The Causal Relationship Among Barley Production and Some Variables in Libya Using The Toda-Yamamoto Causality Test

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ABSTRACT: The study aims to determine the causal relationship between barley production, barley cultivated area, barley price, and barley imports in Libya. The empirical analysis of this study is based on the time series during the period (1990-2014) to utilize the Toda - Yamamoto causality test. The results indicated that the area of barley cultivated, and the barley price were stationary at the first difference, while barley production was stationary at the second difference and barley imports stationary at the level. In addition to that, the model did not suffer from any problems and stability. As for Toda-Yamamoto test for causality among the study variables illustrated to that, there is significant evidence of uni-directional granger causality running from barley imports toward barley production.

Keywords: *Barley Production, Cultivated Area, Price, Imports, Toda and Yamamoto Causality Test, Libya.*

1.INTRODUCTION

The agriculture sector is an important sector due to providing food for citizens (Nurgaziev, 2010). Furthermore, it is creating job opportunities and earning foreign currency from agricultural exports (Bijaya, 2010). Moreover, the supply of raw materials for agricultural industries comes from agricultural advancement (Praburaj et al, 2018).

Barley as a staple food is believed to be the first crop that early farmers domesticated and developed. It was used in many regions as food (Langridge, 2018). Currently, it grows on 48 million hectares in temperate, continental and subtropical climates. On the other hand, it is less demanding regarding environmental conditions, economically viable with fewer inputs, and easier agricultural management compared to other crops. In terms of uses, it is used directly in the human diet, animal feed, beer production, and spirits (Verstegen et al, 2014).

The barley crop in Libya is one of the traditional crops that have been associated with a farmer's life since ancient times, as it is used as flour in the Libyan dietary pattern and in the form of a loaf of bread (Mahmoud and Al-Salai, 2023). In addition, it is used in larger quantities in the animal feed industry as one of the components of animal feed or consumed directly as animal feed (Al-Awami, 2005). The quantity of its production reached 95,000 tons in 2014(FAO, 2024).

2.THE STUDY PROBLEM

The agricultural sector has received great attention by establishing large agricultural projects and encouraging farmers to achieve self-sufficiency in this agricultural product. Despite these efforts, there is still a percentage of the deficit that is covered by importing this commodity. This deficit reflects negatively on achieving self-sufficiency in this important agricultural commodity and livestock production, which leads to the allocating of financial resources in foreign currency to import this material and its impact on the trade balance. The question of the study can be summarized as follows: Do the variables under the study investigation have an impact on enhancing barley production?

3.THE IMPORTANT OF THE STUDY

Given the economic importance of the barley crop as one of the components of food in Libya on the one hand and its use as animal feed on the other hand. Accordingly, great efforts have been made to increase its production locally in an attempt to reduce the import of this commodity. Therefore, this study has practical importance in that the results of this study may help increase the production of this crop and achieve sufficiency of it locally. This target comes from knowing the causal relationship between these variables to determine the impact of each variable on barley production and make production relations more understandable. The importance of this study also comes as an addition to previous empirical studies in this study field.

4.OBJECTIVES OF THE STUDY

The study aims to achieve the following objectives:

1. Descriptive analysis of the study variables during the period 1990-2014.
2. Determine the causal relationship among cultivated area, barley price, barley imports, and barley production.

5.LECTURER REVIEW

Many empirical studies have investigated the relationship between barley production and its determinants such as barley cultivated area, barley price, and barley imports. In Libya, Bashir (1996) conducted a study to identify the most important factors that affected the total production of barley in Libya over the period 1970-1990. The study utilized linear and double logarithmic functions to determine the relationship between the production as the dependent variable and the independent variables that represented in the cultivated areas, imports of barley, and the price of the barley crop. The study indicated that the two most important factors affecting the total production of barley are cultivated areas and imports, respectively.

The study of Al-Rimali (2003) estimated the response of the barley supply function in Libya. The study results revealed that the barley price coefficient had a positive coefficient sign, as it indicated that an increase in the price of barley is an incentive for the producer to increase production. On the other hand, the coefficient of cultivated area was also positive, and therefore it is expected that there will be an increase in production by increasing the cultivated area. In another study, Al-Jadi (2006) in his study relied on time series data during the period (1970 - 2002), and the study found that production increased from about (71) thousand tons in (1980) to (263) thousand tons in (2002) due to an expansion in barley cultivation.

In the same context, Al-Zawam (2007) estimated the factors that determine the production of barley and wheat in Libyan agriculture. The finding of the study demonstrated that the cultivated area has an impact on production. The study recommended developing scientific research in the agricultural field, providing suitable varieties, and focusing on horizontal and vertical expansion to increase production and find a way to support and finance farms in the event of a loss. Nisreen (2009) aimed in her study to analyze the effect of the price of barley and its impact on the production and cultivated area of the barley crop in Libya. The study indicated that the production areas of this crop are vulnerable to fluctuation and decline due to the price of this crop, which is not proportional to the cost of production, which leads to a decrease in the cultivated area and then production.

In Iraq, Lafta (2020) sought to estimate the supply functions of the barley crop as well as assess its pricing performance. The study clarified it that the fluctuation of cultivated areas and the low yield per unit area negatively affected the cultivation of barley crops. The finding of the study also concluded that the lower price per ton of barley compared to wheat and the cultivated area and price are impacting barley supply. Using the Nerlove dynamic model Mahmood (2010) sought to estimate the supply response of planted acreage for barley in Iraq during the period (1997-2007). The results of the study concluded that an increase in the price of barley by 10% leads to an increase in the cultivated area in Iraq by 2.5% in the short term and 2.9% in the long term. The study also indicated that an increase in the price of wheat by 10% leads to a decrease in the areas planted with barley by - 1.05% and - 2.03% in the short term and by - 1.19% and - 3.55% in the long term, respectively.

In another study in Syria (AL Hassoun et al, 2016), studied the impact of changes in production costs and prices on barley cultivation in Hama Governorate during the season (2011-2012). The study was based on a random sample of 200 farmers. The results of the multiple regression analysis found that 47% of the changes in barley crop cultivation were due to changes in the selling price of a kilogram of barley. Next, a range of neighboring countries study the factors affecting cultivating the barley crop in Egypt (Ali et al, 2020) conducted research in the Ras Sidr Center in the South Sinai Governorate, in the villages of Abu Suwayra and Wadi Sidr in the Ras Sidr Center, where the research focused on studying the factors affecting the tendencies or direction of farmers in cultivating the barley crop in the South Sinai Governorate. In this regard, a simple random sample of about 50 respondents from both villages was chosen equally, at 20% of the total number of holders. The results of a study found that there is an increase in the barley cultivated area and production of barley at the level of South Sinai Governorate. This is because of reliance on barley for animal feed and family food in the research sample.

6.METHODOLOGY AND SOURCE OF DATA:

6.1.Model Specification:

This study relied on descriptive analysis and quantitative analysis by using the Toda-Yamamoto causality test to determine the causal relationship among the study variables as follows:

BPR= $\int$ (CBA,BP BE) **.....(1)**

$$BPR = \alpha + \beta_1 CBA_{t1} + \beta_2 Bp_{t2} + \beta_3 BI_{t3} + \varepsilon t \quad \text{..... (2)}$$

Where,

BPR = Barley Production
CBA = Cultivated Barley Area
BP = Barley Price
BI = Barley Imports
e = error term; and
t = 1990, 2014

The previous equation (2) refers to that BPR is the dependent variable affected by the CBA, BP, and BI which are independent variables. For a test of the causal relationship among variables under the study investigation Toda-Yamamoto test (1995). In this context, the revised Wald test for restriction on each parameter of the Vector Auto Regression VAR (k) is adopted by the Toda-Yamamoto Granger Causality approach, where the VAR (k + dmax) is estimated with the coefficients of the last lagged dmax vector being ignored. Furthermore, the chi-square allocation of a function with degrees of freedom that corresponds to the number of eliminated lagged variables is adopted by Wald statistic.- The Toda-Yamamoto equation is written as follows:

$$Y = \alpha_0 + \sum_{i=1}^{k} \lambda_{1i} Y_{t-i} + \sum_{j=k+1}^{k+d\,max} \phi_{1i} Y_{t-j} + \sum_{i=1}^{k} \theta_{1i} X_{t-i} + \sum_{j=k+1}^{k+d\,max} \delta_{2i} X_{t-j} + \mu_{1t} \quad ..(3)$$

$$X = \alpha_1 + \sum_{i=1}^{k} \lambda_{2i} Y_{t-i} + \sum_{j=k+1}^{k+d\,max} \phi_{2i} Y_{t-j} + \sum_{i=1}^{k} \theta_{2i} X_{t-i} + \sum_{j=k+1}^{k+d\,max} \delta_{2i} X_{t-j} + \mu_{2t} \quad ..(4)$$

Where,
k = the long length
Dmax = order of the maximum integrated.

6.2.Source of data:

The study utilized secondary data during the period (1990-2014). This data is extracted from statistical bulletins issued by official authorities in Libya, as well as the Arab Organization for Agricultural Development, in addition to the Food and Agriculture Organization.

7.EMPIRICAL RESULTS

7.1.Descriptive analysis of the study variables

This part deals with the descriptive analysis of the study variables under investigation, which are the total production of the barley crop, the cultivated area of barley, as well as the imports of barley, in addition to the price of the barley crop. In this context, the data in Table 1 noted that barley production was inconstant, where it decreased from 141.476 thousand tons in 1990 to 23 thousand tons in 1995. Thereafter, it increased to 102 thousand tons in 2010, and then it decreased to 95 thousand tons in 2014. The barley total production ranged between a minimum of about 23 thousand tons in 1995, and a maximum of about 141,476 thousand tons in 1990. It also appears that barley production changes from year to year. Regarding the cultivated area of barley, the average area of barley cultivated was 278.90 thousand hectares during the period (1990-2014). It is also noted that this area fluctuated up and down, with a minimum amounting to about 76 thousand hectares in the year 1995, and a maximum amounting to about 287.9 thousand hectares in 2014 as shown in Table 1. As for barley imports, the annual average was 338.96 thousand tons, where the highest value of barley imports was about 930 thousand tons in 1993, and the lowest value was about 37.82 thousand tons in 2000. About the price of barley, the highest value was about 2345.5 dinars in 2014, and the lowest price was about 120 in 1990 and 1991, with an annual average was around 1023.15 dinars during the study period Based on the above table, the results indicated that all variables have a positive skew except barley production, and the values of the mean, median, and standard deviation for all variables are normally distributed. Moreover, the standard deviation of these variables was lower than the mean. That means that the data are more reliable or clustered closely around the mean..

Table1: The study variables values during the period (1990 - 2014)

Years	Production Thousand Tons	Area Thousand ha	Imports Thousand Tons	Barley Price Libyan Dinar
1990	141.476	297	832.238	120.0
1991	125.000	320	478.792	120.0
1992	90.000	171	280.000	208.0
1993	50.000	124.706	930.000	233.0
1994	40.000	102.106	450.000	261.0
1995	23.000	76	217.823	295.0
1996	28.200	170	130.950	333.0
1997	42.100	94.07	638.000	375.0
1998	65.000	213	215.004	413.0
1999	75.000	288	300.000	450.0
2000	85.000	82.031	37.822	696.0
2001	85.000	257.388	141.486	808.0
2002	85.000	356.943	205.377	926.3
2003	85.000	255.969	87.968	1044.6
2004	85.000	279.574	266.698	1162.8
2005	100.000	477.773	159.344	1281.1
2006	100.000	424.586	242.705	1399.4
2007	100.000	560.699	48.806	1517.6
2008	100.000	587.733	177.131	1635.9
2009	101.000	528.043	410.000	1754.2
2010	102.000	563.400	472.244	1872.4
2011	98.130	132.448	152.889	1990.7
2012	98.000	210.00	179.413	2109.0
2013	97.000	200.00	714.765	2227.2
2014	95.000	200.00	704.637	2345.5
Average	**83.8362**	**278.8988**	**338.9637**	**1023.1480**

Source: Compiled and computed from:
1. Arab Organization for Agricultural Development, Agricultural Statistics Yearbook, (Various reports).
2. United Nation Food Agriculture Organization. Food Balance Sheet. Different Volumes. Rome

Table2: Descriptive statistical analysis of the study variables

Variable	Barley Production	Barley Cultivated Area	Barley Imports	Barley Price
Mean	83.83624	278.8988	338.9637	1023.148
Median	90.00000	255.9690	242.7050	926.3000
Maximum	141.4760	587.7330	930.0000	2345.500
Minimum	23.00000	76.00000	37.82200	120.0000
Std. Dev.	28.48371	161.1631	251.4746	741.8548
Skewness	-0.554922	0.640447	0.934947	0.340793
Kurtosis	3.030190	2.227587	2.768261	1.705457
Jarque-Bera	1.284026	2.330533	3.698129	2.229586
Probability	0.526232	0.311840	0.157384	0.327983

Source: Eviews version 12 outputs

7.2.Unit Root Tests

The issue of the stationary of the data is important in a time series analysis of economic variables; it can be said that the time series data is stationary if the mean and variance are constant concerning time (Gujarati & Porter, 2010). Phillips-Perron (1988) unit root test has been employed to detect the stationary of the variables, and it has become popular in the analysis of financial time series (Voumik et al., 2020). The regression equation of the PP test is written as follows:

$$\Delta Yt = \alpha_0 + \gamma\, t + \delta\, Yt\text{-}1 + \varepsilon\, t \quad \text{.....(5)}$$

The results of the PP test in Table 3, show that the time series of the study have a different integrated. The cultivated area of barley (CBA) and barley price (BPRI) is stationary at the first difference I (1), while barley imports (BIM) is stationary at level 1(0) and barley production (BPRO) is stationary at the second difference.

Table 3: Results of Unit Root Test for PP Tests

Variables	Level	First Difference	Second Difference	Decision
BPRO	-2.4235	-2.0956	-5.8418	I(2)
CBA	-1.9898	-6.0984	-	I(1)
BIM	-3.8296	-	-	I(0)
BPRI	2.5092	-3.3508	-	I(1)
Critical Values				
1%	-3.7378	-3.7529	-3.7695	
5%	-2.9918	-2.9980	-3.0048	
10%	-2.6355	-2.6387	-2.6422	

Note: BPRO = barley production; CBA = cultivated area of barley; BIM= barley imports; BPRI = barley price.
* Indicates the rejection of null hypothesis at 1% level of significance
** Indicates the rejection of null hypothesis at 5% level of significance
*** Indicates the rejection of null hypothesis at 10% level of significance
Source: Eviews (version 12) outputs

Since the barley production variable was the maximum order of integrated in the second integrated when this study conducted the PP unit root test. The series of the variables also does not have the same order of integration. Therefore, the Toda-Yamamoto causality test in this study can be used.

7.3.Lag Length Selection

Information criteria (IC) are statistics that measure the distance between observations and model classes. The optimal lag is determined using several information criteria, which are (LR, FPE, AIC, SC, and HQ). From the results of Table 4, it appears that the optimal lag is lag 2(k) according to the previous several information criteria.

Table 4: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-580.20	NA	1.36e+17	50.8005	50.99798	50.85017
1	-488.77	143.1086	1.98e+14	44.2413	45.22872	44.48966
2	-457.13	38.5238*	5.88e+13*	42.8809*	44.658*	43.327*

Source: Eviews (version 12) outputs
* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

7.4.Diagnostic Tests

According to the vector autoregression, the model does not suffer from any problems and stability, where the diagnostic tests confirm the absence of serial correlation and its prob (0.83) is greater than 0.05. As for the JB test, it confirms that the model is normally distributed (0.39). Besides that, figure 1 shows that the reciprocal values of all unit roots of the model were less than 1, and all of them were within the unit circle which indicates that the model is stable.

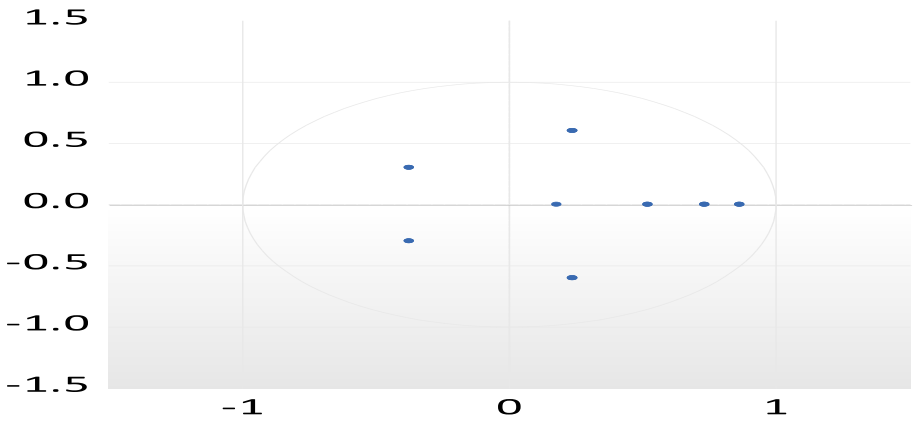

Figure1: The stability of the model

7.5.Toda-Yamamoto Tests of Granger Causality

To perform Toda-Yamamoto causality using the Block Exogeneity Wald tests at (k+dmax) = 4. Table 5 shows that causality test results based on Block Exogeneity Wald. These results revealed that there is significant evidence of uni-directional Granger causality running from the barley imports toward barley production since the probability of $\chi 2$ is (0.0068) which is less than 5% significant level, meaning that the null hypothesis can be rejected.

Table 5: VAR Granger Causality/Block Exogeneity Wald Tests

Null Hypothesis	Chi-sq	Prob.	Direction of causality
CBA does not cause BPRO	1.3231	0.5160	No Causality
BIM does not cause BPRO	9.9696	0.0068	BIM → BPRO
BPRI does not cause BPRO	0.3541	0.8377	No Causality
BPRO does not cause CBA	0.5849	0.7464	No Causality
BPRO does not cause BIM	1.3142	0.5183	No Causality
BPRO does not cause BPRI	3.8370	0.1468	No Causality

Source: Eviews (version (12) outputs

8.RECOMMENDATIONS

The study recommends the following recommendations:-

1- Providing support from the government to barley farmers by activating the support policy after harvesting the barley crop.

2- Reducing the prices of barley seeds at the beginning of the plowing season.

3- Purchasing or activating agricultural research centers to develop or creating new barley seed varieties that suit for the Libyan environment and sell them to barley farmers at reasonable prices.

4- Establishing and repairing existing productive projects for growing barley to reduce the import of barley

5- Providing loans to farmers that are linked to production to encourage farmers to produce and continue in production.

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الملخص العربي

العلاقة السببية بين إنتاج الشعير وبعض المتغيرات فى ليبيا باستخدام اختبار السببية تادو- ياماماتو

فوزى صالح فرج الفيسى

قسم الاقتصاد الزراعى – كلية الزراعة – جامعة بنى غازى – ليبيا

تهدف هذه الدراسة إلى تحديد العلاقة السببية بين إنتاج الشعير، المساحة المزروعة، سعر الشعير، وواردات الشعير في ليبيا. اعتمد التحليل التجريبي لهذه الدراسة على السلاسل الزمنية خلال الفترة (1990-2014) للاستفادة من اختبار تودا - ياماموتو للسببية. وأظهرت النتائج أن مساحة الشعير المزروعة، وسعر الشعير مستقرة عند الفرق الأول، في حين إنتاج الشعير مستقرعند الفرق الثاني، اما واردات الشعير **كانت مستقرة عند المستوى.** أضف إلى ذلك أن النموذج لم يعاني من أي مشاكل مستقرة. أما بالنسبة لاختبار تودا- ياماموتو للسببية بين متغيرات الدراسة اوضحت نتائج الدراسة، ان هناك أدلة هامة على وجود علاقة سببية أحادية الاتجاه تنطلق من واردات الشعير نحو إنتاج الشعير.

الكلمات المفتاحية:- إنتاج الشعير، المساحة المزروعة، السعر ، الواردات ، اختبار السببية تودا وياماموتو، ليبيا.