Estimating price and income elasticity of olive oil demand in Libya during 1980–2010

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المستخلص

تمثل دراسة الطلب على زيت الزيتون اهمية كبيرة نظرا لما لهذه السلعة من مكانة عند المستهلك الليبي. وتهدف هذه الدراسة الى تقدير مرونة الطلب السعرية و الدخلية في المدى القصير و الطويل باستخدام بيانات سلسلة زمنية للفترة 1980-2010. ولغرض التحليل اعتمدت هذه الدراسة في تحقيق أهدافها على طريقة التكامل المشترك باستخدام نموذج الانحدار الذاتي للفجوات الموزعة(اختبار الحدود) للكمية المطلوبة من زيت الزيتون و سعر زيت الزيتون وسعر زيت الذرة و متوسط دخل الفرد. وتم استخدام المجموع التراكمي لمربعات البواقي لاختبار استقرارية معلمات دالة الطلب على زيت الزيتون. واشارت النتائج الى وجود تكامل مشترك بين المتغيرات، وان الطلب على زيت الزيتون ذو مرونة سعرية منخفضة في المدى القصير، وتعد مرونة الطلب الدخلية محدد اكثر فعالية مقارنة بسعر زيت الزيتون حيث المستهلكين اكثر استجابة للدخل منه للسعر في المدى القصير. وتشير قيمة معامل تصحيح الخطأ الى ان الكمية المطلوبة من زيت الزيتون تتعدل سنويا بما يعادل 62%.

Key words: demand, price elasticity, income elasticity, bounds test, olive oil, Libya.

Introduction

As a Mediterranean country, Libya is a natural home for olive trees, and its arid climate is suitable for their cultivation. Olive oil has been a major crop in Libya and a component of the Libyan diet. Though the use of olive oil had been largely limited to the producing regions of the world, its consumption in non-traditional markets has increased since the 1990s (Mtimet, 2008,p2).Olive oil is more expensive than other kinds of vegetable oil because the trees become productive only after they reach the age of five years.

Based on the importance of olive oil in the Libyan diet and to cater to domestic demand, the olive oil industry has been targeted as a promising strategic sector for growth and development by the Libyan government. The total number of olive trees in Libya was estimated at 5.67 million in 2001, and by 2007 it increased to 5.79 million. Olive tree cultivation is concentrated in the western region (Agricultural Censuses, 2007, p37), which comprises 205,000 hectares of the total 1.716 million hectares of arable land. Between 2001 and 2010 the annual production of olive fruit increased from 150 thousand tons to 205 thousand tons, while the average annual production of olive oil decreased from 30 to 15 thousand tons. Moreover, olive oil imports decreased sharply during 1980–2010 from 61300 to 1300 tons, and this was associated with a decrease in annual total consumption from 91.3 in 1980 to 16.3 thousand tons in 2010 (Fig. 1).

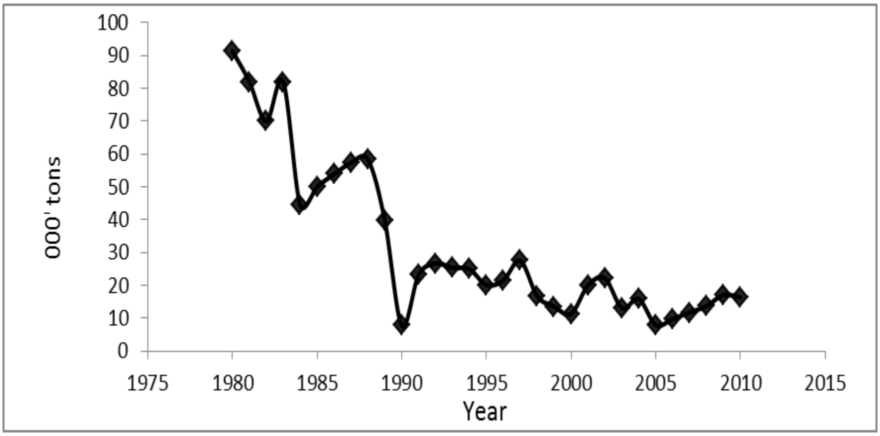

Figure 1: Annual consumption of olive oil in Libya.

The main objective of this study is to empirically estimate the short- and long-run price and income elasticities of olive oil demand in Libya.

The rest of this study is organized as follows. In the next section, we will describe the material and methods used in this study. Results are presented and discussed in the subsequent section.

Material and Methods

The data used in this study covers the period 1980–2010.The quantity of olive oil demanded was defined as the annual total consumption. The maize oil import price was calculated from the import quantity and value data, and then converted to Libyan dinar by using the exchange rate. These data were obtained from various issues of the Statistical Yearbook from Food and Agriculture Organization (FAO). Per capita income was defined as the gross domestic product (GDP) divided by the population, and the relevant data were obtained from the Economic Bulletin, Libyan Central Bank.

In general, cointegration is regarded as the empirical application of the theoretical notion of a long-run equilibrium relationship. When variables in a relationship are nonstationary, spurious regression results could be obtained. The conventional approach in achieving stationarity is to estimate the model in first differences of the data. This approach, however, results in loss of information on the long-term relationship between the variables (Tzouvelekas et al 2001).

For investigating the long-run equilibrium (cointegration) among time-series variables, several econometric methods have been proposed in the last three decades. Univariate cointegration examples include the method of Engle and Granger (1987), and the fully modified OLS procedures of Phillips and Hansen (1990). For multivariate cointegration, the procedures of Johansen and Juselius(1990) and the full information maximum likelihood procedures of Johansen (1996) are widely used in empirical research.

The Autoregressive Distributed Lag (ARDL) modeling or bounds test approach to cointegration, developed by Pesaran and Pesaran(1997) and Pesaran et al. (2001) was employed. The bounds testing approach to cointegration does not require a preliminary unit root test for the variables included in the model, in contrast to the Johansen cointegration test. The ARDL modeling approach has several advantages over other single cointegration procedures because the long- and short-run parameters of the model can be estimated simultaneously while avoiding the problems posed by non-stationary time series data. In addition, the ARDL technique has become popular, particularly because it can be applied irrespectively of the order of integration, i.e., purely I(0), purely I(1) or mutually co-integrated (and in small samples), whereas other cointegration techniques require all the variables to be of equal degrees of integration, i.e., either purely I(0) or I(1) (and large samples). In this study, the following specification was considered for the demand for olive oil in Libya:

$$Qd_t = F(PO_t, Yd_t, PM_t, U_t) \qquad (1)$$

In time period t, Qd is the quantity of olive oil demanded, PO is the price of olive oil, Yd is the per capita income, PM is the price of maize oil, and U is an error term.

To investigate the existence of a long-run relationship, Pesaran et al. (2001) proposed the bounds test based on the Wald or F-statistic. The asymptotic distribution of the F statistic is non-standard under the null hypothesis that no cointegration relationship exists between the examined variables, irrespective of whether the explanatory variables are purely I(0) or I(1). The cointegration relationship estimated using the bounds test is based on the following Unrestricted Error Correction Model (UECM):

$$\Delta \ln Qd = bo + \sum_{t=0}^{n} b_1 \Delta \ln PO_{t-1} + \sum_{t=0}^{n} b_2 \Delta \ln PM_{t-1} + \sum_{t-1}^{n} b_3 \Delta \ln Yd_{t-1} + \sum_{t-1}^{n} b_4 \Delta \ln Qd_{t-1}$$
$$+ b_5 \ln PO_{t-1} + b_6 \ln PM_{t-1} + b_7 Yd_{t-1} + b_8 \ln Qd_{t-1} \longrightarrow (2)$$

Where ΔlnQd, ΔlnPO, ΔlnPM and ΔlnYd are the first differences of the logarithms of the model variables. The null hypothesis is tested by considering the UECM for olive oil demand equation (2), excluding the lagged variables. More formally, we performed a joint significance test, where the null and alternative hypotheses are as follows:

$$H_O : b_5 = b_6 = b_7 = b_8 = 0$$

$$H_A : b_5 \neq b_6 \neq b_7 \neq b_8 \neq 0$$

For some significance levels, if the F-statistic falls outside the critical bounds, a conclusive inference can be made without considering the order of integration of the explanatory variables. For example, if calculated value of the F-statistic is more than the critical bounds, then the null hypothesis of no cointegration is rejected. If the calculated F-statistic falls between the upper and lower bounds, the decision about cointegration between the underlying variables is inconclusive. Here, the order of integration for the explanatory variables must be known before any conclusion can be drawn.

To evaluate the goodness of fit of the ARDL model, the diagnostic and stability tests were conducted. The diagnostic test examines the serial correlation, functional form, normality and heteroscedasticity associated with the model.

Stability testing of the coefficients of the regression parameters was done using the Brown et al. (1975) stability testing technique, also known as cumulative sum of squares of recursive residuals (CUSUMSQ).

Results and Discussion

The average of olive oil production was 11970 tons. In 1980, the price of olive oil was 1000 Libyan dinars/tons, but by 2010 it reached 5944 L.Y. dinars/tons with mean equal to 5710 L.Y.dinars/ tons (Table 1).

Table 1: Summary statistics of the variables

Variables	Olive oil production (tons)	Olive oil demand (tons)	Oil price (Libyan dinars per ton)	Per capita income (L.Y dinars)
Mean	11,970	32,096	2,048	5,710
Maximum	30,000	91,395	5,944	20,176
Minimum	5,000	7,713	1,000	1,697
Standard deviation	6,687	24,184	1,582	5,470

The ARDL procedure starts by determining the appropriate lag order (p) in equation (2). For this purpose, we used the Akaike Information Criterion (AIC). The AIC indicates that p = 1 is the most appropriate lag length for the model.

The first step in the analysis is to examine the time series properties of the variables through the modified Dickey-Fuller Generalized Least Square (DF-GLS test). The DF-GLS unit root test has high power compared to standard ADF unit root test. We applied DF-GLS tests for both levels and their first differences and the results are show in Table 2.

Table 2: DF-GLS Unit Root estimation

Variables	ADF Test (Levels)	ADF Test (First difference)
LQd	-3.694	-7.908
LPO	-0.835	-5.515
LYD	-1.345	-4.548
LPM	-3.519	-5.817

The critical values for the variables in levels and first different are -3.190 and -2.890 at 5% and 10% significance level, respectively.

The results of Table 2 suggest that the null hypothesis of a unit root in the time series cannot be rejected at a 5% level of significant. Therefore, no time series appear to be stationary in variable levels when the test is applied on the level of the data except for olive oil demand (LQd) which is I(0). However, when the variables are transformed into first differences they become stationary and consequently the related variables can be characterized as integrated of order 1, I (1).

Since it has been determined that the variables under examination are mutual integrated of order (0) and (1), we then proceed by investigating the cointegration relationship between the variables,

The first step of the ARDL analysis is testing for the presence of long-run relationships by computing a general F-statistic using all the variables appearing in log levels. The calculated F-statistic, 4.125 at 5%, is higher than the upper bound critical value. This implies that the null hypothesis of no cointegration cannot be accepted and that there is indeed a cointegration relationship among the variables. The relevant critical value bounds (with an unrestricted intercept and no trend, with four regressors) were obtained from Pesaran et al. (2001).These bounds are −1.95 and 3.60.

Table3: Estimated short run and long run coefficients of olive oil demand in Libya using ARDL(1,0,0,1,0).

The dependent variable is lQd.

Regressor	Short Coefficient	T-ratio [Probability]	Long Coefficient	T-ratio [Probability]
LQd (-1)	0.370	2.093 [0.04]		
LPO	-0.723	-1.803[0.08]	-1.166	-2.207 [0.03]
LYD	-1.009	-1.786 [0.08]	0.495	1.168 [0.25]
LYD(-1)	1.316	2.246 [0.03]		
LPM	-0.065	-0.559 [0.58]	-0.104	-0.540 [0.59]
C	9.118	2.567 [0.01]	14.686	5.828 [0.00]

all variables are expressed in natural logarithms.

The short-run dynamics of the model are given in Table 3. All coefficients have the expected signs and most of the variables are statistically significant. The coefficient of the olive oil price is statistically significant at the 5% level and has the appropriate sign. The short-run own price elasticity of demand for olive oil is sufficiently less than 1, which means that demand is not responsive to the price of olive oil .We can also see that the change in the price of maize oil has a statistically insignificant effect. However, the change in income has wrong sign and statistically less significant for the current year, but it is significant at lagged one period at the 3% level and has the appropriate real income per capita was found to be the most significant determinant of the demand for olive oil in Libya, emphasizing the importance of olive oil in the Libyan diet. Per capita income has a significant and positive short-run relationship with olive oil demand, indicating that higher per capita income will lead to higher olive oil demand.

The regression for the underlying ARDL equation fits very well at R2=65% and also passes the diagnostic tests against serial correlation F=2.245[0.148] and the heteroscedasticity test F=0.0013[0.971].The error correction coefficient (ECM), estimated as -0.62, is highly significant (t =3.428[0.002]), has the correct sign, and is relatively large. Approximately 62% of the disequilibria of the previous year's shock converge back to the long run equilibrium in the current year.

The cumulative sum of recursive residual plots (CUSUMSQ) statistic (Fig.2) is consistently in the center of their 5% bounds, indicating stability in the coefficients over the sample period, which indicates stability in the coefficients over the sample period.

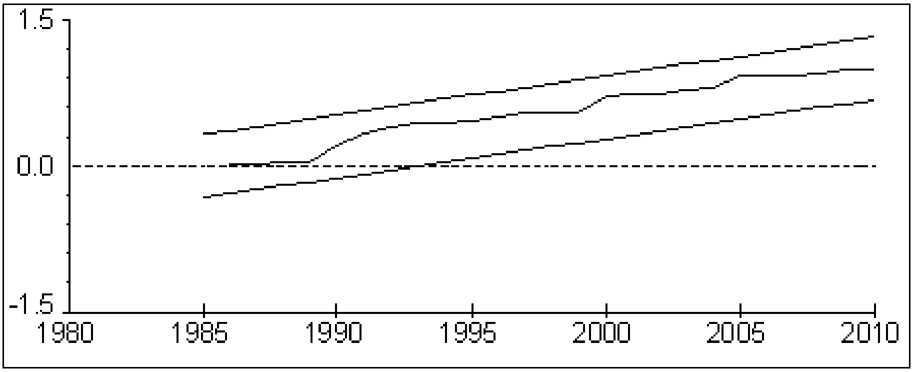

Figure 2: Cumulative sum squares of recursive residuals over the years.

The straight lines represent critical bounds at 5% significance level

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