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ANALYZING FOOD IMPORT DEMAND IN INDONESIA: AN ARDL BOUNDS TESTING APPROACH

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Abstract

Over the last few decades, Indonesia has seen an increase in its food imports and continues to see steady increases due to changing consumer taste and preferences. The current study analysed aggregate food import demand and its determinants using annual data and the ARDL bounds testing approach to cointegration for the period 1984-2020. The Augmented Dicky-Fuller test was used to determine the order of integration of each variable which was found to be order 1 for all variables. The outcome of the unit root test suggested a possible cointegrating relationship between food imports and its determinants which was investigated using the ARDL bounds testing approach. The bounds test concluded that there exists a long-run equilibrium relationship between food imports and its determinants. In both time horizons relative prices, exchange rate and domestic production were found to negatively affect food imports while real income had a positive effect. Food imports for Indonesia was found to be price-inelastic in both time horizons. In addition, imported was found to be a luxury good with income elastic demand in both time horizons. Food import demand was found to be most responsive to changes in real income and domestic production during the study period. The adjustment parameters also suggest that around 92.4% of short- to long-run disequilibrium is corrected each year. Finally, the study suggested that policies to control excessive food import quantity in Indonesia can include setting import quota, giving subsidies to farmers, applying taxes to specific food items and devaluation of currency.
Keywords: *Cointegration, food import, determinants, error-correction model, Indonesia.*
JEL Codes: *F12, F14, Q11*

1. Introduction

Indonesia is a developing country with a population of more than 275 million people (Ing & Zhang 2022, Wurisastuti *et al.* 2022). Food availability is particularly important to create national food and nutrition security and self-sufficiency. Domestic production has not been able to meet national food needs, so imports are needed (Mardoni 2022, Maun *et al.* 2022, Widiana *et al.* 2022). The trend of Indonesia's imported food is increasing. Indonesia's imported food consumption data from 1989 to 2021 shows an increasing trend. In 1989, consumption of imported goods including household food and beverages, both main and processed food, was 706.1 thousand tons, and in 2021 it was 6,406.9 thousand tons. Indonesia is also a tourist destination for people all over the world, hence, in addition to providing food for domestic residents, Indonesia must also provide food for tourists visiting Indonesia.

The pattern of household food consumption in Indonesia is dominated by carbohydrates derived from grains, especially rice (Anindita *et al.* 2022, Falcon *et al.* 2022, Sinaga *et al.* 2022). Based on data from the National Socio-Economic Survey (SUSENAS) conducted by the Central Bureau of Statistics (BPS) of Indonesia, the largest share of Indonesian household expenditure is grains, followed by processed foods and beverages, meat and milk groups, and fruits and vegetables. Almost all Indonesian households at five poverty levels consume enough for their staple food, namely rice (Khoiriyah *et al.* 2020). The household trend towards consumption of prepared food and beverages increased significantly during the covid 19 period, namely by 19.27% in 2016 and by 39.65% in 2021. This data shows that households in Indonesia consume food and beverages quite high. Especially in 2021, the percentage of monthly average expenditure per capita by commodity of food group of Indonesia is divided into 5 food groups. The most of expenditures are due to prepared food and beverages (32%), others (28.31%) consisted of eggs and milk, fruits, meat, beverages stuffs , oil and coconut, legumes, spices, tubers, and other food items., cigarettes and tobacco (12%), cereals (11.08%, vegetables (8.41%), and fish/shrimp/common squid/shells (7.7%).

The government has undertaken a number of initiatives to support household food and nutrition security. They have implemented a number of programs, including the "rice-poor program" (known locally as "Raskin"), which provides powdered milk for toddlers (five-year-old babies), community empowerment through the Sustainable Food Garden (Local term: Pekarangan Pangan Lestari or P2L) and "Food Consumption Diversification" (local term Program Penganekaragaman Konsumsi Pangan or P2KP), as well as fertilizer and seed subsidies as well as the provision of agricultural mechanization equipment. However, factors such as a sizable population, a sizable tourism industry, expanding household lives, and shifting eating patterns away from carbohydrates and toward meat, dairy, fruit, and vegetables all contribute to a growth in imported food. The policy of the National Food Security program in 2021 focuses on encouraging the production of food commodities by building infrastructure and using technology. Implementation of the restructuring program starting in 2021 consists of five programs, namely: (1) Availability, Access and Consumption of Quality Food; (2) Added Value and Industry Competitiveness; (3) Science and Technology Research and Innovation; (4) Vocational Education and Training; and (5) Management Support. All agricultural policies and food production policies aim to increase production towards national food security. However, despite many efforts, food import continues to increase each year as consumers taste and preferences become more diverse.

There are many studies that estimates an aggregate import demand function for both developing and developed nations using a time-series econometrics approach. According to Goldstein and Khan (1985), aggregate imports can be fully explained by relative prices and real income. However, studies by Ibrahim and Ahmed (2017) and Ibrahim and Elsharif (2020) for Sudan; Hyuha *et al.* (2017) for Uganda; Hor *et al.* (2018) for Cambodia; Hibbert *et al.* (2012) for Jamaica; Keho (2019) for Cote d'Ivoire; Metwally (2004) for GCC countries; Mishra and Mohanty (2017) for India; Yahia (2015) and Elbeydi (2013) for Libya; and Mugableh (2017) for Jordan, notes that there are many other determinants of aggregate imports that must be considered in order to better understand the dynamics of imports. Some of the key determinants included in these studies were domestic production, exchange rate, final consumption, foreign direct investment, remittances, and export revenue. However, most studies focus on aggregate imports rather than food imports explicitly, in addition, to the best of the authors knowledge, no study has been done for Indonesia regarding estimating food import demand and its determinants.

In the empirical literature there are various approaches to studying aggregate import demand, e.g., ordinary least squares (OLS), Engle-Granger approach, Johansen approach, error-correction mechanism, autoregressive distributed lag (ARDL) approach Hadi and Chung (2022). According to Shrestha and Bhatta (2018), most time-series data are nonstationary and the use of standard OLS estimation can yield spurious or misleading results. However, in the presence of nonstationary variables, cointegration techniques can be used to assess the existence of long-run relationships and determine whether the results are spurious or valid (Gujarati 1995). Approaches to cointegration such as Engle and Granger (1987) and Johansen and Juselius (1990) are widely used in the empirical literature, however, they possess some limitations such as not being applicable when series are of mixed orders of integration. This is overcome by a less restrictive approach to cointegration developed by Pesaran *et al.* (2001) in the ARDL bounds testing approach. The ARDL approach possesses many advantages other the other aforementioned approaches such as it does not require all series to be integrated of order 1 or I(1), can be used in small samples, and can accommodate both the long-run and short-run model simultaneously (Nkoro & Uko 2016). Furthermore, the ARDL approach provides unbiased assessment results in the long-run (Belloumi 2014).

An assessment of the empirical literature reveals that the ARDL approach to cointegration has not been used previously to study aggregate food import demand and its determinants in Indonesia, hence, this study seeks to fill this gap. The primary aim of this study is to determine the aggregate food import demand function for Indonesia and to identify the key determinants for the period 1984-2020 using annual time-series data. The results of this study can help to gain a more comprehensive understand of the dynamics of food imports and its determinants. Understanding how these determinants interact with food imports in Indonesia can aid policymakers in formulating food import polices that are geared towards promoting meeting domestic demand, lowering domestic food prices, and providing incentives to local food producers in an effort to become more food self-sufficient.

2. Materials and Method

2.1 Indonesia Food Import Demand Function

The imperfect substitution model is widely used in the empirical literature to study aggregate import demand, wherein the primary assumption is that imports are not perfect substitutes for domestic commodities of a given country (Goldstein & Khan 1985, Dutta & Ahmed 2004). Additionally, this approach to international trade also assumes infinite world supply because according to Murray and Ginman (1976), estimation of international import demand has an identification problem which can be easily solved if we assume infinite world supply elasticity. Basically, if imports to a particular nation constitutes a minuscule portion of total global imports, then it is reasonable to consider that the world's supply to that nation is perfectly elastic which means that the rest of the world can easily increase exports to that nation without increase prices (Mishra & Mohanty 2017, Ibrahim & Ahmed 2017). Therefore, since, Indonesia imports but a relatively small fraction of total global food imports, it is safe to assume infinite world supply. Therefore, according to Goldstein and Khan (1985), the assumption of infinite world supply means that a single equation model can be used to estimate aggregate imports for a given nation. Many scholars ascertain that variations in aggregate imports can be fully explained by relative prices and real income, see examples, Ibrahim and Ahmed (2017), Ogbonna (2016), Omotor (2010), Hor *et al.* (2018), Keho (2019), Ibrahim and Elsharif (2020). In addition, a log-linear specification is preferred since it allows for easy interpretation of the estimated parameters of the import demand function (Hor *et al.* 2018). Therefore, the empirical food import demand function for Indonesia is

$$M_t = M\left(\frac{P_{im}}{P_d}, Inc\right) \tag{1}$$

where M_t is aggregate food imports by Indonesia. P_{im} is defined as the import unit value. P_d is domestic price of food. It must be noted that the measure of P_d varies across studies, however, Nguyen and Jolly (2013) and Ibrahim and Elsharif (2020) noted that the consumer price index (CPI) can be used to represent domestic prices. Hence, in this study CPI is used to represent the domestic prices of food in Indonesia. $\frac{P_{im}}{P_d}$ represents the relative price (RP_t) of food imports. Inc_t is real income which is usually represented by real GDP. Hence, the food import demand function for Indonesia is specified as follow

$$ln\,M_t = \alpha_0 + \alpha_1 lnRP_t + \alpha_2\, ln\, Inc_t + e_t \quad (2)$$

From equation (2) it is expected that α_1 should be negative in order to be consistent with the theory of demand which states that there is an inversed relationship between price and demand. This is since, an increase in import prices relative to domestic prices, will cause import quantity to be affected (Ibrahim & Elsharif 2020). This results in the import price elasticity being negative. In addition, demand theory states that the derivative of the import demand function should be negative with respects to import prices (Ibrahim & Elsharif 2020). When the price of imported food increases, and domestic food prices remains unchanged, then import quantities decline as domestic food is relatively cheaper for consumers so they will substitute which further justifies import price elasticity being negative. On the other hand, α_2 is expected to be positive. The expected effect of real income on food import quantity is positive, if the good is normal and negative if inferior. However, the imperfect substitution approach to international trade rules out the possibility of imported goods being inferior, hence, the expected sign of the income effect is supposed to be positive (Narayan and Narayan 2005). The error term (e_t) is white noise.

It is well documented that aggregate imports can be studied with only relative prices and real income, however, there are many other determinants of import demand, more specifically food import demand such as exchange rate and domestic food production. For instance, Ibrahim and Elsharif (2020), Nguyen and Jolly (2013), Bathalomew (2010), Uzunoz and Akcay (2009), Anaman and Buffong (2001), Jiranyakul (2013), states that exchange rate plays a significant and import role in determining aggregate import demand. This is since, when domestic currency depreciates in relation to exporting country currency, then imports become relatively more expensive for importing country, hence, imports will fall. Additionally, domestic food production also plays an important role in determining food import demand in Indonesia. This is since there should exist an inversed relationship between domestic food production and food imports. An increase in domestic food production decreases import dependency and offers the opportunity to consumers to obtain food at a cheaper price which means that food import volumes will decreases. In order to incorporate exchange rate and domestic production into the food import demand model, equation (2) is expanded as follow

$$ln\,M_t = \alpha_0 + \alpha_1\, ln\, RP_t + \alpha_2\, ln\, Inc_t + \alpha_3\, ln\, E_t + \alpha_4\, ln\, Q_t + e_t \quad (3)$$

where M_t, RP_t, Inc_t, and e_t are all previously define. E_t is the exchange rate of the Indonesian rupah (IDR) to the USD. α_3 is expected to be negative. This is since devaluation of the IDR against the USD would make food imports more expensive to Indonesian consumers which would negatively affect food import volumes. Q_t is domestic food production. α_4 is also expected to be negative. This is since, increased domestic food production will lead to increase domestic food supply which will then mean less food would need to be imported to meet the demand of Indonesian consumers.

2.2 Empirical Analysis

2.2.1 Stationarity

In time-series analysis, it is of paramount importance that unit root test is performed in order to ascertain if the underlying time-series are stationary. This is because regression analysis involving time-series data assumes that the series are all stationary (Gujarati & Potter 2009). According to Kennedy (2008) and Gujarati (1995), a time-series is said to be stationary when its stochastic properties, such as the mean, variance, and covariance between observations, are constant over time. Shrestha and Bhatta (2018) ascertains that most macroeconomic variables tend to exhibit a strong upward or downward movement over time with no tendency to revert to a fixed mean, hence, they are nonstationary. Furthermore, Nguyen and Jolly (2013) also notes that most macroeconomic variables are integrated of order 1. Stationarity is an important concept in empirical work involving time-series because performing Ordinary Least Squares (OLS) regression using nonstationary time-series can result in spurious regression (Shrestha and Bhatta 2018, Granger and Newbold 1974). In other words, regression results may suggest a significant relationship between two variables that might actually be unrelated. Spurious results can result in false conclusions being made. Additionally, the use of spurious results to inform policy decisions would lead to ineffective policy recommendation. Therefore, it is very important to determine the order of integration of each time-series being used in regression analysis.

A time-series is said to be integrated of the order d when its dth difference is found to be stationary. The Augmented Dicky and Fuller (1981) (ADF) test is widely used in empirical work to ascertain the order of integration of a time-series. The ADF test can be performed with and without a trend (Gujarati 1995). Firstly, the test is performed on the level variables and if the series is found to be nonstationary, then, it is differenced d number of times to make it stationary. Supposed that a series y_t is used to test for unit root, the general form of the ADF test is

$$\Delta y_t = a_0 + \gamma y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + a_1 t + e_t \tag{4}$$

where Δ is the difference operator, Δy_t is the first difference of y_t, y_{t-i} is the lags of y_t, t is a trend term and e_t is a white noise error term. The ADF test is performed under the null hypothesis $\gamma = 0$ against the alternative which states that $\gamma < 0$. If we fail to reject the null hypothesis, then the series has a unit root or is nonstationary. However, if we fail to accept the null hypothesis, then we concluded that the series is generated by a stationary process. This study utilizes the ADF test with and without trend to assess the order of integration of each variables used.

2.2.2 Cointegration Analysis and Error-Correction Mechanism

As stated prior, the use of OLS or other similar method for nonstationary time-series data can result in spurious results. In order to avoid this, the nonstationary series can be differenced to be made stationary, however, differencing can lead to valuable long-run relationships between variables being lost that would have been given by the level variables (Gujarati 1995). Shrestha and Bhatta (2018), notes that two or more variables may form a long-run equilibrium relationship despite deviations from equilibrium in the short-run. Additionally, according to Enders (2008), if a group of time-series data have an equilibrium relationship, then they cannot move independently from each other, hence, they are cointegrated. Cointegration analysis enables us to determine the long-run equilibrium relationship among variables that are nonstationary. This is since, any short-run deviation will die out gradually and long-run equilibrium will be achieved.

Several methods exist to assess if there exists a long-run relationship between variables. Engle and Granger (1987) develop a two-step residual-based approach to test for cointegration among nonstationary series while Johansen (1988) and Johansen and Juselius (1990) developed a method to test for cointegration in multiple-equation models using maximum likelihood estimation. However, both methods have limitations of either not being able to determine all possible cointegrating relationship as in the case of Engle-Grange method or being too restrictive as in the case of the Johansen and Juselius method which explicitly require all series to be integrated of the same order, order 1. This study utilizes the ARDL bounds testing approach to cointegration by Pesaran *et al.* (2001) due to it being less restrictive, works well in small samples, and allows for simultaneous estimation of the long-run and short-run parameters of the model. Th ARDL bounds testing approach starts by specifying a conditional error-correction model (ECM) as outlined in equation (5)

$$\Delta\, ln\, M_t = \beta_0 + \sum_{i=1}^{q} \beta_1\, \Delta ln\, M_{t-i} + \sum_{i=1}^{p} \beta_2\, \Delta ln\, RP_{t-i} + \sum_{i=1}^{p} \beta_3\, \Delta ln\, Inc_{t-i} + \sum_{i=1}^{p} \beta_4\, \Delta ln\, E_{t-i} + \sum_{i=1}^{p} \beta_5\, \Delta ln\, Q_{t-i} + \beta_6\, ln\, M_{t-1} + \beta_7\, ln\, RP_{t-1} + \beta_8\, ln\, Inc_{t-1} + \beta_9\, ln\, E_{t-1} + \beta_{10}\, ln\, Q_{t-1} + +\varepsilon_t \quad (5)$$

in equation (5), β_0 is the intercept, $\beta_{1-}\beta_5$ are the short-run parameter estimates, β_6-β_{10} are the long-run parameter estimates and ε_t is the error term.

Now that the conditional ECM is specified the bounds test can be used to ascertain if the variables are cointegrated. This is done by using an F-test to test for joint significance of the long-run parameters in equation (5). The hypothesis for testing for cointegration among variables is as follow

H_0: $\beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$, No Cointegration

H_1: $\beta_6 \neq \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq 0$, Cointegration

The computed F-statistic is compared with the critical bounds value in order to accept or reject the null hypothesis of no cointegration. There are three possible outcomes from the comparison. Firstly, if the computed F-statistic is greater than the upper-bound critical value at 5%, the null hypothesis of no cointegration is rejected in favour of the alternative of cointegration. Secondly, if the computed F-statistic is smaller than the lower-bound critical value at 5%, the null hypothesis is not rejected it is concluded that there is no long-run relationship among the variables. Finally, if the computed F-statistic falls between the lower- and upper-bound critical value at 5%, then the results are inconclusive, or no conclusion can be made about the relationship that exist among variables. However, if cointegration is discovered, then an ECM can be specified as follow

$$\Delta\, ln\, M_t = \beta_0 + \sum_{i=1}^{q} \beta_1\, \Delta ln\, M_{t-i} + \sum_{i=1}^{p} \beta_2\, \Delta ln\, RP_{t-i} + \sum_{i=1}^{p} \beta_3\, \Delta ln\, Inc_{t-i} + \sum_{i=1}^{p} \beta_4\, \Delta ln\, E_{t-i} + \sum_{i=1}^{p} \beta_5\, \Delta ln\, Q_{t-i} + \lambda ECM_{t-1} + \varepsilon_t \quad (6)$$

where lambda (λ) is the error-correction mechanism (ECM) or speed of adjustment parameter. This is obtained by estimating the long-run equation in equation (3) using OLS and then obtaining the residuals and lagging one period. The ECM contains the long-run information that would have been lost from differencing

$$ECM_{t-1} = \beta_6 \ln M_{t-1} + \beta_7 ln\, RP_{t-1} + \beta_8\, ln\, Inc_{t-1} + \beta_9\, ln\, E_{t-1} + \beta_{10}\, ln\, Q_{t-1} + \varepsilon_t \quad (7)$$

The ECM is used to measure the speed of short-run disequilibrium towards long-run equilibrium (Hor *et al.* 2018, Narayan & Narayan 2005). Additionally, in a partial equilibrium setting, the short-run parameters and the ECM is used to derive the long-run parameters by dividing the negative of the short-run parameter by the ECM (Nzuma and Sarker 2010). The ECM has specific properties in single equation models such as it must be less than one with a negative sign and statistically significant in order to have convergence to long-run equilibrium (Muhammad & Zafar 2016, Ibrahim & Ahmed 2017, Keho 2019). In order to ensure that the estimated parameters are reliable test for autocorrelation, heteroskedasticity, functional form, normality and stability of the estimated parameters are conducted.

2.3 Data and Sources

This study utilizes secondary time-series data on food import quantity, relative food import prices, real income proxied by real GDP, domestic food production quantity, and exchange rate of the Indonesian Rupiah (IDR) against the US dollar for the period 1984-2020 for Indonesia. All quantities are given in metric tons while all values are given in US dollars. Data on imported food quantities, value, and domestic food production quantities were collected from the Food and Agriculture Organization of the United Nations. Data on real GDP at constant 2015 prices, CPI (2010=100), and exchange rate were obtained from the World Bank. Relative prices were obtained by dividing import unit value by domestic prices which is proxied by CPI. All variables are transformed to logarithmic form for estimation. All empirical estimation and diagnostic testing were done in EViews 12.

Table 1 highlights the descriptive statistics for each of the variables used in the study. For the period 1984-2020, Indonesia imported on average around 11.88 million tons of food and produced domestically around 306.34 million tons annually. On average, annual real GDP was reported to be around US $520.62 billion. Furthermore, GDP has continued to see increase annually for the nation increasing from US $194.55 billion in 1984 to around 1,049.33 billion in 2020. The relative price of food imports for Indonesia has experienced decreases over time. For instance, the price per tonne of food imports in 2020 was around US $571.00. Additionally, imported food is becoming relatively cheaper than domestically produced food which makes its more attractive to Indonesian consumers.

Table 1. Descriptive Statistics for each Variable for the Period 1984-2020

Variables	Units	Mean	Std. Dev.	Minimum	Maximum
Food Imports *(M)*	Millions of Tons	11.880	7.343	1.972	25.890
Relative Prices *(RP)*	Ratio	11.494	9.019	3.706	34.836
Real GDP *(Inc)*	Billions of USD	520.621	257.701	194.548	1,049.330
Exchange Rate *(E)*	IDR to USD	4,302.210	4,624.375	1,025.945	14,582.203
Domestic Production *(Q)*	Millions of Tons	306.337	142.639	138.465	611.680

GDP = Gross Domestic Product (2015=100); USD = United States Dollar; IDR. = Indonesia Rupiah.

3. Results and Discussion

3.1 Unit Root Test Results

The ADF test was used to determine if the variables being used in the study were stationary. The results of the ADF test are presented in Table 2. The test was performed both with and without a trend. From the results, can it be found that all of the variables have a unit root in their level form. Hence, regression analysis using the variables in level form can possibly lead to spurious regression. However, when the ADF test was conducted on the first difference of each variable, it was found that the series were all stationary. Therefore, all series were found to be first difference stationary or I(1) stationary processes.

Table 2. Augmented Dicky-Fuller Test for Unit Root

Variable	Intercept		Intercept and Trend	
	Test Statistic	p-value	Test Statistic	p-value
Level Variables				
lnM_t	-1.233	0.649	-2.867	0.185
$lnRP_t$	-1.487	0.529	-1.915	0.626
$lnInc_t$	-0.759	0.819	-2.335	0.406
lnE_t	-1.513	0.516	-1.698	0.732
lnQ_t	0.339	0.977	-2.217	0.467
First Differenced Variables				
ΔlnM_t	-7.774	0.000	-7.812	0.000
$\Delta lnRP_t$	-4.435	0.001	-4.557	0.005
$\Delta lnInc_t$	-3.629	0.010	-3.612	0.043
ΔlnE_t	-4.527	0.001	-4.650	0.004
ΔlnQ_t	-4.872	0.000	-4.861	0.002

Note: Authors Calculations.

3.2 ARDL Model Results

Since the results of the ADF test revealed that all of the variables are first differenced stationary, an ARDL model was estimated. Prior to estimation, the appropriate lag length of each variable was determined using two information criteria – Akaike information criteria (AIC) and Schwarz Bayesian information criteria (SBIC) (Shrestha and Bhatta 2018). For Indonesian food imports, both information criterion seletecd the ARDL (2,0,2,2,0) where the dependent variable (lnM) has 2 lags, the independent variables, the relative prices (lnRP) and exchange rate (lnE) had 0 lags, and real GDP and domestic food production had 2 lags.

Table 3. Results for ARDL (2,0,2,2,0) Model

Variable	Parameter	Std. Error	t-Statistic	Prob.
lnM_{t-1}	0.459	0.130	3.523	0.002
lnM_{t-2}	-0.384	0.130	-2.948	0.007
$lnRP_t$	-0.585	0.186	-3.145	0.004
$lnInc_t$	0.572	0.887	0.644	0.525
$lnInc_{t-1}$	0.067	1.191	0.056	0.956
$lnInc_{t-2}$	2.477	0.716	3.458	0.002
lnE_t	-0.429	0.185	-2.232	0.028
lnQ_t	-0.847	0.496	-1.708	0.099
lnQ_{t-1}	0.018	0.626	0.029	0.977
lnQ_{t-1}	-1.307	0.559	-2.341	0.027
Constant	-22.253	4.568	-4.871	0.000
R^2 = 0.979	Adj. R^2 =0.972	DW = 1.883	F-stat. =126.131	Prob(F) = 0.000

Note: Authors Estimations.

Table 3 presents the results of the ARDL (2,0,2,2,0) model. The esrtimated ARDL model was found to be statistically significant as the F-statistic was 126.131. The model was also found to be free from autocorrelation as highlighted by the Durbin-Watson (DW) statistic was found be 1.883. The model was also found to have high explanatory power as highlighted by the R^2 and adjusted R^2 value who's values were 0.979 and 0.972, respectively. For instance, based on the adjusted R^2, it was found that about 97.2% of the variation in food imports is being explained by the included determinants.

3.3 Bounds Test Results

The bounds testing approach by Pesaran *et al.* (2001) was used to investigate the possible long-run relationship that might exist among food imports and its determinants since all series were found to be integrated of order less than 2, I(2). The results of the bounds test are presented in Table 4. The F-statistic of the Wald test was found to be 12.971 which is significantly greater than the 5% upper bound which is 4.01. Hence, the null hypothesis of no cointegration is rejected and we concluded that there is a long-run equilibrium relationship among the variables in the food import demand model for Indonesia.

Table 4. Bound Test Results to Cointegration

Dependent Variable	**Model**	**F-Statistic**
$\ln M_t$	ARDL (2,0,2,2,0)	12.971
Critical Bounds of the F-Statistic		
K=4	**I(0) Bound**	**I(1) Bound**
10%	2.45	3.52
5%	2.86	4.01
1%	3.74	5.06

Note: Authors Calculations.

3.4 Long-Run, Short-Run, and ECM Results

The results of the bounds test concluded that the variables in the food import demand model for Indonesia all share a long-run equilibrium relationship and the results are not spurious in nature. Therefore, the results of the long-run and short-run models are presented in Table 5 for the ARDL(2,0,2,2,0) model. It must be noted that since the models are log-linear, the estimated coefficients are elasticities and are interpreted with the ceteris paribus assumption imposed. Examination of the results reveal that all estimated coefficients possess the appropriate sign and magnitude consistent with economic theory.

In the long- and short-run, aggregate food import demand in Indonesia is determined by relative prices, real GDP, the exchange rate, and domestic food production. The results reveal that relative price has a negative and statistically significant impact on food import demand in both time horizons. Similar results were found by Nguyen and Jolly (2013), Mishra and Mohanty (2017) and Ibrahim and Elsharif (2020). It was found that a 1% increase in the relative price of food imports is expected to bring about on average a 0.63% decrease in food import demand in the long-run. However, a 1% increase in relative prices in the short-run is expected to bring about on average a 0.59% decrease in food imports. This is consistent with economic theory since quantity demanded and prices have an inversed relationship. Food imports were found to have inelastic import demand in both time horizons. That is, when it comes to imported food for Indonesia, there is a less than proportionate change in the quantity demand when relative prices change. Real Income was found to have a statistically significant positive impact on Indonesian food imports. This is in line with studies done by Nguyen and Jolly (2013), Omotor (2010), Keho (2019), and Hyuha *et al.* (2017). It was found that a 1% increase in real income of Indonesia is expected to bring about on average a 3.37% increase in food import demand in the long-run, however, in the short-run import demand increases by around 3.12% on average. This is very consistent with economic theory as an increase in income increases consumer demand as consumer now have the ability to purchase. In addition, food imports were also found to be a luxury good with income elastic demand, where change in quantity demanded is highly responsive to changes in income. According to Paramashanti (2020), Indonesia has seen so growth in GDP in previous years. Therefore, the income elasticity would suggest that food imports will continue to increase in the future as income increase and Indonesian citizens taste and preferences become more attuned to foreign foods, and they now have the ability to pay for such foreign food items.

The exchange rate of the Indonesian Rupiah (IDR) against the United States dollar was found to negatively affect food imports in both the long- and short-run. A 1% increase depreciation of the IDR against the US dollar is expected to bring about a 0.47% and 0.43% decrease in food imports in the long- and short-run, respectively. This is since, when a currency depreciates, foreign commodities become relatively more expensive, hence, demand would shift away from importing that commodity. Therefore, when the IRD depreciates against the US dollar, food imports is expected to decrease. This is consistent what results by Matlasedi (2017) and Hadi and Chung (2022). Domestic food production was also found to negatively impact food imports for Indonesia in both the long- and short-run. The result show that a 1% increase in domestic food production in Indonesia is expected to bring about on average a 2.31% and 2.14% decrease in food import demand in the long- and short-run, respectively. This result is expected as an increase in domestic production increases domestic food supply which could lead to domestic food being relatively cheaper than imported foods which would lead to an increase in consumption of domestic food and a decrease in imported food in Indonesia. In addition, the magnitude of the elasticity coefficient for domestic production suggest that food import volume is highly responsive to changes in domestic food production, hence, government policies that are geared towards increasing domestic food production such as subsidies to local farmers and promoting consumption of locally produced foods might be a good strategy to help Indonesia become more self-sufficient.

Table 5. Results of Long-Run and Short-Run Import Demand Model

Variable	Parameter	Std. Error	t-Statistic	Prob.
Long-Run				
$lnRP_t$	-0.633	0.226	-2.800	0.009
$lnInc_t$	3.372	0.534	6.318	0.000
lnE_t	-0.465	0.225	-2.064	0.049
lnQ_t	-2.312	0.547	-4.228	0.000
Short-Run and ECM				
Constant	-22.253	4.568	-4.871	0.000
$\Delta lnRP_t$	-0.585	0.186	-3.145	0.004
$\Delta lnInc_t$	3.116	0.569	5.479	0.000
ΔlnE_t	-0.429	0.185	-2.322	0.028
ΔlnQ_t	-2.137	0.534	-4.001	0.001
ECM_{t-1}	-0.924	0.133	-6.929	0.000
Model Fit				
R^2 = 0.737	Adj.R^2 = 0.684	F-Stat. = 14.001	Prob(F-Stat.) = 0.000	

Note: Authors Estimation.

Finally, it was also found that the error-correction mechanism (ECM) was statistically significant at the 1% level, less than one and possess the appropriate negative sign which supports reversion to long-run equilibrium. As stated prior, the ECM measures the speed of adjustment of short-run disequilibrium to long-run equilibrium (Narayan & Narayan 2005). The coefficient of the ECM was found to be 0.924 which implies that any deviation of food import from its long-run equilibrium level is corrected by around 92.4% in the next period.

3.5 Model Diagnostic Test Results

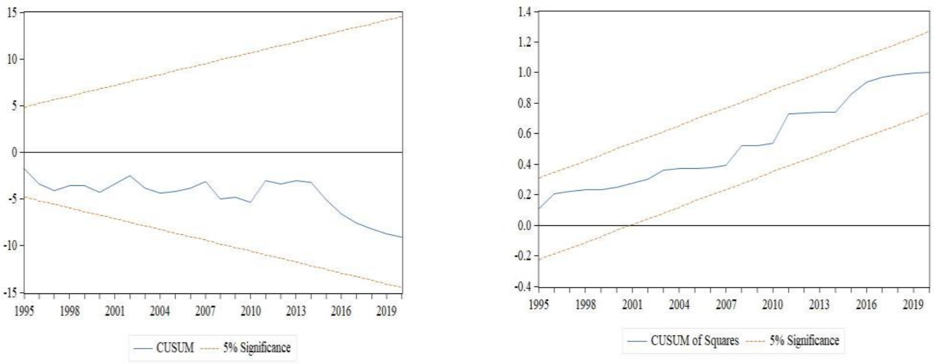
Table 6 reports the result of the diagnostic test that were conducted to assess the reliability of model estimates. To assess normality of the residuals, the Jarque-Bera test was conducted where the p-value was found to be 0.868, which means that the null hypothesis of normality could not be rejected, suggesting that the residuals are normally distributed. The Breusch-Godfrey LM test was conducted to determine if the problem of autocorrelation was present in the model. The p-value for the Breusch-Godfrey LM test was 0.287 which means that the null hypothesis of no autocorrelation could not be rejected, hence, the model was found to be free from autocorrelation. Test for heteroscedasticity and autoregressive conditional heteroscedasticity (ARCH) was also conduced. The Breusch-Pagan-Godfrey test for heteroscedasticity yielded a p-value of 0.191 which suggest that the null hypothesis of homoscedasticity could not be rejected, hence, the assumption of constant variance is maintained. Furthermore, test for ARCH yielded a p-value of 0.859 which means that the model has no ARCH effect. Finally, Ramsey's reset test was used to determine if the model was properly specified or has no omitted variables. The p-value was found to be 0.082 which is greater than the 5% significance level, therefore, it is concluded that the food import demand model for Indonesia has no omitted variables.

Table 6. Diagnostic Test Results

Diagnostic Test Conducted	**Test Statistic**	**p-value**
Normality using Jarque-Bera ($\chi 2$)	0.283	0.868
Serial Correlation using Breusch-Godfrey LM Test (*F-Statistic*)	1.315	0.287
Heteroscedasticity using Breusch-Pagan-Godfrey (*F-Statistic*)	1.513	0.191
Heteroscedasticity: ARCH (*F-Statistic*)	0.032	0.859
Ramsey's Reset (*F-Statistic*)	3.275	0.082

Note: Authors Calculations

In macroeconomic data, there could be multiple instances of structural changes in the economy (Mishra and Mohanty 2017). Therefore, it is important to check for stability of the coefficients in both the short- and long-run. Following Mishra and Mohanty (2017), test for model stability was also conducted using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ), which is highlighted in Figure 1. The results show that plot of the CUSUM and CUSUMSQ are within the 5% critical bound, hence, the ARDL model was found to be stable.



(**a**) (**b**)

Figure 1. Stability Test Results: (a) Cumulative Sum (CUSUM) Test and (b) Cumulative Sum of Squares Test

5. Concluding Remarks

The current study was conducted to determine the aggregate food import demand function for Indonesia and its determinants for the period 1984-2020 using annual time-series data. Given that most time-series data are nonstationary in level, the ADF test was used to determine if the series were stationary. After it was found that all variables were integrated of order 1, the ARDL bounds testing approach to cointegration was used to determine if there existed a long-run equilibrium relationship among aggregate food imports and its major determinants.

It was found that relative prices, real income, exchange rate, and domestic production are all major determinants of food import demand in both the long- and short-run. In both time horizons, relative prices, exchange rate and domestic production all negatively affected aggregate food imports while real income had a positive effect. When it comes to Indonesian food imports, demand was found to be price inelastic or not very responsive to changes in prices. In addition, the income elasticity was more than unity which revealed that food imports could be classified as a luxury good with income elastic demand. Furthermore, food imports were very responsive to changes in income and domestic production in both the long- and short-run. The speed of adjustment coefficient was found to be 0.924 which means that around 92.4% of short-run disequilibrium to long-run equilibrium is correct each year. The estimated model was found to have normally distributed residuals, free from serial correlation and heteroscedasticity, is well specified and the parameters are stable and reliable.

According to the attained results, food import demand is highly responsive to changes in real income and domestic production. Therefore, governments can maybe develop policies that seek to improve domestic food production by maybe offering subsidies to local food producers that can aid in production and marketing of local Indonesian foods. In addition, promoting the consumption of local foods over those that are imported can also help to reduce food consumption. In addition, the government might consider applying taxes on some imported food items to help reduce household consumption or maybe setting import quotas on certain food items. Foreign exchange was also seen to negatively affect food import demand. As the strength of the Indonesian Rupiah (IDR) depreciates in relation to the US dollar, food imports decline. Hence, the Indonesian government and policymakers might want to consider depreciating the IDR against the US dollar in times of excessive food import demand in an attempt to reduce import consumption expenditure as it would make imported foods more expensive.

This study has a few limitations. Firstly, it utilized annual data which makes the sample size relatively small, especially when cointegration analysis and models with lags are used. It might be suggested using monthly data to improve the quality of the estimated parameters; however, such data is difficult to obtain. Secondly, only four determinants were used to explain variation in food imports over the period 1984-2020. However, there are other factors of food import demand such as tourist numbers and expenditure, export revenue, and remittances which might all have a significant impact but was not included due to data availability. It is suggested that future studies maybe include these variables in their model.

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