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AN EFFECTIVE PRAGMATIC ANALYSIS OF SOYBEAN IMPORTS DEMAND IN EGYPT: IMPACT OF PRICE AND EXPENDITURE

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ABSTRACT

This study empirically analyses the demand for soybean imports from Argentina, the USA, and other countries to Egypt using the *Almost Ideal Demand System* (AIDS model) during the period (2001-2021). The model parameters used to calculate the Marshallian elasticities for which the own-price elasticities of soybean imports are 1.175, -0.857, and 0.101 for Argentina, the USA, and other countries, respectively. The cross-price elasticity of soybeans imported from Argentina and the USA are complementary relationships; and the soybeans imported from the USA have a substitutability relationship with other countries. Expenditure elasticities are elastic for soybeans imported from the USA and inelastic for soybeans imported from Argentina. If the expenditure on soybean imports increases by 10%, the soybeans imported from the USA and Argentina will increase by 11.23% and 7.36%, respectively. So, the research suggests that, in order to avoid becoming dependent on a small number of nations, Egypt must diversify the sources of its soybean imports. Additionally, it can lower imports in the future by boosting domestic manufacturing and using a variety of supply sources for goods That alludes to the primary innovation of the research, which is that soybeans imported from the USA have a substitutability relationship with other nations and a complementing cross-price elasticity with soybeans imported from Argentina.

Keywords Soybeans, Demand system, AIDS model, Marshallian elasticities, expenditure elasticities.

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INTRODUCTION

Egypt is one of the largest soybean imports in the world, importing more than 2.2 million tonnes in 2022 (Statista, 2023), ranking fifth among all Soybean importers, which depicts 5.04% of global soybeans imports. Egypt imports soybeans from the United States, Argentina, and Brazil, that represents 85.7% of soybean imports to Egypt in 2021 **(**FAO**, 2023)**. On average (2019-2021), Egypt imports 97.6% of soybeans from the United States, Argentina, Ukraine, Uruguay, and Brazil **(**FAO**,** 2023**)** to cover its needs for animal protein and vegetable oils. Soybean imports cost the state treasury 1.8 billion US dollars in 2021 and 2 billion US dollars in 2022 **(**TrendEconomy**,** 2023**)**.

Soybean is the most important source of protein, oilseed, and minerals for humans and animals, with 69% of total protein meal consumption by livestock and 58% of world oilseed production (Kahraman, 2017**)**. It is mainly imported to Egypt as a protein source used as animal feed to reduce the country's reliance on imported corn. Also, it has many products, such as soya milk, which is used in other Egyptian products. Egypt imports soybeans because of domestic needs (AgFlow, 2023) and because of the limited resources of water and farmland, Egypt does not have enough soybean production capacity to meet its domestic demand. Therefore, soybean imports into Egypt are growing and are expected to grow in the coming years **(**Reidy, 2023) due to the increasing demand for animal feed, as derived from consumer demand for meat, in addition to the growing popularity of soy-based products (Eliw *et al*., 2022).

The demand for soybeans in Egypt has some benefits and drawbacks: first, soybeans are a good source of protein and other nutrients for animal feed; second, soybean imports help compensate Egypt's dependence on imported corn, and soybeans can be used to produce a variety of products. However, the drawbacks are the cost

of imports and that imports of soybeans affect the local soybean industry. Overall, soybean imports are a crucial component of the Egyptian economy (Eliw *et al*., 2019).

Since the soybean is one of the main constituents in the majority of animal feed formulations, Egypt is significantly dependent on foreign feed materials. The nation's meager local production of these feed ingredients has caused severe fluctuations in prices and interruptions to the supply chain. Furthermore, changes in the price of commodities globally may have a major effect on Egypt's animal feed costs, which may in turn affect Egyptian customers' prices for animal products (TechSci-Research, 2023).

MATERIALS AND METHODS

The main objective of soybean imports is to meet the lack of protein content in animal feed and for other purposes. The study of soybean imports in this study applied the demand system, based on time series secondary data from the database of Trade Map and FAO, from 2001 to 2021, using the *Almost Ideal Demand System* (AIDS) to analyze the demand for soybeans in Egypt. The AIDS model provides share equations in an n-good system starting from a given cost function, which has been extremely well-liked. This method offers several advantages adhering to economic theory and can be applied to analyze demand using statistical methods.

The AIDS is a modeling framework used to analyze Egyptian Soybean demand. It incorporates the concept of habit formation, which suggests that Egypt has utilities based on its past consumption patterns. The AIDS model allows for the estimation of price and income elasticities, which are important for understanding how changes in prices and income affect import demand (Sherafatmand and Baghestany, 2021).

Empirical AIDS model: The demand model went through several stages, after Richard Stone (1954) (Stone, 1954) and the Rotterdam model (1965) (Theil**,** 1965**)**, then the Translog model (1975) (Christensen, Jorgenson, & Lau, 1975), Angus Deaton and John Muellbauer suggested (AIDS) in (1980) (Deaton and Muellbauer**,** 1980). According to an indirect utility function that depends on exogenous variables, such as price and income, this model assumes a linear form of the Engle curve. This utility model can be represented by **Eq.(1)**. (Alnafissa and Alderiny, 2020)

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j) + \beta_i [\ln(X) / \ln(a(P))] + \varepsilon_i \quad (1)$$

$$n = 3, i = 1, 2, 3$$

This is a linear approximation (LA) model. where w_i refers to the budget share of soybeans imported from country i; α, β, and γ are the parameters to be estimated; p_j refers to the price of soybean imported from country j; ε_i is the error term; and X is the total expenditure on soybean imports given by **Eq. (2)**.

$$X = \sum_{i=1}^{n} p_i q_i \quad (2)$$

where $\mathbf{q_i}$ is the quantity demanded of the ith good (SAS, Estimating an Almost Ideal Demand System Model, 2023); and $\ln(a(P))$ is the translog price index, which is defined as

$$\ln(a(P)) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln(p_i) + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln(p_i) \ln \quad (3)$$

The Translog price index in equation (3) is nonlinear, which usually complicates the estimation process. To overcome this problem, (Deaton and Muellbauer, 1980) propose a linear approximation model for AIDS (LA/AIDS) using the stone price index. (Stone, The Measurement of Consumers' Expenditure and Behaviour in the United Kingdom. 1920-1938, 1954), which is calculated from **Eq. (4)**: (Zhu, 2023; Basarir, 2013)

$$\ln(a(P)) = \sum_{i} w_i \ln p_i \quad (4)$$

Constant of demand function: Economic theory imposes the following restrictions on budget share parameters.

The budget balanced or "*adding-up*" requirement guarantees that the expenditure shares will always equal one, (i.e., $\sum_{i=1}^{n} w_i = 1$ This means that the ratio of spending on soybean imports to the exported joules equals the correct one. **(**Eliw *et al*., 2019).

$$\sum_{i=1}^{n} \alpha_i = 1; \sum_{i=1}^{n} \beta_i = 0; \sum_{i=1}^{n} \gamma_{ij} = 0 \quad (5)$$

According to economic theory, "*homogeneity*" ensures that people do not react negatively to changes in income and prices just because the numbers have changed. This feature declares that there is no "*money*

illusion." In other words, consumers will not double their purchase of imports, even if prices and income double. If the import amounts are homogeneous in terms of revenue and prices to zero, this criterion is satisfied. (Nygård, 2013)

$$\sum_{i=1}^{n} \gamma_{ij} = 0 \quad (6)$$

The "*symmetry*" condition is a property of demand functions that states that the compensated demand for one good does not change when the prices of all other goods change. This condition can be derived from *Shepard's Lemma*, which is a mathematical theorem that relates the expenditure function to the demand functions. To impose the symmetry condition on the AIDS model, we set the cross-price elasticities of demand equal to each other. This implies that the compensated demand for country *i* does not change when the price of country *j* changes (Eliw *et al*., 2019).

$$\gamma_{ij} = \gamma_{ji} \quad (7)$$

The "*negativity*" condition states that the *Slutsky* substitution matrix, which is a matrix that contains the own-price and cross-price elasticities of demand, must be negative semidefinite. This implies that any two components in the matrix must have a product less than or equal to zero. The assumption behind the negativity condition is that a price change always has a negative substitution effect. This is because consumers would shift their preferences from one good to another as prices increase. The income effect cannot counteract this replacement effect, because of the negative condition.

Demand elasticities: The computed parameters of the (AIDS) model can be used to calculate demand elasticity.

Let "*expenditure elasticity*" η_i^E represent the percentage change in demand for imported soybeans from country *i* in response to a 1% increase in income equation (8), and let η_{ij}^P be the percentage change in the demand for soybeans imported from country *i* in response to a 1% increase in the price of soybeans imported from country *j* which call "*Marshallian Price elasticity*" equation (9). According to (Alston, Foster, & Gree, 1994; SAS, Calculating Elasticities in an Almost Ideal Demand System, 2023), the expenditure and price elasticities of the AIDS model can be calculated to implicate the rationale among price, expenditure and Soybean imports.

Expenditure elasticity:

$$\eta_i^E = 1 + \frac{\beta_i}{w_i}, \qquad i = 1, 2, \ldots, n \quad (8)$$

where η_i^E is the *expenditure elasticity,* which measures the sensitivity of the demand for soybeans imported from country *i* to changes in income. A positive expenditure elasticity means that demand for soybeans imported from country *i* increases when income increases, and a negative expenditure elasticity means that demand for soybeans imported from country *i* decreases when income increases Marshallian price elasticity:

$$\eta_{ij}^P = \frac{\gamma_{ij} - \beta_i\left(w_j - \beta_j\left[\ln(X)/\ln\left(a(P)\right)\right]\right)}{w_i} - \delta_{ij} \quad (9)$$

$$\delta_{ij} = \begin{cases} 1 \text{ if } i=j \\ 0 \text{ otherwise} \end{cases}, \qquad i, j = 1, 2, \ldots, n$$

where, η_{ij}^P is the *price elasticity* and expresses the responsiveness of the relative change in the quantity of soybeans imported from country *i* to the relative change in the price of soybeans imported from country *j*. If $i = j$, it is possible to obtain own-price elasticity, and if $i \neq j$, it obtains cross-price elasticity. (SAS, Calculating Elasticities in an Almost Ideal Demand System, 2023)

To achieve this methodology, the Statistical Analysis System (Stata 18) software was used (StataCorp, 2023) to obtain this model and analyze the parameters, statistical hypotheses, and elasticities that achieved the research objectives.

RESULTS AND DISCUSSION

Descriptive analysis: Egypt imports soybeans from the USA and Argentina as a major source of soybeans, importing approximately 85% of its imports on average from (2019-2021), in addition to Brazil, Ukraine, Uruguay, Canada, and other countries.

Table 1, defines the budget share, prices, and expenditures of soybean imports from Argentina, the USA, and other countries. The budget share of the USA soybean imports was between 15.8% and 84.9% on average 49.1%, and the budget share of Argentina soybean imports was between 3.3% and 48.1% on average 24.8%. The price per tonne of the USA imported soybeans was between 214.69 US dollars and 1259.86 US dollars on average 461.47 US dollars, and Argentina imported soybeans were between 217.91 US dollars and 1089.75 US dollars, on average 459.54 US dollars. Whereas the expenditure of soybeans imported was between 35.3 thousand US dollars and 1.97 million US dollars on average of 753.4 thousand US dollars.

Table 1: Descriptive analysis summary of study variables.

Variables	Mean	Std. Dev.	Min	Max
Argentina soybeans import budget share (w1)	.248	.125	.033	.481
USA soybeans import budget share (w2)	.491	.211	.158	.849
Other countries soybeans import budget share (w3)	.261	.134	.107	.496
Price of Argentina soybeans imports (p1)	459.539	234.949	217.909	1089.745
Price of USA soybeans imports (p2)	461.47	255.478	214.686	1259.859
Price of soybeans imports from other countries (p3)	441.349	203.122	204.292	1036.506
Total expenditure on soybeans imports (x)	753.4	607.9	35.301	1971

Note: prices are USD per tonne, and total expenditure is thousands of USD

Although the percentage of budget share on soybean imports from the USA was greater than Argentina and the other countries on average during the study period, as it is clear from **Table 1**. But the dispersion was greater in the USA than in the rest, which indicates the difference in the percentage of spending on imports.

Estimation of AIDS model: The three equations describe the expenditure share of imports from three sources: Argentina (w_1), the USA (w_2), and other countries (w_3). Because the sum of the budget shares is $\sum w_i = 1$, and under the condition of addition, the number of system equations can be reduced to two. The coefficients estimated using these equations are presented in **Table 2**.

The AIDS coefficient estimates are presented in the form of price and expenditure elasticities. As been logically observed from these relationships among the USA, Argentina, and other countries, there a +ve/-ve relations according to the values in **Table 2**. Where, the budget share of soybeans imported from Argentina (w_1) responds positively to an increase in its price but responds negatively to a change in the price of imports from the USA and other countries. The budget share of soybeans imported from the USA (w_2) responds positively to an increase in price and in other countries.

Table 2: The result of parameters of the AIDS model.

Expenditure share (w_i)	Intercept (α_0)	Price of soybeans imported from country $\ln(p_i)$			Total expenditure $\ln(X/P)$
		Argentina	USA	Other countries	
Argentina	0.030	0.484	-0.162	-0.322	-0.059
	(0.40)	(2.41)*	(-0.88)	(-1.84)*	(-2.71)***
USA	0.718		0.120	0.042	0.064
	(4.31)***		(0.310)	(0.21)	(1. 42)
Other countries	0.252			-0.162[A]	-0.005
	(2.21)*				(-0.17)

Note: α estimates sum to 1, β estimates sum to 0, γ estimates sum to 0 over countries. The value between parentheses refers to the z-test. Single, double, and triple asterisks (*) denote significance at the 10%, 5%, and 1% levels respectively. A: The Stata program does not estimate this value and it was calculated from the $\sum \gamma = 0$.

Marshallian and Expenditure Elasticities: The main purpose of estimating the AIDS model is to calculate elasticities, which are calculated using prices and expenditures.

Table 3**Table 3** illustrates uncompensated and expenditure elasticities.

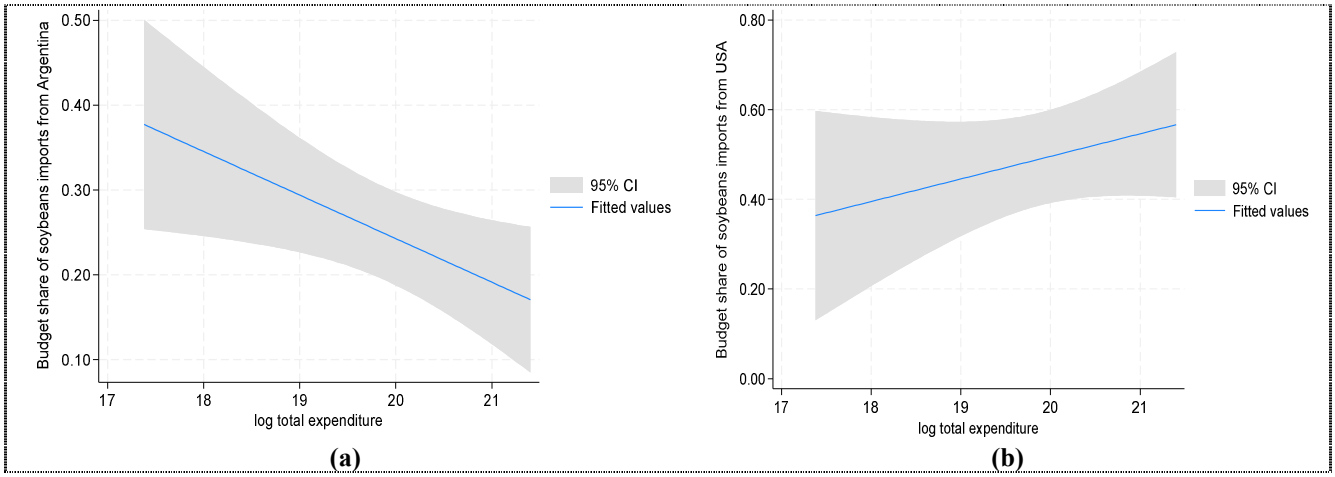
Table 3: Price and expenditure elasticity of soybeans import demand.

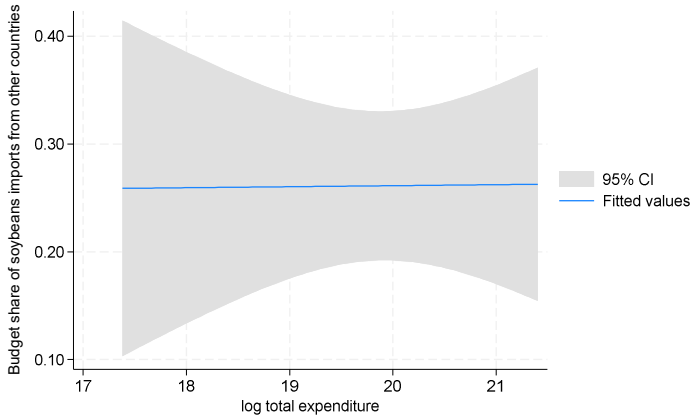
	Marshallian price elasticity			expenditure elasticity
	Argentina	USA	Other country	
Argentina	1.175	-0.534	-1.376	0.736
	(1.31)	(-0.63)	(-1.76)*	(7.040)***
USA	-0.317	-0.857	0.050	1.123
	(-0.89)	(-1.17)	(0.13)	(12.250)***
Other country	-1.258	0.176	0.101	0.981
	(-1.84)*	(0.22)	(0.13)	(8.140)***

Note: Elasticities are calculated at prices and expenditure means. The value between parentheses refers to the z-test. Single, double, and triple asterisks (*) denote significance at the 10%, 5%, and 1% levels respectively.

Price elasticity: The own-price elasticities of soybean imports are 1.175, -0.857, and 0.101 for Argentina, the USA, and other countries, respectively. Cross-price elasticity measures the responsiveness of demand from country imports to changes in the prices of other countries. According to the result of cross-price elasticity, the product is either complemented if the cross-price elasticity is negative or substituted if the cross-price elasticity is positive. This is dropped from the same commodity from different sources. This means that soybeans imported from Argentina and the USA have a complementary relationship, while soybeans imported from the USA have a substitutability relationship with other countries.

Expenditure elasticity: In accordance with the estimated expenditure elasticity values and their *p-value*, all estimates are positive and statistically significant at the 1% level. The estimate indicates that demand for soybean imports from the USA is elastic to expenditure on soybean imports and increases by 11.23% when the amount allocated to spending on imports increases by 10%, which can identify it as a luxury good. Similarly, the soybeans imported from Argentina are inelastic to expenditure on imports (normal and necessary goods), and the demand increases by 7.36% when the amount allocated for spending on imports increases by 10%; For other countries, the imported soybeans increase by 9.81% when the amount allocated for spending on imports increases by 10%, which is close to unitary elasticity.





(c)

Note: CI is the 95% confidence interval

Figure 1: Estimated Engel curves of budget share for expenditure on soybeans imports.

The Engel curve in **Figure 1** describes the budget share of expenditure on soybean imports with a 95% confidence interval (CI). The soybean budget share from Argentina, presented in **Figure 1-(a)**, indicates a negative association with total expenditure on Egyptian soybean imports, while **Figure 1-(b)** shows a positive association with total expenditure on Egyptian soybean imports, which means that if the total expenditure on Egyptian soybean imports rises, soybean imports from The USA will be higher and soybean imports from Argentina will be lower.

Conclusions: This study used annual data for soybean imports from 2001–2021 to analyze the demand for soybean imports from Argentina and the United States, Egypt's main soybean suppliers, which accounted for over 85% of its imports on average from 2019 to 2021. According to the results, the own-price elasticities of soybean imports are 1.175, -0.857, and 0.101 for Argentina, the USA, and other countries, respectively. Soybeans imported from the USA have a substitutability relationship with other countries, and the cross-price elasticity for Argentina and the USA is complimentary. Additionally, expenditure elasticities are inelastic for soybeans purchased from Argentina and elastic for soybeans imported from the United States. If import expenses for soybeans increase by 10%, the corresponding increases in imports will be 7.36% and 11.23%, respectively. So, this paper suggested that the Egyptian side must diversify in importing soybeans from more than one country to ensure that it does not depend on a limited number of countries. Also, in the future, it can reduce imports by increasing local production with diversified sources of obtaining goods.

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