Bull. Fac. Agric., Cairo Univ.,53 (2002) : 351-364.

GRADUAL SWITCHING STRUCTURAL CHANGES IN EGYPT FRESH FRUIT DEMAND: GRADUAL REGRESSION MODEL WITH AUTOCORRELATED ERRORS

(Received: 14.5.2001)

By
A. A. Al - Kheraiji

Department of Extension and Agricultural Economics, College of Agriculture, King Saud University, Qassim Branch, Saudi Arabia

ABSTRACT

In this paper, the consumption patterns of Egyptian fruits were analyzed using a time-varying parameterization of the LA/AIDS model. The modified model provides evidence of a structural change, which was accompanied with significant change in price and expenditure elasticities. The estimated elasticities showed that oranges and bananas were less responsive to their own-price changes when the structural change factors were taken into consideration. The gradual change in Egypt fruit demand during the late 1980s would help policy makers in evaluating government programs and in enhancing their attempts to study and use accurate measures for consumption forecasting.

Key words : *autocorrelated error,demand , elasticities , gradual switching regression , la/aids, structural change.*

1. INTRODUCTION

Since the introductions of Almost Ideal Demand System (AIDS) by Deaton and Muellbauer [1980], many applications of this model have been made to analyze consumer demand for food. Most applications of AIDS have also involved static and stable demand systems in which consumers are assumed to fully and instantaneously adjust their optimal purchase of commodities to current changes in prices and income. Attempts to incorporate dynamic elements have sometimes involved using the linear approximation of AIDS (LA/AIDS) (Eales and Unnevhr, 1998). or to incorporating a habit effect in the consumer expenditure function (Chen and Veeman, 1991). The question of the stability of the demand system, also, has been explored through food demand studies. Excluding some important variables, such as changing in the economic environment, or consumer's preferences, will produce a structural change in the demand system, in which situation turns have serious implications for policy decisions and forecast accuracy. Observed changes in fruit consumption patterns in Egypt since 1980 have led to an interest in the size and stability of demand parameters for fresh fruits. The issues of whether there has been a structural change in demand for fresh fruits due, for example, to changes in prices and incomes, or the new regarding the benefits of fresh fruit consumption, are of importance to producers' choice of marketing strategies and to policy makers. One such change occurred in the late 1980s to Egypt fruit consumption. Egyptian per capita consumption of fruits has increased dramatically since 1980.

Per capita consumption of oranges, bananas, and apples (accounted for more than 75 percent of total per capita consumption of fresh fruits) has more than doubled between 1980 and 1999 especially apple consumption (increased by twenty folds). Moreover, bananas and apple consumption was more varying during the 1990s than during the 1980s. While banana consumption in 1982 was less than 11 percent of its 1996 level, apple consumption in 1996 increased by more than 12 folds than its consumption level in 1982. This variability may have been caused by relative prices or non-economic factors such as health concerns and dietary habits, which may have caused differential changes in tastes and preferences.

On the other hand, this phenomenon has been hypothesized to

constitute a structural change in fruit demand. The focus of this paper is that in estimating and testing the stability of demand parameters it is important that demand models should be properly specified and misspecification can lead to biased parameter estimates and to invalid conclusions of structural change (Pearl, 1990). Therefore, a system of demand equations for oranges, bananas and apples for Egyptian fruit consumption demand is estimated. These fresh fruit commodities are assumed to be weakly separable from other consumption items. This paper presents estimates of price and expenditure elasticities obtained from a model which allows for differential gradual switching structural changes in the demand for each commodity. These estimates are compared to estimates obtained from a demand system which assumed no structural change.

2. MODEL SPECIFICATION

The gradual switching Almost Ideal Demand System AIDS employed by Moschini and Meilke(1989) and the linear approximation version LA/AIDS developed by Deaton and Muelbauer (1980) are adopted for the present study. The LA/AIDS is linear in parameters and is a first order local approximation to any system of demand equation. The (conditional) LA/AIDS system of share equations can be written as:

$$w_{it} = \alpha_i + \sum_k \gamma_{ik} \log P_{kt} + B_i \log \left(\frac{X_t}{P^*}\right) + e_{it} \qquad (1)$$

Where t represents time, i and k index commodities, W_i represents the expenditure budget shares of the i^{th} are good, P denotes nominal prices for each commodity, X is total expenditures on the ith good, P^* is a price index and e is a time-wise independent error term that is contemporaneously correlated across the system. P^* is approximated by Stone's share weighted price index:

$$Log\, P^* = \sum_i w_i \log P_i \qquad (2)$$

A time transition path λ_{kt} is introduced into each equation of the LA/AIDS model and represents gradual structural change in the system. The transition function expressing the transition or time path from one regime to the other is approximated by a linear function of time t (Ohtani and Katayama, 1986) and defined as:

$$\lambda_{kt} = 0 \qquad \text{for} \quad t = 1,2,3,\ldots\ldots\ldots\ldots t_1^*,$$
$$\lambda_{kt} = (t - t_1^*)/(t_2^* - t_1^*) \qquad \text{for} \quad t = t_1^* + 1, \ldots\ldots, t_2^* - 1 \qquad (3)$$
$$\lambda_{kt} = 1 \qquad \text{for} \quad t = t_2^*, t_2^* + 1, \ldots\ldots\ldots, T$$
$$t_1^* \leq T - m/(n-1) \quad , t_2^* \geq m/(n-1) \quad , t_1^* < t_2^*$$

Where

t_1^* = the end point of the first regime,

t_2^* = the start point of the second regime,

n = the number of equations in the demand system, and

m = total number of free parameters to be estimated.

Incorporating the time transition path into the LA/AIDS model yields:

$$W_i = \alpha_i + \gamma_i \lambda_{it} + \sum_k (\gamma_{ik} + \delta_{ik} \lambda_{kt}) \log P_{kt}$$
$$+ (\beta_i + \phi_i \lambda_{it}) \log \frac{X_t}{P^*} + e_{it}$$

$\Longrightarrow$ (4)

According to Eq (3), at time $t = t_1$, the parameters $Q_1 = (0, \gamma_{ik}, \beta_i)$ of Eq.(4), being to gradually switch along a linear time path to $Q_2 = (\gamma\gamma_i, \gamma_{ik} + \delta_{ik}, \beta_i + \Phi\phi_i)$. At $t = t_2$, the switch is complete; hence t_2 signifies the beginning of the second regime. If $t_2 = t_1 + 1$, the shift in regime is abrupt. However, with $\gamma\gamma_i = \delta\delta_{ik} = \phi_i = 0$, Eq. (4) reduces to the basic AIDS model. After estimation of Q, t_1, and t_2, a test for structural change can be constructed as a test of the hypothesis that:

$$Q_2 - Q_1 = 0 \qquad (5)$$

Upon estimating Eq. (4), the following restrictions are imposed on the system:

Adding-up,

$$\sum_i \alpha_i = 1, \sum_i \gamma_i = 0, \sum_i \gamma_{ik} = 0, \sum_i \delta_{ik} = 0, \sum_i \beta_i = 0, \sum_i \phi_i = 0; \tag{6}$$

$$\sum_k \gamma_{ik} = 0, \sum_k \delta_{ik} = 0; \tag{7}$$

Homogeneity, and Symmetry

$$\gamma_{ik} = \gamma_{ki}, \delta_{ik} = \delta_{ki} \tag{8}$$

Equation (4) is estimated to obtain the time path parameters. Upon estimation, however, autocorrelation was detected in the system. Therefore, gradual switching demand model of (Moschini and Meilke, 1989) was estimated accounting for first- order autocorrelatiom as follows:

$$W_{it} - \rho W_{it} = \theta + \gamma_i(\lambda_{it} - \rho\lambda_{it-1}) + \sum_k [\gamma_{ik} + \delta_{ik}(\lambda_{kt} - \rho\lambda_{kt-1})]$$

$$(Log P_{kt} - \rho Log P_{kt-1}) + [\beta_i + \phi_i(\lambda_{it} - \rho\lambda_{it-1}]$$

$$(Log \frac{X_t}{P^*} - \rho Log \frac{X_{t-1}}{P^*}) + e_{it} - \rho e_{it-1} \tag{9}$$

Where $-1 \leq \rho \leq 1$ and represents the first-order autocorrelation coefficient, and θ is the new intercept. Denoting $\varepsilon_i = e_{it} - \rho\, e_{it-1}$, the maximum likelihood estimate of $\delta\sigma_i^2$ is giving by $\varepsilon`\varepsilon/ T$. the concentrated log – likelihood ratio is given by:

$$L_{(i)\max}(t_1^*, t_2^*, \rho) = -\frac{T}{2}(\log 2\Pi + 1) - \frac{T}{2}\log \sigma_i^2 \tag{10}$$

The maximum likelihood estimates of t_1^*, t_2^* and ρ can be obtained by searching over all combinations of these parameters. The rejection region of the likelihood ratio test at the 5 percent level for the null hypothesis, Ho: $\rho = 0$, is:

$$L_{(1)\max}(t_1^{**}, t_2^{**}, \rho^{**}) - L_{(1)\max}(t_1^{**}, t_2^{**}, \rho^{**} = 0) > \chi^2/_2$$

(11)

Where (t_1^{**}, t_2^{**}) are the estimated parameters of t_1, t_2 respectively. After t_1^* and t_2^* are chosen for each commodity, the transition path of $\lambda\lambda_{kt}$ are then included in each equation of the demand system.

The gradual switching LA/AIDS model employed by Moschini and Meilke (1989) and adopted for the present study is specified in first-difference form as:

$$dw_{it} = \gamma_i d\lambda_{it} + \sum_k [\gamma_{ik} d\log p_k + \delta_{ik} d(\lambda_{kt} \log p_{kt})] + \beta_i d\log\frac{X_t}{p^*} + \phi d(\lambda_{it} d\log\frac{X_t}{p^*})$$

(12)

Where d denotes that the variables are in difference form.

A change in the price and expenditure parameters of the model suggests that the way in which consumers respond to changes in price and income has changed.

A comparison of price and expenditure elasticities, before and after structural change, may indicate the nature of this behavioral change. Marshallian under the assumption of structural change and conditional on fruits expenditure are given by Moschini and Meilke (1989) [1]:

$$\varepsilon_{ii} = \frac{\gamma_{ii} + \delta_{ii}}{w_{ia}} - (\beta_i + \phi_i) - 1,$$

(13)

$$\varepsilon_{ij} = \frac{(\gamma_{ij} + \delta_{ij})}{w_{ia}} - (\beta_i + \phi_i)(\frac{w_{ja}}{w_{ia}}),$$

(14)

---

[1] Budget shares are believed to shift gradually with the shifts in consumer preferences. The time transition path in each equation should catch the gradual switching trend. Thus any potential bias in elasticity estimates caused by structural changes should be small.

$$\varepsilon_{ix} = \frac{(\beta_i + \phi_i)}{w_{ia}} + 1 \qquad (15)$$

Where W_{ia} is the mean of the i^{th} good share in total expenditure after structural change. To obtain elasticities prior to the structural change, the Φ parameters in (13), (14), and (15) are set zero and substituting w_{ia} (the mean of the good share in total expenditure) for w_{ia}. To compare elasticities evaluated ai the same level of the exogenous variables, the mean of the estimated share over the whole period is used to represent w_{ia}, and w_{ib} is obtained by substracting from w_{ia} the average bias measure (w_{ia}, w_{ib}). However, budget shares are believed to shift gradually with the shift in preferences. The time transition path in each equation should catch the gradual switching trend. Thus any potential bias in elasticity estimates caused by structural changes should be small.

3. DATA

The fruit demand system to be estimated on a per-capita basis includes oranges, bananas and apples. Average annual prices and disappearance data for these commodities from 1980 to 1999 were collected from various issues of the Annual Statistical Book in Egypt and various issues of Agricultural Economic Bulletin.

4. ESTIMATION AND RESULTS

The proper time transition path must be obtained prior to estimating the gradual switching regression model. Maximum likelihood estimates of the gradual switching LA/AIDS model specified in (9), with the homogeneity and symmetry restrictions imposed, are obtained using SHAZAM package. Since (9) has discontinuous derivative with respect to t_1, and t_2, we search over all possible combination of t_1, t_2, ρ for the values that maximize the log likelihood function.

The time path for various values of ρ are listed in Tables 1 to 3. For oranges, a structural change began in 1987 and ended in 1992 (Table 1). Conversely, the transition path for bananas began in 1988

and ended in 1996 (Table2). The switching period for apples began in 1990 and ended in 1997. The coefficient of autocorrelation in the three commodities equations based on their time transition path is 0.48, 0.64 and 0.15 for oranges, bananas, and apples respectively. The maximum likelihood estimates, conditional on the optimum value of t_1, t_2, and ρ (12) for the gradual switching LA/AIDS model are given in (Table 4). The equation representing apples is deleted from the system to avoid singularity condition. The parameters of the deleted equation are recovered using the restrictions imposed by equations (6) – (8).

Over 80 percent of the price and expenditures parameters in (Table 4) are more than twice the size of their standard errors. All expenditure parameters are significant at the 90 percent level or above. Likelihood ratio test statistics distributed as chi-square are computed to test the hypothesis of no structural change. These computed values along with associated degrees of freedom and critical values at the 0.01 and 0.05 probability levels are given in Table 5. The Hypothesis of no structural change in all categories is rejected at either the 0.01 or 0.05 probability level.

The above tests provide strong indications of structural change in Egypt fruit demand. The impact of such change on demand equations and elasticities can be seen by evaluating the price and exenditure elasticities with time transition path as presented in Tables 6 and 7. Bananas and apples are more price elastic demand than oranges while the own-price elasticities are relatively more elastic than the cross-price elasticities , the cross-price elasticities show that oranges and apples, are complementary, but not significant. Furthermore. our results show that orange and apple are not substitute. However, structural change that occurred during the late 90s may support this results. Oranges and apples portrayed as luxury good while bananas is characterized as necessities.

Equation (12) was also estimated without time transition path as reported in Table 4 and their corresponding elasticities in Table 7. The own-price elasticities and expenditures elasticities are higher in absolute value if structural changes are not considered. With the structural change factors taken into consideration, the estimated elasticities show that these commodities, except apples, are less responsive to their own-price changes.

Table (1): Maximum Likelihood Ratios for Values of ρ for Range Equation Switching Time at 1987 and End at 1992.

Values of ρ	- 0.1	0	0.1	0.2	0.3	0.4	**0.48**	0.5	0.6	0.7	0.8	0.9	1
SSE	0.4339	0.3639	0.3002	0.2428	0.1916	0.14673	**0.14320**	0.1523	0.1630	0.1722	0.1991	0.2055	0.2146
MLR	9.9279	11.6874	13.6115	15.7348	18.1019	20.7703	**20.7890**	20.7011	19.9881	19.3211	19.041	18.780	18.3526

SSE = Sum of Square Errors.
MLR = Maximum Likelihood Ratios.

Table (2): Maximum Likelihood Ratios for Various Values of ρ for Banana Demand Equation Switching Time at 1988 and End at 1996.

Values of ρ	- 0.1	0	0.1	0.2	0.3	0.4	0.5	0.6	**0.64**	0.7	0.8	0.9	1
SSE	0.1163	0.0956	0.0771	0.0608	0.0467	0.0347	0.0248	0.0172	**0.0155**	0.0186	0.0802	0.09337	0.09780
MLR	23.0966	25.0523	27.2010	29.5787	32.2289	35.2000	38.5343	39.1233	**39.1325**	38.9104	37.774	38.651	39.0717

SES = Sum of Square Errors.
MLR = Maximum Likelihood Ratios.

Table (3):Maximum Likelihood Ratios for Various Values of ρ for Apple Demand Equation Switching Time at 1990 and End at 1997.

Values of ρ	- 0.1	0	0.1	**0.15**	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
SSE	0.1104	0.0957	0.0823	**0.0703**	0.7221	0.0823	0.0934	0.0963	0.1207	0.1884	0.2007	0.266	0.3442
MLR	23.6150	25.0496	26.5531	**27.0011**	26.8010	26.3150	26.1055	25.7880	25.1982	24.6661	23.7135	22.6622	21.1099

Table (4): Estimated Coefficients of the Gradual Switching LA/AIDS Model.

Equation	Time Transition Path.	Oranges		Banana		Apples		Expenditure	
		Prices	Prices + Time	Prices	Prices + Time	Prices	Prices + Time	Exp.	Exp. + Time
Oranges	-0.1144 (0.7617)	0.5670 (0.0053)	0.0237 (0.0317)	-0.0757 (0.0121)	0.0039 (0.0318)	0.0187 (0.0102)	-0.0276 (0.0315)	0.2422 (0.0191)	-0.0594 (0.02121)
Banana	0.8899 (0.8378)	-0.0757 (0.0121)	0.0039 (0.0318)	-0.0201 (0.0558)	0.0216 (0.0566)	0.0958 (0.0444)	-0.0255 (0.0366)	0.0163 (0.0286)	-0.2104 (0.02353)
Apples	-0.7755 (1.3040)	-0.4913 (0.0149)	0.0276 (0.0430)	0.0958 (0.0676)	-0.0255 (0.0705)	-0.1145 (0.0536)	0.0531 (0.0455)	-0.2585 (0.0358)	0.2698 (0.03658)

(Asymptotic standards errors are in parentheses).

Table (5): Testing for Structural Change.

Hypothesis structural change	Likelihood ratio test statistic	Degree of freedom	$\chi^2_{0.01}$	$\chi^2_{0.05}$
All parameters	81.35	11	27.69	22.35
Intercept parameters	6.01	2	9.21	5.99
Price and Exp. Parameters	21.1	3	11.34	7.81

Table (6): Conditional Elasticities with Time Transition Path.

Elasticities of	Prices of			Expenditure
	Oranges	Banana	Apples	
Oranges	-0.68 (0.053)	-1.2 (0.045)	-1.06 (0.0353)	1.4 (0.035)
Banana	-1.05 (0.13)	-0.80 (0.226)	-0.72 (0.146)	0.39 (0.094)
Apples	-0.54 (0.381)	-1.09 (0.461)	-1.14 (0.298)	1.05 (0.239)

* Standards errors are in parentheses.

Table (7): Conditional Elasticities without Time Transition Path.

Elasticities of	Prices of			Expenditure
	Oranges	Banana	Apples	
Oranges	-1.13 (0.012)	-0.34 (0.027)	-0.09 (0.201)	1.53 (0.042)
Banana	-0.26 (0.038)	-1.09 (0.177)	0.29 (0.141)	1.05 (0.091)
Apples	-1.58 (0.063)	0.75 (0.285)	-1.48 (0.226)	2.09 (0.151)

5. CONCLUSION AND JUSTIFICATION

In this study, empirical estimates from the LA/AIDS model using gradual switching structural changes were obtained to evaluate and examine the demand for fresh fruits in Egypt. The study strongly rejects the hypothesis of no structural change in Egyptian fruit demand. Instead, results suggest a gradual change, starting in 1987 and completed in 1992 for oranges. Conversely, the transition period took 8 years for bananas to be completed (1988-1992). The switching period for apples began in 1990 and ended in 1997.

To assess this empirical finding, Egypt started in 1987 applying special policies and programs to enhance the agricultural sector. Therefore, the production of fruits between 1987 and 1998 doubled from its 1974-1986 level U.N. Production Year Book. Furthermore, there were extensive health programs and food consumption concerns regarding healthy nutrition. Orange consumption (1987-1992) also increased during this period because of these programs and the reduction in exports especially to the Soviet Union, which was the main market for Egyptian oranges. These factors besides low prices enhanced orange demand and orange consumption. Bananas and apple production also increased during these periods and, therefore, increased supply in the Egypt markets. As a result of these factors, prices decreased especially in apple market, which has no foreign markets.

The structural change is found to have a significant impact on the estimated parameters of the model. Estimated elasticities, therefore, show that oranges and bananas are less responsive to their

own-price changes when the structural change factors are taken into consideration. The finding of a gradual structural shift in expenditure on Egyptian fruit consumption during the late 1980s suggests the use by researchers of gradual switching demand model or the use of dummy variable modeling fruit consumption for policy analysis, policy evaluation, program design, and forecasting.

6. REFERENCES

Agr. Econ. Bulletin, Different issues. Egypt, Ministry of Agriculture Economic Sector Affairs, Central Department.

Annual Statistics Book, Egypt, Egypt Statistics Central Department, Different issues.

Chen P. Y. and Veeman M. (1991). An Almost Ideal Demand System Analysis for Meat with Habit Formation and Structural Change. Can. J. Agr. Econ. 39: 223-235.

Deaton A. and Muelbauer J. (1980). Almost Ideal Demand System. American Eco. Rev. 70: 312 –26.

Eales J. S. and Unnevhr L.J. (1998). Demand for beef and chicken: Separability and structural change. Amer. J. Agr. Econ. 70: 512 – 32.

Moschini G. and Meilke K.D.(1989). Modeling the pattern of structural change in U.S meat demand. Amer. J. Agr. Econ. 71: 253-61.

Ohtani K and Katayama S. (1986). A Gradual Switching Regression Model with Autocorrelated Errors. Economic Litters 21:169-172.

Pearl R. C. (1990). Trends in consumption and processing of fruits and Vegetables in the United States. Food Technology. 44 :102 – 4

United Nations Production Year Book, FAO, Different issues.

التغير التركيبي التدريجي للطلب على الفواكه الطازجة في مصر: تقدير دالة الطلب بوجود الارتباط الذاتي

عبد الله بن على الخريجى

قسم الارشاد والاقتصاد الزراعى – كلية الزراعة –جامعة الملك سعود
فرع القصيم –المملكة العربية السعودية

ملخص

تستهدف معظم الدراسات الاقتصادية في الطلب على السلع الغذائية دراسة المتغيرات الاقتصادية وتأثيرها على الطلب دون التمييز بين المتغيرات الاقتصادية والتغيرات في النمط الاستهلاكي بسبب تغير أذواق المستهلكين وتفضيلاتهم. تم في هذه الدراسة إثبات وجود تغير هيكلي في الطلب على الفواكه في مصر بدأ نهاية الثمانينات الميلادية مما أثر على هيكلة الطلب على هذه السلع. كما أن المرونات المشتقة بوجود هذا التغير انحرفت عن القيم الأصلية إذا اعتبرنا أن الطلب على الفواكه كان ثابتاً خلال الفترة موضع الدراسة حيث أصبحت السلع أقل استجابة للتغير في سعرها. من ناحية ثانية، استغرقت الفترة الزمنية المصحوبة بالتغير الهيكلي حوالي ٤ سنوات في الطلب على البرتقال،و٨ سنوات في الموز، و٧ سنوات في الطلب على التفاح. أخيراً، فإن هناك عوامل اقتصادية واجتماعية وصحية صاحبت هذه الفترة الزمنية وساعدت في حدوث مثل هذا التغير مما يحتم ضرورة مراعاة هذه الظواهر وتأثيرها على الطلب عند رسم السياسات المستقبلية أو تقييم البرامج الإصلاحية الخاصة بدراسة سلوك المستهلك وتوفير الغذاء.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (٥٣) العدد الثالث (يوليو ٢٠٠٢):٣٥١-٣٦٤.