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Relationship Between Organic Agriculture and Export of Olive Oil in Tunisia via an ARDL Model

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***Abstract*—This paper aims to study the presence of the relationship between the organic olive-growing area and the export of olive oil in the Tunisian economy, such as the producer price index for the case of olives and the exchange rate. A cointegration approach through an Auto Regressive Distributed Lag model (ARDL model) was mobilized for the period (2001-2021). The test results show the existence of a significant short and long-terms cointegration relationship between the olive area, the exchange rate and the export of olive oil. Similarly, unidirectional causal relationships have also been determined between the producer price index and the olive area on the one hand, a unidirectional causal relationship is caused by the exchange rate on the olive-growing area and this exerts unidirectional causality on the export of olive oil. The promotion of organic farming in Tunisia depends not only on the development of organic areas but also on the economic situation of the country. Thus, it can be concluded that limiting the depreciation of the national currency and improving the producer price index can improve the exchange rate and contribute positively to the development of organic olive areas and the export of olive oil in general**

Keywords*— *Organic farming, olive oil exports, olive-growing areas, ARDL model, short and long-term relationship.

I. INTRODUCTION

Since 1999, Tunisia has established a national strategy of organic agriculture with the aim to improve its international competitive position and increase the added value of the agricultural exports. Organic farming is becoming increasingly important in the agricultural sector. In fact, the areas of organic agriculture reached about 326 thousand hectares in 2019 against 18,600 hectares in 2002 and the number of operators increased from 481 in 2002 to 7190 in 2019 [1]. The exports of organic products have tripled from 36,000 tons in 2013 to nearly 90,000 tons in 2020 with a value more than 220 million euro, constituting 13% of total food exports. With this result Tunisia is the first exporter of organic products in Africa. Olive oil, dates, horticultural products and aromatic and medicinal plants are the main products exported [2]. Olive cultivation is the main activity of organic agriculture with 148,000 ha representing nearly 75% of the total national organic area [3]. Tunisia contributes with 10% of the world production and 20% of total exports. The main export market is the European Union being since the seventies the traditional market for Tunisia (60% of total export sales) [4]. However, consumer awareness with respect to Tunisian olive oil in the EU is low. This owes in part to the fact that most of the olive oil is exported in bulk and to the practice of European importers to mix Tunisian olive oil with other olive oils without being obliged to declare its Tunisian origin [5]. In Fact, Tunisia is the first in the world in certified olives areas, is the first in Africa and 28rd in the world in certified area, this means new challenges for Tunisia in order to be able to exploit market demand, national and international [6]. Although production and exports have increased significantly, the Tunisian olive oil sector faces many challenges, including (i) high levels of volatility in olive oil exports; (ii) price dependence on the EU market and other international markets; (iii) remarkable increase in producer prices and (iv) The repercussions of the country's economic crisis on the depreciation of the national currency and the continued increase in exchange rates. The prices have fluctuated sharply, with a downward trend and operating margins have been reduced, putting many farms in a situation that threatens their survival and the food security [7]. All these factors can play an important role in the competitiveness and efficiency of organic olive oil exports as well as in the national economy and the balance of trade. In the present study, the objective of this paper is to identify the relationship between the export olive oil in Tunisia and the cultivated of organic area for the period 2001-2021 by integrating each time an important factor as a producer price index and the exchange rate.

Several academic studies have been carried out on the production of organic olive oil in order to identify the

determinants for the promotion of olive oil exports in several countries. In this section, in this section, a literature review on some case studies has been developed.

Panel data with the gravity model are used to analyze the increase in olive oil exports and intra-industry trade in Mediterranean countries for the period from 1998 to 2016. The results of the analysis supported the idea that an increase in country size had a positive impact on the olive oil trade [8].

Studied the relationship between the area cultivated in organic agriculture and agricultural value added in certain countries of the European Union was examined for the period 2010-2018. Germany, Austria, France, Spain, Italy, Greece, the Netherlands, Denmark and Sweden were included in the study. The dynamic panel ARDL model was used. In the countries examined according to the Pooled Mean-Group (PMG) estimator, a significant positive relationship was found between the area cultivated organically and long-term agricultural value added. Similarly, a bidirectional causal relationship was also determined between agricultural value added and area cultivated in organic agriculture [9].

In Tunisia, some papers are interested in this question linked to organic olive growing, as examples

An econometric model showed that olive oil is a normal good, the direct price elasticity of demand is inelastic and the cross-price elasticity of demand with seed oils is positive, which indicates the existence of a substitution relationship between the two products [10].

A study of the performance of Tunisian olive oil exports compared to its main competitors over the last fifteen years, on the European market and four potential markets: the United States- United States, Canada, Japan and Brazil indicated that Tunisia's sustainable international competitiveness in the olive oil market depends on its national production and that of its European and Turkish competitors [11].

Another analysis of Tunisian consumer behavior towards agri-food with an emphasis on olive oil via the methods of Principal Component Analysis (PCA) and Ascending Hierarchical Classification (HAC) showed that socio-economic characteristics such as high income and education level of consumers, perception of difference on taste or quality and point of sale are important variables and essential tools to develop future oil marketing strategies organic olive [12].

Another research work aims to provide strategies oriented towards more conscientious agricultural practices in the Tunisian organic olive sector using farm sustainability indicators approach. The results indicated that in some cases there is no antagonism between environmental factors, socio-territorial and economic sustainability, therefore it is possible to simultaneously improve the three dimensions [13].

This work in Tunisia has succeeded in emphasizing the commercial and agri-food aspect downstream of the olive sector, but the emergence as well as the promotion of the organic olive sector requires a more in-depth upstream look to increase production and competitiveness of this sector. In this sense, this paper aims to identify the presence of long-term relationship between the export olive oil in Tunisia and certain control and cyclical variables such as organic olive growing area, producer price index and rate exchange. The idea of this paper is to arrive at useful recommendations for the perspective and promotion of organic agriculture in Tunisia and mainly olive growing and the export of olive oil.

II. MATERIAL AND METHODS

Data on the export value of olive oil in Tunisia (1000 US$), the Olive Producer Price Index (2014-2016 = 100) and on the exchange rate were obtained from the Food and Agriculture Organization of the United Nations (FAOSTAT), and data on the organic olive growing area were obtained from the National Office of Oils of Tunisia [14]. The years 2001-2021 are the period studied in the study taking into account the criterion of availability of data knowing that the development of agriculture in Tunisia is officially started following Law No. 30 of April 5, 1999 marks the official birth of organic agriculture in Tunisia, the first country to implement national organic regulations [15]. Therefore, the study data are linked to their availability since the start of organic farming in Tunisia. This constraint was not a major constraint in developing our methodological framework to develop a dynamic model called ARDL (Auto Regressive Distributed Lags) for the study period (2001-2021) as well as the validation of statistical tests and our results scientifically.

A. Specification of the ARDL cointegration model

In agricultural production, having past information is important for building strategies and recommendations. Therefore, the analysis of an autoregressive distributed lag (ARDL) model including lagged values of the variables is preferred for this purpose. Indeed, the ARDL model is widely accepted for the cointegration of non-stationary variables corresponding to error correction dynamics [16]. An important advantage of the ARDL modeling approach is that it is useful regardless of whether the regressors are (0) or I (1). Again, ARDL allows a large number of offsets. Finally, it accepts the development of a dynamic error correction (EC) model that coordinates short-term elements with long-term stability, thus not losing any long-term data [17, 18].

The Auto Regressive Distributed Lag model (ARDL) which is part of the class of dynamic models, makes it possible to capture temporal effects and is presented as follows:

$$Y_t = a0 + \sum_{i=1}^{p} \Sigma a_i Y_{t-i} + \varepsilon_t \qquad (1)$$

$$\varepsilon_t \sim \text{idd}\ (0, \sigma) : \ error\ term.$$

We consider an endogenous variable (Yt) which can be explained by:

$$Y_t = \beta + \Sigma b_i X_{t-i} + z_t \qquad (2)$$

Indeed, the combination of the two models gives what is called the ARDL model (autoregressive models with staggered or distributed delays), thus its form is written:

$$Y_t = \varphi + \sum_{i=1}^{p} \Sigma a_i Y_{t-i} + \sum_{i=0}^{q} \Sigma b_i X_{t-i} + e_t \quad (3)$$

Note that ($b0$) explains the short-term effect of (X_t) on (Y_t), and to explain the long-term effect of (X_t) on (Y_t) we must calculate (λ) from the relation long term:

$$Y_t = k + \lambda + X_t + u$$

with

$$\lambda = \Sigma b_i \,/\, (1 - \Sigma a_i)$$

As part of study which seeks to study the determinants of the exploitation of olive oil in relation to organic agriculture and the structural and cyclical variables of Tunisia, the representation of ARDL econometric model is presented fewer than two forms to remedy the conditions of statistical applicability for short-period series (rank of the matrix and the number of coefficients):

Model 1:

$$lnEXPO_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta lnEXPO_{t-i} + \sum_{i=1}^{q} \alpha_2 \Delta lnALOIV_{t-i} + \sum_{i=1}^{q} \alpha_3 \Delta lnIPPRO_{t-i} + b_1 lnEXPO_{t-i} + b_2 lnALOIV_{t-i} + b_3 lnIPPRO_{t-i} + e_t \quad (4)$$

Model 2:

$$lnEXPO_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta lnEXPO_{t-i} + \sum_{i=1}^{q} \alpha_2 \Delta lnALOIV_{t-i} + \sum_{i=1}^{q} \alpha_3 \Delta lnCH_{t-i} + b_1 lnEXPO_{t-i} + b_2 lnALOIV_{t-i} + b_3 lnCH_{t-i} + e_t \quad (5)$$

Δ First difference operator; *Ln* is the natural logarithm *a0:* Constant; *a1 … a3*: Coefficients, Short-term effects; $b1 \ldots b3$: Long-term dynamic coefficients of the model; e_t ~idd (0, σ): error term (white noise).

EXPO: Value of Export of Olive oil for Tunisia (1000 US$), ALOIV: organic olive growing area (ha), IPPRO: Olive Producer Price Index (2014-2016 = 100), CH: Exchange rate (Local currency units per USD, Tunisian Dinar, Annual value).

III. RESULTS AND DISCUSSION

A. Study of the stationarity of variables

The analysis of time series begins with a study of the stationarity of the variables concerned. To do this, two categories of the most common tests are used, namely: the Augmented Dickey-Fuller test (denoted ADF) and that of Phillips-Perron (denoted PP) whose null hypothesis is non-stationarity. Thus, Table 1 shows the results of these two tests for the endogenous variable is the value of olive oil exports in Tunisia, LEXPO and its determinants are organic olive growing area LALOIV , olive production price index LIPPRO and rate exchange rate LCH. All the series studied according to the two tests (ADF and PP) are non-stationary in level for the series (LEXPRO, LIPPRO and LCH), while the series is stationary in level for (LALOIV). However, it appears from Table 1 that the variables are stationary after the first difference and are integrated of order 1, I (1). The results obtained then reveal the possibility of the applicability of the ARDL model as well as the existence of a cointegration relationship between the different variables studied will be tested by Peseran Bounds test [19].

TABLE I. PHILLIPS-PERRON (PP) AND AUGMENTED DICKEY-FULLER (ADF) TESTS

UNIT ROOT TEST TABLE (PP)					
At Level					
		LEXPO	*LALOIV*	*LIPPRO*	*LCH*
With Constant	t-Statistic	-2.4063	-3.1413	-1.4439	0.6327
	Prob.	*0.1525*	*0.0395*	*0.5403*	*0.9869*
		n0	**	n0	n0
At First Difference					
		d(LEXPO)	*d(LALOIV)*	*d(LIPPRO)*	*d(LCH)*
With Constant	t-Statistic	-6.6536	-2.8279	-17.9947	-2.6824
	Prob.	*0.0000*	*0.0731*	*0.0000*	*0.0953*
		***	*	***	*
Order of integration		I(1)	I(0)	I(1)	I(1)
UNIT ROOT TEST TABLE (ADF)					
At Level					
		LEXPO	*LALOIV*	*LIPPRO*	*LCH*
With Constant	t-Statistic	-2.5722	-3.0067	-0.6149	0.8785
	Prob.	*0.1149*	*0.0514*	*0.8452*	*0.9928*
		n0	*	n0	n0
At First Difference					
		d(LEXPO)	*d(LALOIV)*	*d(LIPPRO)*	*d(LCH)*
With Constant	t-Statistic	-6.7919	-2.8279	-8.7707	-2.7580
	Prob.	*0.0000*	*0.0731*	*0.0000*	*0.0831*
		***	*	***	*
Order of integration		I(1)	I(0)	I(1)	I(1)

Notes: * Significant at the 10%; ** Significant at the 5%; *** Significant at the 1% and (no) Not Significant.

B. Determination of the optimal ARDL model

The information criterion of (Akaike and Schwarz) will use to select the optimal ARDL model, the one which offers statistically significant results with the least parameters. Table 2 presents the results of optimal model retained. Model 1 retained is that of: *Model 1* ARDL (1, 0.1) and *Model 2* is that of ARDL (1, 0.0).

TABLE II. LAG ORDER SELECTION CRITERIA

Model	AIC	SC	Specification
1	3.832697 1.482790*	3.982057 2.080230*	ARDL (1, 0, 1)
2	3.384557 -1.132460*	3.533917 -0.535020*	ARDL (1, 0,0)

* indicates lag order selected by the criterion. AIC: Akaike information criterion. SC: Schwarz information criterion.

C. *Model validation*

The specification obtained in model 1 ARDL (1, 0.1) and model 2 ARDL (1, 0.0) are generally satisfactory. Model 1 makes it possible to significantly explain at the 1% threshold with 65.3% of the export value of (LEXPO) olive oil by the variables organic olive growing areas (LALOIV) and the production price index (LIPPRO) (F-statistic = 7.06) at the 1% significance level. Model 2 makes it possible to explain 65.3% of the export value of LEXPO olive oil by the variables organic olive growing areas (LALOIV) and the exchange rate (LCH) at the 1% significance level (F-statistic= 11.83). For the robustness tests in Table 3, the hypothesis H0 is accepted by all the tests (Probability >5%) and therefore the residuals meet the conditions of validity of two ARDL models, namely the absence of Autocorrelation, the existence of Normality and Homoscedasticity.

TABLE III. DIAGNOSTIC TESTS ON THE ARDL MODEL

ARDL Models	Test hypothesis	F-statistic	Probability
Model 1	Correlation	0.194132	F(1,14) = 0.6662**
	Heteroskedasticity	0.543511	F(1,17) = 0.4710**
	Normality	1.48	0.47**
Model 2	Correlation	0.145518	F(1,15) = 0.7082**
	Heteroskedasticity	0.844129	F(1,17) = 0.3711**
	Normality	0.8767	0.6450**

Significant at the 5%; ***.

The cumulative sum (CUSUM) of recursive residuals were also used to test for parameter stability. As depicted in Fig.1 and Fig.2 below, the parameters are stable over time at 5% significance level as the cumulative sums did not go beyond the area between the critical lines.

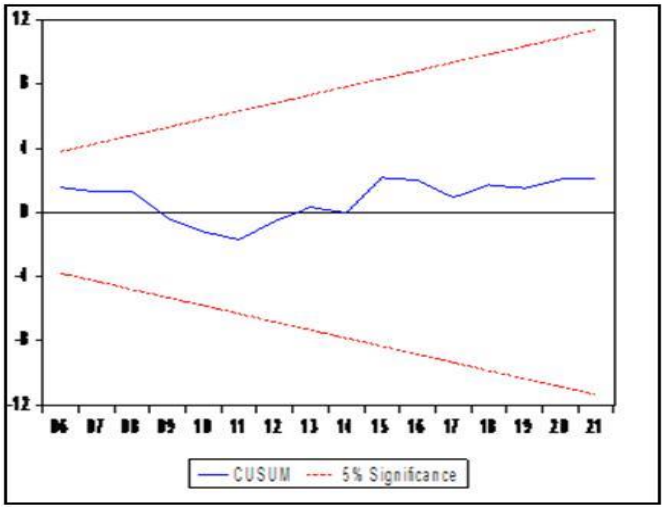

Fig. 1. Stability of model 1.

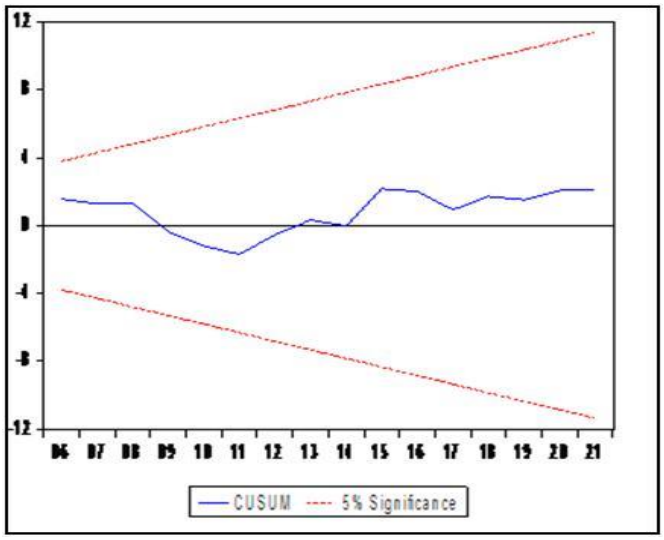

Fig. 2. Stability of model 2.

D. Cointegration test of the ARDL Model: Bounds test

Table 4 provides values of the Bounds test which uses the Fisher test to verify the cointegration hypotheses. This test consists of testing the null hypothesis of the absence of cointegration against the alternative hypothesis of the existence of a cointegration relationship by the approach of Pesaran [19] and in the approach of Naranyan [20] for small samples. The test procedure is such that we must compare the values of the terminals with that of Fisher. If the Fisher value is greater than the upper limit, the null hypothesis is rejected, whereas in the opposite case where the Fisher value is less than the lower limit, the null hypothesis is accepted. It appears from the Bounds test table that the Fisher statistic which takes the value of (6.58) is greater than the first upper bound which is (4.85) as well for the model ARDL 1 at 5% level. Even for the ARDL 2 model, the Bounds test table shows that the Fisher statistic which takes the value of (8.51) is greater than the first upper bound which is

(4.85) at 5% level. This leads us to reject the null hypothesis of the absence of a cointegration relationship and consequently an acceptance of the alternative hypothesis of the existence of a cointegration relationship between the variables retained. This evidence of the existence of cointegration relationships made it possible to estimate the long and short term relationships of our ARDL cointegration models.

TABLE IV. COINTEGRATION TEST OR BOUNDS TEST

ARDL Bounds Test Model 1			**ARDL Bounds Test Model 2**	
Test Statistic	Value	k	Value	k
F-statistic	9.34	2	11.97	2
Critical Value Bounds				
Significance	**I0 Bound**	**I1 Bound**	**I0 Bound**	**I1 Bound**
10%	3.17 (1.501)	4.14(3.828)	3.17 (1.501)	4.14(3.828)
5%	**3.79 (1.855)**	**4.85 (4.560)**	**3.79 (1.855)**	**4.85 (4.560)**
2.5%	4.41 (2.228)	5.52 (5.310)	4.41 (2.228)	5.52 (5.310)
1%	5.15 (2.734)	6.36 (6.320)	5.15 (2.734)	6.36 (6.320)

(.); Naranyan's values. *Short and long term relationships: cointegration ARDL*

For Model 1: LEXPO=f (LALOIV, LIPPRO)

The estimates obtained in Table 5 above show that the adjustment coefficient is negative and statistically significant(significant at the 1%), which shows the existence of an error correction mechanism and therefore a long-term relationship between the variables, the value of this coefficient is 1.04 which demonstrates an adjustment of 104% of the export of olive oil from its balance. In the first part of the table, the variable area of organic olive growing has a significantly positive on the export of olive oil in Tunisia in the short term (significant at the 1%); an increase of 1% in areas can increase the export of olive oil of 1.20%. The other production price index variable has a negative impact but it is not significant. These results show that in the short term, the extension of the organic olive growing area plays an important role than the producer price index for promoting the value of export of olive oil. In the same table 5, the lower part provides us with the long-term coefficients; the results show that in the long term the area of organic olive growing is significant, thus an increase of 1% in areas can lead to an increase in the export of olive oil by 1.15% in the long term. The other variable, the producer price index, remains significant even in the long term. These results show that the expansion of organic olive growing areas in Tunisia is an important factor in promoting the export value of olive oil in the short and long term. The recent development of organic agriculture in Tunisia, particularly olive growing, in the last twenty years has played an important role in the export of olive oil. The contribution of organic olive growing to the Tunisian economy encourages farmers and entrepreneurs to invest in this sector and this contribution will further strengthen Tunisia's place in the export of olive oil in the short and long term**.**

TABLE V. ARDL COINTEGRATING AND LONG RUN MODEL1

Cointegrating Form (Model 1)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(LALOIV)	**1.205560**	**0.337456**	**3.572500**	**0.0028*** **
D(LIPPRO)	-0.106054	0.502907	-0.210881	0.8358
CointEq (-1)	-1.046365	0.203889	-5.132026	0.0001***
Cointeq = LEXPO - (1.1521*LALOIV -0.8763*LIPPRO + 3.2670)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LALOIV	**1.152141**	**0.290976**	**3.959568**	**0.0013*** **
LIPPRO	-0.876281	0.593783	-1.475759	0.1607
C	3.267004	1.769368	1.846424	0.0847*

Notes: *** Significant at the 1%..

For Model 2: LEXPO=f (LALOIV, LCH)

The estimates obtained in Table 6 above show that the adjustment coefficient is negative and statistically significant (significant at 1%), which shows the existence of an error correction mechanism and therefore a long-term relationship between the variables, the value of this coefficient is 1.10 which testifies to an adjustment of 110% of the export of olive oil from its balance. This result indicates a return to balance in the last two months of each year. In the first part of the table, the organic olive growing area variable has a significantly positive effect on the export of olive oil to Tunisia in the short term (significant at 1%), an increase of 1% in areas can an increase in olive oil exports of 1.16%. While the exchange rate variable has a negative and significant impact (significant at the 5% level), an increase in the exchange rate by 1% can lead to a decrease in olive oil exports of 1.08%. . These results show that in the short term, the extension of the organic olive growing area plays a positive role, contrary to the exchange rate, on the value of olive oil exports. In the same table, the lower part provides us with the long-term coefficients, the results show that in the long term the area of organic olive growing has a significant positive impact (significant at 1%), while the exchange rate at a significant negative impact (significant at 5%), but with lower coefficients than the short term.

TABLE VI. ARDL COINTEGRATING AND LONG RUN MODEL2

Cointegrating Form (Model 1)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(LALOIV)	1.169170	0.257314	4.543755	0.0003
D(LCH)	-1.080396	0.486072	-2.222708	0.0410
CointEq (-1)	-1.107561	0.189990	-5.829591	0.0000
Cointeq = LEXPO - (1.0556*LALOIV -0.9755*LCH + 1.1465)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LALOIV	1.055626	0.181016	5.831663	0.0000
LCH	-0.975473	0.438835	-2.222871	0.0410
C	1.146547	1.944284	0.589702	0.5636

Notes: *** Significant at the 1%..

These results linked to the positive contribution of the control variable the area of organic olive growing in the export of olive oil can indirectly justify the relationship between organic farming and the value of agricultural production. For example, Çukur's paper revealed a significant positive relationship between the area cultivated in organic agriculture and long-term agricultural added value in some European countries [9]. Likewise, the negative and insignificant

relationship between the export price index of olive oil is also confirmed in another context of date export work in Tunisia [21]. In this paper, the coefficient associated with price competitiveness is negative but not significant, indicating that the price weakly affects the level of date exports. Therefore, we can deduce in our study that the negative sign is logical since the increase in the producer price index reflects an increase in the cost of production which also includes the amount of organic certification in front of a sales price less competitive internationally in terms of currencies. Model 2 confirms this interpretation by the significantly negative relationship between the exchange rate and the export of olive oil. Indeed, the appreciation of exchange rates leads to a drop in exports and depreciation leads to an increase in exports. The depreciation of the exchange rate of foreign currencies (Euros or Dollars) compared to the local currency indicates the devaluation of the country's currency and therefore a drop in the value of exports. This remark is justified through the analysis of the positive (appreciation) and negative (depreciation) components of the exchange rate to determine whether exchange rate considerations have a differential effect on export trade [22].

For this case study, the ARDL model succeeded in confirming the existence of a short and long term relationship between the export of oil, organic olive growing area and the exchange rate in first model in contrast to the absence of this significant relationship with the variable the producer price index in second model. This relationship will be explained more with the causality test in the following section.

E. Causality test between variables

When non-stationary variables are not cointegrated or are integrated at different orders, the traditional Granger causality test becomes ineffective. In this case, the causality test in the sense of Toda-Yamamoto was used [23]. The null hypothesis states the absence of causality between variables (probability > 5%). From this Table 7, deduce the following causalities in the Toda-Yamamoto sense: in the model 1, a unidirectional causality between LIPPRO and LALOIV: the olive producer price index has an impact on the organic olive growing area.

TABLE VII. RESULTS OF TODA-YAMAMOTO CAUSALITY TESTS

ARDL model	Dependent variable	Explanatory or causal variables		
		LEXPO	**LALOIV**	**LIPPRO**
Model 1	LEXPO	-	4.27 (0.11)	0.46 (0.79)
	LALOIV***	0.78 (0.67)	-	15.75 (0.00)
	LIPPRO	0.69 (0.70)	2.23 (0.32)	-
Model 2	Dependent variable	LEXPO	LALOIV	LCH
	LEXPO**	-	7.23 (0.02)	0.27 (0.87)
	LALOIV***	2.64 (0.26)	-	16.67 (0.00)
	LCH	0.91 (0.63)	3.10 (0.21)	-

Notes: ** Significant at the 5%; *** Significant at the 1%.

In model 2, unidirectional causalities between LEXPO and LALOIV and the other between LCH and LALOIV: the exchange rate has an impact on the organic olive growing area, which has its effects on olive exports. The following Figure.3 summarizes the causal links found between variables:

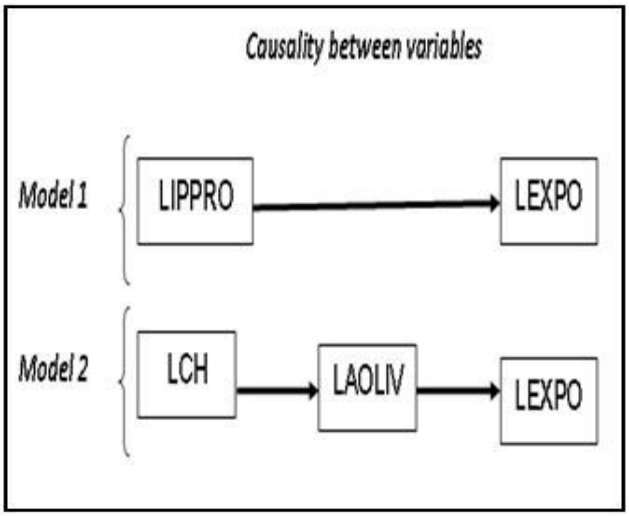

Fig. 3. Causality between variables

Thus, can see that the exchange rate does not directly influence the value of olive exports; it passes through the organic olive growing area to indirectly explain the dynamics of olive exports in Tunisia. The causality tests in the sense of Toda-Yamamoto deduce that the organic olive growing area is the main lever of olive exports in Tunisia. Indeed, the fluctuation of the exchange rate and the depreciation of the national currency can indirectly disrupt exports via the increase in the cost of production, otherwise the increase in production prices due to purchases of imported inputs for olive farming respectful of organic certification standards in Tunisia.

In the current study conducted the existence of a positive relationship was determined between the area cultivated in organic agriculture, the exchange rate and the value of olive oil export. During the literature review, no econometric studies examining this relationship were found. However, studies on the subject indicate that organic agricultural production creates higher added value. A dynamic panel ARDL models showed the existence of a significant positive relationship between the areas cultivated in organic agriculture and long-term agricultural added value in some European Union countries for the period of 2010-2018 such as Germany, Austria, France, Spain, Italy, Greece, Netherlands and Denmark [9]. In Russia, the gross domestic product (GDP) has increased considerably thanks to value-added organic agriculture, showing the importance of this activity in the economy in general [24]. Similarly in Tunisia, the relationship between the values of olive oil exports, the organic olive growing area and the exchange rate in Tunisia is confirmed either directly or indirectly in several studies and research reports on Tunisia. Indeed, the contribution of organic olive farming 27% of the value of total olive oil exports [13]. Generally speaking, the olive oil sector contributed 8% to the value of total agricultural

production and 36.6% to the value of food exports [6]. These Tunisian contributions to world production and exports as well as the competitiveness of olive oil on the world market and on the European market have been higher in recent years [25].

The originality of this paper showed that econometric analyzes through an ARDL (Auto Regressive Distributed Lags) model for the period (2001-2021) revealed a statistically significant positive relationship at the threshold of 1% 5% in the short and long term between the value of olive oil exports, the organic olive growing area and the exchange rate in Tunisia. In the present study, a unidirectional causal relationship was also determined between the producer price index and the organic olive growing area in the first model and two unidirectional causal relationships are exerted by the exchange rate on the organic olive growing area and this has impacted the value of olive oil exports. These results are considered important for policy makers. Given that the present study highlighted a positive relationship between the values of olive oil exports, the organic olive growing area and the exchange rate in Tunisia, support for organic agriculture should be increased in order to make a positive contribution to the export of organic products. On the other hand, policies to support farmers to bear part of the production burden in order to have a profitable and competitive producer price index. Furthermore, the urgency of an economic recovery is necessary today to slow down the depreciation of Tunisian Dinars against the Euro and the Dollars. Although olive oil export revenues generated a surplus which contributed to the reduction of the chronic deficit in the trade balance, the climatic situation as well as the political and economic instability in the country had an impact on the Tunisian economic system by the increase in inflation and the depreciation of the national currency against foreign currencies. It is believed that it is necessary today to carry out more studies revealing the relationship between organic farming and agricultural and economic added value to develop an effective strategic policy that encompasses export, marketing and opening up to new markets other than the traditional European market in order to improve the price-quality competitiveness of organic products in Tunisia.

IV.CONCLUSION AND RECOMMENDATIONS

The importance of organic olive growing in Tunisia is justified by their remarkable contribution to olive oil exports. Indeed, the objective of this article was to endorse the existence of this relationship between organic olive growing and olive oil exports as well as other key factors through the application of an ARDL (Auto Regressive Distributed Lags) for the period (2001-2021). The empirical results showed the existence of a positive and statistically significant relationship in the short and long term between the development of organic agriculture and the export of olive oil in Tunisia. This relationship is confirmed in other work showing the impact of olive oil exports on economic growth in Tunisia via a cointegration analysis of the error correction model [26]. Likewise, this article also showed the presence of a statistically negative relationship between the exchange rate and olive oil exports in the short and long term. Unidirectional causal relationships were also determined between the producer price index, organic olive growing area, exchange rate and olive oil exports. The causality test revealed the importance of implicit factors such as the producer price index which reflects the high cost which prevents the profitability of the olive activity, thus reflecting the major constraint to the practice of organic farming by the majority of Tunisian farmers. Indeed, the increase in the exchange rate negatively affects Tunisian exports following the depreciation of the Tunisian dinar. To curb this depreciation and the high cost of production in an inflationary context, a revival of the Tunisian economy is necessary to improve the value of the local currency and productive economic activities. The adoption of incentive policies taking into account these determinants can improve the competitiveness of Tunisian olive oil on world markets in quantity and quality establishing a quality premium [27].

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REFERENCES

[1] Bolaji, M., Babatunde, R. O., & Omotesho, O. A. (2023). Assessment of The Technical Efficiency and Cost and Returns on Seed Yam Farms in North-Central. *International Journal on Food, Agriculture and Natural Resources*, *4*(3), 37-42.

[2] Dekhili, S., Achabou, M.A., Hamdoun, M., 2020. La préférence des consommateurs tunisiens pour l'huile d'olive. Effets du label biologique et de la région d'origine. Management & Prospective 37, 121–140. https://doi.org/10.3917/g2000.375.0121

[3] Mariem, Z., Zied, D.M., Oussema, J., Salah, B., 2019. Assessment of the Tunisian olive oil value chain in the international markets: Constraints and Opportunities. FARA Res. Result 4.

[4] ONAGRI, 2022. Observatoire National de l'Agriculture [WWW Document], n.d. URL http://www.onagri.nat.tn/

[5] Weber, M., Salhab, J., Tsatsimpe, K., Sanchez-Quintela, S., 2019. Olive Oil in the North-West of Tunisia: Findings from a Value Chain and Jobs Survey (Jobs Group Papers, Notes, and Guides No. 32169322). The World Bank.

[6] Arfaoui, M., Erraach, Y., Boudiche, S., 2022. The performance of the Tunisian olive oil exports within the new distribution of world demand. New Medit 21. https://doi.org/10.30682/nm2202b.

[7] Jeder, H., Hattab, S., Frija, I., 2020. An econometric analysis for food security in Tunisia. New Medit 19. https://doi.org/10.30682/nm2004a.

[8] Kashiwagi, K., Erraach, Y., Arfa, L., Zaibet, L., 2020. Growing Olive Oil Export and Intra-Industry Trade in Mediterranean Countries: Application of Gravity Model. Sustainability 12, 7027. https://doi.org/10.3390/su12177027.

[9] Çukur, F., Işin, F., Çukur, T., 2021. DETERMINATION OF THE RELATIONSHIP BETWEEN ORGANIC FARMING AREA AND AGRICULTURAL ADDED VALUE IN SOME EUROPEAN UNION COUNTRIES WITH PANEL ARDL ANALYSIS. Appl. Ecol. Env. Res. 19, 5007–5016. https://doi.org/10.15666/aeer/1906_50075016.

[10] Ali, C., Bechir, S.M., 2003. La demande de l'huile d'olive en Tunisie: une analyse économetrique. New Medit 26–28.

[11] Sonia, B., Mehrez, A., Yahia, S.H., Mariem, A., 2022. CONSUMPTION OF ORGANIC FOOD IN TUNISIA AND CONSUMER BEHAVIOR: CASE OF OLIVE OIL. European journal of economics and management sciences 20–28.

[12] Elfkih, S., Guidara, I., Mtimet, N., 2012. Are Tunisian organic olive growing farms sustainable? An adapted IDEA approach analysis. Spanish Journal of Agricultural Research 10, 877–889. https://doi.org/10.5424/sjar/2012104-2624.
[13] ONH, 2020. National Office of Oils, 2020. Available at: https://www.onh.com.tn/ Pehlivanoğlu,
[14] F., Erarslan, C., Demir, S., 2021. Factors affecting competition in olive oil exports: Panel data analysis of selected countries. Case study. Agricultural Economics (AGRICECON) 67, 511–518. https://doi.org/10.17221/494/2020-AGRICECON.
[15] Willer, E.H., Lernoud, J., 2019. The World of Organic Agriculture Statistics and Emerging Trends 2019.
[16] Hassler, U.; Wolters, J. Autoregressive distributed lag models and cointegration. In *Modern Econometric Analysis*; Springer: Berlin/Heidelberg, Germany, 2006; pp. 57–72.
[17] Masih, M.; Hamdan, B. The impact of monetary policy on deposit and lending rates in industrial and developing countries: An application of ARDL approach. *J. Int. Financ. Econ.* **2008**, *8*, 114–122.
[18] Mallick, H.; Agarwal, S. Impact of real interest rates on real output growth in India: A long-run analysis in a liberalized financial regime. *Singap. Econ. Rev.* **2007**, *52*, 215–231.
[19] Pesaran, M.H., Shin, Y., Smith, R.J., 2001. Bounds Testing Approaches to the Analysis of Level Relationships. Journal of Applied Econometrics 16, 289–326.
[20] Narayan, P., 2004. Fiji's Tourism Demand: the ARDL Approach to Cointegration. Tourism Economics 10. https://doi.org/10.5367/000000004323142425
[21] Abderraouf, L., Ali, C., Lassaad, L., 2003. Estimation d'une fonction d'exportation des dattes tunisiennes: une analyse de cointégration. New Medit 44–48.
[22] Kingsley, S., Decker, M., Gerth, E., n.d. Rome in Spain, Spain in the Americas: Amphoras, Olive Jars & the Economics of Long-Distance Trade. Oceans Odyssey 4, 1622.
[23] Toda, H.Y., Yamamoto, T., 1995. Statistical inference in vector autoregressions with possibly integrated processes. J. Econom. 66, 225–250.
[24] Polushkina, T., Akimova, Y., Kovalenko, E., Yakimova, O., 2020. Organic agriculture in the system of the sustainable use of natural resources. BIO Web of Conferences 17, 00219. https://doi.org/10.1051/bioconf/20201700219.
[25] Karray, B., 2006. Olive Oil world Market Dynamics and Policy Reforms: Implications for Tunisia.
[26] Bakari, S., 2020. The Impact of Olive Oil Exports on Economic Growth: Empirical Analysis from Tunisia. BİLTÜRK Journal of Economics and Related Studies 2, 441–458. https://doi.org/10.47103/bilturk.675714.
[27] Larbi, W., Chymes, A., n.d. The impact of the government policies and incentives to promote the export of agricultural products in Tunisia: case of olive oil.