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Research Article

Demand of Imported Rice in Mozambique (2011 - 2020)

Sandre Macia[1, 2, 3 *], Júlio Macuacua[3], Alfeu Vilanculos[3, 4], Filipe Mahaluça[3, 5]

[1]Centre of Excellence in Agri-Food Systems and Nutrition (CE-AFSN), the Eduardo Mondlane University, Maputo, Mozambique

[2]National Statistics Institute, Directorate of National Accounts and Global Indicators, Maputo, Mozambique

[3]Higher Institute of Accounting and Auditing of Mozambique, Maputo, Mozambique

[4]Faculty of Economics, Eduardo Mondlane University, Maputo, Mozambique

[5]Department of Economics, University Saint Thomas of Mozambique, Maputo, Mozambique

Abstract

Rice plays an important role in the food and nutrition security of the Mozambican population and has been importing rice to meet growing consumption needs. There are several studies regarding demand of imported rice worldwide. However, it is noted that despite the importance of imported rice in national consumption, the empirical and quantitative studies on the demand for imported rice in Mozambique are scarce. This study results from the need to contribute to filling the information gap by providing the quantification of the impact of income and price on the consumption of imported rice. Based on monthly rice import data from 2011 to 2020, obtained from INE, the Source Differentiated Almost Ideal Demand System (SDAIDS) model and the Seemingly Unrelated Rules (SUR) approach are applied to estimate demand systems for imported rice. The period was chosen due to availability of data. The results of this study show that the national production of rice still does not cover internal needs, so the country resorts to imports to fill the deficit. The elasticities of demand for rice imported into Mozambique show that all income elasticities of demand are statistically significant, except for "other countries" or Rest of the World. The results also show that when income increases by 1%, the demand for rice increases by 1.2% when coming from "Pakistan", and by 1.1% when coming from "Singapore", by 1.03% for "Vietnam"; and in for those from "Myanmar" (1.1%), which suggests that rice from these countries can be classified in the luxury goods category. The results also illustrate that when the price increases by 1%, the quantities demanded decrease, on average, by 1.06% for rice coming from "Pakistan"; by 1.06% for those from "Singapore"; 1.22% for those from "Myanmar"; 0.96% for those from "Vietnam"; by 0.89% for "India"; by 0.79% for "China"; in 0.974% for "Thailand" and in 0.56% for those coming from "other countries". The low levels of production and productivity show that it is still a challenge to guarantee rice self-sufficiency in Mozambique, and efforts to improve supply must continue, since the country's dependence on imported rice can potentially create conditions of vulnerability and insecurity and adverse market effects have competitive advantages.

Keywords

Rice, Imports, Consumption, Almost Ideal Demand System, Expenditure Elasticity

*Corresponding author: sandremacia@gmail.com (Sandre Macia)

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1. Introduction

Rice plays an important role in the diet of approximately half of the world's population [20, 49, 21]. Global rice consumption in 2018 was estimated at more than 488 million tons [50, 41]. The Asian continent produces more than 90% of the rice consumed in the world, and 6 countries (China, India, Indonesia, Bangladesh, Vietnam and Japan) are responsible for more than 80% of the world production and consumption of rice [7, 41, 50].

Driven by the effect of population growth, urbanization and changing consumer behavior, rice consumption is increasing rapidly in Sub-Saharan Africa [2, 32]. However, rice production in Africa does not cover consumption needs. For example, in 2018, rice consumption in Sub-Saharan Africa was estimated at approximately 33.2 million tons, partially covered by imports of approximately 15.5 million tons, which equivalent to 33% of the rice sold worldwide [50].

Mozambique has about 900,000 hectares of potential land for rice production [30]. Is the most suitable crop to grow in light or heavy textured soils in the lower floodplains of the central provinces and north. Also, rice is cultivated in rich soils along the numerous rivers as well as in the dry and flat irrigated areas of the south [24, 38].

2. Problem Statement and Justification

Rice is the third most cultivated cereal after maize and sorghum in Mozambique. Furthermore, is the main source of carbohydrates, playing a key role as a source of income and potential to export [42]. Due to increasing consumption, rice has gained more prominence in recent. With an annual consumption growth rate of 8.6%, rice has surpassed other cereals such as maize (5.5%), wheat (7.4%) and sorghum (4.7%) in local markets [31].

Meanwhile, current production levels does not cover consumption needs, so Mozambique has to import to meet its consumption needs. Figure 1 shows that more than half of the rice consumed in Mozambique is imported, and in 2020 the proportion of imports in total rice consumption was 70% [30].

The rise in international prices between 2007 and 2009 particularly affected food and fuel prices in several countries worldwide including Mozambique. However, Mozambique prices remained high even after the fall in international markets [44].

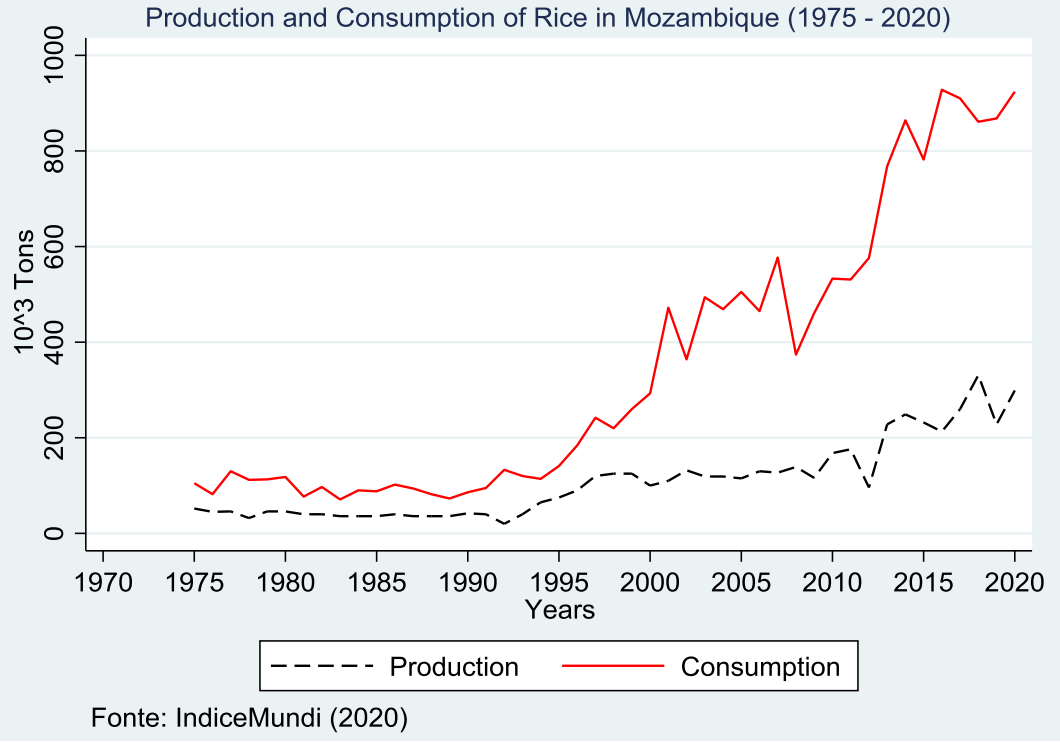

Figure 1. *Production, import and consumption of rice in Mozambique (2011 – 2020).*

Considering that the impact of prices and income on consumption can be measured by the elasticities of demand, studies of demand systems for imported products have been carried out in Mozambique and in several parts of the world. For example, for meat: (i) the study about the imported broilers in Mozambique [25]; (ii) the investigation of the

competitiveness of meat from different origins in Japan [40]; (iii) the estimation of demand systems for imported meat in Japan [55]. To mention few. Regarding to demand of imported rice, worldwide are several studies, like in Bangladesh [28]; Philipines [35], Tanzania [36], Pakistan [1], Indonesia [56], Nigeria [41] and in Côte d'Ivoire [14]. The authors of these studies estimate the impact of prices and income on the demand for imported products by country of origin, applying the Source Difference Almost Ideal Demand System (SDAIDS) model.

Therefore, there is an abundance of studies on the demand for imported rice worldwide. However, and despite the importance of imported rice in national consumption, the empirical and quantitative studies on the demand for imported rice in Mozambique are scarce. This study results from the need to contribute to filling the information gap by providing the quantification of the impact of income and price on the consumption of imported rice. Based on monthly rice import data from 2011 to 2020, obtained from National Statistics Institute (INE), the Source Differentiated Almost Ideal Demand System (SDAIDS) model and the Seemingly Unrelated Rules (SUR) approach are applied to estimate demand systems for imported rice. The period was chosen due to availability of data.

The results of this study can contribute to a better understanding of the sensitivity of consumption of imported rice to changes in prices and income. This understanding can be useful for defining or improving price and income policies to guarantee food and nutrition security. The overall objective of this study is to analyze the demand for imported rice in Mozambique. Specifically, it is intended to: (i) describe the consumption pattern of imported rice and, (ii) determine the elasticities of demand for imported rice using the SDAIDS model.

3. Literature Review

Worldwide about 149 million hectares are cultivated with rice, with a total production of 15 million tons, and the average hectare yield in Africa is 2 ton/ha [22]. The highest yield in Africa is 8 ton/ha recorded in Egypt and the lowest yield is recorded in the Democratic Republic of Congo with 0.7 ton/ha [22].

Rice productivity in Sub-Saharan Africa is stagnant, in contrast to Asia where technological advances provide significant increases in productivity [27]. Therefore, rice development in Africa has not been sufficiently explored and its potential can be properly harnessed by empowering producers and other actors and linking them to markets [33].

The rapid expansion of rice imports in many West African countries has been classified as a perverse effect of trade liberalization on the livelihoods of smallholders and an obstacle to the development of the domestic rice sector [14]. As a result, producers, along with development and lobbying, Agricultural and Resource Economy Review organizations in the Customs Union of the Economic Community for West African States (ECOWAS), are pushing hard for greater protection of the sector [14]. Domestic rice through an increase in the import tariff. This type of restrictive trade policy can represent an opportunity to reduce imports and renew local industry [14].

Several studies have shown that poor households are negatively affected from rising food prices primarily because most of them are net food buyers [29, 48]. But the impact is country-specific and depends on macroeconomic conditions, household production, and pattern of consumption [15].

3.1. Production and Consumption of Rice

According to the National Rice Plan (2020 -2030), about 97.7% of rice is cultivated by the family sector in a rainfed system, which is subject to uncertainty associated with various natural phenomena such as (i) climate change and the cycle of natural events (cyclones, floods/floods and drought), (ii) biotic factors (pests and diseases), (iii) use of traditional production techniques, which results in very low yields. The rice growing season encompasses the period from October to June, with November being the month of massive transplanting and May the main harvest month across the country [42].

In Mozambique, rice is one of the most produced and consumed cereals and is defined as a staple food crop. The list of staple food crops in Mozambique includes maize, wheat, beans, cassava, tomato, potato, sweet potato and tomato [41, 42]. According to the results of the Integrated Agricultural Survey (IAI2020), in Mozambique the staple food crops occupy an area of 3.2 million hectares, and rice is the second crop most cultivated crop occupying an area of 283 thousand hectares (9%) after maize, which occupies 2.3 million hectares (71%). The largest cultivated areas are located in the Provinces of Sofala with 120 thousand hectares (42%) and Zambézia 94 thousand hectares (33%) [43].

The national average productivity of rice is estimated at 0.63 ton/ha, the highest being 1.2 ton/ha in Maputo Province, 0.95 ton/ha in Gaza and 0.91 ton/ha in Tete [43]. The national average productivity of 0.63 ton/ha, places Mozambique as penultimate in the list of rice producing countries, surpassing only the Democratic Republic of Congo with 0.59 ton/ha [22]. In relation to neighboring countries, the income of Mozambique corresponds to 50% of the income obtained in Zambia, 39% of Malawi, 25% of Tanzania and Zimbabwe, 22% of South Africa, 14% of Madagascar and less than 10% of income obtained by the largest producers [22]. The low levels of rice production and productivity are largely explained by the use of traditional cultivation techniques and the low use of inputs [43].

Despite the low levels of production and productivity, in recent years there have been significant increases in produc-

tion. For example, rice production increased from 100 thousand tons produced in 363 thousand hectares in 2012, to 375 thousand tons in 2015 in an area of 313 thousand hectares and 137 thousand tons in 283 thousand hectares in 2020 [41, 42, 43].

The 283 hectares of rice production (Table 1) corresponds to 31% of 900 thousand hectares of the estimated area potentially suitable for rice production in Mozambique. In terms of production, rice stands out with 137 thousand tons, ranking third after maize (1.6 million tons) and sorghum with 142 thousand tons. Rice stands out in Province of Zambézia with 43,000 tones, Sofala with 40,000 tones and Nampula with 22,000 tones and Gaza with 18,000 tones [38, 43].

Table 1. *Rice production in Mozambique.*

Province	Production (ton)	Productivity (kg/ha)	% Explorations	Cultivated area (ha)
Niassa	2950	680	9.2	5832
Cabo Delgado	9201	707	15	19188
Nampula	22331	828	7	20275
Zambezia	42861	605	22.6	94083
Tete	183	911	0.3	668
Manica	475	618	1.3	1367
Sofa	40719	468	37.1	120247
Inhambane	270	455	2.2	1186
Gaza	17757	952	12.6	20584
Maputo Province	496	1156	1	490
Total	137243	633	12.8	283920

Source: [44]

In terms of number of farms, the rice is fourth most practiced staple food crop, with 12.8%, after maize (83.8%), peanuts (23.6%) and sorghum (18.3%). In province of Zambézia, 22.6% of farms cultivate rice, Sofala 37.1%, Cabo Delgado, 15%, and in Gaza, 12.6% [34].

In terms of consumption, the data from the sixth national survey consumption expenditure survey (IOF2022) indicate that in Mozambique rice is the third most consumed food with 5.3%, after maize flour with 21.3% and cassava flour with 5.4%. [32].

While the rainfed production system is frequently practiced in the provinces of Sofala, Zambézia, Nampula and Cabo Delgado, the irrigated system is more concentrated in the provinces of Gaza and Maputo. Commercial production is mainly concentrated in the irrigated systems of: Chókwè, Xai – Xai, Bilene, Buzi, Matutuine and Mopeia, which contribute with only 2.3% of the national production. Although the productivity of the commercial sector is relatively high when compared to that of the family sector, the success in meeting the needs of national consumption is still far from desired. The average rice crop yields range from 1.0 to 1.2 ton/ha in rainfed and 2.8 to 3.5 ton/ha in irrigated systems [43]. The success of satisfying the needs of national consumption is still far from desired.

The average rice yields range from 1.0 to 1.2 ton/ha in rainfed and 2.8 to 3.5 ton/ha in irrigated systems [43]. The aimed success of satisfying the needs of national consumption is still far from desired.

Mozambique has been importing rice to meet growing consumption needs, as production is below consumption needs. Table 2 shows that more than 90% of rice imported into Mozambique comes from seven countries, Thailand (52%); Pakistan (15%), Vietnam (10%), India (6%). Singapore (4%), Myanmar (3%) and China (3%). These countries are the leaders in the production and export of rice in the world.

Table 2. Values of Mozambican rice imports from 2011 to 2020 and by country.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average	% Average
Thailand	37425	67906	113673	108456	30447	74022	38603	44845	100417	29441	64524	52
Pakistan	11934	9670	13836	12740	8721	19866	18161	28521	40555	25258	18926	15
Vietnam	4521	14082	18318	13539	2901	13585	8527	12709	24048	10292	12252	10
India	630	2642	52179	7085	2399	1097	576	1034	1020	9641	7830	6
Singapore	1654	43	652	1415	256	2512	2292	4015	7199	23390	4343	4
Myanmar			1455	127				313	7908	9572	3875	3
China	222	83	205	642	1186	391	1554	8223	3708	15309	3152	3
Others	10044	6177	7553	5818	6990	2631	4122	3505	2460	7413	8049	7
Total	66431	100603	207871	149823	52900	114104	73836	103166	187314	130316	122951	100

Source: [31]

In relation to Table 3 shows that, occupying more than 283 thousand hectares, rice ranks second in basic food crops, after maize (2.3 million hectares). Sofala stands out with 120 thousand cultivated area dedicated to rice, Zamb ézia with 94 thousand tons, and Nampula and Gaza with 20 thousand hectares each.

Table 2. Area cultivated with basic crops (hectares).

Province	National	Maize	Rice	Sourghum	Millet	Big peanut	Small Peanut
Niassa	152290	125244	5832	10145	2772	4831	3466
Cabo Delgado	218151	146766	19188	18576	4083	20995	8543
Nampula	336199	176894	20275	30864	2272	16990	88904
Zambezia	547045	377159	94083	32869	3912	14291	24731
Tete	554611	434053	668	58336	19497	23673	18384
Manica	336948	273179	1367	35595	9042	3423	14342
Sof á	571843	366678	120247	63107	3533	5514	12764
Inhambane	121859	68101	1186	5224	2388	3146	41814
Gaza	317410	257572	20584	7732	5886	5135	20501
Maputo Province	76548	60717	490	132	92	1093	14024
National	3232904	2286363	283920	262580	53477	99091	247473
Structure %	100	71	9	8	two	3	8

Source: [44]

3.2. Review of Empirical Research on Demand for Imported Rice

Agricultural prices are notoriously unstable and influence the decisions of farmers and traders simultaneously [18]. Farmers often face sharp price fluctuations across time and place, which introduces uncertainty and affects producers and consumers. This situation often forces farmers to accept low prices for their products, and subsequently consumers end up paying higher prices [48].

In Côte d'Ivoire was used the SDAIDS model to estimate the elasticities of demand for imported rice based on rice import data from 1996 to 2011 [14]. The authors divided rice

into three types, first quality, pattern and party. The results of this study indicate that the demand for rice of the first quality imported in Côte d'Ivoire, was price elastic when coming from Thailand (-1.11), Vietnam (-1.14) and Rest of the World (-1.03) and inelastic when coming from the United States of America (-0.58) [14].

In Nigeria was estimated the elasticities of demand for food, including rice, using the LA/AIDS model [41]. The results of the Marshallian prices elasticities demand were all negative, which indicates that an increase in price leads to a decrease in the quantity of rice demanded and this follows the law of demand where the demand curve has a negative slope. Based on Marshallian price elasticities of demand, the demand for rice (which is inelastic) is less than unity (-0.508), which means that rice is a staple good in Nigeria, which implies that the demand for rice in Nigeria does not change much in response to changing prices. Cross-price elasticities were mostly negative and this shows a high level of substitutability [41].

Likewise, the income elasticities of demand were all positive and less than one, meaning the products considered are normal goods, where rice stood out for presenting the highest income elasticity of demand (0.843), followed by corn with 0.548, wheat with 0.507 and sorghum with 0.138. In the recommendations, the authors emphasize that the fact that rice demand is inelastic to price and income, highlights the need for efforts to increase rice supply in order to balance demand [41].

In Bangladeshi was carried out a study to analyze the consumer spending patterns and demand for food including rice using the LA/AIDS model. According to the authors, the high proportion of rice consumption in urban (33.74%) and rural (45.49%) areas indicates that an increase in per capita income could result in an upward movement of the rice demand curve [51]. The income elasticity of demand for rice (0.76%) showed that it was a normal good, while the other goods considered, pulses, 1.09%; edible oil, 1.06%; fruits and vegetables, 1.0%; fish and meat, 1.20%; milk and dairy products, 1.16%, were in the luxury goods category. The price elasticities of demand showed that the demand for all foods considered, with the exception of milk and dairy products, -1.07; had an inelastic demand for the price, with rice, -0.81; legumes, -0.98; cooking oil, 0.97; fruits and vegetables, -0.69; fish and meat, -0.96, which means low sensitivity of the quantities demanded in relation to price changes. According to the authors, as rice is the main food of Bangladesh, a price increase is not desirable because the majority of the population has low income and is tied to the market [51].

The cross elasticities of other foods showed low substitution effects and little stability, such that the government's price regulation strategy may not be a good option to control the effects of prices on the economy. The authors also recommend any policy that aims to aggregate income or total household income, or consumer support, in order to defend the low-income population in the face of price increases. 97; fruits and vegetables, -0.69; fish and meat, -0.96, which means low sensitivity of the quantities demanded in relation to price changes [51].

In Indonesia, where rice is the staple food of households and the country has resorted to imports to meet domestic demand that exceed the production [53]. Was estimated the demand systems for imported rice using AIDS models, and the results indicate that the demand for rice imported from Vietnam (-3.26), Thailand (-2.16) and the USA (-1.44) was price elastic and that from other countries (-0.85) had inelastic demand. On the other hand, the income elasticity of demand showed positive results, which means that imported rice is a normal good in Indonesia, being luxury when it comes from Vietnam (1.2) and Other countries (1.14) [53].

The results of the cross-demand price elasticities, in Indonesia, show a substitution relationship between rice imported from Vietnam and the USA (0.65), Vietnam is other countries (1.18), USA and other countries (1.57) and United States of America and Thailand (1.57), where the results show a relation of complementarity (negative sign) to cross and inelastic demand (less than 1 in absolute terms). In terms of policy implications, the author points out that the fact that the results show that the increase in prices leads to a decrease in rice imports, which is a staple food, then the government should adopt policies to increase domestic production and reduce dependence on imports.

The Linear Approximate Almost Ideal Demand System (LA/AIDS) model to assess the elasticity of demand for rice in the Philippines [35]. This study found that rice was a normal and essential commodity in the Philippines because demand for rice was inelastic to changes in income (0.422) and price (-0.505). Assessed the dietary substitutability of imported and domestic rice and maize by estimated price and expenditure elasticity in Tanzania, and found that Tanzanian consumers preferred domestic rice. The results show that Tanzanian consumers prefer domestic varieties of rice with poor substitutability between domestic and imported varieties [35].

4. Methodology

This chapter presents the methodology followed to estimate the demand systems for imported rice in Mozambique and their respective elasticities. To respond to the objectives of the study, the methodology is divided into four subchapters. In subchapter 4.1, the procedures for estimating the Linear Approximated Source Difference Almost Ideal Demand System (LA/SDAIDS) model are presented to obtain the systems of equations of demand for imported rice, from eight sources, and respective elasticities, using the Seemingly Unrelated Regression (SUR) approach. In subchapter 4.2, the description of the Marshallian and Hiksian demand. Subchapter 4.3 presents the source and data processing and subchapter.

4.1. Specification of the AIDS Model

In Mozambique rice is imported to fill the growing needs of rice consumption in the domestic market, since national production still does not meet demand. Therefore, the study of rice imports applies the procedures for the study of demand systems to analyze the effect of prices and income on the demand for imported rice in Mozambique. The theoretical framework of analysis applied in this study considers eight origins of imported rice, namely, Thailand, which represents 52% of rice imported by Mozambique; Pakistan (15%), Vietnam (10%), India (6%). Singapore (4%), Myanmar (3%) and China (3%) and other countries (7%).

The Almost Ideal Demand System (AIDS) developed by Deaton and Muelbauer in 1980 is used in this study. The AIDS model has advantages compared to previous demand systems such as the Linear Expenditure System, the Rotterdam model and the Translog [16].

The main advantages of the AIDS model are: i) it makes a first-order and arbitrary approximation for all demand systems, satisfying all axioms of exact choices and perfectly aggregating all consumers, admitting that market demands are derived from decisions of a representative rational consumer; ii) it dispenses with the invocation of the parallelism of Engel curves, thus constituting a great advance in the estimation of flexible functional forms; (iii) it complies with the axioms of consumer choice; (iv) it allows symmetry and homogeneity hypotheses to be estimated or tested and, above all, (v) it is flexible, that is, it has the capacity to accommodate any pattern of substitution between products [4, 5, 6, 16, 53, 47, 56].

The Almost Ideal Demand System (AIDS) model is one of the few models used to analyze the demand for imported products, as it is flexible, theoretically plausible and easy to apply [55]. The AIDS model is specified so that the origins of the product are differentiated. The AIDS by differentiated origins model includes conventional AIDS formulations as special cases. Source differentiation is important in import demand analysis.

The specification of the Almost Ideal Demand System (AIDS) model starts with a specific class of preferences that allow exact aggregation of consumers [16, 12]. This model represents market demands as a reflection of the decisions of a representative and rational consumer, whose preferences constitute the so-called Price Independent Generalized Logarithmic - PIGLOG, and are represented by an expenditure function that defines the minimum expenditure necessary to reach a level of utility for certain prices.

Among the limitations of the AIDS model, the following stand out: i) the excessive number of parameters to be estimated, which is problematic for markets with many products. However, for markets with few products this problem does not arise [3, 38], and ii) the fact that it is static, which means that it does not capture the statistical properties of the data and the dynamic specification of the series [4, 6].

For the source-differentiated AIDS model (or simply SDAIDS), the expenditure function is rewritten to approximate the behavior of the importer who differentiates goods from different origins. The expenditure function given utility u is:

$$\ln\left[E(p,u)\right] = (1-u).\ln\left[a(p)\right] + u.\ln\left[b(p)\right] \tag{1}$$

Where

$$\ln\left[a(p)\right] = \alpha_0 + \sum_i \sum_h \ln(p_{ih}) + \frac{1}{2}\sum_i \sum_j \sum_h \sum_k \gamma^*_{ihjk} \ln(p_{ih}) \ln(p_{jk}) \tag{2}$$

and

$$\ln\left[b(p)\right] = \ln\left[a(p)\right] + \beta_0 \prod_i \prod_h p_{ih}^{\beta_{ih}} \tag{3}$$

Where α , β and γ^* are parameters. The subscripts i and j denote goods (i, j = 1,...,), h and k denote products. The number of products is not necessarily the same for all goods and good i can be imported from m different origins, while good j can have n origins (when *i z j, h 1,..., m e k 1,..., n*). Substituting equations (2) and (3) into (1), the expenditure function can be rewritten as:

$$\ln\left[E(p,u)\right] = \alpha_0 + \sum_i \sum_h \alpha_{ih} \ln(p_{ih}) + \frac{1}{2}\sum_i \sum_h \sum_j \sum_k \gamma^*_{ihik} \ln(p_{ih}) \ln(p_{jk}) + \beta_0 u \prod_i \prod_h p_{ih}^{\beta_{ih}} \tag{4}$$

By Shephard's Lemma, the proportion of the budget allocated to import the good ia from origin h can be obtained by differentiating $\ln\left[E(p,u)\right]$ about $\ln(p_{ih})$. Thus, the share

of the budget (ω_i) is a function of prices and utility as:

$$\omega_{ih} = \alpha_{ih} + \sum_j \sum_k \gamma_{ihjk} \ln\left(p_{jk}\right) + \beta_{ih} u \beta_0 \prod_i \prod_h p_{ih}^{\beta_{ih}} \quad (5)$$

Where $\gamma_{ihjk} = \frac{1}{2}\left(\gamma^*_{ihjk} + \gamma^*_{jkih}\right)$. Solving equation (4) in order of u and substituting in equation (5) results in the SDAIDS model in the form of proportion of expenditure:

$$\omega_{ih} = \alpha_{ih} + \sum_j \sum_k \gamma_{ihjk} \ln\left(p_{jk}\right) + \beta_{ih} \ln\left(\frac{E}{P^*}\right) \quad (6)$$

Equation (6) represents the specification of the AIDS model developed by [12]. In this equation, wi represents the share of expenditure on rice imports in country i in total expenditure, as a dependent variable; E is the country's total expenditure on rice imports (obtained as the sum of the values of rice import expenditure from all considered origins - China, India, Singapore, Thailand, Pakistan, Vietnam, Myanmar and Rest of the World -; P_j - is the price of rice imports from country j; P^* - is the Stone Price Index; γ_{ij} – is the estimated coefficient for each of the countries considered; β_{ij} - is the estimated coefficient for the expenditure.

Finally, the P represents the TRANSLOG model price index defined by the expression:

$$\ln\left(p^*\right) = \alpha_0 + \sum_i \sum_h \alpha_{ih} \ln\left(p_{ih}\right) + \frac{1}{2} \sum_i \sum_h \sum_j \sum_k \gamma^*_{ihik} \ln\left(p_{ih}\right) \ln\left(p_{jk}\right) \quad (7)$$

Equation (7) represents the TRANSLOG index that makes the system non-linear, making the estimation process difficult. Therefore as an alternative, the Stone's geometric index is used, which results from the sum of the (logarithms of) prices weighted by their relative income [14].

The Stone index is represented by the formula:

$$P = \sum w_j * \ln P_j \quad (8)$$

Where ω_j is the share (share) of expenditure allocated to rice imports in each of the countries considered and Pj is the nominal price of rice imported from country j.

Substituting equation (8) into equation (6), we get:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \left(\log E - \sum_{i=1}^{n} w_i \log P_j\right) \quad (9)$$

However, replacing the TRANSLOG price index with the Stone index causes concurrency problems, because the dependent variable (wi) also appears on the right side of the LA/AIDS model. Thus, to solve this problem one must use the lagged part for equation (6), thus obtaining equation (10) as follows [14, 19]:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \left(\log E - \sum_{i=1}^{n} w_{i,t-1} \log P_j\right) \quad (10)$$

The AIDS model that uses Stone's index is called “Linear Approximate Almost Ideal Demand” (LA/AIDS). The only difference between the original AIDS model and the linear version of the same model (LA/AIDS) is in the specification of the price index [4, 5, 11].

The AIDS model is subject to the constraints of Adding-up, symmetry and homogeneity. Adding-up constraint ensures that the sum of partial consumptions cannot exceed total consumption.

Adding-up

$$\sum \gamma_i = 0 \quad \sum \beta_i = 0 \quad \sum \alpha_i = 1 \quad (11)$$

Therefore, the Adding-up constraint guarantees that the sum of the expenditure shares (share) is always equal to 1, which means that the Marshallian demands must satisfy the budget constraint.

$$E = \sum_{i=1}^{n} p_i q_i \quad (12)$$

As the budget constraint cannot be violated, considering the Adding-up constraint implies that changes in total consumption or changes in prices lead the consumer to choose a new basket of goods [11]. The demand for rice from other countries is estimated using the Adding-up constraint.

The principle of homogeneity means that the sum of all coefficients of prices of rice imported from Thailand, Pakistan, India, China, Singapore, Myanmar, Vietnam and other countries, in the Thailand equation is equal to zero. This condition is also verified in the other equations of demand for rice imported by each of the seven remaining origins. Therefore, theory of homogeneity considers that Hicksian demands are zero degree homogeneous in prices, and Marshallian demands are homogeneous in total expenditure and prices. Likewise, this constraint implies that the demand functions are homogeneous of degree zero, which means that equiproportional changes in expenditure (E) and in prices (p) do not affect demand, that is, consumers do not suffer from monetary illusion. If all prices and income change at the same rate, the quantities consumed remain the same [4, 5].

$$\sum_{i=1}^{n} \gamma_{ij} = 0 \quad (13)$$

The symmetry constraint considers that the derivatives of the demand function in relation to the crossed prices are symmetric, that is, for all i ≠ j

$$\gamma_{ij} = \gamma_{ji} \quad (14)$$

The symmetry condition results from the application of Shephard's lemma to the expenditure function. In the AIDS model the symmetry constraint can be derived directly from the estimated coefficients (γ). Shephard's lemma provides a precise formula for the demand for each good in the market with respect to the level of utility and prices. Therefore, the Slutsky symmetry constraint means: (i) the price parameter of rice imported from Thailand in the Pakistan equation is equal to the price parameter of rice imported from Pakistan in the Thailand equation; (ii) the price parameter of rice imported from Thailand in the China equation is equal to the price parameter of rice imported from China in the Thailand equation; (iii) the price parameter of rice imported from Thailand in the India equation is equal to the price parameter of rice imported from India in the Thailand equation, and so on.

However, in models such as LA/AIDS in which the dependent variables are the shares of products in the total expenditure, with the sum giving one, as in the Logit model, which also imposes restrictions between the parameters, the errors of the equations are not independent of each other, hence the estimation by the Ordinary Least Squares (OLS) method results in inefficient coefficients, being the most adequate and easy to implement method the Seemingly Unrelated Regression- SUR, presented by Arnold Zellner in 1962, which makes use of error correlations between equations [39].

The SUR model represents a generalization of the linear regression model and consists of several regression equations and is widely used in the estimation of demand systems, as the errors between the equations are correlated. Although OLS provides consistent estimates, equation by equation, they are not as efficient as in SUR [39].

The estimation procedure using is a Seemingly Unrelated Regression Equations to an equation (other sources) excluded from the model to avoid singularity in the equations (deleting a different equation did not change the results), and the coefficients of the eliminated equation were retrieved using the adding-up conditions [14, 39].

4.2. Elasticities of Demand

The income elasticity of demand measures how much the quantity of a good responds to a change in consumers' income. If the income elasticity of demand is positive and less than one, the good is considered a basic necessity, and if it is greater than one, the good in question is considered a luxury good. When the income elasticity of demand is zero, the good is said to have satiated consumption and when it is less than zero, the good in question is considered to be inferior [26].

The price elasticity of demand is a measure of how much the quantity demanded of a good reacts to a change in the price of the good in question. Thus, and depending on the result, one can have: i) perfectly inelastic demand, which occurs when elasticity equals zero, that is, an increase in price leaves the quantity demanded unchanged; ii) inelastic demand, when the elasticity, in module, is less than one; iii) demand with unitary elasticity, when it is equal to one; and iv) elastic demand, when the elasticity is greater than one in absolute terms. And finally, the cross-price elasticity of demand which is a measure of how much the quantity demanded of one good responds to a change in the price of another good.

The elasticities of demand in the LA/AIDS model can be obtained by the following formulas [4-6, 25]:

Income Elasticity of Marshallian Demand

$$\eta_i = 1 + \frac{\beta_i}{w_i} \quad (15)$$

Where, η_i is the Marshallian income elasticity of demand; wi – is the share of rice import expenditure from country i in the total rice import expenditure in Mozambique; β_{ij} - is the estimated coefficient for the expenditure.

Marshallian price elasticity of demand

$$\varepsilon_{ii} = -1 + \frac{\gamma_{ii}}{w_i} - \beta_i \quad (16)$$

Being, ε_{ii} is the price elasticity of demand; γ_{ij} is the estimated coefficient for each product (tables 1 and 2); β_{ij} - is the estimated coefficient for the expenditure; wi – is the share of rice import expenditure from country i in the total rice import expenditure in Mozambique.

Marshallian cross-demand price elasticity

$$\varepsilon_{ij} = \frac{\gamma_{ii}}{w_i} - \beta_i \frac{w_j}{w_i} \quad (17)$$

Where, ε_{ij} is the price elasticity of cross-demand; γ_{ij} – is the estimated coefficient of each product; β_{ij} - is the estimated coefficient for the expenditure; wi – is the share of rice import expenditure from country i in the total rice import expenditure in Mozambique; ε_i - is the price elasticity of cross demand; ω_j - is the proportion of expenditure in qj

Hiksian price elasticity of demand

$$\eta_{ij} = \eta_{ij}^{c} - \varepsilon_i \omega_j \quad (18)$$

Where: η_{ij} - is the price elasticity of uncompensated demand; η_{ij}^{c} - is the price elasticity of compensated demand; ε_i - is the income elasticity of demand; ω_j - is the proportion of expenditure in qj

4.3. Source and Treatment of Data

For this study, monthly rice import data from 2001 to 2020 and by country of origin were used. The data were obtained from the National Statistics Institute (INE), Directorate of Sectorial and Enterprise Statistics (DESE) and refer to quantities and values, on the basis of which prices were calculated by dividing the values by the quantities. The period was choice due to availability of data. The following countries of origin were considered: Thailand, Pakistan, India, China, Singapore, Myanmar, Vietnam and other countries which together constitute sources of more than 90% of the imported rice consumed in Mozambique. All other countries are grouped in a residual group called Rest of the World, thus totaling 8 origins.

In order to estimate the LA/AIDS model using the SUR approach, in STATA. 15, first, the total expenditure on rice imports in the country (E) was obtained by adding the expenditure on rice imports in each of the origins, that is,, $E_i = \sum p_i q_i$ where i is the month. In the final work file, and used for estimating demand systems, each line corresponds to a month of a specific year and in the columns are the amounts, prices, values and share (w_i) of expenditure by country of origin. The proportion (Share) of expenditure by each country in each month was obtained by dividing the total expenditure by each of the 8 sources considered, $w_j = \frac{p_j q_j}{E_i}$ where j represents the country of origin and i represents the time (month of a specific year).

Then, the logarithms of prices and expenditure were determined. The sum of the products of the logarithms of prices for each country of origin ($\ln p_j$) by the respective lagged proportion ($w_{i,t-1}$) that is, $w_{j,t-1} * \ln p_j$, resulted in the Stone Index (P), summarizing to:

$$P = \sum_k w_{k,t-1} \ln(p_k) = w_{1,t-1} * \ln(p_1) + w_{2,t-1} * \ln(p_2) + w_{3,t-1} * \ln(p_3) + ... + w_{8,t-1} * \ln(p_8)$$

where k varies from 1 to 8, where, 1= “China”; 2= “India”; 3= “Pakistan”; 4= “Singapore”; 5= “Thailand”; 6= “'Vietnam”; 7= “Myanmar” and 8= “Rest of the World”.

The parameters of the systems of demand equations with reference to the LA/AIDS model were estimated after verifying the compliance of the Adding-up, homogeneity and symmetry constraints ($\sum \gamma_i = 0$ $\sum \beta_i = 0$ $\sum \alpha_i = 1$ and $\gamma_{ij} = \gamma_{ji}$).

5. Results and Discussion

5.1. Descriptive Analysis

From 2011 to 2020, Mozambique imported more rice from Thailand, with about 50.4% of the volume of rice imports; followed by Pakistan with 20.7%, Vietnam with 9.6% and lastly Myanmar with less than 1%. Table 4. Still in table 4 there are the coefficients of the products (γ), of the expenditure (β) and the proportion of expenditure (ω_j) of rice imports from Mozambique from the 8 origins considered. In addition to country coefficients, the table shows standard errors and statistical significance at 5%. For the analysis of statistical significance, the Z test was performed under the null hypothesis that the parameter is null (not statistically significant) and the alternative that it is different from zero (statistically significant).

The use of the rice import expenditure variable from the 8 origins considered ensured the observance of the Adding-up restriction. Thus, the sum of the proportion (ω) of import expenditure from each of the origins in the total rice import is equal to unity. Likewise, the sum of the coefficients corresponding to the constant or intercept (α), of each equation, is equal to one (1) and the total of the expenditure coefficients (β) and the expenditure cross coefficients (γ) of the 8 origins considered is equal to zero, in short, $\sum \gamma_i = 0$; $\sum \beta_i = 0$; $\sum \omega = 1$; $\sum \alpha_i = 1$.

Table 3. *Estimated coefficients.*

Estimated Coefficients													
		China			India			Pakistan			Singapore		
Share	Products	coef. (Y)	standard error	P-value	coef. (Y)	standard error	P-value	coef. (Y)	standard error	P-value	coef. (Y)	standard error	P-value
0.0260542	China	0.0053	0.0018	0.0040	-0.0056	0.0021	0.0080	-0.0027	0.0019	0.1550	0.0010	0.0018	0.5660
0.0682123	India	-0.0056	0.0021	0.0080	0.0069	0.0075	0.3540	-0.0060	0.0102	0.5560	-0.0005	0.0025	0.8460
0.207264	Pakistan	-0.0027	0.0019	0.1550	0.0015	0.0069	0.8220	-0.0019	0.0094	0.8360	-0.0001	0.0023	0.9660
0.0226238	Singapore	0.0010	0.0018	0.5660	-0.0010	0.0108	0.9240	0.0120	0.0147	0.4150	-0.0014	0.0036	0.6890
0.5038342	Thailand	0.0016	0.0018	0.3630	-0.0056	0.0116	0.6300	0.0166	0.0159	0.2950	-0.0027	0.0039	0.4920
0.0959661	Vietnam	-0.0005	0.0018	0.7760	0.0027	0.0059	0.6430	0.0011	0.0080	0.8920	-0.0001	0.0020	0.9480
0.0075522	Myanmar	0.0004	0.0005	0.3650	-0.2399	0.0794	0.0030	0.1228	0.1097	0.2630	0.0087	0.0266	0.7430
0.0684932	Other countries	0.0004	0.0005	0.3650	-0.0051	0.0104	0.6240	0.0134	0.0143	0.3460	-0.0017	0.0035	0.6290
B	Expenditure (LEP)	-0.0024	0.0028	0.4030	-0.0041	0.0106	0.6980	0.0424	0.0144	0.0030	0.0013	0.0036	0.7120
A	_cons	0.0472	0.0474	0.3190	0.1549	0.1995	0.4380	-0.5819	0.2723	0.0330	-0.0033	0.0670	0.9610
W	Share	0.0261			0.0682			0.2073			0.0226		

Table 4. *Continued.*

Estimated Coefficients												
	Thailand			Vietnam			Myanmar			Other countries			Total
countries	coef. (Y)	standard error	P-value	coef. (Y)	standard error	P-value	coef. (Y)	standard error	P-value	coef. (Y)	standard error	P-value	
China	0.0016	0.0018	0.3630	-0.0005	0.0018	0.7760	0.0004	0.0005	0.3650	0.0000	0.0016	0.9860	0.0
India	-0.0017	0.0166	0.9190	0.0005	0.0065	0.9410	0.0001	0.0006	0.8720	0.0074	0.0149	0.6210	0.0
Pakistan	0.0016	0.0153	0.9190	-0.0018	0.0060	0.7600	0.0003	0.0005	0.5840	0.0034	0.0137	0.8030	0.0
Singapore	-0.0134	0.0238	0.5720	0.0049	0.0093	0.5970	-0.0005	0.0008	0.5520	0.0006	0.0215	0.9760	0.0
Thailand	0.0070	0.0256	0.7850	0.0108	0.0100	0.2820	0.0006	0.0009	0.5050	-0.0263	0.0232	0.2560	0.0
Vietnam	-0.0063	0.0131	0.6290	0.0040	0.0051	0.4250	0.0001	0.0005	0.8000	-0.0012	0.0117	0.9200	0.0
Myanmar	-0.0996	0.1767	0.5730	0.0672	0.0687	0.3290	-0.0017	0.0016	0.3020	0.1348	0.1606	0.4010	0.0
Other countries	-0.0489	0.0230	0.0340	0.0128	0.0089	0.1530	0.0007	0.0007	0.2840	0.0286	0.0209	0.1710	0.0
Expenditure (LEP)	-0.0093	0.0235	0.6920	0.0033	0.0092	0.7210	0.0008	0.0007	0.2950	-0.0318	0.0211	0.1310	0.0
_cons	0.8268	0.4429	0.0620	-0.0237	0.1730	0.8910	-0.0156	0.0138	0.2580	0.5895	0.3985	0.1390	1.0
Share	0.5038			0.0960			0.0076			0.0685			1.0

5.2. Demand Elasticities

The results in Table 5 show that the income Elasticities of demand for rice in Mozambique are positive, meaning that the quantities demanded of rice increase with increasing income.

Table 4. *Elasticities Prices and Income of Marshallian Demand.*

Elasticities Prices and Income of Marshallian Demand							
	Price	**Standard Error**	**P-value**	**Income**	**Standard Error**	**P-value**	**share**
China	-0.793	0.071	0	0.910	0.108	0,000	0.026054
India	-0.895	0.108	0	0.940	0.155	0,000	0.068212
Pakistan	-1,052	0.044	0	1,205	0.070	0,000	0.207264
singapore	-1,064	0.159	0	1,058	0.157	0,000	0.022624
Thailand	-0.977	0.046	0	0.982	0.047	0,000	0.503834
Vietnam	-0.961	0.0518	0	1,034	0.096	0,000	0.095966
Myanmar	-1,226	0.219	0	1,103	0.099	0,000	0.007552
Other countries	-0.551	0.294	0.061	0.535	0.308	0.082	0.068493

Rice imported by Mozambique from the 8 origins considered can be classified as a normal good Table 5. All income elasticities of demand are statistically significant, except for "other countries" classified as Rest of the World. The results also show that (four) 4 of the (eight) 8 origins considered here - "Pakistans", "Singapore", "Vietnam" and "Myanmar" present elastic demand in relation to income. Thus, any positive (negative) variation in income allows consumers to purchase more (less) rice from these countries, such that when income increases by 1%, the demand for rice increases by 1.2% when coming from "Pakistan", and by 1.1% when coming from "Singapore", by 1.03% for "Vietnam"; and in for those from "Myanmar" (1.1%). These results suggests that rice from these countries can be classified in the luxury goods category. On the other hand, rice from "China" (0.9%); "India" (0.9%) and "Thailand" (0.98%) show almost unitary Elasticities. Rice from "other countries" (0.5%) has a relatively rigid demand for income variation, such that when income increases (decreases), the quantities demanded for these products increase (decrease) in a lower proportion.

These results suggest that rice imported from Pakistan, Singapore, Vietnam and Myanmar is more preferred by Mozambicans with increasing income, being in the luxury goods category, compared to rice from China, India, Thailand and Other Countries, whose quantities demanded increase less than proportionally, thus classifying it in the essential goods category.

The high elasticities of demand for imported rice in Mozambique represent a challenge, since: i) national production does not satisfy demand [23]; ii) equally, the productivity of domestic rice remains low (0.63 ton/ha) [34]; iii) there is a trend towards an increase in rice consumption [33].

With a view to reversing the current supply deficit scenario, the National Rice Plan (2020-2030) defines the development of the rice subsector as an imperative to guarantee food and nutrition security in Mozambique. Foresees progressive increases in production and productivity through the intensification of the use of agricultural inputs and improved technologies from a deficit of 21.8% in 2020/21, until reaching a surplus from 2021/22.5.3%; 27.5% in 2022/23; 42.2% in 2023/24 up to a maximum surplus of 60.8% in 2025/26. And in terms of production, in the first year that surplus is forecast, 2021/21, the production of clean rice will be 731 thousand tons and a yield of 2.4 tons per hectare [42].

However, comparing the results of the Integrated Agricultural Survey (IAI, 2020) with the projections of the National Rice Plan (2020 - 2030), it is noted that a large discrepancy, such that the production levels of 137 thousand tons calculated in the survey, correspond to about 16% of the stipulated target of 841 thousand tons, for 2020/21, which raises the deficit for this period from 5.3% forecast to about 87.3% [42].

Compensated, or Marshallian, price elasticities of demand are also in Table 5 and show that price elasticities of demand are statistically significant, except for rice from other countries. The negative sign is consistent with economic theory since the demand curve is downward sloping.

The demand, uncompensated or Marshallian, for rice imported into Mozambique is price elastic, which means that the increase (decrease) in the price implies a more than proportional decrease (increase) in the quantities demanded, ceteris

paribus. Thus, when the price increases by 1%, the quantities demanded decrease, on average, by 1.06% for rice coming from "Pakistan"; by 1.06% for those from "Singapore"; 1.22% for those from "Myanmar"; 0.96% for those from "Vietnam"; by 0.89% for "India"; by 0.79% for "China"; in 0.974% for "Thailand" and in 0.56% for those coming from "other countries".

The demand for rice in Mozambique is sensitive to price variations, in a situation in which, as suggested by [46], domestic prices remained high even after international prices fell. Indeed, in Figure 2 it can be seen that from the end of 2015 onwards, the average prices of rice on the national market doubled and no longer followed a downward trajectory. The increase in rice prices in 2015 follows the general price behavior recorded in this period, as shown in Figure 2.

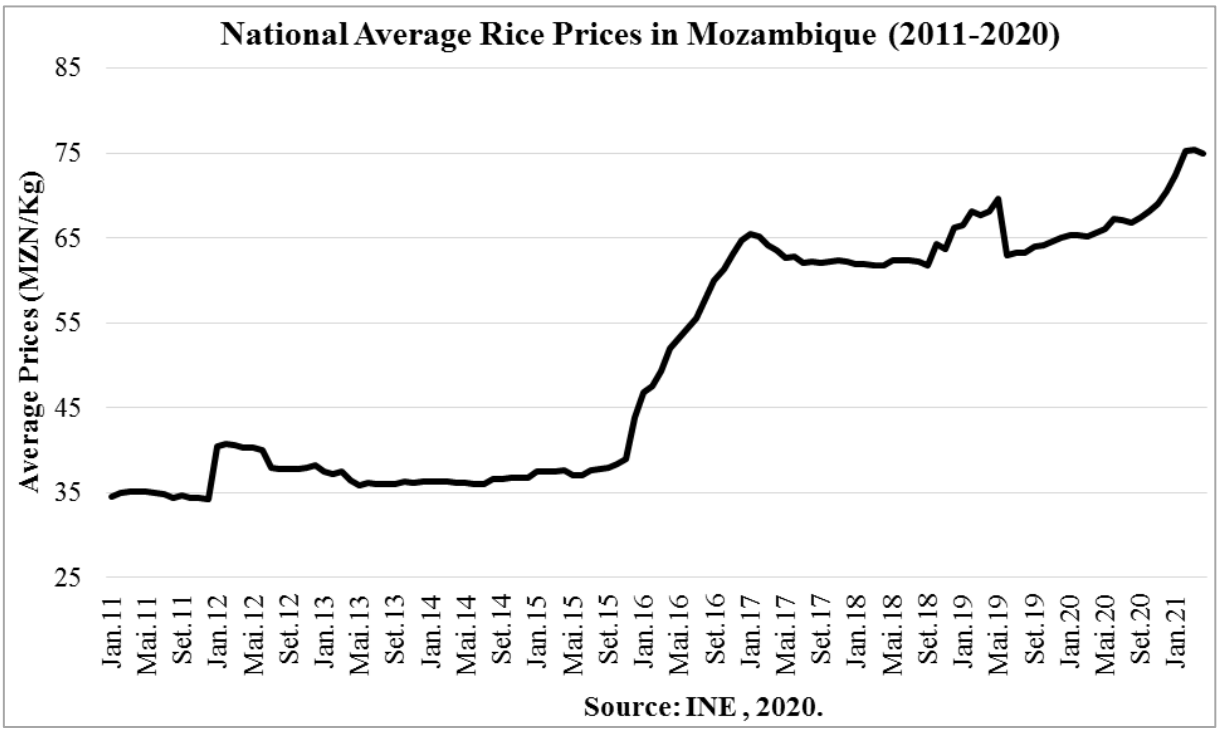

Figure 1. *National Average Rice Prices in Mozambique (2011-2020).*

In Mozambique, rice is largely (97.7%) produced by small family subsistence producers (family sector) in a rainfed regime [31]. Rainfed production is generally subject to a greater degree of uncertainty due to the duration and intensity of rainfall and other environmental factors. Rice production under rainfed conditions in the lowlands is predominantly carried out in areas of greater poverty where the family sector has faced the consequences of climate change and employs traditional techniques. As a result, incomes are very low [44].

As a net importer of food, Mozambique suffers the effects of rising international prices and, on average, registers high prices, even with a reduction in the international market [3, 36]. On the other hand, from 2005 onwards, the world registered a significant increase in food prices, where the maximum values were reached in 2008 and 2011 [10].

The cross-price elasticities of demand are in Table 6. From the analysis of the results of the Marshallian elasticities, it appears that all the cross elasticities of demand are less than one, in absolute terms, except for the relation between the rice imported from India and that from Mynmar (-3,517), the which suggests a weak response of the quantities demanded by consumers of rice imported from one country as a response to the variation in prices of rice from another country. On the other hand, 2/3 of the cross elasticities have a negative sign, which shows a strong relationship of complementarity of rice imported from the 8 origins considered.

From Table 6, it can be seen that the Marshalian cross-price elasticity of rice imported from India shows a complementarity relationship (negative cross-price elasticity) with rice from China (-0.081), Singapore (-0.014), Thailand (-0.052), and the highest with Myanmar (-3.517). Likewise, rice imported from Singapore has a complementary relationship with rice from India (-0.026), Pakistan (-0.016), Thailand (-0.147), Vietnam (-0.011) and Other Countries in the world (-0.078). However, the relationship of complementarity between the same products is difficult to justify, unlike the relationship of substitutability that can be associated with flavor or other differentiating qualities, which determine consumer choices [31]. The National Rice Plan 2020-2030 highlights the following constraints for the rice subsector in Mozambique: (a)

low use of technologies, being: (i) certified seeds (8.7%); (ii) fertilizers (2.8%); (iii) Pesticides (6.3%); (iv) Machinery (4.2%); (v) Irrigation (4.3%); (vi) credit (2.0%); (b) low access to infrastructure and marketing support services that burden transaction costs (access roads, warehouses, electricity); (c) insufficient and inadequate financial services; (d) poor water management capacity in the fields due to poor land/soil leveling; (e) high levels of post-harvest losses and waste; (e) climate change and the cycle of natural events: cyclones, floods, floods, droughts and droughts; [34]. Therefore, the competition between imported and locally produced rice is not yet identified as a constraint as there is an increasing demand for rice in Mozambique. On the other hand, there is competition among rice peers from Vietnam and India (0.003), Vietnam and Singapore (0.051), Vietnam and Thailand (0.095), Vietnam and Mynmar (0.042) and Vietnam and Other Countries of the World (0.131).

Table 5. *Marshallian cross-price demand elasticities.*

Cross demand elasticity												
	China			**India**			**Pakistan**			**Singapore**		
	Elasticity	**standard error**	**P-value**	**Elasticity**	**standard error**	**P-value**	**Elasticity**	**standard error**	**P-value**	**Elasticity**	**standard error**	**P-value**
China	-0.7930	0.0710	0.0000	-0.0806	0.0311	0.0100	-0.0182	0.0092	0.0480	0.0429	0.0775	0.5790
India	-0.2080	0.0820	0.0100	-0.895	0.108	0,000	-.0258851	.0212094	0.3780	-0.0256	0.1105	0.8160
Pakistan	-0.0840	0.0740	0.2580	0.0351	0.0981	0.7200	-1.0520	0.0440	0.0000	-0.0164	0.1006	0.8710
singapore	0.0410	0.0680	0.5490	-0.0138	0.1593	0.9310	-.0773469	.040225	0.4560	-1.0640	0.1590	0.0000
thailand	0.1070	0.0780	0.1710	-0.0517	0.1554	0.7390	.009758	.0160631	0.7410	-0.1473	0.1573	0.3490
vietnam	-0.0110	0.0690	0.8730	0.0459	0.0849	0.5890	.1705033	.0551763	0.7040	-0.0114	0.0880	0.8970
Myanmar	0.0170	0.0180	0.3450	-3.5167	1.1632	0.0020	.0830395	.017049	0.2640	0.3842	1.1734	0.7430
Other countries	0.0220	0.0190	0.2380	-0.0709	0.1476	0.6310	-.0134338	.0274867	0.4440	-0.0778	0.1476	0.5980
INCOME	0.9097	0.1079	0.0000	0.9399	0.1548	0,000	1.2047	0.0695	0,000	1.0579	0.1570	0,000
share		0.0261			0.0682			0.2073			0.0226	

Table 6. *Marshallian cross-price demand elasticities.*

Cross demand elasticity												
	Thailand			**Vietnam**			**Myanmar**			**Other countries**		
	Elasticity	**standard error**	**P-value**	**Elasticity**	**standard error**	**P-value**	**Elasticity**	**standard error**	**P-value**	**Elasticity**	**standard error**	**P-value**
China	0.0037	0.0037	0.3250	-0.0062	0.0188	0.7400	0.0442	0.0686	0.5200	0.013	0.025	0.6160
India	-0.0021	0.0326	0.9490	0.0027	0.0671	0.9680	-0.0178	0.1109	0.8730	0.294	0.0134	0.5180
Pakistan	0.0069	0.0295	0.8150	-0.0261	0.0606	0.6660	-0.0526	0.2618	0.8410	-0.082	0.0074	0.4520
Singapore	-0.0263	0.0475	0.5800	0.0506	0.0977	0.6040	-0.0752	0.1129	0.5050	-0.067	0.0245	0.9500
Thailand	-0.9770	0.0460	0.0000	0.0950	0.0952	0.3190	0.0339	0.1643	0.8360	0.018	0.001	0.6260
Vietnam	-0.0108	0.0255	0.6720	-0.9610	0.0518	0.0000	0.0119	0.0608	0.8450	-0.019	0.034	0.8700
Myanmar	-0.1976	0.3506	0.5730	0.0419	0.0527	0.4260	-1.2260	0.2190	0.0000	.0167	0.011	0.4010

Cross demand elasticity												
	Thailand			Vietnam			Myanmar			Other countries		
	Elasticity	standard error	P-value	Elasticity	standard error	P-value	Elasticity	standard error	P-value	Elasticity	standard error	P-value
Other countries	-0.0959	0.0441	0.0300	0.1310	0.0901	0.1460	0.0656	0.1232	0.5940	-0.551	0.29	0.0610
Income	0.9816	0.0466	0,000	1.0342	0.0956	0,000	1.1035	0.0988	0,000	0.5351	0.3079	0.0820
share		0.5038			0.0960			0.0076			0.0685	

Compensated demand Elasticities, or Hicksian Elasticities, are shown in Table 7 and are generally smaller, in absolute values, than uncompensated price Elasticities, based on the assumption that the consumer has been compensated with income to maintain demand constant utility [20]. Table 7 shows that all compensated demand prices are negative, as in uncompensated demand, which is consistent with economic theory.

With income compensation, the demand for imported rice from all 8 origins is inelastic to price changes, which suggests that with a 1% price increase, the quantities demanded decrease to a lesser extent. Therefore, demand for rice imported from Pakistan went from elastic when not compensated (-1,052) to inelastic (-0.009) with income compensation. The same behavior can be seen with rice from Singapore, which went from -1,064 from uncompensated to -0,063 with compensation, and that from Mynmar that went from 1,226 to 0,225 in price elasticity of compensated demand.

In the study carried out in Côte d'Ivoire indicated that the demand for rice imported from Vietnam (-3.26), Thailand (-2.16) and the USA (-1.44) was price elastic [14]; while for Mozambique, imported rice Pakistan (-1,052), Singapore (-1,064) and Myanmar (-1,226) showed price-elastic demand. On the other hand, the study made in Indonesia showed that imported rice was a luxury good when coming from Vietnam (1.2) and other countries (1.14) [56]; and for Mozambique rice is a luxury good when coming from from Pakistan (1,205), Singapore (1,058), Vietnam (1,034) and Myanmar (1,103). Comparing with the results obtained in Côte d'Ivoire [14]. It is noted that the demand for first quality rice in Côte d'Ivoire was price elastic for Thailand (-1.11), Vietnam (-1.14) and the Rest of the World. (-1. 03) and inelastic for the United States of America (-0.58). In relation to income Elasticities of demand, it is highlighted that standard and broken rice are normal goods regardless of origin.

Table 7. *Hicksian cross-price demand elasticities.*

Elasticities of compensated demand (Hiksian)								
	China	India	Pakistan	Singapore	Thailand	Vietnam	Myanmar	Other countries
China	-0.205	-0.016	0.231	0.067	0.498	0.093	0.052	0.049
India	-0.184	-0.101	0.224	-0.002	0.492	0.102	-0.009	0.331
Pakistan	-0.060	0.099	-0.009	0.008	0.501	0.073	-0.044	-0.045
Singapore	0.065	0.050	0.172	-0.063	0.468	0.150	-0.067	-0.030
Thailand	0.131	0.012	0.259	-0.123	-0.014	0.194	0.042	0.055
Vietnam	0.013	0.110	0.420	0.013	0.484	-0.042	0.020	0.017
Myanmar	0.041	-3,453	0.333	0.408	0.297	0.141	-0.225	0.203
Other countries	0.046	-0.007	0.236	-0.054	0.399	0.230	0.074	-0.417

6. Implications of Demand Elasticities on Policy Measures

Rice plays an important role in the food and nutrition security of the Mozambican population. However, the low levels of production and productivity show that it is still a challenge to guarantee rice self-sufficiency in Mozambique. However, efforts to improve supply must continue, since the country's dependence on imported rice can potentially create conditions of vulnerability and insecurity and adverse market effects have competitive advantages.

The results of this study show that the national production of rice still does not cover internal needs, so the country resorts to imports to fill the deficit. The elasticities of demand for rice imported into Mozambique show when the price increases, the quantities demanded decrease more than proportionally when coming from Pakistan, Singapore, Vietnam and Myanmar, and when income increases the quantities demanded of rice from those origins increase more than proportionally, being, therefore, in the category of luxury goods.

The National Rice Plan 2020-2030 highlights the following constraints for the rice subsector in Mozambique: (a) low use of technologies, being: (i) certified seeds (8.7%); (ii) fertilizers (2.8%); (iii) Pesticides (6.3%); (iv) Machinery (4.2%); (v) Irrigation (4.3%); (vi) credit (2.0%); (b) low access to infrastructure and marketing support services that burden transaction costs (access roads, warehouses, electricity); (c) insufficient and inadequate financial services; (d) poor water management capacity in the fields due to poor land/soil leveling; (e) high levels of post-harvest losses and waste; (e) climate change and the cycle of natural events: cyclones, floods, floods, droughts and droughts [43].

On the other hand, there is competition between rice peers from Vietnam and India (0.003), Vietnam and Singapore (0.051), Vietnam and Thailand (0.095), Vietnam and Mynmar (0.042) and Vietnam and Other Countries of the World (0.131).

In this way, it is recommended that the policy measures, advocated in various plans in the agricultural sector in general, and in the rice subsector in particular, be put into effect, partly in compliance with the commitments assumed by Mozambique within the scope of the New Partnership for Africa's Development (NEPAD) and from *Comprehensive Africa Agriculture Development Program* (CAADP). These initiatives advocates the allocation of resources for the development of the agricultural sector, leveraging the following structuring pillars: i) soil and water management; ii) management of rural infrastructure to improve access to markets; iii) increase in the supply of food to reduce hunger; and v) agricultural research and dissemination of technologies and innovations [13, 54].

Abbreviations

AIDS: Almost Ideal Demand System
CAADP: Comprehensive Africa Agriculture Development Program
ECOWAS: Economic Community for West African States
DESE- Directorate of Sectorial and Enterprise Statistics
NEPAD: New Partnership for Africa's Development
INE National Statistics Institute
IOF – Household Budget Survey
OLS: Ordinary Least Squares ()
SDAIDS: Source Differentiated Almost Ideal Demand System
SUR: Seemingly Unrelated Rules

Author Contributions

Sandre Macia: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Júlio Macuacua: Validation, Writing – review & editing

Alfeu Vilanculos: Formal Analysis, Investigation, Supervision, Validation

Filipe Mahaluça: Formal Analysis, Investigation, Methodology, Validation, Visualization

Conflicts of Interest

The authors declare no conflicts of interest.

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