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The West Bank olive market

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ABSTRACT

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An econometric model of the West Bank olive subsector was constructed for the period 1968–85, to provide a means of assessing the technical and behavioural forces that regulate the supply of and demand for green olives. A system of demand-and-supply equations was estimated using the two-stage least-squares (2SLS) procedures. Farm prices of green olives were found to be significantly related to quantity and per-head food expenditures. A reduced-form solution to the structural model was derived to test the forecasting ability of the model to predict the endogenous variables when the exogenous variables are given. The model was used to determine the allocation of the West Bank olives which could maximize returns to growers. The model should be both a useful tool for policy makers and of practical value to decision makers in the olive industry.

INTRODUCTION

Agriculture plays a vital role in the economics of the West Bank. In 1985, the agricultural sector accounted for 32% of the West Bank gross domestic product (at factor cost), as compared to the manufacturing sector's contribution of 7%. Almost 50% of the manufacturing in the West Bank is primarily agriculture-based (Judea, Samaria and Gaza District Statistics).

The West Bank's single most important agricultural product is olives, which contributed about 23% of the total farm cash receipts and 13% of the total domestic product during the period 1982–85. In addition, the significance of the olive crop arises from its contribution in the agricultural and total exports of the West Bank. Exports of olive products accounted for 10%

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and 60% of the West Bank total and agricultural exports (Judea, Samaria and Gaza District Statistics; Quarterly Statistics of the Adminestered Territories).

The trend in the West Bank olive production shows considerable growth over time. While olive production averaged 47000 tons [1] during 1968–77, it rose to 61000 tons during 1978–85. However, olive production reached a peak of 120000 tons in 1979. In contrast, olive production reached a trough of 10000 tons in 1974 (Central Bureau of Statistics, Statistical Abstract of Israel). The increase in olive production has been the result of an increase in olive area as well as increase in yield. Olive area rose from 638000 dunums [2] in 1972 to 716000 dunums in 1985. In addition, the use of new nursery plants of olives had moderated variations in the annual crop production. As a result, while the yield of olives averaged 54 kg per dunum during the period 1968–75, it increased to 92 kg per dunum during the period 1976–85 (Ramallah Agricultural Statistics; Sawalha, 1986).

The West Bank exports of olive products accounted for more than 40% of total domestic sales. Jordan has been the major importer, receiving more than 95% of the olives from the West Bank. In the Jordanian market, the West Bank had little competition for the sales of its olives, where its share in that market is 95% (United Nations, FAO Trade Yearbook; Judea, Samaria and Gaza District Statistics).

The prices of the West Bank olives were very unstable. The price fluctuation is partly explained by fluctuations in olive production, an important determinant of the prices. In general, prices fall when production is high and vice versa. The weighted average price of olives was US$523 per ton during 1968–85, with a range of US$277 to US$1164 per ton. In general, prices received by growers for olives rose during the 20 years 1968–85, although with considerable year to year fluctuations. While the weighted average price of green olives was US$493 during 1968–76, it rose to US$561 per ton during the period 1977–85 (Ramallah Agricultural Statistics). Olive producers have been in a quandry about whether to increase or reduce acreage, to which variety to give preference, whether to increase or reduce pickling vs. pressing utilization and what institutional changes might be made to improve prices and incomes [3].

[1] metric ton = 1000 kg.

[2] dunum = 0.25 acre ≈ 0.1 ha.

[3] The material and the results of this publication were summarized from an update study, which reported in detail the West Bank olive industry as Technical Publications Series No. 17, Rural Research Centre, An-Najah National University, Nablus, West Bank (El-Jafari, 1987).

OBJECTIVES

The objectives of this study were to: (a) analyze the market system for olives in the West Bank; (b) estimate and forecast annual farm level prices received for green olives used for pickling and oil purposes; (c) determine the optimum allocation of a predetermined quantity of the West Bank olives between pickling and pressing uses; and (d) use the statistical results of the estimated model to develop guidelines and recommendations about factor adjustment required in the West Bank olive market.

No empirical studies have done about the West Bank olive industry. Only two studies have been conducted. The main objective of those studies was to present a descriptive analysis of the West Bank olive industry (Awartani, 1982; Awad, 1984). The significance of those studies arises from providing information as background for quantitative relationships employed in the modeling of the West Bank olive market. Thus, this study differs from the above in period covered, basic goals, and intended use of the results.

ECONOMIC AND STATISTICAL MODEL

Because this study focused on determination and prediction of price and of product allocation at the farm level, the economic model did not attempt to analyze the entire olive production and marketing system. It was necessary to assume that supply was predetermined. In this context, it was contended that olive trees generally take several years to make production for commercial purposes. This implies that the long lag-period between olive planting and production makes change in crop supply unobservable in the short-run. Also, the relationship between the farm-level demand and retail demand was constant over time. The West Bank Department of Agriculture series on olive oil shows that, for the intervals 1968–77 and 1978–85, marketing margins averaged 68% and 72%, respectively. In addition, there is no retail market for pickled olives, where green olives are pickled by the households. Thus, commercial processing for pickled olives is still limited in the West Bank. Accordingly, our assumptions about the farm-retail relationship appear to be reasonable (Ramallah Agricultural Statistics).

Originally it was assumed that allocation and prices of green olives would be determined simultaneously. If the price of pickled olives rose, the quantity allocated to pickling would rise and the supply of green olives available for the olive-oil market would fall, thus affecting the price of green olives used for oil. The economic model, which best described allocation of the West Bank olives, can be presented as follows.

– Demand for pickled olives at farm level:

$$P_{pt} = \mathrm{f}(q_{pt}, \mathrm{FE}_t, P_{pt-1}) \quad (1)$$

– Demand for pressed olives at farm level:

$$P_{ot} = f(q_{ot}, FE_t, S_{t-1}, P_{ot-1}) \quad (2)$$

– Supply of pickled olives at farm level:

$$q_{pt} = f(P_{pt}, P_{ot}, Q_t, W_t, T, q_{pt-1}) \quad (3)$$

– Supply of pressed olives at farm level:

$$q_{ot} = f(P_{pt}, P_{ot}, Q_t, W_t, T, q_{ot-1}) \quad (4)$$

$$q_{Dpt} = q_{Spt} = q_{pt} \quad (5)$$

$$q_{Dot} = q_{Sot} = q_{ot} \quad (6)$$

$$q_{pt} + q_{ot} = Q_t \quad (7)$$

A description of variables in the above equations is presented below.

– Endogenous variables:

q_{pt} quantity exchanged of pickled olives at farm level in period t
q_{ot} quantity exchanged of pressed olives at farm level in period t
P_{pt} price of pickled olives at farm level in period t
P_{ot} price of pressed olives at farm level in period t

– Exogenous variables:

FE_t per-capita food expenditures in the West Bank in period t
S_{t-1} stock of olive oil lagged one period in period t
W_t wage rate at farm level in period t
T trend, 1968 = 1, 1969 = 2, ..., 1985 = 17
Q_t total olive production in the West Bank in period t
q_{pt-1} quantity exchanged of pickled olives in period $t-1$
q_{ot-1} quantity exchanged of pressed olives in period $t-1$
P_{pt-1} lagged price of pickled olives in period t
P_{ot-1} lagged price of pressed olives in period t

Equations (1) and (2) provide the theoretical framework for the demand for olive products in the pickling and pressing markets. For example, an inverse relationship is hypothesized between the quantity demanded of olives in the pressing market and the price paid for the raw product. That is, the lower the price, the greater the quantity demanded, and vice versa.

The lagged stocks of olive oil at the beginning of the pressing season are expected to have a negative relationship with the price of pressed olives at the farm level. If the carry-over stocks of olive oil are high, a smaller quantity of pressed olives will be demanded, and vice versa. Because pickled olives are stored for less than 1 year, equation (1) does not include the lagged stocks of pickled olives as an exogenous variable affecting the demand for olives in the pickling market.

Per-capita food expenditure is an important variable in explaining the demand for olive products. Accordingly, it is hypothesized that, as consumer food expenditures increase, consumption and prices of olive products will also increase.

Equations (3) and (4) include the possible variables that are expected to have an influence on the quantity allocated of the West Bank olives into pickling and pressing markets. For example, growers will allocate more olives for pickling markets if the price for pickled olives in that market increases, or if the price of pressed olives in that market decreases. The time variable takes account of the many factors in the allocation equations which could not be quantified due to the unavailability of data or which had to be left out of the statistical analysis to maintain simplicity. The factors which were not included technology, marketing policies, and restrictions imposed by marketing firms to get a certain quality of olive products.

The Nerlovian partial adjustment concept was adopted in specifying the model. The primary justification was that, in reality, there was no endogenous variable which could achieve its desired level. The adjustment process continuously occurs, moving toward the desired level. The partial adjustment concept was incorporated into the model by introducing a lagged endogenous variable into each equation. The coefficient of the lagged endogenous variable was expected to be positive (Nerlove and Addison, 1958).

In conclusion, equations (1) through (4) are considered as the theoretical framework for specifying the pickling and pressing market allocation model for the West Bank olives.

The above equations show that quantity supplied, quantity demanded, and prices are determined simultaneously in the system of equations described above. Therefore, the two-stage least-squares (2SLS) procedure was used to estimate the theoretical relationships given the simultaneous nature of the olive model (Gujarati, 1978).

Structural parameter estimates are based upon annual time-series data from the 1968–85 sample period. Data were drawn from various publications. Data on total olive production, quantities of olives allocated into the pickling and pressing markets, per-capita food expenditures and stocks of olive oil are drawn from Statistical Abstract of Israel. Data on olive prices were found in the publications of Ramallah Department of Agriculture, Agricultural Statistics.

ESTIMATION OF THE MODEL

In general, the results of the statistical estimation were satisfactory by the usual measures of level of significance and conforming of signs to the theoretical expectations. The value of the t-statistic for each coefficient is reported. The estimated behavioral equations with their t-ratios (numbers beneath the regression coefficients), the coefficient of determination, R_2, the Durbin–Watson Statistic D-W, and Durbin h statistic are given below. The estimated coefficients were evaluated on the basis that they have signs consistent with the conceptual formulation and they were larger relative to their respective standard errors (Kennedy, 1979). Therefore, the final estimated forms are presented containing only the estimated coefficients which were larger than their estimated standard errors (i.e., t-ratios were greater than 1).

The evaluation of the forecasting power of the estimated model was based upon Theil's inequality statistics U_1 and U_2, respectively defined as the first and second inequality coefficients. The coefficients U_m, U_s and U_c, also used to trace the sources of forecast errors, are the components of the numerator of Theil's inequality coefficients U_1 and U_2. The U_m, U_s and U_c are called the bias, the variance and the covariance proportions, respectively. For more details about Theil's inequality coefficients, see Rubinfeld and Pindyck (1981, pp. 360–367).

To provide economic implications of the estimated model, the estimates of the direct demand-and-supply elasticities and cross-elasticities for olive products at farm level are discussed and presented here. Estimated elasticities were evaluated at the means of the relevant variables and for the most recent year, 1985. In the case of the simultaneous equations, the estimated elasticities were derived from the structural form estimates of the model. As with all elasticities, structural-form elasticity estimates are partial; however, the elasticity estimates should be interpreted with caution. In a simultaneous-equation model, a change in an endogenous variable would result in changes in other endogenous variables within the system to restore the equilibrium. Hence, the assumption that all other endogenous variables remain constant is not fulfilled (Baumes and Conway, 1985). Finally, the estimated model for the West Bank pickled and pressed olives are presented below.

Estimated model for the West Bank pickled olives

The estimated supply and demand equations for the allocation of the West Bank olives to the pickling market at the farm level are presented below.

– Supply of pickled olives at the farm level:

$$q_{pt} = -5.39 + 0.27P_{pt} - 0.26P_{ot} + 0.18Q_t - 4.77W_t + 0.69T \quad (8)$$
$$\qquad (2.88) \quad (3.21) \quad (2.65) \quad (3.4) \quad (2.69)$$

$R_2 = 0.74$ D-W $= 1.87$

– Demand for pickled olives at the farm level:

$$P_{pt} = 113.89 - 6.1q_{pt} + 0.37\text{FE}_t + 0.46P_{pt-1} \quad (9)$$
$$\qquad (2.42) \quad (2.85) \quad (1.76)$$

$R_2 = 0.61$ $h = 1.01$

As expected, the supply of pickled olives was positively related to the farm price of pickled olives, but negatively associated with price of pressed olives at farm level. Total olive production also positively affected the supply. The coefficient of the wage rate was negative, as expected. This result indicated that the labor costs were considered an expense to olive growers in the West Bank. The estimated equation (8) is the long-run supply of pickled olives. The lagged dependent variable q_{pt-1} showed insignificant relationship with q_{pt}. This result implies that quantity allocated of pickled olives achieved its desired level in the current period.

With respect to own price, the supply of pickled olives was elastic, increasing over time. The estimated elasticities for supply of pickled olives are shown in Table 1. In addition, the price of pressed olives at the farm level has a negative effect on the quantity of olives allocated to the pressing market. A reduction in the farm price of pressed olives by 1% would increase the quantity allocated of olives to the pickling market by 2.4%. However, the West Bank olive growers became highly responsive to changes in olive prices at the farm level. In the recent year, 1985, the own-price supply elasticity and the supply elasticity with respect to the price of pressed olives were 3.8 and −3.3, respectively.

The supply elasticity of pickled olives with respect to olive production was less than unity at the mean value and over time. In 1985, that indicated quantity of olives allocated to the pickling market would increase by 0.74% if the total olive production increased by 1%.

The supply elasticity of pickled olives with respect to the wage rate increased in the recent year, in absolute values. This result was as expected. Olive growers became more responsive to labor costs. In the 1980's, new methods have been adopted in harvesting olives in addition to hand-harvesting.

With respect to own price, the demand for pickled olives was inelastic (−0.90). In 1985, the own price demand elasticity rose to −1.26. Per-capita food-expenditure elasticity was positive and less than unity. At the mean values and in the recent year, 1985, per-head food-expenditure elasticity was 0.89 and 1.0, respectively. This result indicated that the pickled olives are regarded as a necessary good.

TABLE 1

Estimated demand and supply elasticities of the West Blank pickled olives at farm level computed at mean values and at 1985 values [a]

Variables	Long-run demand elasticities [b]		Long-run supply elasticities	
	Value at mean	1985 value	Value at mean	1985 value
Endogenous variables				
P_{pt}	−0.90	−1.26	2.70	3.80
P_{ot}	–	–	−2.40	−3.30
Exogenous variables				
Q_t	–	–	0.54	0.74
W_t	–	–	−1.02	−1.68
FE_t	0.89	1.00	–	–

[a] Derived from equations (8) and (9), respectively.

[b] Since the estimated supply equation for pickled olives was the long-run supply equation, the derived elasticities from equation (8) are the long-run elasticities. To be consistent, demand elasticities from equation (9) were calculated in the long-run, where the long-run demand elasticities were calculated as follows. The estimated equation (9), the short-run demand for pickled olives, was transformed to long-run demand equation, where in the long-run P_{pt-1} tend to equal P_{pt}, thus:

$$P_{pt} - 0.46P_{pt} = 113.89 - 6.1q_{pt} + 0.37\,\mathrm{FE}_t$$

$$P_{pt} = 210.9 - 11.3q_{pt} + 0.69\,\mathrm{FE}_t$$

Since the demand for pickled olives at farm level was estimated with prices as a function of quantity, it was necessary to solve for the quantity demanded in terms of prices and per-head food expenditures, where:

$$q_{pt} = 187.7 - 0.088P_{pt} + 0.069\,\mathrm{FE}_t$$

Estimated model for the West Bank pressed olives

The estimated supply-and-demand equations for pressed olives at the farm level are presented below. Estimates were derived by using 2SLS.

– Supply of pressed olives at the farm level:

$$q_{ot} = 3.96 + 0.26P_{ot} + 0.26P_{pt} + 0.82Q_t - 3.35W_t - 0.81T \quad (10)$$
$$(3.09) \quad (2.46) \quad (11.69) \quad (1.8) \quad (3.04)$$

$R_2 = 0.94 \quad$ D-W $= 1.6$

– Demand for pressed olives at farm level:

$$P_{ot} = 43.84 - 2.24q_{ot} + 0.24\mathrm{FE}_t + 0.94P_{ot-1} - 0.001S_{t-1} \quad (11)$$
$$(1.8) \quad (1.9) \quad (2.5) \quad (1.96)$$

$R_2 = 0.55 \quad h = 1.3$

Equation (10) indicated that the quantity supplied of the West Bank olives for pressing was positively related with the farm price of pressing olives, P_{ot}, but had a negative relationship with the pickled-olive price at the

TABLE 2

Estimated demand and supply elasticities of the West Bank pressed olives at farm level computed at mean values and at 1985 values [a]

Variables	Long-run demand elasticities [b]		Long-run supply elasticities	
	Value at mean	1985 value	Value at mean	1985 value
Endogenous variables				
P_{ot}	−0.10	−0.27	1.23	2.42
P_{pt}	–	–	−1.33	−2.76
Exogenous variables				
W_t	–	–	−0.35	−0.37
Q_t	–	–	1.23	1.40
FE_t	0.77	1.03	–	–
S_{t-1}	−0.02	−0.02	–	–

[a] Derived from the estimated equations (7) and (8), respectively. S_{t-1} stocks of olive oil lagged one period in period t.

[b] Long-run demand elasticities for pressed olives were computed by following the same procedure as in Table 1.

farm level. The total olive production was positively and strongly related to pressed-olive supply. The negative coefficient of the wage rate implied that labor costs were considered as an expense to olive growers.

Supply of pressed olives was elastic at the mean value and in the recent year, 1985. Also, the cross-supply elasticity with respect to the price of pickled olives was greater than unity at the mean value in the recent year. The results in Table 2 indicated that olive growers in the pressing market were highly responsive to changes in the pickled- and pressed-olive prices, unlike results in Table 1 which showed that olive growers in the pickling market were highly responsive to changes in olive prices.

The supply elasticities with respect to olive production at the mean value and in the recent year were 1.23 and 1.4, respectively. On the other hand, results on the supply elasticity with respect to wage rate were not similar to those results and implications in the pickling market. Quantities of pressed olives supplied were less responsive to change in wage rate. Labor is still considered an important production factor in processing olive oil.

Equation (11) shows that the quantity of pressed olives demanded at farm level was negatively associated with farm price of pressed olives and with lagged stocks of olive oil. In contrast, per-capita food expenditures had positive influences on the quantity of pressed olives demanded.

Results in Table 2 indicate that the demand for pressed olives was inelastic at the mean values and in the recent year, 1985. The own-demand elasticity was −0.27 in the recent year 1985, while it was −0.10 at the mean value. This result supports the fact that green olives are considered as the only intermediate commodity in producing olive oil. Therefore, olive-oil marketing firms are not highly responsive to any changes in the price of green olives. In addition, per-capita food-expenditure elasticities at the mean value were less than unity, increasing over time.

Demand for pressed olives was less responsive to changes in lagged stocks of olive oil. Demand elasticity with respect to the level of October olive-oil stocks was very small and constant over time (-0.02). This result implies that stocks of olive oil were not strong determinants for demand of pressed olives.

VALIDATION OF THE WEST BANK OLIVE MARKET MODEL

The forecasting performance of the estimated model was evaluated within and beyond the sample period. Within the sample period, the prediction power of the estimated model was evaluated based upon the bases of Theil's inequality coefficients, U_1 and U_2. Other measures, U_m, U_s and U_c, were used to detect sources of errors such as model specification. In addition, a comparison between the actual and predicted values of the endogenous variables was done for the years 1984 and 1985. The forecast error, the upper and lower confidence limits, forecast values, and actual values were calculated to provide comparison between the actual and predicted values. Beyond the sample period, generating an unconditional forecasting and Theil's inequality coefficients were used to evaluate the forecasting performance of the estimated model.

The derived reduced-form equations were used to generate values for the endogenous variables which can be compared with the original data series to see how well the model 'tracks' the historical data. In the case of the simultaneous-equations system, the predicted values of the endogenous variables were obtained from the derived reduced-form equations. This kind of analysis was used for forecasting since it not only takes account of overidentifying restrictions, but also preliminary experiments on the past data showed better prediction results from the estimates of the derived reduced form than from the unrestricted reduced form (see Intriligator, 1978, p. 499).

Sample period evaluation for the olive market model

The values of Theil's inequality coefficients, U_1 and U_2, are quite low, less than 0.25, suggesting that the estimated model predicted the farm prices and quantities of green olives better than a naive no-change model during the estimation time period (Table 3).

TABLE 3

Theil's inequality coefficients for predicted values of the endogenous variables, based on the derived reduced-form equations of the West Bank olive markets at farm level, 1968–85

Endogenous variables	Statistics				
	U_1	U_2	U_m	U_s	U_c
Quantity allocated of green olives to the pickling market	0.11	0.16	0.0	0.07	0.92
Price of pickled olives at farm level	0.13	0.19	0.0	0.12	0.88
Quantity allocated of green olives to the pressing market	0.05	0.08	0.0	0.01	0.98
Price of pressed olives at farm level	0.18	0.25	0.0	0.14	0.85

The test values of U_m indicated that there were no systematic errors in the endogenous variables. The value of U_s indicated that the variations were equal for the predicted and actual values of the series in the derived reduced-form equations. The high values of U_c indicated that errors were random in nature (see Table 3).

The 95% level confidence intervals for the farm prices and quantities of green olives allocated for pickling and pressing uses were calculated from the derived reduced-form equations within the sample period for the years 1984 and 1985. The upper and lower confidence limits, forecast values, actual values, forecast errors, variance of forecast and the percentages of forecast errors are shown in Table 4. All the forecast errors were smaller than 15% of the actual values. One exception can be made about quantity of olives allocated for pickling uses. Predictions fail to accurately capture actual movements, missing by 25% for the year 1985. Nevertheless, the forecasted value for 1984 is within 4% of the actual value.

TABLE 4

Within-sample-period forecasts for the West Bank olive market model, 1984–85

Endogenous variables	Year	Actual value	Lower confidence limit	Forecast value	Upper confidence limit	Variance of forecast	Forecast error	% of forecast error
q_{pt} (1000 ton)	1984	17.22	10.6	17.8	25.1	3.38	−0.62	3.6
	1985	10.78	6	13.5	21	3.1	−2.72	251
q_{ot} (1000 ton)	1984	24.23	15.8	23.36	30.9	3.53	0.86	3.5
	1985	45.67	35.37	42.87	50.37	3.0	2.8	6.1
P_{pt} (US$/ton)	1984	708.19	451	708	964	136	0.19	0.02
	1985	958	631	888	1145	160	80	8
P_{ot} (US$/ton)	1984	623	422	716	1010	119	−93	11
	1985	1087	633	927	1221	140	−159	14

Beyond-sample-period evaluation for the West Bank olive market model

An evaluation of the forecasting performance of the reduced-form equations beyond the sample period was made over a time interval for which values of both endogenous and exogenous variables are known with certainty. This type of prediction, which produces unconditional forecasts, was carried out since some of the exogenous variables appeared with time lags, while the others were known in advance, where we might be able to forecast them perfectly or near perfectly. In addition, in this applied work, it was desirable to the olive-market model to generate unconditional forecasts, since this removes a large source of forecasting error (Rubinfeld and Pindyck, 1981, pp. 207–229).

Beyond-sample-period forecasts were made for 2 years, 1986 and 1987. After the forecasts of the olive prices and quantities were obtained, the confidence interval for each point forecast was constructed. An approximate 95% confidence interval based upon an econometric model is given by

$$\hat{P}_{\mathrm{i}} + 2.145\ S_{\mathrm{f}}$$

where $\hat{P}_{\mathrm{i}}$ is the predicted value beyond the sample period, S_{f} is the sample standard error beyond the sample period and S_{f2} is the sample variance of the forecast errors beyond the sample period. The sample variance of the forecast's errors beyond the sample period was calculated based upon the following formula, (Neter and Wasserman, 1974, pp. 233–234).

$$S_{\mathrm{f2}} = S_{\mathrm{A2}}\left[1 + X_{\mathrm{h}}'(X'X)^{-1}X_{\mathrm{h}}\right]$$

where S_{A2} is the variance errors of estimation of the estimated econometric equation, X is the matrix of the values of the right hand side variables for the sample period, and X_{h} is a row vector of the values of right-hand side variables for the forecast period.

Forecasting performance of the West Bank olive-market model beyond the sample period is reported in Table 5. In general, the statistics in Table 5 were greater than the corresponding ones in Table 3. This was expected

TABLE 5

Forecasting performance of the West Bank olive market model beyond the sample period, 1986–87

Endogenous variables	Statistics				
	U_1	U_2	U_{m}	U_{s}	U_{c}
Quantity allocated of green olives to the pickling market	0.14	0.22	0.10	0.1	0.80
Price of pickled olives at farm level	0.17	0.25	0.09	0.17	0.74
Quantity allocated of green olives to the pressing market	0.11	0.14	0.07	0.10	0.83
Price of pressed olives at farm level	0.25	0.31	0.08	0.20	0.72

TABLE 6

Beyond-sample-period forecasts for the West Bank olive market model, 1986–87

Endogenous variables	Year Year	Actual value	Lower confidence limit	Forecast value	Upper confidence limit	Variance of forecast	Forecast error	% of forecast error
q_{pt}	1986	19	15	22	29	4.5	−3	−15
	1987	13.4	3	10	22	3.7	3.4	25
q_{ot}	1986	101	33	110	220	22	−9	−8.9
	1987	65	11	60	78.5	16.3	5	7.6
P_{pt}	1986	1652.7	1645	1640	22.33	413.18	12.7	0.7
	1987	1662	1208	1700	2192	448.74	−38	−2.2
P_{ot}	1986	1052.6	590	1000	1410	263.2	52.6	4.9
	1987	975	716	1050	1383	263.2	−75	−7.6

because the beyond-sample-period forecast is a more 'rigorous' test of the forecasting performance of the estimated model. The values of Theil's inequality coefficients, U_1 and U_2 were less than 1. The high values of U_c indicated that a substantial proportion of forecast errors was due to random or unsystematic factors.

The 95%-confidence forecast intervals for green olive prices and quantities were calculated on the bases of the restricted reduced-form equations. The upper and lower confidence limits, forecast values, actual values, forecast error, variance of forecasts, and the percentage of forecast error for the prices and quantities of green olives are presented in Table 6. The actual values of all endogenous variables lay in the estimated confidence intervals. Table 6 indicated that olive growers were relatively more certain about prices than quantities of green olives allocated for pressing and pickling uses. The forecast errors for olive prices fell within −8 to 5% of the actual values for the years 1986 and 1987. In contrast, the forecast errors for olive quantities fell within −15 to 25% of actual values for the years 1986 and 1987.

In conclusion, the predicting and forecasting ability of the derived reduced form model varies from year to year and from variable to variable. Forecasts are best for green olives allocated to the pressing market and farm prices of pickled and pressed olives within and beyond the sample period. For the quantities of green olives allocated for pickling uses, the reduced-form equation for 1985 and 1987 fails to capture the directional movement, where the forecast errors are within −15 to 25%, respectively. Nevertheless, the forecast value for 1984 is within 4% of the actual value.

OPTIMUM ALLOCATION OF THE WEST BANK OLIVES

Olive growers are concerned about how to allocate a given crop between pickling and pressing uses to maximize their gross revenues. The model can be used to identify such an optimum point for growers.

Defining V_t the total returns by:

$$\text{Max } V_t = \hat{P}_{ot}\hat{q}_{ot} + \hat{P}_{pt}\hat{q}_{pt}$$

Subject to the demand functions (1) and (2) and the identity $Q_t = q_{pt} + q_{ot}$, the problem can be reformulated to solve for q_{ot} and q_{pt}, the estimated pressing and pickling allocation, respectively, that would earn a maximum total return to growers. On average, the optimal solution for growers would require a reduction of pressing allocation by about 34% and an increase in the smaller pickling allocation by almost 31%. The model suggests that total sales revenue to growers over the entire period could have been increased by 30%, or \$0.6 million above the actual achieved. However, the optimal allocation became increasingly more beneficial in recent years. In the first five seasons of the 1980s, optimal revenues exceeds actual by 18%. This outcome is consistent with the results reported in Tables 3 and 4, which showed the good fit of green-olive prices and quantities.

SUMMARY AND CONCLUSION

This study has conceptualized and estimated an aggregate simultaneous market model of the West Bank olive sector. Olives were disaggregated into pickling and pressing quantity, and the farm level was identified. Empirical results indicated that the demand for both pickled and pressed olives were inelastic. The own-demand elasticities for pickled and pressed olives were -0.9 and -0.1, respectively, at the mean values. In contrast, the own-supply elasticities for pickled and pressed olives were 2.7% and 1.23%, respectively. These results implied that olive growers were more responsive to change in the prices of pickled olives than pressed olives.

The econometric model suggests that per-head food-expenditure elasticities in the 1968–85 period were less than unity for olive products. The indicated positive per-head food-expenditure elasticities logically can be expected to encourage expansion of olive production in the West Bank and Gaza Strip.

The finding of higher own-demand elasticities for pickled olives than for pressed olives suggests that grower returns could be increased by allocating a greater proportion of the total olive crop to the pickling market. The model can also be used to forecast price and allocation of olives for given levels of the predetermined variables, and to determine the allocation of the West

Bank olives which would maximize sales revenue to growers. The model should be both a useful tool for policy makers and practical value to decision makers in the olive industry.

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