Aggregate Import Demand Function in Mauritania: Cointegration Analysis,
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Summary:
This article examines the functional form of aggregated import demand for the case of Mauritania during the period between 1974 and 2017. The paper compares the traditional form (which considers the imported quantity of goods and services to depend on real GDP and relative price), with another supposed relatively new functional form (which assumes the real volume of aggregate imports depends on: expenditure on public consumption, expenditure on private consumption, expenditure on total investment, exports, import price and domestic price).

In the empirical analysis of the global import demand function for Mauritania, the Autoregressive Distributed Lag model (ARDL) was used.

The bounds test of cointegration shows the absence of cointegration between the variables of the traditional form (quantity imported, real GDP and relative price). On the other hand, the cointegration was confirmed for the variables constituting the second form (quantity imported, consumption expenditure (public and private), investment expenditure, exports and prices).

Key words: Cointegration, Estimation, Function, Import, Model.
Fonction de demande d'importation agrégée en Mauritanie :
Analyse de cointégration

Résumé :

Cet article examine la forme fonctionnelle de la demande d’importation agrégée pour le cas de la Mauritanie en considérant la période qui s’étale entre 1974 et 2017.

Le papier compare la forme traditionnelle (qui considère que la quantité importée des biens et services dépend du PIB réel et du prix relatif), avec une autre forme fonctionnelle supposée relativement nouvelle (qui fait dépendre le volume réel des importations agrégées par : la dépense en consommation publique, la dépense en consommation privée, la dépense en investissement total, les exportations, le prix à l’importation et le prix domestique).

Dans l’analyse empirique de la fonction de la demande d’importation globale pour la Mauritanie, on s’est appuyé sur le modèle autorégressif à retards échelonnés (ARDL). Le test de cointégration aux bornes montre l’absence de cointégration entre les variables de la forme traditionnelle (Quantité importée, le PIB réel et le prix relatif). En revanche, la cointégration a été confirmée en ce qui concerne les variables constituant la deuxième forme (Quantité importée, la dépense en consommation (publique et privée), la dépense en investissement, les exportations et les prix).

Mots-clés : Co-intégration ; Estimation ; Fonction ; Importation ; Modèle d’analyse.
Introduction:

Understanding the behavior of import demand is crucial for planning international trade and designing exchange rate policy (Mugableh, 2016). Indeed, Mauritanian foreign trade strongly follows the combination of the effect of internal factors (including the need to satisfy import needs in the midst of an environment characterized by the absence of substantial production) and external factors (hence emphasis on gross export which is strongly conditioned by fluctuations in the international market and the volume of external demand).

Mauritania, like the majority of developing countries, does not have sufficient resources to provide all the goods and services that the nation needs. Besides that, the State does not have all the intermediate goods necessary for its industry. From which point of view, the use of imports becomes a necessity for the satisfaction of needs. Since the independence and Mauritanian imports have increased in relation to exports, especially for the last three decades, which has been noted that the trade balance goes in the negative increase. This situation can lead to serious macroeconomic balances and reduce the competitiveness of the Mauritanian economy, and in order to find a solution, we must know the causes behind this increase over time, starting with the determinants that influence imports.

Following the evolution of imports, we find that the highest value of imports was marked in 2012 (US $ 3.96 billion)[Figure 1]. Overall, imports averaged a real value of $ 1.5 billion. By comparing the average of exports (US $ 1.75 billion) with that of imports, the result will be an average surplus of US $ 0.26 billion during the period (1974 -2017). During this same period the peak of the trade balance was in 1994 of which it recorded a surplus of 1.09 billion US dollars. In the other coast, the most unpleasant deficit was in 2012 with a value of (-1.63 billion US dollars). By product type, Mauritania's imports consist mainly of capital goods (38%), petroleum products (20%), food products (17%), building materials (8%), cigarettes and Tobacco (1%), Textiles and Clothing (3%), Cosmetics and Chemicals and Vehicle and Parts (5%) (Office National de la Statistique, 2017).
The purpose of this study is to estimate a function of the aggregate import demand. And to do this we will work on two specifications that are generally adopted indicating the most appropriate for the case of Mauritania. These two functions are: the traditional function that links the imported quantity with the real GDP and the relative price (Import price on the domestic price), and the (new) function which explains the imported quantity by the components of expenditure and the price’s components. In the empirical analysis of the global import function, we rely on the Autoregressive Distributed Lag model developed by Pesaran and Shin (1998), which has been expanded by the work of Pesaran et al. (2001). The use of this model is justified by the fact that it takes into account both the short-run and long-run relationships of the variables tested. It also makes it possible to estimate variables of different integration levels (I (1) and I (0)).

In the same context, we will use a cointegration test procedure called « bounds test to cointegration » of Pesaran et al (2001). The bounds test to cointegration is applied against the background of the ARDL model which serves as its base, and takes the form of an error correction model. The choice of the ARDL model and of the cointegration test (bounds test), is argued by the heterogeneity of order of integration for the variables, and by the power of these technics. The order of integration was tested by the Augmented Dickey-Fuller test.

In terms of organization, this article is structured as follows: In the next section (II), we examine some empirical studies previously conducted on the import function. Section (III) describes the research methodology followed. In section (IV), we discuss the empirical results. Section (V) will be devoted to the conclusion and suggestions of the appropriate policies.
1. Review Of Literature

The import function in Mauritania has not attracted the attention of many authors. Cheong (2003) has worked on the global import demand function for the 18 economies forming the Organization of Islamic Cooperation which includes Mauritania as a member country. Cheong specified a traditional function in which the import quantity depends only on economic activity (real GDP) and relative price. Its results evoked the absence of cointegration between these variables in the case of Mauritania. After Cheong, Yoichi and Shigeyuki (2009) examined the import function in the least developed countries (including Mauritania).

They worked on the traditional functional form by exploiting the panel cointegration technique. The results showed the existence of cointegration between imported quantity, real GDP and relative price. But these results do not indicate a particular case for Mauritania because the data used are in panel and the models are not individual. Let us note here that these two works are the only ones existing (to our knowledge) for the case of Mauritania.

In addition, much empirical work has been done on the functional form of import demand. As such, the authors have subdivided into two heterogeneous groups: the first group used a function that is based on traditional variables like the real GDP and the relative price, while the second group looks at the components of consumption next to prices, to describe the behavior of global import demand.

Among the authors who have adopted the traditional form in their works, we quote among others: Bahmani-Oskooee (1986) who specified a traditional function of import demand by injecting the exchange rate for: Brazil, Greece, India, Israel, Korea, South Africa and Thailand. He concluded that the income and the effective exchange rate have statistically significant effects on imports for Brazil, Greece and Israel. For Korea, Thailand and South Africa, the real GDP and the relative prices better explain the import demand. Gafar (1988) examined the aggregate import demand of Trinidad and Tobago over the period 1967-1984. The econometric results show that the traditional import demand model has yielded satisfactory results. Mwega (1993) used an ECM to estimate the elasticities of import demand in Kenya between 1964 and 1991. The results show that the elasticities of the relative prices and the real income in the short-run, are insignificant or weakly significant.

Rijal et al. (2000) studied import demand for Nepal between 1968 and 1997. The results show that imports demand is inelastic relative to their own price and to domestic price in the long and short terms. However, it is elastic in relation to real income in the short and long terms. Ziramba

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(2010) attempted to model the import demand for crude oil in South Africa based on real income and crude oil price during the period 1980-2006. A unique long-run cointegration relationship exists between the import of crude oil and explanatory variables. Mugableh (2016) estimated overall import demand for Jordan over the period (1980-2015). The bounds test was used to test co-integration, while the ARDL approach is used to obtain the elasticities. The results show a cointegration relationship between variables when the import volume is a dependent variable.

As for the works that made resort to the components of consumption, we cite the studies of the following authors: Giovannetti (1989) presented the overall Italian imports according to the expenditure components. The results show that « an aggregate import equation which includes disaggregated demand variables among the explanatory variables has a better fit and better prediction than a standard specification with a single demand variable ».

Abbott and Seddighi (1996) estimated the United Kingdom's import demand between 1970 and 1990, and it was concluded that an ECM incorporating the expenditure components seems to be working well. Alias and Cheong (2000) studied the behavior of Malaysia's overall imports for the period 1970-1998, and their results indicate that the components of final expenditure and the relative price explain import demand, both in the long-run and in the short-run. Frimpong and Oteng-Abayie(2006) studied the import behavior in Ghana during the period 1970-2002.

The import demand was inelastic to public and private consumption expenditures and to the relative price in the long-run, in contrast to investment and exports, which are the main determinants. In the short-run, the spending on public and private consumption is the main determinant of import demand. In what follows, we will work on both models for the case of Mauritania, while showing the most appropriate form to explain the demand behavior of Mauritanian imports.

2. Research Methodology

In this study of Mauritania's global import function, we adopt the model of imperfect substitutes which considers imports as not being perfect substitutes for domestic products (Goldstein and Khan, 1985). For the import equation specifications, a log-linear model is better than a linear and more practical, because the elasticities can be obtained directly from the regression equation (Khan and Ross, 1977). In order to know the determinants that explain the import demand in Mauritania, we will specify two functions: a function called traditional (by convention - here: (1) in which the imported quantity is in function of the real GDP and the relative price (see Bahmani-Oskooee, 1986), (Doroodian et al., 1994), and (Anon, 2004)) , and another called the new function
(by convention - here: (2) in which import depends on the components of consumption and prices (see (Giovannetti, 1989), (Alias and Cheong, 2000) and (Fukumoto, 2012)). Based on the foregoing, the following two functions are specified:

The traditional function \( F_1: M = f(Y, P) \)

And the new function \( F_2 : M = f(CG, CP, I, X, PM, PD) \)

In log-linear form, these two equations are written successively as follows:

\[
F_1: LM_t = \alpha_0 + \alpha_1 LY_t + \alpha_2 LP_t + \varepsilon_t \quad \text{Where} \quad \alpha_1 \geq 0 \text{ and } \alpha_2 \leq 0 \tag{3}
\]

\[
F_2: LM_t = \beta_0 + \beta_1 LC_G_t + \beta_2 LC_P_t + \beta_3 LI_t + \beta_4 LX_t + \beta_5 LM_P t + \beta_6 LP_D t + \varphi_t \tag{4}
\]

Where: \( \beta_1, \beta_2, \beta_3, \beta_4, \beta_6 \geq 0 \text{ and } \beta_5 \leq 0 \)

Hence \( t \) represents the time (year), \( L \) is the natural logarithm, \( M \) is the import volume, \( Y \) is the real GDP, \( P \) is the relative price obtained by dividing the import price (\( PM \)) by the domestic price (\( PD \)), \( CG \) is the expenditure on public consumption, \( CP \) is the expenditure on private consumption, \( I \) is the expenditure on total investment (gross fixed capital formation + stock variation) and \( X \) is exports. The variables are all in real terms and the data were provided by the World Bank (see Table 1 below). \( \varepsilon_t \) and \( \varphi_t \) represent the error terms respectively for the traditional model and the new model.

**Table 1: Nature and source of the data**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>( M )</td>
<td>Real imports, which are all goods and services produced abroad and returned to Mauritanian territory. These are imports in value deflated by the import price index (base: 2010 = 100).</td>
<td>World Bank’s Database</td>
</tr>
<tr>
<td>( Y )</td>
<td>Real gross domestic product, it measures the result of economic activity. it is the current-price GDP deflated by the GDP deflator (base 2010 = 100).</td>
<td>World Bank’s Database</td>
</tr>
<tr>
<td>( P )</td>
<td>This is the relative price calculated by the ratio of import price to domestic price.</td>
<td>World Bank’s Database</td>
</tr>
<tr>
<td>( CG )</td>
<td>Expenditure on public consumption in real terms: aggregates the final consumption of goods and services by the public administrations. The GDP deflator was used to deflate nominal public consumption (base 2010 = 100)</td>
<td>World Bank’s Database</td>
</tr>
<tr>
<td>( CP )</td>
<td>Expenditure on private consumption in real terms: includes expenditure on final consumption of goods and services by households. The GDP deflator was used as a deflator of nominal private consumption (base 2010 = 100).</td>
<td>World Bank’s Database</td>
</tr>
</tbody>
</table>
Table 1: Nature and source of data (continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Investment in real terms: is measured at the national accounts level by gross capital formation (Gross fixed capital formation + Stock variation) in value deflated by the GDP deflator (Base: 2010 = 100)</td>
<td>World Bank’s Database</td>
</tr>
<tr>
<td>X</td>
<td>Real exports: represents all goods and services sold by Mauritania to the rest of the world, expressed in value deflated by the GDP deflator (Base: 2010 = 100)</td>
<td>World Bank’s Database</td>
</tr>
<tr>
<td>PM</td>
<td>Import price: this is the import price index, and it was calculated by dividing the import at current prices by imports at constant prices (Base: 2010 = 100). Both series come from the World Bank.</td>
<td>World Bank’s Database</td>
</tr>
<tr>
<td>PD</td>
<td>The domestic price: is indicated by the GDP deflator. The latter reflects what happens at the general level of prices in a given economy. This series results from the division of nominal GDP into real GDP (Base: 2010 = 100).</td>
<td>World Bank’s Database</td>
</tr>
</tbody>
</table>

Source: Developed by the authors to explain the variables

The equations (3) and (4) represent the behavior of long-run import demand. The ARDL-ECM models associated with these two equations can be written respectively as below:

\[
F_1: \Delta LM_t = C + \sum_{i=1}^{p} \alpha_i \Delta LM_{t-i} + \sum_{i=0}^{p} \beta_i \Delta LY_{t-i} + \sum_{i=0}^{p} \theta_i \Delta LP_{t-i} + \delta ECM_{t-1} + \varepsilon_t
\]  

\[
F_2: \Delta LM_t = B + \sum_{i=1}^{p} \mu_i \Delta LM_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta LCG_{t-i} + \sum_{i=0}^{p} \pi_i \Delta LCP_{t-i} + \sum_{i=0}^{p} \epsilon_i \Delta LI_{t-i} + \sum_{i=0}^{p} \rho_i \Delta LX_{t-i} + \sum_{i=0}^{p} \omega_i \Delta LPM_{t-i} + \sum_{i=0}^{p} \vartheta_i \Delta LDP_{t-i} + \delta ECM_{t-1} + \phi_t
\]  

Where \(\Delta\) is the first difference, \(p\) is the number of optimal lag of the variable, \(\alpha_i, \beta_i\) and \(\theta_i\) are the coefficients of exogenous variables in short-run for the traditional function \(F_1\), \(\mu_i, \gamma_i, \pi_i, \epsilon_i, \rho_i, \omega_i\) and \(\vartheta_i\) are the weights of the explanatory variables in the short-run for the new function \(F_2\), \(\delta\) and \(\sigma\) are the equilibrium restoring forces respectively for model 1 and 2 (must be negatively significant), \(ECM_{t-1}\) is the residual term of the long-run relationship lagged by one year. \(\varepsilon_t\) and \(\phi_t\) are the short-run error terms respectively for models 1 and 2, \(C\) and \(B\) are the constants of the short-run models.

The following modeling strategy involves the steps listed below:

1. The normality of variables: first, we study the probabilistic characteristics of the variables included in the study, especially the normality of the variables so that the econometric tools are applicable to them. The Jarque-Bera normality test (1981) was designed for this purpose.

   This test is defined as the sum of squared skewness and kurtosis coefficients.
2. The stationarity: here, we opt for the ADF (Dickey-Fuller Augmented) test applied on the variables in levels or differences for those which are not stationary. The ADF test (1981) was used because the Dickey-Fuller (DF) test assumes that the error is a white noise. However, there is no reason for this hypothesis to be, a priori, verified (Bourbonnais, 2015, p.250). On the other hand, the Augmented Dickey-Fuller test is stricter and more careful because it takes into account the autocorrelation of the errors while proposing an AR(p-1) specification for the error.

The ADF tests are based, under the alternative hypothesis: $|\phi_1| < 1$, on the estimation by the OLS of the three following models:

- **Model[1]**: $\Delta x_t = \rho x_{t-1} - \sum_{j=2}^{p} \phi_j \Delta x_{t-j+1} + \epsilon_t$ (None)  

  \[ \text{(7)} \]

- **Model[2]**: $\Delta x_t = \rho x_{t-1} - \sum_{j=2}^{p} \phi_j \Delta x_{t-j+1} + c + \epsilon_t$ (intercept)  

  \[ \text{(8)} \]

- **Model[3]**: $\Delta x_t = \rho x_{t-1} - \sum_{j=2}^{p} \phi_j \Delta x_{t-j+1} + c + bt + \epsilon_t$ (trend and intercept)  

  \[ \text{(9)} \]

The value of $p$ can be determined according to the Akaike or Schwarz criteria, or, starting from a sufficiently large value of $p$, we can estimate a model with $p - 1$ lags and then $p - 2$ lags up to the coefficient of lag is significant (Bourbonnais, 2015).

3. Estimate the long-run and short-run relationships following the procedure of Pesaran and Shin (1998) and Pesaran et al. (2001) while determining the elasticities of import demand with respect to exogenous variables. For this, we will borrow the estimation method based on the model ARDL (Autoregressive Distributed Lag). This procedure has the particularity to take into account the temporal dynamics in the explanation of a time series, thus improving the forecasts and the efficiency of the decision-making or the adoption of the economic policies, contrary to the simple model whose instantaneous explanation (immediate effect or not spread over time) only restores part of the variation of the endogenous variable. As with any dynamic model, information criteria (AIC and SIC) will be used to determine the optimal offset that is the lag for which the criterion value is the minimum of all values. In our study we will base our choice on the criterion that seems the strictest namely that of Schwarz (SIC).
The criterion value of Schwarz is calculated using the following formula:

\[ SIC = log|\hat{\Sigma}| + \frac{2logn}{n} - k^2p \]  

(10)

Hence, \( \hat{\Sigma} \) is the variance-covariance matrix of the estimated residues; \( n \) is the number of observations; \( p \) is the lag of the estimated model and \( k \) is the number of exogenous variables.

4. Bounds test to cointegration: This test is, in fact, a Fisher test of joint significance of the coefficients of the K variables in level and it confronts the following hypotheses:

\[ H_0: C_i = 0 \forall i = 1, 2, ..., k \text{ against } H_1: C_i \neq 0 \forall i = 1, 2, ..., k. \]

Where \( C_i \) is the coefficient of the exogenous variable \( (i) \) in the long-run relationship. \( H_0 \) is the null hypothesis of absence of a long-run equilibrium relation, and which is confronted by the alternative hypothesis \( H_1 \) which declares the presence of a long-run uniform relation between the variables considered.

In our case, these hypotheses are presented for each of our models \( (F_1 \text{ and } F_2) \) as follows:

\[ F_1 \quad H_0: \alpha_i = 0 \forall i = 1, 2. \text{ against } H_1: \alpha_i \neq 0 \forall i = 1, 2. \]

\[ F_2 \quad H_0: \beta_i = 0 \forall i = 1, 2, ..., 6 \text{ against } H_1: \beta_i = 0 \forall i \neq 1, 2, ..., 6 \]

The statistic of this test is the Fisher statistic (F-statistics). Pesaran et al. (2001) show that it does not follow a standard law. They simulated two sets of critical values for this statistic, with several cases (depending on whether a constant and / or a trend is introduced) and different thresholds (Lounes, 2012). The first set corresponds to the case where all the variables of the model are stationary \( (I(0)) \) and represents the lower bound; the second set corresponds to the case where all the variables are integrated \( (I(1)) \) and represents the upper bound. To conclude, we compare the Fisher test statistic with the two bounds (See Table 5).

3. Results And Discussion

A normally distributed variable is considered if the Jarque-Bera probability is greater than 5% (Doucouré, 2003). The
Table 2 summarizes the Jarque-Bera test results for all the variables involved in the study, and we find that all the probabilities associated with the statistics (JB) exceed the 5% and as a result of which we can guarantee the normality of all variables over the period: 1974 - 2017. The normality of the items allows us to apply the ARDL model which is based in some way on the ordinary least squares (OLS) approach. The application of the OLS technique stipulates the normality of the variables.
Table 2: Normality test of variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>LM</th>
<th>LCG</th>
<th>LCP</th>
<th>LI</th>
<th>LX</th>
<th>LPM</th>
<th>LPD</th>
<th>LY</th>
<th>L(PM/PD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std. Dev.</td>
<td>0.59</td>
<td>0.47</td>
<td>0.38</td>
<td>0.80</td>
<td>0.49</td>
<td>0.32</td>
<td>0.39</td>
<td>0.41</td>
<td>0.15</td>
</tr>
<tr>
<td>S.</td>
<td>0.69</td>
<td>-0.52</td>
<td>-0.33</td>
<td>0.62</td>
<td>0.55</td>
<td>-0.28</td>
<td>0.20</td>
<td>0.53</td>
<td>-0.06</td>
</tr>
<tr>
<td>Ku.</td>
<td>2.05</td>
<td>2.29</td>
<td>2.08</td>
<td>2.10</td>
<td>2.00</td>
<td>2.30</td>
<td>2.17</td>
<td>1.94</td>
<td>2.29</td>
</tr>
<tr>
<td>JB.</td>
<td>5.18</td>
<td>2.91</td>
<td>2.34</td>
<td>4.30</td>
<td>4.05</td>
<td>1.48</td>
<td>1.56</td>
<td>4.09</td>
<td>0.94</td>
</tr>
<tr>
<td>Prob.</td>
<td>0.08</td>
<td>0.23</td>
<td>0.31</td>
<td>0.12</td>
<td>0.13</td>
<td>0.48</td>
<td>0.46</td>
<td>0.13</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Notes: 1. The standard deviation (Std. Dev.) is a statistic that measures the dispersion of a dataset relative to its mean and is calculated as the square root of the variance. 2. S (Skewness), Ku(Kurtosis), JB(the Jarque-Bera statistics) and Prob (the Jarque-Bera probability). 2. Jarque-Bera tests the null hypothesis $H_0$: the variable does not follow the normal law, against $H_1$: the variable follows the normal law.

Source: The authors (using Evies 10)

By examining the stationarity of the variables, we find that all variables are stationary in level (I(0)) or integrated of order one (I(1)) as shown in [
Table 3]. The endogenous variable (the import demand: \textit{LM}) has become stationary after being differentiated only once, so it is a variable \textit{I(1)} for all models (intercept and trend with intercept). For the relative price variable (\textit{LPR}), it is stationary in level with all the specifications (intercept and trend with intercept).

The variable of private consumption expenditure (\textit{LCP}) is stationary in level \textit{I(0)} for the case (intercept) at 5\% but it is stationary in first difference \textit{I(1)} for the model (trend and intercept), and for that we can consider it as \textit{I(0)}. This is the same situation in regards to the investment expenditure variable at the 10\% level. For all the other variables, the \textit{ADF} test shows that they are all integrated of order one \textit{I(1)}, whatever for the model [2] or for the model [3].

For the comparison of the \textit{ADF} statistic to the MacKinnon critical value, we took a single Mackinnon value for each model (intercept or trend and intercept) and for each tolerance threshold (5\% and 10\%). This value is fixed for all variables because the Mackinon values change according to the confidence level (1\%, 5\% and 10\%) and the specification tested (Model), but not according to the time series. A series is considered stationary if $|\textit{ADF}| > |\textit{Mackinnon}|$, if not, the variable must be differentiated until the condition is met.
Table 3: Unit root tests

<table>
<thead>
<tr>
<th>Models</th>
<th>Variables</th>
<th>ADF statistic (Level)</th>
<th>ADF statistic (1st difference)</th>
<th>MacKinnon 5%</th>
<th>MacKinnon 10%</th>
<th>Order of integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LM</td>
<td>-0.144045</td>
<td>-5.118022*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LY</td>
<td>-1.220424</td>
<td>-6.906660*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LPR</td>
<td>-3.040214**</td>
<td>-</td>
<td>I(0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>LCG</td>
<td>-0.796918</td>
<td>-5.029228*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LCP</td>
<td>-1.377197</td>
<td>-5.499840*</td>
<td>-2.91</td>
<td>-2.60</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>LI</td>
<td>-1.261046</td>
<td>-7.971022*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LX</td>
<td>-0.174325</td>
<td>-5.857241*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LPM</td>
<td>-1.990538</td>
<td>-5.384177*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LPD</td>
<td>-1.731694</td>
<td>-5.618455*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trend and Intercept</td>
<td>LM</td>
<td>-1.180954</td>
<td>-5.162289*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LY</td>
<td>-1.857353</td>
<td>-7.177399*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LPR</td>
<td>-4.374793*</td>
<td>-</td>
<td>I(0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LCG</td>
<td>-1.082028</td>
<td>-5.036647*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LCP</td>
<td>-4.799713*</td>
<td>-</td>
<td>I(0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LI</td>
<td>-3.060240***</td>
<td>-7.862677*</td>
<td>-3.50</td>
<td>-3.19</td>
<td>I(0)</td>
</tr>
<tr>
<td></td>
<td>LX</td>
<td>-2.717518</td>
<td>3.303287***</td>
<td></td>
<td></td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>LPM</td>
<td>-2.261476</td>
<td>-5.414696*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LPD</td>
<td>-2.112604</td>
<td>-5.552566*</td>
<td>I(1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1. (*), (**), and (***), denote that the variable is stationary at 1%, 5% and 10%.
2. I(0) means that the variable is stationary at level without differentiation, and I(1) means that we differentiated it once to make it stationary.

Source: The authors (using Eviews 10)

After estimating an ARDL model [Figure 4], we obtained the elasticities of the variables for each import function (traditional function and function of expenditure components) and the results are summarized in the [
These results can be discussed for each function separately: for example, for the traditional function whose the imported quantity depends only on the aggregate real GDP and the aggregate relative price, we notice that the variables are not significant or their weights equal to zero in the short-run.

With regard to the long-run influence, the bounds test to cointegration [Table 5] indicates the absence of the cointegrating relationship between the real import volume, the real GDP and the relative price and as a consequence of which, the traditional form does not explain the behavior of import demand in the case of Mauritania. On the other hand, the bounds test revealed the existence of cointegration in the case where the import demand is in terms of: the expenditure on private consumption, the expenditure on public consumption, the expenditure on investment, the exports, the import price and the domestic price level (inflation).
Table 4: Long and short terms relationship

<table>
<thead>
<tr>
<th>Variables</th>
<th>Traditional function</th>
<th>New function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficients</td>
<td>Coefficients</td>
</tr>
<tr>
<td></td>
<td>Long-run</td>
<td>Short-run</td>
</tr>
<tr>
<td>LY</td>
<td>1.06(2.98)*</td>
<td>-</td>
</tr>
<tr>
<td>L(PM/PD)</td>
<td>-1.06(-1.05)</td>
<td>-</td>
</tr>
<tr>
<td>LCG</td>
<td>0.35(6.04)*</td>
<td>-</td>
</tr>
<tr>
<td>LCP</td>
<td>0.17(2.09)**</td>
<td>0.44(5.12)*</td>
</tr>
<tr>
<td>LI</td>
<td>0.34(4.93)*</td>
<td>0.35(7.57)*</td>
</tr>
<tr>
<td>LX</td>
<td>0.52(6.74)*</td>
<td>-</td>
</tr>
<tr>
<td>LPM</td>
<td>-0.91(-5.42)*</td>
<td>-</td>
</tr>
<tr>
<td>LPD</td>
<td>0.45(3.09)*</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: 1. (*) and (**) denote that the variable is significant at 1% and 5%.
2. (-) means that the coefficient is not significant or equal to zero for the variables in short-run form.
3. The values in parentheses represent the Student’s ratios associated with the coefficients.
4. We mean by the traditional function the following form: \( M = f(Y, P) \) with \( P = PM/PD \).
5. We mean by the new function the following form: \( M = f(CG, CP, I, X, PM, PD) \).
6. The empty a spaces in the table show that these variables are not concerned by the functional form.

Source: The authors (using Eviews 10)

Table 5: Bounds test

<table>
<thead>
<tr>
<th>Models</th>
<th>K</th>
<th>F – Statistic</th>
<th>l(0) –5%</th>
<th>l(1) –5%</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>( M = f(Y, P) )</td>
<td>2</td>
<td>1.858922</td>
<td>3.79</td>
<td>4.85</td>
<td>N. Cointegration</td>
</tr>
<tr>
<td>( M = f(*) )</td>
<td>6</td>
<td>12.37896</td>
<td>2.45</td>
<td>3.61</td>
<td>Cointegration</td>
</tr>
</tbody>
</table>

Notes: \( M = f(*) \) ⇔ \( M = f(CG, CP, I, X, PM, PD) \); \( l(0) – 5\% \) and \( l(1) – 5\% \) represent the lower and upper bounds at 5% confidence level; \( K \) is the number of exogenous variables in each model.

The decision rule for cointegration is as follows: if the value of \( F \) is less than \( l(0) = \) no cointegration; if the value of \( F \) is greater than \( l(1) = \) there is a cointegrate relationship and if the value is between \( l(0) \) and \( l(1) \), we can not conclude.

Source: The authors (using Eviews 10)

For the new function, the long-run elasticities mean that the increase in general government consumption expenditure by \( 10\% \) leads to an increase in import demand of \( 3.5\% \). As well as an increase in household consumption expenditure by \( 10\% \) leads to a real import increase by a pace of \( 1.7\% \). For the investment, an increase of this variable via \( 10\% \) implies a rebound of imports of \( 3.4\% \), and these same imports will be increased by \( 5.2\% \) if we pivot positively the exports to \( 10\% \).

In terms of price elasticities, they are consistent with traditional theories of demand. Indeed, an increase in import prices to \( 10\% \) leads to a decrease in the quantity imported by \( 9.1\% \), while the increase in domestic prices (inflation) leads to an increase in imports to \( 4.5\% \).
In the short-run, the import demand is influenced only by the private consumption expenditure and the investment expenditure respectively by the weights of 0.44 and 0.35. This results are supported by statistics (such as $R^2$ and F-statistics), as well as robustness tests [Table 6]. The coefficient of the residual lagged by one period (restoring force at equilibrium) was significantly negative for both functions (-0.21 and -0.72), which implies that the traditional function corrects the disequilibrium of its previous period by 21% per year and the expenditure components model (new function) corrects it by 72%.

The coefficient of determination ($R^2$) shows that the exogenous variables of the traditional function (real GDP and relative price) explain only 12% of the import variation in Mauritania, the fact that may explain the absence of the cointegration relationship. On the other hand, the model that takes into account disaggregated variables (consumption expenditure (public and private), investment expenditure, exports, import price and domestic price) could explain 85% of the import variation.

The robustness tests ensuring the validity of the models were summarized in [Table 6] and were all in the waiting. In this context, the Serial Correlation LM test confirms the independence of errors for both models (Prob> 0.05). We also report that the Ramsey Functional Specification Test (RESET) gave probabilities greater than 5%, indicating that both models (F1 and F2) are correctly specified. In addition, the Jarque-Bera normality test and the heteroskedasticity test (ARCH) confirmed that the residues are normally homoscedastic.

### Table 6: Explanatory statistics and robustness tests

<table>
<thead>
<tr>
<th>Stat. and probability</th>
<th>Traditional function $M = f(Y, P)$</th>
<th>New function $M = f(\ast)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM(-1)</td>
<td>-0.21 (0.0202)</td>
<td>-0.72 (0.0000)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.12</td>
<td>0.85</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.10</td>
<td>0.84</td>
</tr>
<tr>
<td>F-statistic</td>
<td>170.8 (0.00)</td>
<td>275.54 (0.00)</td>
</tr>
<tr>
<td>DW</td>
<td>1.33</td>
<td>1.67</td>
</tr>
<tr>
<td>Serial correlation LM : $\chi^2(2)$</td>
<td>4.26 (0.1185)</td>
<td>2.03 (0.36)</td>
</tr>
<tr>
<td>Ramsey RESET</td>
<td>1.03 (0.3153)</td>
<td>0.92 (0.34)</td>
</tr>
<tr>
<td>Normality : $\chi^2(2)$</td>
<td>1.48 (0.475)</td>
<td>0.96 (0.61)</td>
</tr>
<tr>
<td>ARCH : $\chi^2(1)$</td>
<td>0.07 (0.7851)</td>
<td>0.19 (0.6)</td>
</tr>
<tr>
<td>CUSUM</td>
<td>Stable</td>
<td>Stable</td>
</tr>
<tr>
<td>CUSUMSQ</td>
<td>Stable</td>
<td>Stable</td>
</tr>
</tbody>
</table>

Notes: 1. $M = f(\ast) \Leftrightarrow M = f(CG, CP, I, X, PM, PD)$ and $P = PM/PD$

2. The values between parentheses are the probabilities.

Source: The authors (using Eviews 10)
Finally, we checked the stability of the estimated coefficients using the recursive residue tests (CUSUM and CUSUMQ). These tests confirmed that the estimated coefficients are stable for both models (See Figure 2 and Figure 3).

**Figure 2: CUSUM and CUSUMQ for the function :** \( M = f(Y, P) \)

![CUSUM and CUSUMQ plots](image)

**Figure 4: Optimal ARDLs**

![Optimal ARDLs plots](image)

*Source: The authors (using Eviews 10)*
The figure above consists of two graphs. The graph on the right represents the optimal ARDL associated with the import function, the determinants of which are the components of consumption and the components of relative price \([Equation 6]\). It seems that the optimal ARDL (the one with the lowest Schwarz criterion = -1.73) is: 2.0.1.1.0.0.0, that is to say that the import demand of the year \(t\) depends on that of the year \(t-2\), on public consumption expenditure in the year \(t\), on private consumption expenditure in the year \(t-1\), on investment expenditure in the year \(t-1\), exports in the year \(t\), import prices in the year \(t\) and domestic prices in the year \(t\).

As for the graph on the left, it represents the optimal ARDL (1.0.0) associated with the traditional import function, the determinants of which are real GDP and relative price \([Equation 5]\). This graph means that the import demand of year \(t\) depends on the quantity imported for the previous year, the real GDP of year \(t\) and the relative price of the same year \(t\). But this relationship is fallacious because of the lack of cointegration, as the bounds test has shown \([Table 5]\).

4. Conclusion and perspectives:

The main objective of this article is to re-examine Mauritania’s import function using the more robust estimation method, namely the ARDL model and the bounds test to cointegration of Pesaran et al. (2000).

Using annual data provided by the World Bank during the period 1974-2017, an error correction model \((ARDL-ECM)\) was designed.

This study compares two specifications for import demand to identify the one that better explains the behavior of Mauritanian imports. A function called traditional, in which the quantity imported is based on the real GDP \((Y)\) and the relative price \((P)\) and a second function called the “new”, in which the real volume of imports is expressed according to the expenditure on government consumption \((GC)\), household consumption expenditure \((CP)\), total investment expenditure \((I)\), exports \((X)\), import price \((MP)\) and domestic price level \((PD)\).

The empirical results have been in favor of the new function to the detriment of the traditional function. The bounds test to cointegration shows the absence of cointegration between the variables of the traditional form (the import, the real GDP and the relative price). However, the cointegration was confirmed for the variables constituting the second form \((M, CG, CP, I, X, PM, PD)\). As for the elasticities, were obtained by function. For the traditional function, the income and relative price elasticities, in the short-run, are nil or insignificant, and in the long-run are respectively \((1.06\) and \(-1.06\)). But the cointegration test shows that these coefficients do not have confidence. For the new import function \((M = f(CG, CP, I, X, PM, PD))\), the long-run elasticities
of public consumption expenditure \( (CG) \), private consumption expenditure \( (CP) \), investment expenditure \( (I) \) and exports \( (X) \) have been significant and represent the expected signs, and their values are respectively: \( 0.35, 0.17, 0.34 \) and \( 0.52 \). The price elasticities, in the long-run, are also significantly in waiting. These elasticities were respectively \( (-0.91 \text{ and } 0.45) \) for the import price and the domestic price. « Elastic long-run coefficients for all national macroeconomic variables suggest that economic growth will affect Mauritania's trade balance negatively » (Fukumoto, 2012).

In the short-run, the main determinants of import demand are private consumption expenditure and investment expenditure \( (0.44 \text{ and } 0.35) \). This study has made it clear that the traditional function of import demand is not the right model to describe the behavior of Mauritanian imports, and this result is in line with that of Cheong (2003). On the other hand, the function which took into account the components of expenditure, exports and the disaggregated relative price seems to explain better the import demand for the case of Mauritania, and this opinion coincides with that of Giovannetti (1989) according to which « an aggregate import equation which includes disaggregated demand variables among the explanatory variables has a better fit and better prediction than a standard specification with a single demand variable ».

In reality, Mauritania has made extensive use of import demand due to the gap between the modest volume of domestic production and the demand for excessive consumption. And to deal with this situation and based on our long-run results, relevant political implications can be deduced. First, government strategies must prioritize the development of industries based on resources which have a low import content, which should dampen the rise in import demand driven by economic growth. It is important to note that the cross-price elasticity of import prices exceeds, in absolute terms, that of domestic prices. This indicates that import demand is more sensitive to changes in the imported product price than to the domestic product price.

This, too, suggests that Mauritania needs to improve its price competitiveness in the context of foreign trade in order to mitigate its trade deficits and increase its foreign exchange reserves. Because « the price competitiveness is also important for the growth and development of local industry and survival export enclaves »(Frimpong and Oteng-Abayie, 2006). Second, the higher or lower domestic price elasticity \( (0.45) \) suggests that domestic inflation must be brought under control. Although this study does not assess export price elasticities, but the estimated size of import price elasticity \( (-0.91) \) suggests that the Marshall-Lerner condition\(^1\) can be fulfilled. In

\[^1\] This condition suggests that the devaluation of a currency will improve a country's trade balance in the long run if the sum of the absolute values of import and export demand price elasticities is greater than one (Mahmud, Ullah and Yucel, 2004)
other words, exchange rate policies can be used to correct the imbalance in the trade balance. Finally, trade policy can play an important role: In the area of mines, oil and gas, the country must modernize and improve the export structure and try to widen the export base by introducing new technologies and seeking new partners in order to qualitatively and quantitatively increase exports and therefore generate excess income.

Although these policies (in part) lead to an increase in import demand in the short-run following the rebound in investment. However, for the long-run, will lead to the deterioration of imports and the rise of exports, a situation in which we are faced with a surplus trade balance, the fact which will release more income which must be exploited for economic and social development by achieving well-being.

References:


