Econometric model for determinants of rice production and consumption in Egypt

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ABSTRACT

The agricultural sector is considered one of the most important sectors in the Egyptian economy due to its great importance in meeting the needs of citizens for food and clothing. The relative importance of this sector has been observed to decline in recent years. Rice is also one of the important strategic crops that the Egyptian people need in their food due to its high food value, as well as rice is considered one of the important export crops in Egypt, which contributes to providing the foreign currency needed to meet the requirements of the development process and improve the trade balance. The average consumption of rice during the period (2005-2022) amounted to about 5367.5 thousand tons, because large water needs, which conflict with the available water quantities for irrigation, it is noted that production increases by about 1.02%, 1.65%, 0.65%, 0.45% for each 1% increase in the average per capita share of the cultivated area and the farm price in the previous year, the net return in pounds in the previous year for rice in pounds per ton, and the average per capita share of exports for each of them, respectively. The research recommends studying all export prices in rice-exporting countries and dealing with them in the case of Egypt importing rice, taking into account, of course, the consumer preferences of the Egyptian consumer, as some types may be preferred over others.

Keywords: Simultaneous equations model, price, forecasting.

INTRODUCTION

The agricultural sector is considered one of the most important sectors in the Egyptian economy due to its great importance in meeting the needs of citizens for food and clothing. The relative importance of this sector has been observed to decline in recent years. The rice crop is considered one of the important strategic crops that the Egyptian people need in their food due to its high food value (Ahmed, 1996).

The release of rice planting and trade from government interventions had a positive impact on increasing rice production, which was achieved by increasing the area. This was done at the Water overuse and thus violating the decisions in force in this regard. Here, it is necessary to focus on increasing or expanding vertically in rice production to compensate for the increase in rice consumption resulting from population growth, in addition to working on cultivating rice varieties whose stay in the ground from planting to harvest is reduced to no more than 90 days, planting such varieties helps to rationalize the use of water in agriculture as well, rather than wasting it (Abdo Hussein, 2011).

Rice was one of the most important export crops in the Arab Republic of Egypt after cotton. Rice export revenues vary from year to year, due to fluctuations in the quantity exported as a result of restrictions imposed on its production, due to its large water needs, which conflict with the quantities of water available for irrigation. Therefore, the government turns to determine the areas planted with rice according to the available quantities of irrigation water, which leads to fluctuations in production from year to year, which is reflected in the quantities exported and export revenues. Despite the country follows many policies that call for encouraging and developing Egyptian exports, many difficulties prevent achieving a better competitive position for Egyptian rice exports in global markets (Rayhan, 1967).

Some of these difficulties are represented by the lack of coordination between the production and export sectors and the low efficiency of the devices based on them, in addition to the relative increase in the export price of Egyptian rice, when compared to export prices in competing countries, in addition to the government's adoption of a policy of specifying the planted area of rice and prohibiting its export in recent years, which may lead to a deterioration in the value of Egyptian rice exports, and a decrease in the relative importance of its exports in total agricultural exports, which may lead to a weak presence of Egyptian rice exports in its most important global import markets (Hasona *et al.,* 2017).

Study problem:

Rice is considered one of the important export crops in Egypt, which contributes to providing the foreign currency needed to meet the requirements of the development process and improve the trade balance. The average consumption of rice during the period (2005-2022) amounted to about 5367.5 thousand tons. Due to its large water needs, which conflict with the quantities of water available for irrigation, the

DOI: 10.21608/asejaiqjsae.2024.377924
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Received, August 05, 2024, Accepted, September 02, 2024.

government turns to determine the areas planted with rice, which leads to fluctuations in production from year to year. The Country also adopted a policy of prohibiting rice exports in some years, which is reflected in the quantities exported and their revenues, and the presence of Egyptian rice in international markets, this policy may also affect the self-sufficiency rate of rice, in addition to it being a water-intensive crop that farmers compete to plant it and achieve a surplus production, which represents a water and production problem, as well as the major marketing problems that are the subject of the study, which start from the beginning of rice production and vary in addition to the difference in harvest times for each variety or component and the difference in the period of component in the land, which affects the exit of the crop to the market at the suitable time and in the appropriate amount and the desirable form and quality (Hasona *et al.,* 2017).

Study objective:

The research mainly aims to study the determinants of rice production and consumption in Egypt, which necessitated a study during the period (2005-2022). To identify the most important factors and determinants that affect production, consumption, and rice imports and predict the behavior of variables (Ahmed, 1996).

Research method and data sources:

The research relied on the qualitative and quantitative analysis methods in studying the determinants of demand for rice crops at the level of Egypt. The research relied on the use of the Simultaneous equations model, the Prediction, and the research was based on the published data of many sources, the most important of which are: the Food and Agriculture Organization of the United Nations (FAO) database, tread map, the World Bank database, the annual agricultural statistics bulletins of the Economic Affairs Sector of the Egyptian Ministry of Agriculture, previous researches and studies related to the research topic. Some data and statistics published by some sources on the Internet were also used (Ahmed, 1996).

First: A simultaneous equations model for estimating the demand and supply of rice crops in Egypt:

Estimating the multi-equation econometric model is relatively more difficult compared to the single-equation models, due to it requires it requires many stages and steps, starting with characterizing the economic relationships (according to economic logic), then determining the most important variables that will be used according to the simple correlation coefficient matrix, then determining the best mathematical images that will be used in the statistical analysis. After completing the preparation of the model coefficients, the degree of model definition is determined, and then the most appropriate estimation methods for estimation are determined. In this regard, the study used the total image at one time and the average image at another time, in addition to the logarithmic images for each of them. It also used the value of national production and the value of national consumption in their total form at one time and the average at another time. All these permutations and combinations between the variables of the model used were under certain criteria, namely economic logic, statistical significance, and staying as far away as possible from the problems of econometric measurement, to ensure achieving accuracy in the obtained estimates to the greatest extent possible, so that they can be relied upon in prediction later (Roland Key, 1981).

Second: characterizing the econometric model of demand and supply of Egyptian rice using multi-equation models:

The most important economic relationships that make up the econometric model of rice demand and supply can be identified in both the demand function (consumption and exports) and the supply function (production and imports). The exports variable was excluded due to the lack of data in recent years (Abdul Qader, 1990).

A- Demand Function

The demand side for rice is in the form of the consumption function for rice, and these functions can be explained in the following mathematical image:

1- **Consumption function**: The following equation explains:

$$\mathbf{Y_{2t} = f(Y_{2(t-1)}, x_6, x_7, x_8)}$$

Where:

Y_{2t}	Per capita of consumption (kg)
Y_{2t-1}	Per capita of consumption availability in the previous year (kg) t-1
X_6	Per capita of national income pounds/year
X_7	Retail price of rice in pounds/kg
X_8	Retail price of pasta in pounds/kg

2- **Import function**: The following equation shows:

$$\mathbf{Y_{4t} = f(x_{10}, x_{11, x12, x13})}$$

Where:

Y_{4t}	Per capita of import quantity (kg)
$\mathbf{X_9}$	Egypt Import price $/ton
$\mathbf{X_1}$.	Per capita of stock volume (kg)
$\mathbf{X_{11}}$	Per capita of stock volume (kg) in the previous year (t-1)
$\mathbf{X_{13}}$	Exchange rate EGP/USD

B- Supply Function:

The supply side of the Egyptian demand model for rice includes two main relationships, the first of which includes the factors affecting rice production, while the second is the factors affecting the number of exports to Egypt, as the Egyptian demand for rice faces a continuous and increasing demand annually, which led to an increase in exports due to the increasing global need for Egyptian rice (Abdul Qader, 1990).

1- Production function: It can be explained in the following equation:

$Y_{1t} = f(Y_{1t-1}, x_1, x_2, x_3, x_4, x_5)$ **Where:**	
Y_{1t}	Per capita of production in kg
Y_{1t-1}	Per capita production in kg in the previous year t-1
x_1	Per capita of area (m^2)
X_2	Farm price EGP/ton
X_3	Farm price in the previous year EGP/ton in the previous year t-1
X_4	Net return per acre
X_5	Net return per acre in the previous year t-1

Results of statistical estimation of the parameters for the rice simultaneous equations model:

It is clear from the previous results that the model is over-identified. Therefore, the three-stage least squares (3SLS) method was the most appropriate method used to estimate the following econometric model. The results of the statistical analysis were as follows:

1- **Production equation**:

$$\text{Ln } Y_{1t} = 0.09 + 1.02 \ln X_1 + 1.65 \ln X_3 + 0.65 \ln X_5 + 0.45 Y_{3t}$$

(1.87) (6.41) (7.10) (4.34) (3.21)

F = 12.34* R^{-2} = 0.77 D.W=2.02

2- Consumption equation:

$$\text{v } 0.64 \ln X - \ln Y_{2t} = 2.90 + 1.76 \ln Y_{1t}$$

(0.98) (12.12) (-4.3)

F = 22.7* R^{-2} = 0.67 D.W=1.98

3- Importequation:

$$\text{Ln} Y_{3t} = 1.76 - 1.66 \ln Y_{1t} - 0.662 \ln X_9$$

(2.09) (-3.4) (-4.6)

F = 12.3 * R^{-2} = 0.78 D.W=1.89

Source: Collected and calculated from Table (1) in the appendix

It is also clear from the rice production equation that production increases by about 1.02%, 1.65%, 0.65%, 0.45% for each 1% increase in the average per capita share from the cultivated area, the farm price of the previous year, the net return in the previous year for rice in pounds per ton, and the average per capita share of exports for each of them, respectively. That is, the variables that most affected the volume of rice production in a given year were the per capita share of the area, the farm price of the previous year, and the net return in the previous year in pounds per ton for each of them, respectively. The statistical significance was proven at the 0.05 level, and the significance of the model as a whole was proven, as it was shown that about 77% of the changes that occurred in rice production were due to the change in the independent variables under study.

From the above, it is clear from the rice consumption equation that consumption increases by about 1.76% for every 1% increase in the average per capita production in the previous year, while the consumption volume decreases by about 0.64% for every 1% increase in the retail price of rice in pounds per kilogram. That is, the most influential variable on the consumption volume of rice in a given year was the production volume in the previous year, then the retail price of wheat in pounds per kilogram. The statistical significance was proven at the 0.05 level, as was the significance of the model as a whole, and it was shown that about 67% of the changes in rice consumption are due to changes in the independent variables under study.

The rice import equation also shows a decrease in the volume of imports by about 1.66%, 0.66% for every 1% increase in the import price in dollars per ton, the previous year's production. That is, the most influential variable in the volume of rice imports in a given year was the import price in dollars per ton, the previous year's production. The statistical significance was proven at the 0.05 level, and the significance of the model as a whole was proven, as it was shown that about 78% of the changes in rice imports are due to changes in the independent variables under study.

Third: Using current models to predict the expected future values of rice crops:

Future forecasts of economic conditions help in determining a country's policy and its necessary directions to be compatible with these forecasts, as the economic future of some important commodities such as rice can be identified and in light of this knowledge country determines its policy regarding these commodities. The proposed econometric model can be used to estimate the expected values of the internal

Table 1. Predicting the behavior of variables related to the rice simultaneous equations model during the period (2025-2029)

Average per capita consumption in kg per person with constant (0,,1,2) ARIM Mode			Average per capita share of production quantity in kg per capita Model: Linear trend			Model
Upper Limit	Lower Limit	Forecast	Upper Limit	Lower Limit	Forecast	YEAR
52.30	28.81	40.56	48.73	12.65	30.69	2025
51.49	22.54	37.01	46.20	9.52	27.86	2026
50.43	19.69	35.06	43.68	6.36	25.2	2027
49.33	16.89	33.11	41.19	3.18	22.19	2028
48.19	14.13	31.16	38.72	-0.02	19.35	**2029**
50.53	20.41	35.38	43.71	6.34	25.02	Average

Source: Results of statistical analysis using statgraphics program

Follow Table 1. Predicting the behavior of variables related to the rice simultaneous equations model during (2025 – 2029)

Average per capita import quantity in kg per capita Model: Brown's linear exp			Model
Upper Limit	Lower Limit	Forecast	YEAR
2.130	-0.68	0.725	2025
2.130	-0.681	0.725	2026
2.130	-0.682	0.724	2027
2.130	-0.683	0.724	2028
2.130	-0.684	0.723	**2029**
2.130	-0.68	0.72	Average

Source: Results of statistical analysis using statgraphics program

variables included in the model (Roland Key, 1981).

Using simultaneous equations model to predict future rice values:

It is clear from Table (1) that the average per capita share of production, consumption, exports and imports of rice during the period (2025-2029) amounted to about 25.02, 35.38, 0.22, 0.72 kg per capita, respectively.

Recommendations: In light of the above-mentioned results, the research recommends the following**:**

1- Reviewing the export prices of Egyptian rice to be compatible with other competitive export prices.

2- Opening new markets that care more about the low price than the standard specifications of the commodity, as in African countries and Central Asia.

3- Trying to stimulate Egyptian exports of rice to Arab countries, as they are imported at prices higher than the Egyptian export price, despite the even though Egyptian rice is accepted by consumers in these countries.

4- Studying all export prices in rice exporting countries and dealing with them if Egypt imports rice, taking into account, of course, the consumption preferences of the Egyptian consumer, as he may prefer some types over others.

REFERENCES

Abdo Hussein, M.A. 2011. Marketing policies for rice crops in the Arab republic of Egypt, Master's Thesis, Department of Agricultural Economics, Faculty of Agriculture, Alexandria University, p 159.

Abdul Qader, A.M.Q. 1990. Methods of measuring economic relations. Egyptian Universities house, Alexandria - Egypt, p 584.

Ahmed, A.M.A.M. 1996. The most appropriate crop structure for Egyptian agriculture in light of contemporary economic and international variables, Master's thesis, Department of Agricultural Economics, Faculty of Agriculture, Ain Shams University, p 303.

Hasona, H.A.R., A.F.M. Mashhour, S.A.M. Kandi and S.M.F. Ahmed. 2017. An economic study of rice crop loss in Egypt and Sharkia governorate. Zagazig J. Agric. Res. 44: 1457-1467.

Rayhan, M.K. 1967. An economic study of the factors affecting the demand for premium staple cotton in the global market, Master's thesis, Department of Agricultural Economics, Faculty of Agriculture, Ain Shams University, p 258.

Roland Key. 1991. Farm management Palming Contraband Implementation, Micgrom international Book Company New Delhi.

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www.fao.org

www.worldbank.org

Appendixes:

Table 1. shows the most important variables used in estimating the current standard model for rice during the period (2005-2022)

Years	Per capita of available consumption (kg) t-1	Per capita of available consumption (kg)	Net yield per feddan in the previous year in the previous year t-1	Net yield per feddan	Farm price in previous year EGP/ton t-1	Farm price EGP/ton	Area of per capita (m2)	Per capita production in kg in the previous year t-1	Per capita production in kg
2005	63.67	61.56	1902	2148.6	9890	1069.3	23.24	71.25	77.45
2006	61.56	58.28	2148.6	2030.0	1069.3	1077.3	23.88	77.45	83.64
2007	58.28	62.47	2030.0	3031.0	1077.3	1451.0	22.75	83.64	83.53
2008	62.47	79.28	3031.0	2259.0	1451.0	1465.0	24.52	83.53	86.36
2009	79.28	76.03	2259.0	2458.0	1465.0	1495.0	17.67	86.36	64.54
2010	76.03	54.44	2458.0	3430.0	1495.0	1837.0	13.83	64.54	49.59
2011	54.44	49.41	3430.0	3917.0	1837.0	2008.0	19.85	49.59	63.51
2012	49.41	60.17	3917.0	3620.0	2008.0	2067.0	20.93	63.51	64.62
2013	60.17	57.89	3620.0	3581.0	2067.0	2110.0	19.01	64.62	61.22
2014	57.89	58.77	3581.0	3314.0	2110.0	2130.0	17.97	61.22	57.13
2015	58.77	53.84	3314.0	2948.0	2130.0	2250.0	16.36	57.13	49.30
2016	53.84	48.17	2948.0	2391.0	2250.0	2267.0	17.44	49.30	53.20
2017	48.17	57.36	2391.0	5221.0	2267.0	3500.0	16.17	53.20	48.70
2018	57.36	49.85	5221.0	2758.0	3500.0	3552.0	9.25	48.70	30.09
2019	49.85	38.49	2758.0	3759.0	3552.0	3556.0	14.66	30.09	45.43
2020	38.49	43.98	3759.0	3275.0	3556.0	3565.0	12.71	45.43	41.33
2021	43.98	41.83	3275.0	7829.0	3565.0	5964.0	11.32	41.33	38.82
2022	41.83	39.25	7829.0	9791.0	5964.0	14953.0	12.04	38.82	38.75
Average	**56.42**	**55.06**	**3326.20**	**3764.48**	**2847.42**	**3128.70**	**17.42**	**59.43**	**57.62**

Source: www.trademap.org, www.fao.org, www.worldbank.org

Follow table 1. shows the most important variables used in estimating the current standard model for rice during the period (2005-2022)

Exchange rate of pound to dollar	Per capita stock volume (kg) in previous year t-1	Per capita of stock volume (kg(	Egypt import price $/ton	Per capita of import quantity (kg)	Retail price of pasta in pounds/kg	Retail price of rice in pounds/kg	Per capita of national income in dollars per person/year
5.78	5.43	6.00	562.75	0.05	2.29	1.77	1160
5.73	6.00	5.23	619.47	0.07	2.36	1.81	1260
5.64	5.23	6.11	281.27	1.44	2.77	2.2	1460
5.43	6.11	4.68	928.05	0.10	3.89	3.69	1750
5.54	4.68	6.35	874.84	0.13	3.33	3.68	2010
5.62	6.35	6.13	516.23	0.20	3.3	2.67	2250
5.93	6.13	6.74	561.22	1.06	3.59	4.54	2430
6.06	6.74	6.39	930.64	2.04	3.66	4.28	2690
6.87	6.39	7.24	1087.75	0.16	4.34	5.02	2870
7.08	7.24	5.52	3463.51	0.07	4.23	5.11	3060
7.69	5.52	4.33	885.7	0.32	4.34	5.47	3160
10.03	4.33	5.66	826.92	0.55	5.11	6.34	3260
17.78	5.66	5.90	805.87	0.61	7.59	7.53	2940
17.77	5.90	5.72	1045.98	0.58	7.63	9.68	2760
16.77	5.72	5.46	979.84	2.63	8.07	10.55	2690
15.76	5.46	4.82	1016.89	0.46	8.2	9.79	3010
15.64	4.82	5.31	1053.11	0.54	8.91	9.27	3520
19.16	5.31	3.67	1157.07	0.83	12.85	14.11	4100
10.02	5.72	5.62	977.62	0.66	5.36	5.97	2576.67

Source: www.trademap.org, www.fao.org, www.worldbank.org

الملخص العربي

نموذج قياسي لمحددات إنتاج واستهلاك الأرز في مصر

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يعتبر القطاع الزراعي من أهم القطاعات في الاقتصاد المصري لأهميته البالغة في سد احتياجات المواطنين من الغذاء والكساء ولوحظ تراجع الأهمية النسبية لهذا القطاع في السنوات الأخيرة، ويعتبر محصول الأرز من المحاصيل الإستراتيجية الهامة التي يحتاجها الإنسان المصري في غذائه نظراً لارتفاع قيمتها الغذائية ويعتبر الأرز من المحاصيل التصديرية الهامة في مصر، والتي تسهم في توفير النقد الأجنبي اللازم للوفاء بمتطلبات عملية التنمية وتحسين الميزان التجاري وأن متوسط الاستهلاك لمحصول الأرز خلال الفترة (٢٠٠٥-٢٠٢٢) بلغ نحو ٥٣٦٧,٥ ألف طن، ونظراً لاحتياجاته الكبيرة من المياه والتي تتعارض مع كميات المياه المتاحة للري، ويلاحظ تزايد الإنتاج بنحو ١,٠٢ %، ١,٦٥%، ٠,٦٥%، ٠,٤٥% لكل زيادة بنسبة ١% في كلاً من متوسط نصيب الفرد من المساحة المزروعة والسعر المزرعي العام السابق، صافي العائد بالجنيه العام السابق للأرز بالجنية للطن، متوسط نصيب الفرد من الصادرات لكل منهم على الترتيب ويوصي البحث بدراسة كافة أسعار التصدير في الدول المصدرة للأرز والتعامل معها في حالة استيراد مصر للأرز، مع الأخذ في الاعتبار بالطبع التفضيلات الاستهلاكية للمستهلك المصري، حيث انه قد يفضل بعض الأنواع عن غيرها.

الكلمات المفتاحية: النموذج القياسي الآني، الأرز، التنبؤ.