INTERNATIONAL MARKET DEMAND FOR COTTON: A SURVEY OF THE LITERATURE

by

Eric Monke
University of Arizona

Economics
Working Paper Series
No. 32

Note: The Research Reports of the Agricultural Development Systems: Egypt Project, University of California, Davis, are preliminary materials circulated to invite discussion and critical comment. These papers may be freely circulated but to protect their tentative character, they are not to be quoted without the permission of the author.

July, 1981

Agricultural Development Systems:
Egypt Project
University of California
Davis, Ca 95616

International Market Demand for Cotton: A Survey of the Literature

I. Introduction

Empirical analysis of the international market for cotton has proven a formidable exercise. The development of noncellulosic fibers in the 1950's and 1960's, cotton's role as an intermediate input rather than an item of final demand, government interference in the international trade of cotton and cotton textiles, and variations in cotton quality have complicated econometric analysis of post-war cotton demand. Analytical approaches vary widely, ranging from models which regard the world cotton market as a single entity, to models which view the international market as a composite of unique relationships between each exporter and importer of cotton. Data limitations and difficulties in model verification have frequently forced a reliance on ad hoc estimation procedures to maximize statistical correspondence. Reliable estimates of income, own-price and cross-price elasticities of demand remain elusive. The competition among different qualities and the degree of integration of the world cotton market, the role of storage in the price adjustment process, and justification of appropriate lags and leads in price response represent additional unresolved issues in the analysis of cotton demand.

An understanding of the mechanics of the international cotton market can be useful in the formulation of Egyptian cotton policy. Egypt accounts for only a small proportion of total world cotton exports, but is the principal supplier of extra-long staple (ELS) varieties. The impact on foreign exchange earnings of changes in the quantity of ELS exports thus depends on the degree of integration of the international market as well as the price elasticity of demand in the market(s). Income and cross-price elasticities are necessary to determine 'appropriate' world prices for use in cost-benefit analysis of expanded production of different staple lengths of cotton. Specification of appropriate lags in the price response of consumers and the price responsiveness of cotton inventories are useful for short-run price projections and thus can assist government planners in the allocation of cotton production between domestic use and exports.

This paper surveys previous empirical work on the international cotton market. Two topics are of primary interest, the degree of market integration across different qualities and the appropriate behavioral model for use in subsequent estimation of demand parameters. The evidence on market integration, discussed in Section II, is extremely limited. Market share studies represent the only attempts to assess market integration. These studies have focussed on price variations across countries rather than differences in quality parameters such as staple length, micronaire or grade. Section III discusses empirical models of the demand for cotton. While studies vary widely in their use (or non-use) of market models, three results appear sufficiently often to suggest new approaches to the analysis of international cotton demand. First, a number of studies have successfully focussed on the demand for all fibers. Cotton demand is then analyzed as a subcomponent of total fiber demand. These results suggest the possible relevance of conditional demand functions derived from separable utility functions. Second, the ad hoc searches for statistical correspondence between price and quantity variables has consistently yielded significant relationships between consumption and lagged rather than current prices. The role of cotton as an intermediate input for a forward-ordering industry (textiles), suggests an adaptive expectations model in which cotton purchases are made on the basis of expected rather than current prices. A final group of potential models is based on the separability of international and national markets due to institutional structures. In this group of models, world prices become functions of export availabilities, with variations in availability determined by government policies. World prices are not directly relevant to levels of consumption and production, and predictions of future prices depend on speculated changes in government policies and only indirectly on price and income responses of consumers and producers. The latter class of models has not yet been empirically tested.

II. Market Share Analysis and Quality Differentials

Two papers (Sirhan and Johnson, 1971; Johnson, Grennes and Thursby, 1979) suggest that cotton is a heterogeneous product differentiated by country. Differentiation may be due to quality differences, reliability as a source of supply or any other country-specific attribute. Each importing country regards cottons from alternative exporters as close but not perfect substitutes, so that

$$M_a^i \equiv \frac{q_a^i}{Q^i} = f(P_a, P_o),$$

where M_a = country a's market share in the i^{th} market,

P_a = cif price of country a's cotton,

and P_o = a vector of cif prices of cottons from other countries.

Conversion to logarithms and differentiation of the market share identity leads to the following elasticity relationships:

$$\frac{\partial q_a^i}{\partial P_a} \frac{P_a}{Q_a^i} = \frac{\partial M_a^i}{\partial P_a}\frac{P_a}{M_a^i} + \frac{\partial Q^i}{\partial P_a}\frac{P_a}{Q^i} .$$

The price elasticity of demand for a's cotton in the ith market is thus equal to the market share elasticity of country a plus the elasticity of i's total demand with respect to country a's price.

The additional assumption that importers adjust their purchasing pattern gradually in response to changing price environments leads to equation (1):

$$M_{at} = \gamma a + \gamma\beta P_t + (1-\gamma)\, M_{a(t-1)}, \qquad (1)$$

where P_t = the ratio of country a's cif price to the average of other country prices.

If equation (1) is correct, the estimation of international market demand becomes a monumental task. Price and quantity data are needed for all exporting countries in each import market. In the case of cotton, the implied matrix contains as many as 2,000 cells. In addition it is necessary to estimate the price elasticity of import demand for each importing country. Even if a great number of cells are zero, constraints on data availabilities will prevent estimation of the complete international market system.

Sirhan and Johnson's results for the British market suggested a long run market share elasticity for U.S. cotton of between -10 and -20, dependent on the functional form of equation (1). Attempts to estimate market share elasticities for U.S. cotton in West German markets were not successful.

Do these results suggest that cotton is a nonhomogeneous product distinguished by location of production? Does each exporting country have discretionary control over the price of its cotton in each import market? Firch (1972) indicates that for practical purposes, market share elasticities as large as -10 and -20 are not different from -∞. An elasticity of -10 implies that only a 10 percent change in the U.S. price relative to other prices will force the U.S. market share to zero. For an elasticity of -20, only a 5 percent change in the U.S. price is required. Thus discretionary control over prices appears limited at best, and the results of market share analysis do not warrant elimination of the assumption that cotton is a homogeneous product with respect to country of origin. These results are not surprising, given that cotton is an intermediate product which is bleached, dyed, often blended with synthetics or other fibers and transformed into textiles, rope or other processed products before final consumption.

End products of cotton processing could be identified by country of origin, but only if differences in the quality of cotton exist across countries and remain consistent over time. The differences in cotton prices then become quality- rather than country-dependent, and suggest the need for fuller specification of the characteristics of cotton. While cotton is not a perfectly homogeneous commodity, it may still be characterized as a single commodity differentiated by quality characteristics Hedonic analysis to determine the value of quality characeristics becomes the appropriate technique for intergration analysis. If the value of quality variations remains constant over time, the world cotton market can be considered as a single, unified market. Disaggregation of the world market into sub-markets for separate demand analyses are indicated when premia or discounts can not be attached to particular quality characteristics.

Staple length is perhaps the most important quality characteristic of cotton. Both fiber fineness and fiber tensile strength are positively associated with staple length, and longer staples result in finer, stronger yarns than those made from short staple cotton. Staple lengths are graded by thirty-seconds of an inch, and categorized as short (less than one inch), medium (1 to 1.14 in.), long (1.15 to 1.29 in.) and extra-long (greater than 1.29 in.). Long, and extra-long staple cottons are produced from varieties of Gossypium barbadense, while the shorter categories are produced primarily from G. hirsutum varieties.

Grade is a second important indicator of cotton quality. Grade is determined by cotton color, waste content of ginned cotton (leaf paricles and other trash), and preparation (the presence of small knots of tangled fibers, or neps). Specific definitions of grade differ among countries, but lower grades signify higher processing costs or lower quality end products. Neps, for example, result in defects in yarn and fabrics, and are often impossible to remove. Thus lower grades are sold at discounted prices. These price effects can be substantial. Grade differences are currently responsible for as much as a 30 percent variation in the price of a given staple length of U.S. cotton. El-Kholi and Abbas (1980) have documented the deterioration of quality in Egyptian cotton over the period 1951-77. The aggregate costs of quality deterioration were estimated to fall between 10 and 45 million L.E., and were particularly significant for ELS varieties.

Additional indicator of cotton quality include fiber length uniformity and micronaire reading. Increased variation of fiber length makes processing more difficult and leads to increased waste and reduced output quality. Micronaire readings are a measure of fiber fineness, and optimum values are thus dependent on the particular variety of cotton. Within each varietal class, unusually low micronaire values suggest the presence of immature fibers. Immature fibers are susceptible to the formation of neps and dyeing irregularities resulting in poor yarn appearance.

Varieties in cotton quality thus correspond to increased processing costs or altered values of processed products. Quality characteristics are not necessarily associated with country of origin. The extent of fiber immaturity, for example, depends on deviations from optimum growing conditions, and can be expected to vary from year to year. The results of Sirhan and Johnson that country prices do not move in exact synchronization need not indicate market power of exporting countries. Instead, such price differences may reflect country specific changes in the quality of cotton exports.

Little attention has been given to the hedonic analysis of quality variations. Hakim (1972) and other industry observervers have argued that substitution is marginal among different staple lengths, and thus the world market is not integrated across different staple lengths. Hakim claims, for example, that the price margin between ELS and upland (short and medium staple) varieties narrowed during the 1950's and 1960's. This pattern was the result of increased availability of man-made fibers, which were able to imitate the length, fineness and strength of ELS fibers (Hakim, p.124). Hakim's empirical results (ibid., p. 45) appear to suggest the opposite conclusion. ELS prices declined twice as rapidly as upland prices in nominal terms, but this response is necessary to maintain a constant relative price relationship. World prices for ELS varieties show a consistent premia of 90 percent relative to upland prices for the period 1947-70.

$$P_{ELS} = -8.39 + \underset{(12.34)}{1.89}\, P_{UPLAND} + \underset{(4.76)}{18.95}\, DUMMY \quad R^2 = .88$$

where P_{ELS} = Liverpool quotation for Egyptian ELS;

P_{UPLAND} = Liverpool quotation for American Middling 1" cotton; and

DUMMY = 1 for 1951, 1956 and 1967, 0 elsewhere.

III. Models of the Demand for Cotton

A. The Demand for All Fibers and Conditional Demand Functions

Recent developments on the separability of consumer preferences provide a theoretical justification for an approach to cotton demand developed by Donald et al. (1963), and used subsequently by Collins et al. (1979), Dudley (1974), Magleby and Missaien (1971), Thigpen (1978) and Ward and King (1973). Separability of preferences (see, for example, Deaton and Muellbauer, 1980, 122-34) implies that the consumer's utility function can be described as a collection of sub-functions, or

$$U = \emptyset_1 (q_1, q_2, \ldots, q_n)$$
$$= \emptyset_2 (V_1(Q_1), V_2 (Q_2), \ldots, V_h(Q_h)),$$

where $\emptyset_1', \emptyset_2' > 0$.

Each Q represents a vector of q's, and all Q are mutually exclusive. This formulation allows the construction of a utility tree, illustrated in Figure 1. Each V function thus represents a separate utility maximization problem

$$\text{Max } V_i \ (Q_i)$$
$$\text{s.t.} \sum_{z \varepsilon i} P_z q_z = Y_i$$

where $Q_i = (q_1, q_2, \ldots, q_z, \ldots q_n)$,

and Y_i = total sub-group expenditure.

The demand function for each commodity within the subgroup can be written as a function of group expenditure and prices within the group. These are conditional demand functions

$$q_{1i} = \psi_{1i} \ (P_{1i}, P_{2i}, \ldots P_{ni}, Y_i; \bar{a}),$$

where $\bar{q}$ is the set of $q \notin Q_i$.

The effects on the demand for q_{1i} due to changes in total income or changes in prices outside the subgroup are limited to their effects on Y_i, the sub-group expenditure. The total income elasticity of demand for q_i, for example, is the product of the sub-group expenditure elasticity $(\frac{\partial q_i}{\partial Y_i} \frac{Y_i}{Q_i})$ and the inter-group expenditure elasticity $(\frac{\partial Y_i}{\partial Y} \frac{Y}{Y_i})$. The

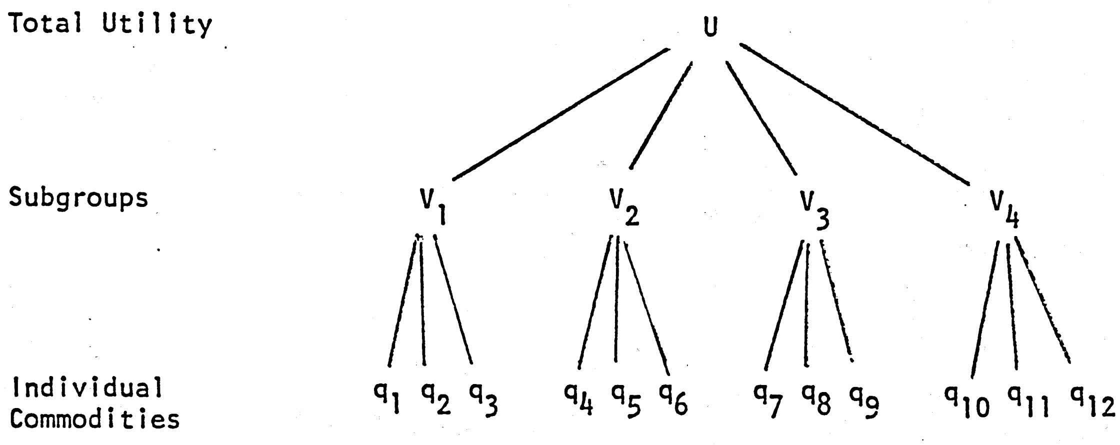

Figure 1. The Utility Tree

principal advantage of the separability approach is the reduction in the number of variables necessary for empirical estimation. A difficulty with the approach involves estimation of the budget allocation among groups. The use of price and quantity indices in the empirical estimations of intergroup relationships creates implausible restrictions on income elasticities. (Deaton and Muellbauer, 129-133). Thus the results of separability analyses can be approximately correct at best.

Consideration of the demand for cotton as part of a two-stage budget allocation process with separable preferences may be a useful context in which to evaluate consumer demand for cotton. Apparel and household furnishings seem plausible group expenditure categories. Relative fiber prices influence the composition of textile products and thus determine the allocation of group expenditure between cotton and synthetics. At the same time, application of this model does some disservice to reality, as industrial uses for fibers such as medical supplies, abrasives, automobile upholstery, and tires do not fall in the aforementioned group expenditure categories. Fortunately, industrial uses of cotton are relatively minor. In the U.S., for example, industrial uses accounted for only 15 percent of total cotton use.

The results of studies of the elasticity of demand for all fibers are summarized in Table 1. The earliest study in this group is that of Donald et al. (1963). In their model, the fiber market consists of four levels of demand-consumer, retailer, fabricator and mill. Donald assumed that demand is unspecified by fiber type until the mill level is reached, where fabricator demands are distributed among alternative fibers on the basis of relative prices and "special conditions" of demand. Donald's results for the U.S. are presented in equation (1) of table 1. The income

Table 1. Estimates of Total Fiber Demand

1. Donald et al., 1927-32, 1935-40, 1948-60, U.S.

$$\ln Q = -0.38 + \underset{(8.89)}{0.8 \ln Y} + \underset{(4.73)}{1.23 \ln \Delta Y} - \underset{(1.93)}{0.27 \ln P}$$

$R^2 = 0.90$

where Q = U.S. per capita fiber consumption in pounds of cotton equivalents, Y = real per capita income, and P = deflated fiber price index, where individual fibers are weighted by total use shares.

2. Dudley, 1953-70, U.S.

$$\ln Q = 0.88 + \underset{(10.38)}{0.86 \ln Y} + 0.51 \ln P_{t-1},$$

$R^2 = 0.91$ DW = 1.29

3. Magleby and Missaien, 1964, Global model with 33 regions

$$\ln Q = a + \underset{(11.7)}{0.62 \ln Y},$$

$R^2 = 0.82$

$$Q = a + \underset{(12.9)}{8.92 \ln Y},$$

$R^2 = 0.84$

Income Level	Elasticity
100	2.45
200	.91
500	.50
1,000	.37
2,000	.29
3,000	.26
Sample average	.65

where Q = per capita raw fiber consumption, unadjusted

Table 1. continued

4. Thigpen, 1970-72 averages, Global model with 19 regions

$$Q = -23.07 + \underset{(11.0)}{4.78}\ \ln Y, \qquad R^2 = .88$$

$$\ln Q^C = 1.66 - \underset{(-6.25)}{194.99}\ \frac{1}{Y}, \qquad R^2 = 0.70$$

where Q = per capita raw fiber consumption;

Q^C = per capita cotton consumption

Income level		Income Elasticities: Fiber Demand	Income Elasticities: Cotton Demand
Developing economies	(\$235)	1.4	0.5
Centrally planned	(\$450)	0.6	0.2
Developed	(4,000)	0.3	0.07

5. Dudley, 1953-70, U.S.

$$Q^{MA} = a_1 - \underset{(1.28)}{3.93}\left(\frac{P^C}{P^P}\right) + \underset{(7.74)}{0.64}\ D^{MA} - \underset{(7.19)}{0.74}T \qquad R^2 = 0.89, \qquad DW = 1.68$$

$$Q^{WA} = a_2 - \underset{(1.54)}{5.11}\left(\frac{P^C}{P^P}\right) + \underset{(2.05)}{0.64}\ D^{WA} - \underset{(3.31)}{0.74}T \qquad R^2 = 0.94 \qquad DW = 2.30$$

$$Q^{HH} = a_3 - \underset{(3.65)}{6.13}\left(\frac{P^C}{P^P}\right) + \underset{(4.09)}{0.12}\ D^{HH} - \underset{(2.07)}{0.10}T \qquad R^2 = 0.71 \qquad DW = 1.78$$

$$Q^{OP} = a_4 - \underset{(5.01)}{3.27}\left(\frac{P^C}{P^P}\right) - \underset{(0.54)}{0.03}\ D^{OP} + \underset{(2.19)}{0.06}T \qquad R^2 = 0.71 \qquad DW = 2.14$$

$$Q^{IU} = a_5 - \underset{(13.01)}{6.80}\left(\frac{P^C}{P^P}\right) + \underset{(8.25)}{0.35}\ D^{IU} - \underset{(10.86)}{0.18}T \qquad R^2 = 0.98 \qquad DW = 2.23$$

$$R^2 = 0.98 \qquad DW = 2.23$$

where Q = cotton consumption per capita; P^C = price of SLM $1\frac{1}{16}$" cotton at group B mill points, U.S. cents/lb; P^P = average of wool, cellulosic and noncellulosic prices, U.S. cents/lb;

Table 1. continued

D = total fiber demand, in lbs. per capita; T = time trend from 1964 through 1970. The superscripts MA, WA, HH, OP and IU represent men's apparel, women's apparel, household furnishings, other consumer products, and industrial uses, respectively.

elasticity of fiber demand is somewhat greater than 0.8 and appears strongly significant. Dudley (1974) estimated a similar function with more recent data (equation (2)), utilizing polyester rather than nylon prices as representative of noncellulosic prices for 1958-70. Unfortunately the Durbin-Watson statistic suggests serial correlation and the price coefficient is of the improper sign. Collins et al.(1979) attempted a time series analysis of FAO consumption data for the 1960-74 period, in which the world was divided into twenty regions. In general, income elasticities appear higher in developed than developing country regions, although results were statistically insignificant for eight of the 20 regions. The omission of a price variable may create some uncertainty about the validity of the results.

Difficulties with the definition of appropriate price indices for fibers have led other authors to rely on cross-sectional data in order to estimate the income elasticity of total fiber demand. Magleby and Missaien (1964) used 1964 FAO data for domestic availability of total fibers to determine income elasticities (equation (3)). The principal shortcoming of these data are their aggregation on the basis of weight rather than utility poundage. Both log-log and semi-log forms were tested, with little difference in terms of closeness of fit. The implications for demand projections, however, differ substantially. The semi-log form suggests elasticities for high income countries which were only one-third as large as the time series estimates of Donald and Dudley, and one-half as large as those suggested by the constant elasticity form. Thigpen (1978) applied a semi-log form to 1970-72 FAO data, and obtained results similar to those of Magleby and Missaien (equation (4)). Both the t-statistic and R^2 were higher than the results of attempts to estimate elasticities of cotton demand from the same data. A semi log-inverse form provided the best fit in the latter case, suggesting income elasticities of demand only one-third as large as those implied in the analysis of all fiber demand.

None of these studies are developed in terms of a two-stage budget model, and thus the second stage of the allocation process remains untested. Dudley's study provides some indication of the potential of this approach. He estimates per capita cotton demand in five end-use categories as a function of relative prices, total fiber demand as a proxy for fiber expenditures, and a time trend for 1964-70 to represent noncompetitive substitution of synthetics for cotton. Unlike most studies, current rather than lagged prices were utilized, which may account for the two cases of insignificant t-statistics. Mean value relative price elasticities ranged from -0.09 to -0.61, with a weighted average elasticity of -0.25. Expenditure elasticities ranged from 0.9 for men's apparel to -0.4 for women's apparel, with a weighted average elasticity of 0.31. The total income elasticity of U.S. demand for cotton implied by these results is 0.27.

B. Adaptive Expectations and Cotton Demand

Color, fabric coarseness and fiber mix are important characteristics of textile end-products, and at each level of textile fabrication and distribution, orders are placed and/or received for the delivery of goods in a future period. The current demand for cotton thus depends on textile production decisions made in some previous time period. These decisions, particularly with respect to fiber mix, are presumably influenced by the expected prices of cotton and other inputs. Assumption of perfect forecast of income and population changes allows an expression of per capita demand for cotton based on expected prices for fibers.

$$Q_t^d = f\ (P_t^{c*}, P_t^{p*}, Y_t, T_1, T_2, \ldots)$$

where P^c = price of cotton

P^p = price of polyester

Y = income

T_1, T_2 = taste and technological trend variables

and * denotes expected values.

Use of the Nerlovian adaptive expectations formulation, $P_t^* = a\ (P_{t-1} - P_{t-1}^*) + P_{t-1}^*$, and assumption of a linear functional form leads to equation (2).

$$Q_t^d = a\alpha + a\beta_1 P_{t-1}^c + b\beta_z\ P_{t-1}^p + (a-b)\beta_2\ P_{t-1}^{p*} + (1-a)\ Q_{t-1}^d - (1-a)\beta_4\ Y_{t-1} + \beta_4 Y_t, \qquad (2)$$

where a and b are the coefficients of expectations on cotton and polyester prices, respectively. If each individual adjusts his expectational errors consistently, a will equal b and P_{t-1}^{p*} is eliminated from equation (3). The remaining independent variables are observable.

The results of empirical analyses, through not developed in terms of adaptive expectations models, often bear some resemblance to equation (2). The results of these studies are summarized in Table 2. The studies of Ecevit (1978) and Adams and Behrman (1976) bear the closest resemblance to the adaptive expectations model. Ecevit's quantity data are in aggregate rather than per capita terms, and thus suggest larger own-price and cross-price elasticities relative to those obtained by Adams and Behrman. The treatment of the quantity variable may also explain the differences in the sign of the time trend coefficient. The important similarities among the two studies are the presence of lagged values of

Table 2. Regression Estimation of Cotton Consumption

1. Ecevit, 1958-75, World

$$Q = \underset{(1.3)}{5747} - \underset{(3.7)}{7633.2}\, P^c_{t-1} + \underset{(3.0)}{3888.4}\, P^p_{t-1} + \underset{(2.8)}{0.481}\, Q_{t-1} + \underset{(4.6}{377.2}\, T$$

$R^2 = .95 \quad DW = 1.7$

where Q = world consumption, '000 bales; P^c = Liverpool cotton price index, P^p = price of 1.5 denier polyester staple (both prices deflated by the CPI for ten industrial countries); T = time.

2. Adams and Behrman, 1955-73, World

a. Developed Economies

$$\ln\left(\frac{Q}{POP}\right) = \underset{(1.0)}{-1.365} + \underset{(2.7)}{0.475}\, \ln\left(\frac{Q}{POP}\right)_{t-1} - \underset{(2.9)}{0.230}\, \ln\left(\frac{P^c}{P^p}\right)_{t-1} + \underset{(1.8)}{0.603}\, \ln\left(\frac{GDP}{POP}\right) - \underset{(2.2)}{0.027}\, T$$

$\bar{R}^2 = .92 \quad DW = 1.6$

b. Developing Economies

$$\ln\left(\frac{Q}{POP}\right) = \underset{(10.7)}{-1.564} - \underset{(0.9)}{0.021}\, \ln\left(\frac{P^c}{P^p}\right)_{t-1} - \underset{(2.9)}{0.046}\, \ln\left(\frac{P^c}{P^p}\right)_{t-2} - \underset{(4.2)}{0.060}\, \ln\left(\frac{P^c}{P^p}\right)_{t-3} - \underset{(2.2)}{0.050}\, \ln\left(\frac{P^c}{P^p}\right)_{t-4}$$

$$+ \underset{(15.0)}{0.471}\, \ln\left(\frac{GDP}{POP}\right)$$

$\bar{R}^2 = .98 \quad DW = 2.7$

Table 2. continued

c. Centrally Planned Economies

$$\ln(\frac{Q}{POP}) = \underset{(4.0)}{0.237} + \underset{(2.9)}{0.197} \ln(\frac{Q}{POP})_{t-1} \underset{(2.6)}{-0.108} \ln(\frac{P^c}{P^p})_{t-1} + \underset{(12.4)}{0.604} \ln(\frac{Q^s}{POP}) + \underset{(3.2)}{0.003T}$$

$\bar{R}^2 = .97$ DW = 1.9

where Q = consumption, '000mt; POP = population, in millions; P^c = UN export price index, P^p = index of manmade fiber textile products; GDP = gross domestic product index; Q^s = production, '000 mt; T = time.

3. <u>Thigpen, 1955-75, World</u>

a. Developed Economies, 1956-75

$$\ln Q = 7.09 - \underset{(-10.15)}{0.20} \ln(\frac{P^c}{P^p})_{t-1} + \underset{(6.44)}{0.24} \ln IPI,$$

R^2 = 088 DW = 1.43

b. Developing Economies, 1955-75

$$\ln Q = 1562.64 - \underset{(-3.49)}{4.90} P^{cl}_{t-1} + \underset{(53.85)}{22.56} IPI$$

R^2 = 0.99 DW = 2.56

c. Centrally Planned Economies

No significant relationships were found.

where Q = mill consumption of cotton in '000 mt; P^c = cif Liverpool price of Mexican SM$1\frac{1}{16}$" cotton, in U.S. cents/lb; P^p = fob plant, U.S. price of 1.5 denier polyester staple in U.S. cents/lb; IPI = UN index of industrial production (an income proxy); P^{cl} = cif Liverpool price for Pakistan 289F S.G. cotton, in U.S. cents/lb, deflated by U.S. wholesale price index.

Table 2. continued

4. Donald et al., 1927-32, 1935-40, 1948-60, U.S.

$$\ln Q = 0.39 + \underset{(5.0)}{0.40} \ln Y + \underset{(4.6)}{0.92} \ln \Delta Y - \underset{(2.3)}{0.14} \ln P_{t-1} - \underset{(4.3)}{0.13} \ln NC - \underset{(4.5)}{0.09} \Delta S$$

$$R^2 = 0.87$$

where Q = per capita cotton consumption, in lbs.; Y = real per capita income; P_{t-1} = real producer price for cotton, lagged 15 months; NC = per capita consumption of noncellulosic fibers, S = ratio of stocks of cotton broadwoven goods to unfilled orders, measured at textile mills.

consumption,cotton prices, and polyester prices (the Adams-Behrman study uses an index of synthetic end-product prices rather than raw material prices).

The estimation of own- and cross-price elasticities may represent the most difficult problem in the study of cotton consumption. The relative price elasticities found by Adams and Behrman ranged from -0.1 to -0.4, and are in agreement with the results of other studies (see equations (3) and (4) of Table 2). Thigpen estimates a lagged relative price elasticity of -0.20 for the developed countries, and a mean value own-price elasticity of -0.09 in the developing economies although his data are not in per capita terms. Donald's results for U.S. demand during the period 1927-60 suggest a lagged own-price elasticity of -.14. Noncellulosics were the dominant synthetic fibers during that period, but unavailability of reliable price series forced the use of quantity data. Synthetic consumption appeared to influence cotton consumption, although the cross-price effects can not be estimated from Donald's results.

The magnitude of elasticities seems unusually small given the technical feasibility of adjusting the polyester/cotton mix in yarn. Noncellulosic fibers can be produced to any desired degree of fineness ranging from shirt material (1.5 denier) to carpet yarn(15.0 denier). Mill adjustments involve cleaning equipment and altering equipment settings and operating speeds, and should not be particularly difficult in a forward-ordering industry. The inability of cotton to mimic the permanent press properties of polyester and the comfort advantages of cotton due to its superior moisture absorption may limit the magnitude of substitution to some degree, but variations of at least 20 percentage points in the share of an individual fiber appear plausible.

The observation of low cross-price elasticities may have been caused in part by the limited availability and relatively high prices of non-cellulosic fibers before the mid-1960's. Polyester prices were four times higher than cotton prices (Thigpen, A-I, 10) but rapid increases in production, due to expansion in the U.S., Japan and Western Europe, resulted in rapid price declines. Since the early 1970's the cotton/polyester price ratio has fluctuated around unity in the U.S., although substantial cross-country differences and manufacturer prices discounting make such estimates uncertain.

A second factor which complicates analysis of the competitive relationship among fibers is the inequality of fiber utilities. Low waste content and the greater strength/weight ratio of synthetic fibers mean that synthetic fibers produce a greater yardage of textile per pound of raw material than cotton. The differences in fiber utility vary by end-use, but data limitations force a reliance on average conversion factors. Donald, et al. (1963, 127) and Thigpen (A-3, 6) are the only authors who attempt to put all fibers on a cotton equivalent basis. Donald et al. used utility factors of 1.28 for cellulosic fibers and 2.0 for nylon, while Thigpen applied a factor of 1.37 to non-cellulosic fibers.

Finally, much of the competition between cotton and polyester fibers was not price-competitive. Polyester materials are far superior to cotton in a number of end-uses due to the uniformity and control over fineness, length and strength of fibers, and much of the substitution for cotton in the 1950's and early 1960's depended on synthetic fiber availability rather than price. The result was a substantial decline of cotton's share in total fiber use. In the U.S., for example, cotton share declined from 68 percent in 1960 to about 50 percent in 1980. Industrial and miscellaneous use markets, such as tires, rope and carpeting, were almost entirely captured by synthetic fibers. Apparel and household furnishing shares also declined substantially, due principally to the easy-care properties of synthetics.

An important implication of lagged price response in consumption is that current prices become entirely dependent on the behavior of stockholders. Duguay and Hansen's findings suggest that stock accumulation is more price responsive than industry demand, which yields the unusual result that short-run elasticities are of a larger magnitude than lagged and long-run elasticities. The analysis of more recent stock data (1953-72) by Adams and Behrman yielded somewhat different results. Current stocks (measured relative to total demand)were not responsive to current prices, and significant relationships between stock levels and prices occurred with a distributed lag over a three-year period. The authors caution, however, that this "may not be a realistic result and may reflect the systematic downward trend of the (deflated price) variable over the sample period" (Adams and Behrman, p.38).

C. Government Policy and the Segregation of the International Market

A final approach to international market demand models regards international trade and world prices for cotton as largely independent of domestic consumers. This relationship results from recognition of the pervasive role of government in cotton and cotton textile trade. Indication of the substantial degree of government interference in trade is provided in number of publications (for example, Bredahl <u>et al.</u>, 1979; Hager, 1979; Magleby and Missiaen, 1971; Petges, 1980). Imports of cotton are usually not taxed, but government controls over domestic textile production and textile export quotas determined under the Multi-Fiber Arrangements, gives government policies a significant influence upon the demand for cotton fibers. On the export side, cotton trade is generally strictly controlled by governments due to priorities for the domestic textile industry. In addition, the reliance on trade taxes as a source of government revenue means that world prices have little relevance to many producing areas. The U.S. is the principal exception to this generalization.

Recognition of the dominance of government policy suggests the possibility of a model in which international market demand may be considered separately from world consumption. Changes in trade participation influence rather than respond to world prices. Price changes can thus be viewed as a function of quantity changes, a reversal of the traditional formulation. If these quantity changes are expressed in excess demand form, a single equation model with price changes a function of excess demand will define an excess supply curve. This curve measures the response of the market to exogenously determined changes in demand. In functional form,

$$\Delta P/P = f(\Delta T/T),$$

where $\Delta T = \sum_i (M_t - M_{t-1}) - \sum_i (X_t - X_{t-1})$, and $T = M_t + X_t$.

The variables are P = price, M = imports, X = exports, i = non-price responsive trade participants, and t = time.

By the trade identity, total imports must equal total exports and

$$(\sum_i \Delta M - \sum_i \Delta X)/T = (\sum_j \Delta X - \sum_j \Delta M)/T$$

where j = all remaining trade participants ($i \neq j$).

Equations (2) and (3) form a model with two unknowns, $\Delta P/P$ and $(\sum_j \Delta - \sum_j \Delta M)/T$, and regression of $\Delta T/T$ on $\Delta P/P$ will thus trace out an excess supply curve. This curve is distinct from the familiar market supply curve, because the excess supply curve comprises both demand and supply responses. Exogeneous information on price response behavior of the j participants in the trade is needed in order to determine market demand and supply elasticities, The principal implication of this model is that world price determination depends entirely on assessments of government policy actions rather than consumer income growth or the development of new fibers. Consumer income growth may lead to increased fiber demand, for example, but whether this demand results in increased import demand for cotton fibers may depend largely on government policy decisions with respect to domestic fiber production and the growth of the domestic textile industry. Thus consumer demand has only an indirect influence on world prices. No attempts have been made to apply this model to an analysis of cotton trade.

IV. Summary

This survey of the literature has not attempted a detailed critique of econometric methods and results from past studies. Rather, the intent has been to develop the groundwork for subsequent research on the international cotton market. The results suggest three principal areas for emphasis. First, the issue of market integration remains undecided. Market linkages among different qualities of cotton have not yet been verified. Secondly, the empirical results of past studies of the cotton market suggest three plausible models of demand behavior -- a two-stage budgeting process, an adaptive expectations model, and a market segregation model. These approaches are not necessarily mutually exclusive. Finally, the consistent failure to find significant relationshiops between consumption and current prices highlights the importance of inventory responses for any short-term projection of world prices.

References

Adams, F. G. and J. R. Behrman, 1976, Econometric Models of World Agricultural Commodity Markets (Cambridge, Mass.: Ballinger Publishing Co.)

Bredahl, M. E., W. H. Meyers, K. J. Collins, 1979, The Elasticity of Foreign Demand for U.S. Agricultural Products: The Importance of the Price Transmission Elasticity, American Journal of Agricultural Economics 61(1): 58-63.

Collins, Keith J., R. B. Evans and R. D. Barry, 1979, World Cotton Production and Use: Projections for 1985 and 1990, ESCS and FAS, USDA, Foreign Agricultural Economic Report No. 154.

Ecevit, Leyla U., 1978, Recent Developments in the World Cotton Market and the Future Outlook, International Monetary Fund Staff Papers 380-405.

El-Kholei, O. A. and M. Abbas, 1980, Effect of Existing Egyptian Cotton Policy on Deterioration of Cotton Quality, The Egyptian Statistical Journal 24(1): 41-73.

Deaton, Angus and J. Muellbauer, 1980, Economics and Consumer Behavior (New York: Cambridge University Press).

Donald J. R., F. Lowenstein and M. S. Simon, 1963, The Demand for Textile Fibers in the United States, Economic Research Service, U.S.D.A., Technical Bulletin No. 1301.

Dudley, George E., 1974, U.S. Textile Fiber Demand: Price Elasticities in Major End-Use Markets, Economic Research Service, U.S.D.A., Technical Bulletin No. 1500.

Duguay, Gerry and B. Hansen, 1978, "The Demand for American Cotton, 1899-1939: An Econometric Disequilibrium Analysis", Working Paper No. 7, Dept. of Economics, U.C.-Berkeley.

Firch, Robert S., 1972, "A Market-Share Approach to the Foreign Demand for U.S. Cotton: Comment", American Journal of Agricultural Economics 52(2): 375-376.

Hager, Christine J., 1979, Textiles: U.S. Trade Agreements, Imports and Consumption, ESCS, U.S.D.A., ESCS-75.

Hakim, Osman Abdel-Rahman, 1972, The Effects of the U.S. Cotton Policy on the World Market for Extra-Long Staple Cotton, unpub. Ph.D. thesis, University of Arizona.

Johnson, Paul R., T. Grennes and M. Thursby, 1979, Trade Models with Differentiated Products, American Journal of Agricultural Economics 61(1): 120-127.

Magleby, R. S. and E. Missiaen, 1971, World Demand Prospects for Cotton in 1980, with Emphasis on Trade by Less Developed Countries, Economic Research Service, U.S.D.A., Foreign Agricultural Economic Report No. 000.

Petges, Richard, 1980, Pakistan's Cotton Industry, Foreign Agricultural Service, U.S.D.A., FAS-M-296.

Sirhan, G. and P. R. Johnson, 1971, A Market-Share Approach to the Foreign Demand for U.S. Cotton, American Journal of Agricultural Economics 53: 593-99.

Thigpen, M. Elton, 1978, International Cotton Market Prospects, World Bank Staff Commodity Paper No. 2, June, 1978.

Ward, L. F. and G. A. King, 1973, Interfiber Comptition with Emphasis on Cotton, ERS, U.S.D.A., Technical Bulletin No. 1487.