideration. While the inflation rate represents the impact of broad price fluctuations on imports and GDP was taken as a measure of total demand and purchasing power. To figure out how much domestic supply is lacking, domestic rice production was used. When combined, these factors provide a balanced analysis of how supply, demand and price conditions work together to affect the volume of imports.

Estimation of the selected factors affecting rice imports in Sri Lanka was the main objective of this study, while investigation and establishing the existence of short and long run equilibrium relationships between these variables were the specific objectives to be achieved. Therefore, this investigation provides vital insights into the economic factors underlying Sri Lanka's rice import reliance. The development of a more resilient and competitive local rice market in Sri Lanka can be advanced not merely by reducing imports, but by effectively addressing the underlying domestic factors that drive import dependency specifically through investments aimed at raising productivity and strengthening supply chain framework (Abeysekara et al., 2016; Kularathne et al., 2024).

Findings from this study will enable policymakers to make more informed decisions to manage rice supply, stabilize prices, and support the growth of the local rice industry. This research will be valuable to numerous stakeholders, including government, agricultural planners, farmers, traders, and consumers, to discover the economic drivers of rice imports. Furthermore, it lays a foundation for future study and adds to the broader objective of ensuring rice market security in Sri Lanka.

Existing literature identifies several main factors influencing rice imports in the country. These include variations in domestic rice production, which are driven by weather patterns, adoption of improved agricultural technologies and practices, and government assistance for local agriculture. Population increase, urbanization, and altering dietary choices all influence rice consumption and import demand (Hossain et al., 2015). Furthermore, economic variables such as exchange rates, inflation, and income levels of consumers can affect both domestic rice production and consumer demand, hence influencing import requirements (Alam et al., 2003). Trade measures undertaken by Sri Lanka and its trade partners, and domestic production or export subsidies, have a substantial impact on the price and availability of imported rice (Ranum et al., 2014).

Agnes et al. (2021) reviews the literature on the development of rice production and consumption, the pricing policy, and the theoretical and practical approaches of rice imports in Indonesia. They highlighted that in the short run, imports would be a way to meet the country's rice needs, meanwhile in the longer run, it might see imports turn into a problem all by itself as the balance of trade in rice is disrupted. In this study they claimed that the disparity between the amount of rice imported and exported will cause Indonesia's rice trade balance to be negative.

The dynamics of import dependency are constantly driven by domestic consumption, production deficits, and currency fluctuations, according to the recent studies conducted in Indonesia by (Akbar et al., 2023; Isnaini et al., 2024; Purba et al., 2024).

Lancon et al. (2007) published a paper in which they described trade regimes and food policy formulation related to rice imports in West Africa. In this study they addressed their concern which is whether reviving the West African rice economy and enhancing food security would depend on a return to a more restricted trade policy by comparing the trends that are followed by the rice economy in Ghana, Nigeria, and Senegal. Those three countries are three major importing countries of the West African subregion, which represent different rice market patterns (national strategies for rice sector development) and trade policies on rice imports.

To estimate the factors affecting rice imports in Iran, Feizabadi (2014) conducted a time series analysis using a cointegration test. In this study, data over the period 1988 to 2013 were analyzed. The Engle-Granger two step cointegration test was employed to test for a long run relationship among the factors: population, rice production, foreign exchange rate, and domestic rice price. The results confirmed the presence of a long run equilibrium relationship, with all variables proving to be statistically significant determinants of rice imports in Iran. Similarly, Hyuha et al. (2018), published a paper in which they discussed the factors affecting import demand of rice in Uganda, but they used an econometric model only using the factors like population, domestic rice production, price, and consumption. Uganda's growing reliance on imports to bridge the gap between growing domestic demand and insufficient local supply was the focus of this research while the results confirmed the significant influence of all four factors on import volumes, leading to policy recommendations focused on enhancing productivity and addressing population dynamics to achieve self-sufficiency. Gholami (2013) makes a similar point in his study on Iran, aligning with the findings of Hyuha et al. (2018) by showing that foreign exchange rates have a negative impact on rice imports. For analysis of this study, the data from the period 1990 to 2011 was used employing the Engle- Granger cointegration test, and the variables used were per capita GDP, foreign exchange rate, and domestic price.

One study by Bashir et al. (2018), for the purpose of identifying factors influencing rice production and consumption in Indonesia using the model of linear regression equation with ordinary least square estimator (OLS), indicates that rice production in Indonesia can be affected by human capital, labor, wages, wetland area, urban population, and rice prices while technology holds no place in affecting rice production. For this purpose, the secondary data from 1990 to 2014 were used. Based on price elasticity estimates, Widarjono (2018) used the Almost Ideal Demand System (AIDS) approach to analyze Indonesia's rice imports and discovered that the country is highly dependent on imports from Vietnam and Thailand.

Putra (2019) found that domestic rice demand and domestic rice prices have a positive effect on imports while domestic rice productivity, foreign rice prices, and foreign exchange rate have a negative effect. To better understand the temporal dynamics of rice production and import in Nepal, Gairhe et al. (2021) carried out a study using secondary data from the years 2009 to 2018. The factors they considered were area, production, productivity, and import of rice using compound growth rate and Markov chain analysis and presenting in both tabular and graphic forms. Nyarko (2017) examined the threat posed by high rice imports to Ghana's food security and sustainable domestic production. This study examined Ghana's reliance on imports to satisfy domestic demand and its implications on local rice farming using a case study method.

To find out the impact of market determined exchange rates on rice production and import in Nigeria, Ammani (2013) analyzed the trend in production, productivity, import, import value, and consumption of rice alongside exchange rate over the period 1986 to 2010 employing a semi log growth rate model and simple linear regression models. The analysis revealed that declining exchange rate would reduce import demand and a free market strategy alone is insufficient without protective trade measures for local agricultural sector. According to the study of Ogundele (2007), named "trade liberalization and import demand for rice in Nigeria: a dynamic modelling" in the long run exchange rate, per capita income and local output of rice affected the rice import demand positively.

Despite the substantial evidence of the other countries, a focused analysis of the Sri Lankan setting reveals certain differences and research gaps. Some local investigations examined the effect of the specific inputs on paddy production, while some examined the effectiveness of policy measures for rice production and domestic rice market improvement (Dulanjani et.al, 2022).

A recent study by Kularathne et al. (2024) used machine learning models such as Support vector machines (SVM), fine trees and Ensemble boosting etc. to examine the impact of economic variables and focused more on Sri Lankan rice output than imports. In a similar direction, Abeysekara et al. (2024) discussed the global trade patterns, but it does not provide precise Econometric assessment of the variables influencing Sri Lanka's import volume.

Previous studies have either focused on policies on food security, production aspects, or descriptive trends. Therefore, this study aims to add to the existing body of research by conducting a comprehensive analysis of the key determinants of rice imports in Sri Lanka, employing advanced econometric techniques to provide policymakers with evidence-based insights that can inform policy decisions, promote domestic production, and ensure food security and price stability in the country.

Methodology

For achieving the objectives of this study, secondary data from Sri Lanka customs, the Department of census and statistics (DCS), and the Central bank of Sri Lanka (CBSL) were obtained for 34 years from 1990 to 2023. The data included rice imports in thousand metric tonnes as the dependent variable and inflation rate (Colombo consumer price index) in percent, real exchange rate in Sri Lankan rupees per US dollar, gross domestic product (GDP) in billion rupees and rice production in thousand metric tonnes as independent variables.

The independent variables were selected based on established import demand theory and empirical literature (Feizabadi, 2014; Putra, 2019). While other factors, such as tariffs and custom duties, are essential determinants for rice imports, they were omitted from this investigation due to the lack of a consistent and reliable quantitative data series over the study period.

The autoregressive distributed lags (ARDL) bounds testing approach, developed by Pesaran et al. (2001), was employed as the principal estimation method. This model is particularly suitable for investigating both long and short run relationships between rice imports and its determinants. A fundamental advantage of the ARDL approach is its robustness in handling variables that are a combination of multiple integration orders, I(0) or I(1), which is frequently observed in macroeconomic data. It also performs reliably with rather limited sample sizes. ARDL model can capture how independent variables affect rice imports in the short term, possibly with immediate responses to economic shocks, and if cointegrated it can capture the long-term relationships as well using the error correction model (ECM).

All variables were log transformed for the ARDL estimation. This transformation improves the accuracy of the model and makes it easier to interpret coefficients as the elasticies. Since all the variables are related to econometrics, using log transformation will help to get a better understanding of the relationships among the variables and to get better accuracy for the fitted model. In this study for normality testing Q-Q plots and the Shapiro- Wilk test was used while, the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test was used for the purpose of detecting integrated orders of the variables. For a well-defined ARDL model, it is essential to choose the appropriate number of lags for each variable because it balances the short-term dynamics and the long-term relationship between the dependent and independent variables. For the optimal lag selection, Akaike information criterion (AIC), Schwarz criteria (SC)/ Bayesian information criterion (BIC) and Hannan-Quinn criterion (HQIC) were used as the criteria that save the model from overfitting and under specification. From the selected optimal lag structure, the ARDL Model was estimated.

General Form of ARDL Model

$$\text{LnRice imports}_t = \beta_0 + \sum_{i=1}^{p} \beta_i \, \text{LnRice imports}_{t-i} + \sum_{j=0}^{q} \alpha_{1j} \, \text{LnGDP}_{t-j} + \sum_{k=0}^{r} \alpha_{2k} \, \text{LnInflation rate}_{t-k} + \sum_{l=0}^{s} \alpha_{3l} \, \text{LnExchange rate}_{t-l} + \sum_{m=0}^{u} \alpha_{4m} \, \text{LnProduction}_{t-m} + \epsilon_t \quad (1)$$

Here in equation (1), β_0 denotes the intercept and β_i are the coefficients for the lagged values of rice imports while α_{1j} , α_{1j} , α_{3l} and α_{4m} are the coefficients for the lagged values of the independent variables. ϵ_t is the error term. Number of lags for rice imports is denoted by p and q, r, s, t are the number of lags for GDP, inflation rate, exchange rate and production respectively. The response variable is Rice imports_t and GDP_{t-j} , $\text{Inflation rate}_{t-k}$, $\text{Exchange rate}_{t-l}$ and Production_{t-m} are the lagged values of the independent variables respectively.

The Bounds F test (Pesaran et al., 2001) is used for checking the existence of the long run equilibrium relationship among the variables, and it is an efficient method for testing cointegration when dealing with mixed orders of integration data (e.g., I(0) or I(1)), excluding the necessity to test the integration order of variables beforehand. The Bounds F test used to find cointegration in the ARDL model, while the t-Bounds test was used with the ECM. ECM can capture both short-term dynamics and long-term equilibrium in the relationship between the dependent and independent variables. If cointegration exists, then an error correction model can be used. The error correction term (ECT) in ECM reflects the adjustment of long run equilibrium.

General form of the ECM

$$\Delta\text{LnRice Imports}_t = \beta_0 + \sum_{i=1}^{p-1} \gamma_i \, \Delta\text{LnRice Imports}_{t-i} + \sum_{j=0}^{q} \alpha_{1j} \, \Delta\text{LnGDP}_{t-j} + \sum_{k=0}^{r} \alpha_{2k} \, \Delta\text{LnInflation Rate}_{t-k} + \sum_{l=0}^{s} \alpha_{3l} \, \Delta\text{LnExchange Rate}_{t-l} + \sum_{m=0}^{u} \alpha_{4m} \, \Delta\text{LnProduction}_{t-m} + \lambda\text{ECM}_{t-1} + \epsilon_t \quad (2)$$

In equation (2), Δ denotes the 1st difference of the variables and γ_i , α_{1j} , α_{1j} , α_{3l} and α_{4m} are the coefficients of the differenced variables (short term dynamics) while λECM_{t-1} is the error correction term (represents the deviations from the long-term equilibrium in the previous period).

After fitting the error correction model, diagnostic tests were conducted to ensure the validity and robustness of the estimated model. The Breusch-Godfrey test was used to check for serial correlation, while the Studentized Breusch-Pagan test detected heteroscedasticity. The Jarque-Bera test verified normality of residuals, and the RESET test examined model specification.

Additionally, the recursive CUSUM test assessed parameter stability. To evaluate predictive accuracy, in-sample forecasting was performed using mean absolute percentage error (MAPE) and mean absolute scaled error (MASE) as accuracy matrices. This allows to access how well the fitted model can predict outcomes using historical data.

Results and discussion

The aim of the study was to estimate the impact of the selected key macroeconomic and supply-side factors on Sri Lankan rice imports between 1990 and 2023. This section interprets the results of the ARDL model, exceeding statistical significance to clarify the economic factors behind the observed trends.

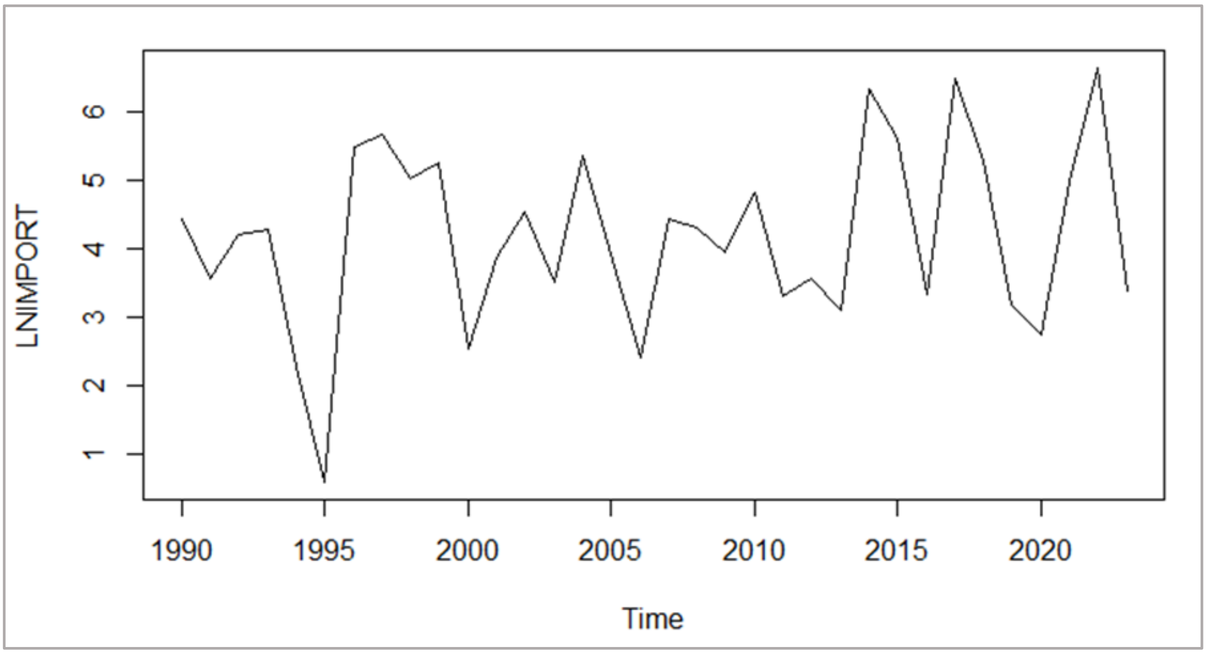

Figure 1. Time series plot of log transformed rice imports in Sri Lanka (1990- 2023)

Figure 1 illustrates significant fluctuations during the period of 1990 to 2023 in log transformed rice imports in Sri Lanka. The captured economic and environmental events are directly correlated with the observed volatility. The sharp peak in imports in aligns with a severe drought that reduced domestic paddy output necessitating large amount of imports to meet consumption needs, as reported by the reports from DCS (2018).

On the other hand, the sharp drop around 1994-1995 coincides with the period of high domestic production due to the implementation of higher tariff rates on rice imports as part of the government's agricultural protection policy as described in the CBSL annual report (1995).

Table 1. Descriptive statistics of the log-transformed variables

Variable	LnImport	LnExchange	LnProduction	LnGDP	LnInflation
N	34	34	34	34	34
Mean	4.20	4.61	8.09	8.07	2.12
SD	1.33	0.54	0.26	1.36	0.64
Median	4.25	4.66	8.07	8.08	2.04
Min	0.59	3.69	7.63	5.77	0.76
Max	6.66	5.78	8.55	10.23	3.91
Range	6.08	2.09	0.92	4.45	3.15
Skewness	-0.27	0.13	0.17	-0.09	0.32
Kurtosis	-0.03	-0.54	-1.22	-1.42	0.33

Source: Data compiled based on secondary data from Sri Lanka Customs, DCS and CBSL.

As can be seen in Table1, the kurtosis of the log transformed imported rice is -0.03, which indicates that the imported rice is slightly flatter than a normal distribution (platykurtic) due to the negativity of the kurtosis values, while skewness holds a value of -0.27, which is close to 0 showing symmetries in the distribution. Based on the kurtosis, values of all the variables are platykurtic except log transformed inflation.

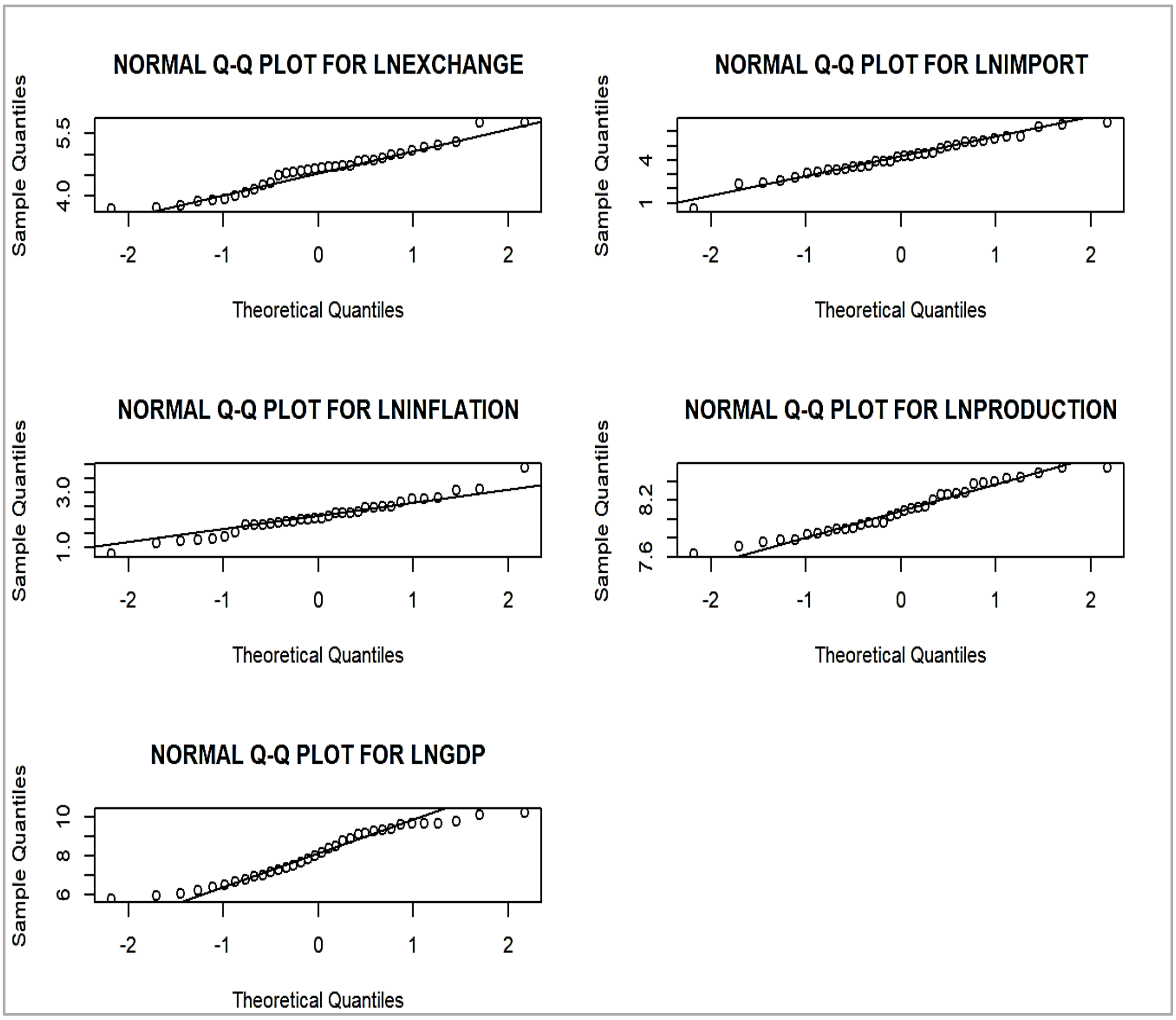

Figure 2. Normal Q-Q plots for log transformed variables.
Source: Data compiled based on secondary data from Sri Lanka Customs, DCS and CBSL

As depicted in figure 2, log transformed exchange and import variables closely follow the straight lines in the normal Q-Q plots, showing the normality in the distributions. Log transformed inflation and production might not be perfectly normally distributed, due to the slight deviation of the datapoints from the straight line, while log transformed GDP considerably shifts from the straight line showing it is likely to be non-normal. To verify the normality of the variables, Shapiro-Wilk statistical test was employed.

Table 2: Normality Test for Log Transformed Variables

Variable	P Value
LnImport	0.80
LnProduction	0.21
LnInflation	0.74
LnExchange	0.32
LnGDP	0.06

Source: Calculations based on the secondary data

From the p values of the Table 2, null hypotheses for all the variables can't be rejected. Thus, all the log transformed variables are normally distributed at a 5% significance level considering the higher values of p than the alpha. Since, Table 2 also gives the same results as Figure 1, confirming the normality of the log transformed variables.

Table 3: Stationarity test

Variable	P Value	I (0)/I (1)
LnImport	0.1	I (0)
ΔLnProduction	0.1	I (1)
LnInflation	0.1	I (0)
ΔLnExchange	0.1	I (1)
ΔLnGDP	0.1	I (1)
LnImport	0.1	I (0)

Source: Calculated based on the secondary data

According to Table 3, all the log transformed variables are stationary at integrated order 0, except log transformed production, exchange and GDP. These variables become stationary at 1st difference. Since there is a mixed order of integrated variables at a 5% significance level, the ARDL model can be used for model building.

Table 4: Best Order for ARDL model

LnImport	LnExchange	LnGDP	LnProduction	LnInflation
1	4	6	2	5

Source: Calculated based on the secondary data

The best lag structure reveals that the current value of the log transformed dependent variable, rice imports, is shaped by its own previous value and the previous 4, 6, 2, and 5 values of the log transformed exchange, GDP, production, and inflation, respectively (Table 4).

Best ARDL Model at 5% Significance Level

With a p value of 0.008, the ARDL model shows a statistically significant relationship at the 5% level. R squared of 0.98 indicates that the model has a very high explanatory power, meaning that the variables included account for roughly 98% of changes of rice imports in Sri Lanka. According to the model, imports from the previous year and domestic rice production from the past two years both have a negative impact on current imports while, factors like GDP and inflation have mixed effects across different time lags.

$$LnRiceImports_t = 119.6453 - 0.7710 \times LnRiceImports_{t-1} + 22.2427 \times LnGDP_t - 27.7638 \times LnGDP_{t-1} - 22.1006 \times LnGDP_{t-6} + 1.5802 \times LnInflationRate_{t-1} - 2.3755 \times LnInflationRate_{t-5} - 3.4546 \times LnProduction_t - 7.5645 \times LnProduction_{t-1} - 5.0987 \times LnProduction_{t-2} + \epsilon_t \quad (1)$$

Table 5: Results of F Bounds test in ARDL Model

Statistic	Lower-bound I (0)	Upper-bound I (1)	Alpha	P value
17.18	*3.23*	*4.35*	0.05	10^{-6}

Source: Calculated based on the secondary data

The bounds F test statistic of 17.18 shows a value significantly higher than the upper bound critical value which is 3.23 at a 5% significance level, and the associated p value of 10^{-6} rejects the null hypothesis of no cointegration, confirming the presence of a steady long run relationship among the log transformed variables. So, this suggests further estimations for long run coefficients and short run error correction models.

Restricted ECM at 5% Significance Level

Error correction term (ECT_{t-1}) captures how quickly at which the factors in the model return to their long run equilibrium following a shock or disturbance. The -1.77 of estimated significant coefficient shows that the correction is taking place very quickly at 177.1%, considerably surpassing the equilibrium before stabilizing. The model exhibits an excellent statistical fit of explaining the variation in rice imports by 99.2% with extremely low p value of 4.903e-08. While domestic production consistently reduces the imports in the current year, the effects of exchange rate, GDP and inflation rate are more complex and spread out over time, implying the dynamic nature of the import demand in Sri Lankan economy.

$$\Delta LnRiceImports_t = 3.8932 \times \Delta Lnexchange_t + 6.0112 \times \Delta Lnexchange_{t-3} + 22.2427 \times \Delta LnGDP_t - 8.7762 \times \Delta LnGDP_{t-1} - 9.2289 \times$$

$$\Delta LnGDP_{t-2} + 8.8179 \times \Delta LnGDP_{t-3} + 14.9930 \times \Delta LnGDP_{t-4} + 22.1006 \times \Delta LnGDP_{t-5} - 1.3078 \times \Delta LnInflationRate_{t} + 3.3929 \times \Delta LnInflationRate_{t-1} + 2.4196 \times \Delta LnInflationRate_{t-2} + 3.1143 \times \Delta LnInflationRate_{t-3} + 2.3755 \times \Delta LnInflationRate_{t-4} - 3.4546 \times \Delta LnProduction_{t} + 5.0987 \times \Delta LnProduction_{t-1} - 1.7710 \times \mathrm{ECT}_{t-1} + \epsilon_t \quad (2)$$

Unrestricted ECM at 5% Significance Level

The estimated UECM model reveals a high significant long run relationship among the factors, as confirmed by a p value of 0.00 at 5% significance level. Approximately 99.16% of the variation in the growth rate of rice imports is explained by the lagged rice imports, GDP, rice production, inflation rate, and their various lagged differences.

The significance of the negative coefficient of $LnRiceImports_{t-1}$ in UECM further verifies the results of the bounds F test. In the long run, GDP, production, and the previous value of the log transformed rice imports play a significant role in predicting the future values of the log transformed rice imports. GDP has a beneficial impact on rice imports meanwhile, production reduces in the both short and long term.

$$\Delta LnRiceImports_{t} = 119.6453 - 1.7710 \times LnRiceImports_{t-1} + 3.25551 \times LnGDP_{t-1} - 16.1177 \times LnProduction_{t-1} + 22.2427 \times \Delta LnGDP_{t} - 9.2289 \times \Delta LnGDP_{t-2} + 14.9930 \times \Delta LnGDP_{t-4} + 22.1006 \times \Delta LnGDP_{t-5} + 3.1143 \times \Delta LnInflationRate_{t-3} + 2.3755 \times \Delta LnInflationRate_{t-4} - 3.4546 \times \Delta LnProduction_{t} + 5.0987 \times \Delta LnProduction_{t-1} + \epsilon_t \quad (3)$$

Table 6: Results of t bounds test in UECM

Statistic	Lower-bound I(0)	Upper-bound I(1)	Alpha	P value
-7.823404	-2.864981	-4.000246	0.05	10^{-6}

Source: Calculated based on the secondary data

Table 6 shows that the test statistic of -7.82 is considerably smaller than both the lower and upper bounds, so the null hypothesis of no cointegration can be rejected at a 5% significance level.

That means there is a statistically significant long run relationship that exists between the variables in the model. P value also further verifies the above cointegration among the variables.

Table 7: Results of diagnostic tests for RECM and UECM

Diagnostic Test	P Value for RECM	P Value for UECM	Conclusion
Breusch-Godfrey test for serial correlation of order up to 1	0.2455	0.1321	No serial correlation among the residuals.
Studentized Breusch-Pagan test	0.5066	0.5483	Homoscedastic.
RESET test	0.7234	0.737	The model is correctly specified.
Jarque Bera Test	0.6071	0.6071	Residuals are normally distributed.
Recursive CUSUM test	0.2418	0.2064	The coefficients of the model are stable.

Source: Authors' calculations based on the secondary data

As shown in table 7, both the models are correctly specified at the significance level of 5%. Above conclusions from the diagnostic tests verify the reliability of the RECM and UECM. So, table 9 effectively shows strong evidence for the robustness and power of the ARDL model for the estimation of factors affecting rice imports in Sri Lanka.

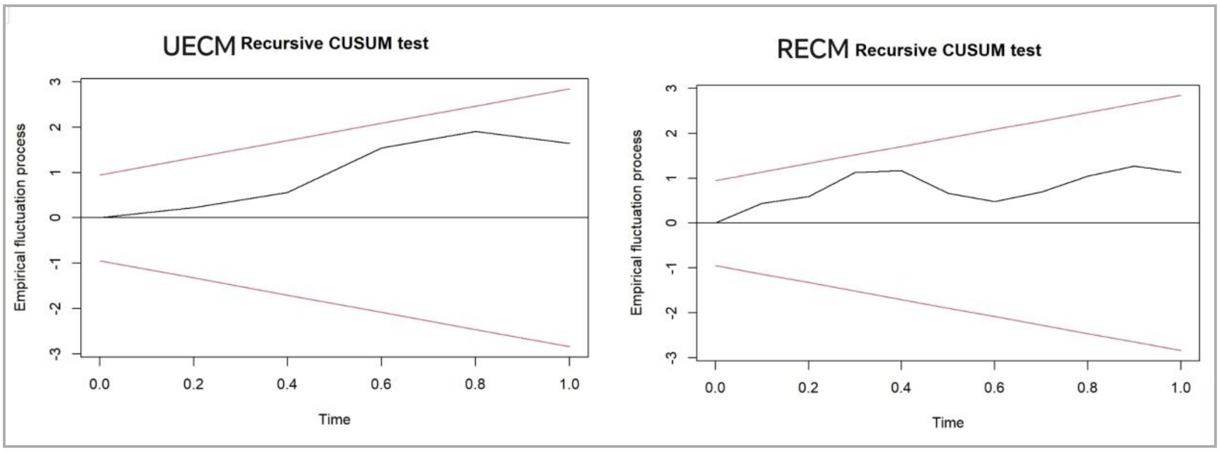

Figure 3. Plot of the Recursive CUSUM Test for UECM and RECM
Source: Calculated based on secondary data

As depicted in Figure 3, the empirical fluctuation process stays within the 5% significance limits for the entire time period, suggesting that the parameters of the UECM and RECM are stable over time without any structural breaks or significant changes in the underlying relationship between the variables. This further explains the results of the recursive CUSUM test diagnosis.

Table 8: Short run and long run multipliers

Short run multipliers				
Term	**Estimate**	**Std. Error**	**t value**	**Pr(>|t|)**
LnExchange	3.89	3.04	1.28	0.26
LnGDP	22.24	7.40	3.00	0.03*
LnInflation	-1.31	0.60	-2.17	0.08
LnProduction	-3.45	1.28	-2.69	0.04*
LongRun Multipliers				
Term	Estimate	Std. Error	t value	Pr(>|t|)

LnExchange	-1.10	1.40	-0.78	0.47
LnGDP	1.84	0.72	2.56	0.05*
LnInflation	-1.76	1.23	-1.43	0.21
LnProduction	-9.10	2.04	-4.471	0.00*

Source: Calculated based on secondary data

Table 8 shows that at a 5% significance level, in both the short and long run, log transformed production negatively impacts the import demand of rice in Sri Lanka while log transformed GDP positively affects. These findings align with standard economic theory and strongly consistent with studies from Indonesia (Putra, 2019), Iran (Gholami, 2013) and similar to the findings of Alam et al. (2003) and Ogundele (2007).

However, during the study period, the log transformed exchange rate and inflation rate were not statistically significant factors of rice imports in Sri Lanka. Even though the negative sign for the exchange rate is theoretically unexpected, considering decline should raise the cost of imports and reduce demand, this finding may reflect Sri Lanka's specific situation as a necessary importer of basic foods. This pattern has also been observed in other imports dependent nations like Ghana (Nyarko, 2017).

Similarly, the non-significancy of inflation shows that, price changes are a less critical determinant of import demand than fundamental factors like domestic production and national income, a detail underlined in research such as Hyuha et al. (2018).

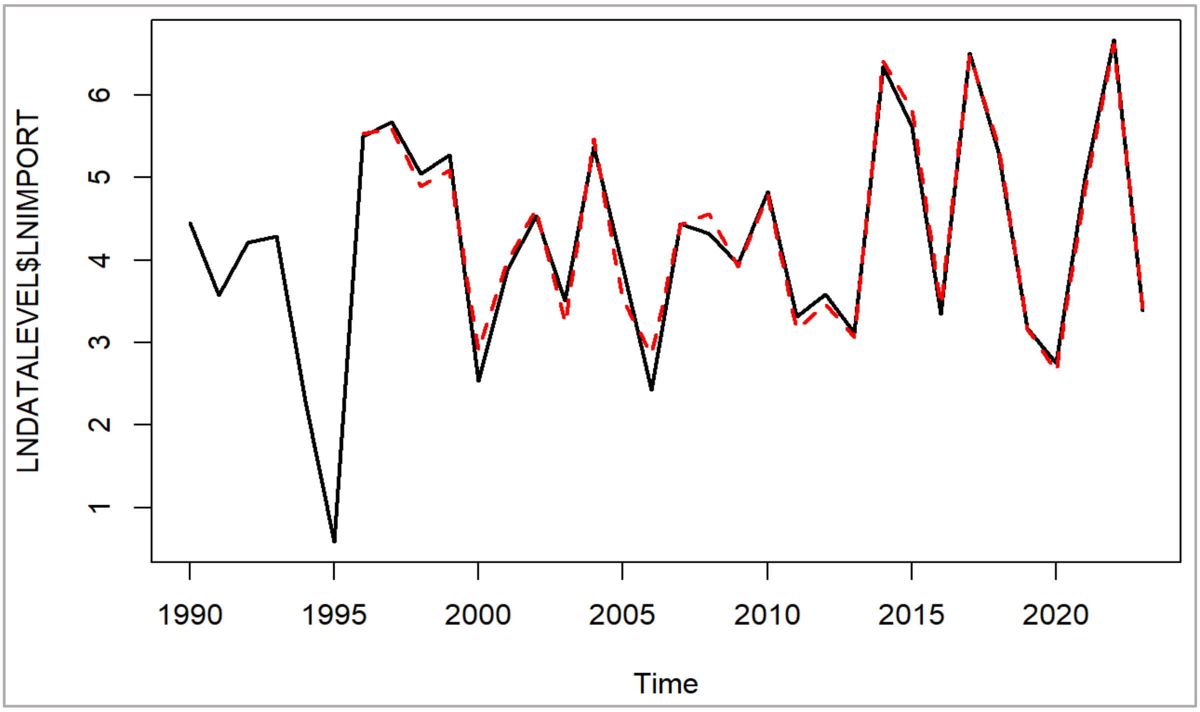

Figure 4. Plot of the in-sample forecasting calculated based on the secondary data.

Figure 4 shows the visual representation of how well the predicted values (red dotted line) fit with the historical data. The closeness of the predicted values to the actual values provides a strong foundation for model's validity by suggesting the underlying structure and dynamics of the rice imports have been effectively modelled. By comparing the predicted values within sample data, the performance metrics like mean absolute percentage error (MAPE) and mean absolute scaled error (MASE) can be assessed.

Table 9. Accuracy metrics

Performance Metric	ARDL	ECM
MAPE	0.04 (3.59%)	0.23 (22.89%)
MASE	0.09 (9.40%)	0.06 (5.52%)

Source: Calculated based on secondary data

ARDL model shows the best predictive accuracy since it holds the lowest MAPE value of 3.59% with MASE of 22.89%, exhibiting the ability of providing the best results preferably for the long run behaviour of rice imports (Table 9). But in terms of MASE with value of 5.52% and MAPE of 9.40%, error correction models UECM and RECM have the higher handling power of scaled errors flaunting the applicability for capturing the short run adjustments in the import demand in Sri Lanka. These results underscore that the ARDL model is better suited for reliable long run trend analysis and stable forecasts while, the ECM is more appropriate for modelling short run dynamics and immediate policy impacts on import demand.

The ARDL model employed in this study has several inherent limitations where it requires careful lag length selection, inability to handle I(2) variables, assumption of linear relationships potentially missing complex nonlinear dynamics. In addition, the modeldoes not automatically account for structural breaks in time series data. It also does not address endogeneity issues or reverse causality between variables. These limitations suggest caution when interpreting results and indicating directions for future methodological advancements.

Employing methods like machine learning or hybrid econometric and ML models, other than using the ARDL, and exploring factors like climate change and trade policies may be other ways to present this study, and also this research can be further extended using time-varying parameter models.

Conclusions

Through this research, the impact of the variables like GDP, inflation rate, exchange rate, and production on the rice imports in Sri Lanka was discussed by applying the ARDL model for capturing both long and short run relationships among the variables. GDP and production are the main drivers of the rice import demand during the study period in both the short and long terms while the exchange rate and inflation rate hold nonsignificant impacts. Higher GDP stimulated import demand; at the same time, higher production led to lower imports significantly. Due to the smaller sample size, the accuracy of the ARDL model outperforms the performance of the UECM and the RECM. However, the ARDL and the EC models accurately capture the long and short run behaviors of independent factors towards rice imports in terms of predictive power and accuracy during the study period with lower MASE and MAPE values.

To reduce rice import dependency, the government should directly target the key drivers highlighted in this study, particularly domestic production and GDP. Specially, encouraging domestic rice production through farmer friendly policies and implementing measures for stabilizing domestic rice prices can help reduce the import demand in Sri Lanka while taking measures to maintain a healthy economic environment is also essential. Furthermore, maintaining a stable economic environment remains essential for managing the significant positive relationship between GDP growth and import demand, ensuring that rising incomes do not outpace the domestic supply.

Conflict of interest statement

The authors declare that they have no conflict of interest.

References

Abeysekara, I., & Rathnayake, I. (2024). Global Trends in Rice Production, Consumption and Trade. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4948477

Abeysekera, S., Weerasinghe, H. M. J.,&Jayasinghe, J. A. S. (2016). Factors affecting rice imports in Sri Lanka: A review. *Journal of Agricultural Economics and Development*, *5*(2), 45-53.

Aggarwal, V. A., Posen, H. E., & Workiewicz, M. (2015). The Origin of Capabilities? A Microfoundational Theory of Firm Heterogeneity. *Academy of Management Proceedings*, *2015*(1), 16969. https://doi.org/10.5465/ambpp.2015.3

Agnes, M., Rasyid, R.,&Sari, N. (2021). Rice imports in Indonesia: Policy review and trade balance implications. *Indonesian Journal of Agricultural Economics*, *11*(1), 33-45.

Agus Widarjono. (2018). Analysis of Rice Imports in Indonesia: AIDS approach. *Journal of Economics Business and Accountancy Ventura*, *21*(2), 259–268. https://doi.org/10.14414/jebav.v21i2.1212

Akbar, W., Subiyantoro, H.,&Sidik, M. (2023). Factors Influencing Rice Import Activities in Indonesia. Ekonomis: *Journal of Economics and Business*, *7*(2), 782-786.

Alam, M. J., Ali, M.,&Rahman, M. A. (2003). Economic factors affecting rice import demand in developing countries. *Journal of International Trade and Development*, *12*(4), 441-458.

Ammani, A. A. (2013). Impact of market-determined exchange rates on rice production and import in Nigeria. *African Journal of Agricultural Research*, *8*(24), 3164-3171. https://doi.org/10.5897/AJAR2013.7548

Annual Report 1995 | Central Bank of Sri Lanka. (2025). Cbsl.gov.lk. https://www.cbsl.gov.lk/en/publications/economic-and-financial-reports/annual-reports/annual-report-1995

Bashir, A., Hussain, M.,&Ahmed, M. (2018). Factors influencing rice production and consumption in Indonesia. *Indonesian Agricultural Journal*, *23*(1), 15-27.

Central Bank of Sri Lanka. (1995). *Annual report 1995*. https://www.cbsl.gov.lk/en/publications/economic-and-financial-reports/annual-reports/annual-report-1995

Dhanapala, M.P. (2007) Bridging the rice yield gap in Sri Lanka. In *Proceedings of thesymposium on Expert Consultation on Bridging the Rice Yield Gap in the Asia-PacificRegion*, 5–8 October 1999, Bangkok, Thailand. pp. 135–145.Department of Census and Statistics. (2020). Annual report on rice consumption. Sri Lanka Ministry of Agriculture.

Dulanjani, P. A.,&Shantha, A. A. (2022). The Impact of Fertilizer Subsidy on Average Paddy Yield in Sri Lanka.*Sri Lanka Journal of Social Sciences and Humanities*,2(2).

Feizabadi, S. (2014). Factors affecting rice imports in Iran: An analysis using cointegration test. *Journal of Economic Research*, *25*(1), 101-117.

Fraterrigo Garofalo, S., Tommasi, T.,&Fino, D. (2021). A short review of green extraction technologies for rice bran oil.*Biomass Conversion and Biorefinery*,*11*(2), 569-587.

Gairhe, S., Joshi, K. D.,&Ghimire, S. (2021). Temporal dynamics of rice production and import in Nepal: A growth rate and Markov chain analysis. *Nepal Agricultural Journal*, *41*(2), 105-116.

Gholami, A. (2013). Analysis of rice import trend and its economic factors: Case of Iran. *Iranian Journal of Agricultural Economics and Development Research*, *44(*3), 205-220.

Hyuha, T., Bashaasha, B., & Kayiwa, V. (2018). Determinants of rice import demand in Uganda: An econometric analysis. *East African Journal of Economics and Trade*, *12*(2), 59-76.

International Trade Administration. (2021). Rice production in Sri Lanka. Retrieved from https://en.wikipedia.org/wiki/Rice_production_in_Sri_Lanka

Isnaini, S. A., Indah, P. N., & Laily, D. W. (2024). The Analysis of Factors Influencing Rice Imports in Indonesia. *Buletin Penelitian Sosial Ekonomi Pertanian Fakultas Pertanian Universitas Haluoleo*, *26*(2), 105–115. https://doi.org/10.37149/bpsosek.v26i2.1412

Kularathne, S., Rathnayake, N., Herath, M., Rathnayake, U., & Hoshino, Y. (2024). Impact of economic indicators on rice production: A machine learning approach in Sri Lanka. *PLOS ONE*, *19*(6), e0303883. https://doi.org/10.1371/journal.pone.0303883

Lancon, F., Erenstein, O.,&Akande, S. O. (2007). Rice imports and trade regimes in West Africa: Implications for food security. *Journal of International Food Policy*, *28*(2), 215-229.

Nyarko, E. (2017). High rice import as a threat to food security and sustainable rice production in Ghana. *Ghana Journal of Agricultural Research*, *35*(1), 11-24.

Ogundele, O. O. (2007). Trade liberalization and import demand for rice in Nigeria: A dynamic modelling approach. *Journal of West African Economic Studies*, *20*(4), 55-70.

Perera, D., et al. (2021). *Policies that matter or are forgettable: The evaluation of paddy policies in Sri Lanka (1998–2018).* Hector Kobbekaduwa Agrarian Research and Training Institute.

Perera, Dilini, et al. *Policies That Matter or Are Forgettable the Evaluation of Paddy Policies in Sri Lanka: 1998 to 2018 Hector Kobbekaduwa Agrarian Research and Training Institute 114, Wijerama Mawatha Colombo 7 Sri Lanka*. 2021.

Pesaran, M. H., Shin, Y.,&Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326. https://doi.org/10.1002/jae.616

Purba, Lindawati, F. S., Ayu, S. F., & Darus, M. B. (2024). The influential factor of the rice import problem in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *1413*(1), 012100. https://doi.org/10.1088/1755-1315/1413/1/012100

Putra, D. R. (2019). Factors influencing rice imports in Indonesia: An econometric analysis. *Journal of Agribusiness Research*, *14*(2), 35-49.

Rajakaruna, S. H. I. (2017). An Investigation on factors affecting exchange rate fluctuations in Sri Lanka. *Staff Studies*, *47*(1).

Ranum, P., Peňa-Rosas, J. P.,&Garcia-Casal, M. N. (2014). Global maize production, utilization, and consumption patterns. *Annals of the New York Academy of Sciences*, *1312*(1), 105-112. https://doi.org/10.1111/nyas.12396

Samaranayake, M. D. W., Yathursan, S., Abeysekera, W. K. S. M., & Herath, H. M. T. (2017). Nutritional and antioxidant properties of selected traditional rice (Oryza sativa L.) varieties of Sri Lanka. *Sri Lankan Journal of Biology*, *2*(2), 25–35. https://doi.org/10.4038/sljb.v2i2.10

Senanayake, S. M. P., & Premaratne, S. P. (2016). An analysis of the paddy/rice value chains in Sri Lanka. *Asia-Pacific Journal of Rural Development*, *26*(1), 105-126.

Widarjono, A. (2018). Analysis of rice imports in Indonesia: An AIDS approach. *Indonesian Journal of Agricultural Economics*, 9(3), 123-134*.*