A HEDONIC ANALYSIS OF SUDAN AND UNITED STATES COTTON PRICES.

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A HEDONIC ANALYSIS OF SUDAN AND UNITED STATES COTTON PRICES

by

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STATEMENT BY AUTHOR

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ABSTRACT

This study investigates the effect of differences in staple lengths and grades on the price of cotton. Particular attention is given to the cottons of the United States and the Sudan. The hedonic technique is used to test the hypothesis of market integration across those qualities and the effects of government pricing policies on the pattern of premia and discounts. A third use is to measure the cost of quality deterioration in Sudanese cotton. The hedonic analysis for the Sudan shows that the market for different staple lengths is integrated, whereas it is not true for the different grades. Sudanese cotton quality has been deteriorating since the early 1970's.

The analysis of the U.S. government loan pricing program reveals that the cotton market for staple length 32 is independent of the other markets throughout the 1962-1981 period. Prices of the remaining staple lengths demonstrate consistent premia for the 1962-1971 period. After 1971, relative prices for the staple lengths demonstrate no consistency. The markets for different grades, on the other hand, are strongly integrated. The free market prices for 1973-1981 suggest that markets for all the staple lengths and grades are integrated.

CHAPTER ONE

INTRODUCTION

Sudan's economy is heavily dependent on the agricultural sector. Over 76 percent of its economically active population was employed in agriculture and related activities in 1980 (United Nations, Food and Agricultural Organizations (UN, FAO) Production Yearbook, 1981, p. 61), accounting for 43% of the country's gross national product (World Bank, World Development Report, 1980, p. 114). Although cotton production is being discouraged in favor of sugarcane, oil seeds, wheat and livestock, it retains a dominant role in the Sudanese economy. The share of cotton in the total export revenues was approximately 41 percent in 1978. This share has declined only slightly over time. In 1960, for example, cotton revenues comprised 52 percent of export earnings. Finally, some industrial projects, such as spinning and weaving factories, are dependent on cotton production.

Cotton production is also an important part of the U.S. economy. Hakim (1972) reported that seven million people were engaged directly in cotton production, and about 14 billion dollars were invested directly in cotton production. Total production of cotton has varied between 10 and 14 million bales (480 pound net weight) over the 1960-1980 period. Table 1 shows that exports have played a significant role in the aggregate demand for U.S. production.

TABLE 1. U.S. Cotton Exports and Values for the 1960-1980 Period

	Exports	
Year	Quantity (1,000 Bales)	Value (1,000 Dollars)
1960	7,238	936,799
1965	3,162	385,764
1970	3,866	492,200
1975	3,397	873,004
1980	5,740*	3,016,471**

Sources: For 1960-1975 (USDA, Statistics on Cotton and Related Data, 1960-1978, p. 57)

*(USDA, Foreign Agriculture Circular, Cotton, 1981)

**(U.S. Foreign Agricultural Trade Statistical Report, 1981, p. 19)

Cotton quality characteristics, particularly with respect to staple length and grade, are important determinants of price. These quality differences are examined by the use of hedonic analysis to test the hypothesis that the markets for different staple lengths and grades are integrated. If these premia are stable over time, a hedonic index can provide the basis for government pricing programs, such as loan rates in the United States and producer prices in Sudan, and thus encourage improved resource allocation and maximization of foreign exchange earnings from cotton exports.

Chapter Two contains a review of previous approaches to hedonic analysis. Hedonic indexes are defined and consideration is given to the theoretical problems that arise from index estimation. Finally, applications of hedonic indexes to industrial and agricultural products are reviewed. Chapter Three gives a brief review of both Sudan and U.S. cotton policies, with particular attention to their effect on cotton quality and the world market. Chapter Four contains the methodology, data, and interpretation of the hedonic results. The summary and conclusions of the study are presented in Chapter Five.

CHAPTER TWO

LITERATURE REVIEW

The price index seeks to compare the price level of two or more situations, i.e., points in time or place. For example, if two situations, 0 and 1, are taken and the prices of the goods are designated P_0^I, P_0^{II}, $P_0^{III} \ldots P_0^n$, and P_1^I, P_1^{II}, $P_1^{III} \ldots P_1^n$. The price index may be looked upon as some kind of average of the price quotients $\frac{P_1^I P_1^{II}}{P_0^I P_0^{II}}$ etc. Indexes are usually expressed as percentages, of the form $\frac{100\ P_1^i}{P_0^i}$. The hedonic price index focuses on the empirical hypothesis that the multitude of models and varieties of a particular commodity can be decomposed into a much smaller number of characteristics. In its parametric version, it asserts the existence of a relation between the prices of different models and the level of their numerous characteristics.

The need for a hedonic approach arose because of computational problems in the evaluation of new models or varieties for the construction of price indexes. One of the first authors to pay attention to the quality problem was Knibbs, who wrote in 1912 that:

> The advances in technology have led in many cases to marked improvement in the quality of manufactured articles. Since, however, the use of the article, thus improved in quality, may

> proceed by imperceptible changes, a feature not uncommon with regard to textiles, for example, it is not always possible to take so exact an account of differences of quality as has been indicated as necessary, (1912, p. Xliii).

He added, "For example, in textiles a tweed at the second date may have the same general appearance and weight and replace the use of that at the first date, but the number of threads in the warp and woof may be wholly different and this may, of course, have affected the price," (1924, p. 49). Court also wrote:

> Commodity-price indexes originally were based almost entirely on prices of standardized raw materials or semifabricated products whose specification remained unchanged over long periods. Recently, however, articles fabricated from hundreds of separate parts, designed for complex functioning, and subject to rapid improvement in design and construction, have played an expanding role. Particular difficulties arise in constructing price indexes for those evolving products of twentieth century technology," (1939, p. 99).

The solution to the problem of valid price comparison is the specification of commodity standards. Court was the first to suggest that articles be priced according to their useful characteristics. Griliches (1970) has also emphasized the problem of selection of relevant characteristics to define a commodity and warned against the use of variables which are direct results of market experiments. An example is the use of quantities produced to explain relative automobile prices. Although the characteristics theory would predict that models which have more quality per dollar will sell better, this may be a characteristic of the market, not of the commodity. For example, the purchasing power of the consumer may be a limiting factor in preference for a high quality product.

Another problem of most analyses involves the choice of weights for different characteristics. Griliches (1970) suggests that an ideal approach would use regression analysis to estimate the prices of relevant characteristics. These prices would then be used in the construction of a more detailed quantity-of-characteristic index. The change in the quantity-of-characteristics index per particular model is defined as:

$$\frac{dQ_i}{Q_i} = \Sigma_j W_j \frac{dq_j}{q_j}$$

where Q_i is quantity index for the ith model of the product, q_j the level of the jth characteristic, and W_j is the value share of that characteristic in the total price of the aggregate commodity, $W_j = P_j q_j$; then the above equation could be rewritten as:

$$\frac{dQ_i}{Q_i} = \Sigma_j P_j dq_j$$

where $\Sigma_j P_j q_j$ is the total value of the jth characteristics. The pure price change is then estimated simply as the rate of change of observed price minus the rate of the change of quality per commodity unit:

$$\frac{d\ \pi_i}{d\ \pi_i} = \frac{dP_i}{P_i} - \frac{dQ_i}{Q_i}$$

However, this model needs relatively recent and often changing price weights that cannot be obtained in continuous intervals. Although the use of the most recent cross-section to derive the relevant price change is practical, such results often yield poor estimates due to multicollinearity and sampling errors. Necessary assumptions for estimations are that left out quality variables must be assumed uncorrelated with included variables, or that existent correlations persist in the future.

A common alternative to the Griliches' approach is to use time dummy variables. The coefficients are interpreted as the direct estimate of the pure price change. Problems of this approach arise in the vagaries of sample selection. Cross-sections often vary significantly in sample size from year to year, causing the difficulty of overall comparability of any two cross-sections. In addition, the observed price variation over time is not due just to the variables considered, but may also be caused by the quality characteristics left out of the estimated equation.

Industrial product prices, especially automobiles, have attracted most of the empirical attention (Court 1939, Griliches 1961, Dhrymes 1967, and Kravis and Lipsey 1969). Court's (1939) study of passenger cars represents the first attempt at a hedonic index. Characteristics, such as horsepower, braking capacity, window area, seat width, and tire size, were combined into an index reflecting consumer values. If the price per car is divided by the index of hedonic value, then valid comparisons of cars can be made in the face of changing specifications.

Court (1939) used two approaches to hedonic measurement. The first was suggested by Sidney I. Wilcox, chief statistician of the U.S. Bureau of Labor Statistics. The methodology was a multiple regression analysis for all the different cars produced in the index base period. The prices of the individual models were the dependent variables, and the corresponding specifications were the independent variables. The coefficients of the different specifications represent their value in the product price. He found that the hedonic value of a car in periods before or after the base period could be obtained by multiplying these coefficients by the appropriate specifications.

The hedonic approach used by Court involved a time series cross-section regression of prices on specifications. The coefficients on time dummy variables provide a direct estimate of the pure price change, i.e., the change in the price of a car between periods holding the specifications constant. To compute the pure price change, Court used time trends equal to the number of time periods minus one. This approach yields a net regression of price on time and avoids over identification of the matrix of independent variables. To illustrate the analysis, Court used three time periods and three specifications. The trend factors are designated as t_1 and t_2 , p = price, w = car weight, f = wheel base, and h = horsepower. The multiple regression equation can be written as follows:

$$p = k + b_{pw \cdot fht_1t_2} w + b_{pf \cdot wht_1t_2} f + b_{ph \cdot wft_1t_2} h + b_{ph \cdot wft_1t_2} h + b_{pt_1 \cdot whft_2t_1} + b_{pt_2 \cdot whft_1t_2}$$

where the subscripts on the regression coefficients indicate the percentage change in price as the result of a change in the corresponding specification, holding other specifications constant. In geometric terms, the net price change during a period is the distance between two parallel multidimensional faces. Each surface shows the effect of different specifications on price, while the distance between the surfaces represents the pure price change over time.

Griliches (1961) examined the relationship of price for U.S. passenger four-door sedans to their different quality specifications for the years 1937, 1950, and 1954 through 1960. Horsepower (H), weight (W) and wheel length (L) were the major numerical quality variables. In addition, dummy variables are given to such qualities as V-8 engine, hard top, automatic transmission, standard power steering, stnadard power brakes and compactness. The estimation used the semi-logarithms form.

The coefficient estimates for some of the years were unstable as a result of high multicollinearity between the three numerical qualities. Usable estimates were obtained only for years in which there was some independent variation along the three numerical quality dimensions, and for combinations of years where the large number of observations allowed determination of separate coefficients with greater precision. In the examination of particular years, the coefficients are usually of positive sign, except for that of the V-8 engine. If horsepower and the other variables are used constant, a V-8 was about four percent cheaper than a six cylinder car in 1960. The coefficient of weight was almost always significantly different from zero and relatively stable throughout the cross-sections. In most cases, the coefficient of horsepower was also significant, but varied somewhat more in magnitude around a downward trend. The most unstable coefficient was that of length--very large and significant in 1950, declining rapidly in the middle fifties, and becoming insignificant and sometimes negative by 1958 and in subsequent years. This result was due to the low variability of length in the sample (the coefficient of variation was only about four percent on the average) and to the substantial increase in the length of lower priced cars since 1957.

The results were then used to estimate the average price change that took place between two periods in the list prices of automobiles, holding all the specified qualities constant. Between 1937 and 1950, approximately one-third of the price change was due to changes in a few selected quality specifications, and between 1954 and 1960 almost all of the price increase was attributable to quality change. Thus, it was not possible to reject the hypothesis that the real price of automobiles did not change over the period.

Dhrymes (1967) made an empirical study on price and quality changes in automobiles and refrigerators. Dhrymes concentrated on two issues. First, quality corrected price indices are correct only when all manufacturers pricing functions are statistically homogenous, so that the coefficients represent consumer evaluations of the quality content of the identifiable characteristics. Second, linear, semilog and double log forms of price equations were considered to determine the best functional form.

Dhrymes included all two- and four-door standard models of automobiles for 1953, 1957, 1961, 1962, 1963 and 1964. Subsamples were established for each of three manufacturers, to test the hypothesis of homogeneity in the pricing functions of the three manufacturers. The comparison between coefficients of determination showed that generally the semilog and double log forms performed better, although the differences were insignificant. Since semilog forms were used by previous investigators, the same practice was followed by Dhrymes.

High collinearity among the independent variables for weight, length, displacement, and brake horsepower led Dhrymes to a principal components' approach. Dhrymes explained:

> In ordinary regression analysis what we try to do is to account for the variations of the dependent variable in terms of variations in the independent (or explanatory) ones... If a few linear combinations of the explanatory variables are formed, the movement of the explanatory variables can be accounted for and, hopefully, the dimensionality of the problem can be reduced, and in that sense the principal components are linear combinations of the explanatory variables, i.e., these linear combinations are mutually uncorrelated, and they are so constructed that the sum of these variances is equal to the sum of the variances of original variables," (1967, pp. 96-97).

Dhrymes results suggested that price behavior varied significantly among manufacturers. One manufacturer experienced a price decline over the period 1953 through 1963 and a price increase between 1963 and 1964. For another manufacturer, an appreciable and consistent price increase over the period 1953 through 1954 was observed. For a third one, it was found that the nominal price was increasing between 1953 and 1961 and decreased after that. Consideration of manufacturers on an individual basis did not yield stable estimates, and Dhrymes' results did not differ much from that of Griliches. They reached the same conclusion, that the real price did not change over time.

Kravis and Lipsey (1969) attempted to use hedonic indexes to compare prices in different countries. International price comparisons faced added problems, such as the international differences in product specifications. They used automotive diesel engines as an example of use of regression methods. Data on 1963 prices (P), horsepower (H), revolutions per minute (RPM), engine displacement (D), and weight (W) were obtained for 73 engines produced in the United States, the United Kingdom, Germany and France. Multicollinearity again proved to be a problem for the estimation. Weight was highly correlated with displacement and inversely correlated with number of revolutions per minute. In that sense, it was doubtful that weight would add much to the explanation of price variation. But the exclusion of weight led to a substantial decrease of R^2 and a significant change in the other coefficients. Thus, weight was included in the equations. Horsepower was eliminated because of its high correlation with the other variables and was substituted by mean effective pressure (M), which is less correlated with the included variables. Thus, W, M, D and R were selected to explain the differences in diesel engine prices.

Three types of regression analysis were tried. One type involved pooling all data, assuming equal element prices in all countries.

$$P = F(M, D, W, R, K, g, f)$$

where,

P = price of engine

K = dummy variable for U.K. engine

g = dummy variable for German engine

f = dummy variable for French engine

A second approach was to fit a separate regression for each country:

$$P_u = F_u\ (M, F, W, R)$$

$$P_k = F_k\ (M, D, W, R)$$

$$P_g = F_g\ (M, D, W, R)$$

$$P_f = F_f\ (M, D, W, R)$$

where,

P_u = the U.S. price

P_k = the U.K. price

P_g = the German price

P_f = the French price

A third technique pooled all data but allowed for international differences in the prices of quality elements by using additive and multiplicative dummy variables:

$$P = F' (M,D,W,R,k,g,f,kM,kD,kW,kR,gM,gD,gW,gR,fM,fD,fW,fR)$$

The last approach, known as flexible pooling, allows for pooling where there are no significant differences among countries in prices of certain elements, and allows for differences in element prices where they appeared to be statistically significant. In addition, the approach enlarges the size of the sample and its range.

The final regressions were based on 67 observations for the United States, the United Kingdom and Germany, and 14 independent variables are included. France was eliminated due to the scarcity of observations. (If France was included, then five additional independent variables would be needed, i.e., one intercept and five slope dummies).

Arbitrary rules were adopted for the inclusion and exclusion of dummy variables from the final equation. First, the slope dummy coefficients for both the country in question and base country should be subjected to prior economic and technical considerations. For example, if the slope dummy for German engine weight, taken in conjunction with the base coefficient, let to a negative relationship between price and German engine weight, then the slope dummy would not be retained in the equation. Second, the intercept or slope dummy had to be at least as large as its standard error. This procedure implies that the variables that measure price differences should be retained only where significant. Third, the retention of the slope dummy variables could not cause the corresponding basic variable to lose its statistical significance. Fourth, when the above three conditions are satisfied by more than one equation, the one with the highest coefficient of determination (R^2) was preferred. Finally, all the slope dummy variables were dropped if the fourth condition was not met by a combination of dummy variables for a given country. The coefficients of the intercept dummies were then taken as an alternative way of analyzing the result as there is no price variation.

Using the above criteria, the best double log functional form included the intercept dummy variable for the U.K. and German slope dummies for displacement and weight. The price relatives, obtained by that method, were 70 for the U.K./U.S. and 85 for Germany/U.S. The best inverse semilog equation gave price comparisons of 81 for U.K./U.S. and 93 for Germany/U.S. In spite of differences between the results, there is no statistical preference of one over the other. The double log form was preferred because it has the advantage of multiplicative rather than an additive relationship among the independent variables.

One of the early attempts to estimate a hedonic price index for agricultural products was made by Waugh (1929). His objective was to discover the quality factors--such as size, shape, color, condition, pack and other physical characteristics--which influence the prices of locally grown vegetables in the Boston wholesale market, and further, to measure quantitatively the influence of these factors on price. Asparagus, tomatoes and hot-house cucumbers were chosen. The data were composed of six or eight lots of a commodity, which were typical of the quality on the market, combined with the actual sales prices of the same lots. A careful, detailed inspection of samples of two or three boxes taken from each lot was made. The amount of green color, the average size of stalks and the uniformity of stalks within the bunch were found to be quality factors influencing asparagus prices. The amount of green color was three times as influential as the average size of stalks and almost twenty times as important as the uniformity of stalks. The quality factors used in the analysis of tomato prices were condition, growth cracks and pack. These quality factors of tomatoes seemed to be related to specific needs during the sale period. For example, condition and color are especially important on Thursdays because of shipment needs. Long, slender cucumbers were preferred and the highest prices paid were for over seven inches long with a diameter between twenty and twenty-five percent of the length. In general, Waugh found that, "those qualities which command premiums in the market seem to reflect real superiority in taste, food value or similar indications of real quality," and "there are some indications that as supplies diminish and average prices increase, the price differentials due to quality decrease," (1929, p. 22).

Petzel and Monke (1979) extended hedonic analysis to the problem of the integration of the international rice market. The authors' objective was to examine the consistency of price behavior among different qualities of rice supplied to the world market. This study examined market integrations from three perspectives--geographical, intertemporal, and quality linkages. Geographical integration deals with links between classes of exporters and importers. The intertemporal one considers monthly time series of Thai and United States prices. These relationships are estimated with bivariate price regressions used to measure integration across different varieties and qualities of rice. Data for Thailand and United States' rice quality and price were used, and data availabilities restricted the investigation to long and medium grain varieties. All the quality indicators were dummy variables.

$$P = f(X_1, X_2, X_3, X_4),$$

where,

X_1 = country of origin

= 1 if United States

= 0 if Thailand

X_2 = length of grain

= 1 if long

= 0 if medium

X_3 = percentage broken

= 1 if less than five percent broken

= 0 if greater than five percent broken

X_4 = raw or parboiled

= 1 if raw

= 0 if parboiled

The logarithmic form was chosen for the estimation. Due to a radical change in price levels on the rice market in 1973, two types of equations were used to test that shift. The first one included an intercept dummy:

$$\log P = f(X_1, X_2, X_3, X_4, D)$$

where,

D = intercept dummy with a value of 1 in period 1967-1972; and zero in period 1973-1978.

The results of the hedonic estimation showed that low percentage of brokens, U.S. origin, and raw rice are valued higher than the other corresponding rice qualities with coefficients of 0.465, 0.285, and 0.166, respectively. The difference in the prices paid for long and medium grain rice is insignificant, with a coefficient of -0.039. The intercept dummy was highly significant with a coefficient of -0.912, showing a much lower overall rice price in the 1967-1972 period than that of 1973-1978.

The above equation does not test the hypothesis of market linkage. Market linkages were investigated by forming another equation:

$$\log P = f(X_1, DX_1, X_2, DX_2, X_3, DX_3, X_4, DX_4, D)$$

where,

DX_1, DX_2, DX_3, and DX_4 are slope dummies.

If there is a linkage in the rice market, then discounts and premiums should be relatively stable showing infinite cross-price elasticities with respect to quality characteristics. The results showed that a shift occurred in the parboiled market. The premiums for other variables remained stable, showing that the rice market is integrated on a Thai-United States' basis, staple length, and percentage brokens.

This means that importers and exporters have enough substitutes to keep prices of different qualities in line with one another.

In summary, the early studies of Knibbs (1912) and Waugh (1929) were the precursors of hedonic price estimates. Knibbs did not use an empirical study to test how quality differences affect prices. Waugh's approach was based on variables that are direct results of market experiments, against which Griliches (1970) warned recently. The application of hedonic indexes started when Court (1939) investigated passenger car price index. His approach was to interpret the coefficient of a time dummy variable in a time-series cross-section regression of prices on specification as a direct estimate of the pure price change. Griliches (1970), Dhrymes (1967), and Kavis and Lipsey (1969) revived the hedonic multiple regression approach for construction of prices indexes. These three studies provided useful examples of making adequate allowance for quality change in interpretation of the significance of price change. Monke and Petzel (1981) extended these studies to the agricultural field and used the hedonic concept to test the hypothesis of market integration. The objectives of earlier studies were the construction of price indexes with regard to quality changes. The later studies, and especially that of Monke and Petzel, aimed at use of hedonic analysis to test hypotheses, such as that of market integration.

CHAPTER THREE

A BRIEF REVIEW OF SUDAN AND UNITED STATES COTTON POLICIES

Sudanese Cotton Policy

Cotton has been produced in Sudan since 1904, beginning as a small pilot scheme in Zeidab in the northern region of the country. Since then it has been the main source of farm income and received principal attention from agricultural policy makers. Before independence, the Sudan Plantation Syndicate was responsible for cotton affairs. Immediately after independence (1956), the Cotton Board in the Ministry of Finance and Economics took over the responsibilities of marketing policies and the Ministry of Agriculture, represented by the government schemes, was responsible for production policies. Also, there were many private companies in charge of marketing of private estates' cotton. In 1969, nationalization of these private estates resulted in the formation of the Public Cotton Corporation.

Before independence, cotton production and marketing policies were determined by the demands of cotton ginners and manufacturers in the United Kingdom. Interest in the Sudan as a supply source was stimulated by the failure of American and Egyptian Crops in 1909 (Gaitskell, 1957). Cotton was also considered an important potential source of revenue to the colonial government. "Faced with the necessity of administering a country as undeveloped as Sudan in the early years of this century, it was essential that the British government should not be burdened by the expense... This could be done by cotton cultivation," (Barnett, 1977, p. 4). As a result of that, the Gezira Scheme was founded in 1913. World War I delayed the production stage until 1925. Extra-long staple cottons were the dominant varieties, due to their fine spinning qualities and high quality fabrics.

After independence, production policy continued to favor extra-long staple varieties (Table 2), and cotton remained the main source of foreign exchange. The net proceeds of the sale of cotton were shared with producers according to a specific formula. The producer shares were 50 percent of the proceeds; that of the national government amounted to 36 percent, and 14 percent was allotted to local government councils, social development programs and research within the region of the scheme, and administration expenses. Producers were free to grow other crops, such as sorghum, cowpea, groundnuts, wheat and vegetables within the cotton rotation.

The world economic recession of 1974, combined with the competition from the man-made fibers and advances in spinning technology, marked a turning point for the world demand for the ELS cotton. Further problems for cotton policy arose when the Sudan government tried to increase the price of ELS cotton in the world market. Monke and Petzel (1981) argued that the emergence of synthetic fibers and advances in spinning technologies indicated that the ELS market may not be independent of the markets for other staple lengths. This caused world demand for the Sudanese ELS cotton to be very elastic. When Sudan would attempt to fix prices, consuming countries simply

TABLE 2. Sudan Cotton Acreage During 1954-1978 Period (in 1000 Feddans). One Feedan = 1.038 Acre

Year	ELS and Long Staple Varieties	Medium and Short Staple Varieties
1954	436	193
1955	380	260
1956	399	177
1957	575	161
1958	495	206
1959	611	243
1960	719	190
1961	681	225
1962	728	405
1963	733	333
1964	738	312
1965	749	301
1966	750	385
1967	784	373
1968	774	385
1969	790	375
1970	801	314
1971	815	320
1972	820	337
1973	824	353
1974	871	340
1975	621	357
1976	550	447
1977	550	605
1978	505	450

Source: Sudan Cotton Review, 1965-1978.

shifted to shorter staple lengths in which Sudan had no dominant role. No practical measures were taken to clear the market, such as adjustment of ELS and long staple cotton prices. The result of this policy was large increases in carryover during the latter half of the 1970's as shown in Table 3.

Government response to fluctuations in demand and prices of ELS cottons emphasized diversification into other crops, such as groundnuts and wheat, and other varieties of cotton. Specific goals were established for cotton production. First, production would be limited to meet world demand for longer staples given the expected availabilities from other exporting countries. Second, the accumulated stock would be eliminated by reduced production in the late 1970's. Third, sales campaigns were recognized to try to maximize prices. Finally, production policy needed to emphasize increased flexibility with respect to staple length.

International market demand for Sudanese extra-long staples was estimated between 500,000 and 600,000 standard bales (420 pound weight) for 1975/76 and 1977/78, including 20 to 30 thousand bales per year for local consumption. By 1975, total uncommitted supply of extra-long and long staples reached 1.34 million bales, and average production was planned at 400,000 bales in order to draw down the stock within a five year period. Planned extra-long and long staple areas were reduced from 810,000 to 620,000 acres in 1975/76 and to 550,000 acres in 1976/77 and 1977/78. The area for 1978/79 declined further to 505,000 acres due to rain and flood damage.

TABLE 3. Sudan, Ending Stocks (August 1)
(in 1000 of 480 pound bales)

Season	Total Supply	Exports	Stocks	% Share of Stocks in Total Supply
1969/70	1886	1086	800	0.42
1970/71	1853	1053	800	0.43
1971/72	1844	994	850	0.46
1972/73	1702	1092	610	0.36
1973/74	1626	726	900	0.55
1974/75	1843	543	1300	0.71
1975/76	1721	991	730	0.42
1976/77	1369	609	760	0.56
1977/78	1592	692	900	0.57
1978/79	1487	817	670	0.45
1979/80	1125	800	325	0.29

Source: World Cotton Statistics, 1974-1980.

The results of the diversification policy were not encouraging as stocks continued to accumulate. A principal reason was that aggregate cotton acreage did not decline substantially. Total cotton acreage declined only from 1.2 to 1.1 million acres between 1975 and 1980. Timing and water requirements constituted important constraints on the substitution among crops. Other factors which hampered the diversification program involved the slow adjustment to new agronomic practices and the lack of extension services, limitations in transport and power availabilities, and lack of processing facilities such as saw-gins for short staple cotton.

Sudanese policy makers thought prices for ELS cotton declined relative to medium staple and short staple varieties on the world market after 1974. Price data presented in Table 4 do not confirm this change. Another issue not taken into consideration by Sudanese policy makers in the decision to substitute different staple lengths in cotton production involved the trade-off between yield and price. Average yields of Sudanese ELS cotton were 572, 314, 205, and 201 pounds per acre for 1960, 1965, 1970 and 1975, respectively; whereas that of medium staple were 786, 697, 426 and 398 for the same years. The yield premium for medium staple is almost double that of ELS in that period. Thus, the higher yields of shorter staple lengths may offset their price discounts compared to ELS varieties, and growing shorter staple cotton may result in more farm income and foreign exchange earnings. The effect of these policies on Sudanese cotton qualities and prices will be examined by the use of hedonic analysis.

TABLE 4. Average Prices of Sudanese Cotton Varieties, 1972-1980 (in cents/pound)

Year	Extra-long Staple	Medium Staple	Short Staple
1972	42.6	36.9	31.2
1973	74.9	58.3	46.5
1974	84.4	69.5	61.6
1975	91.4	65.4	55.0
1976	91.0	74.7	67.5
1977	89.2	76.1	71.5
1978	98.9	75.1	68.4
1979	101.5	78.1	66.9
1980	99.0	82.0	72.8

Source: Sudan Cotton Review, 1978-1980.

United States Cotton Policy

Cotton production and marketing policies emerged in the late 1920's in an attempt to raise farm incomes. The Agricultural Marketing Act of 1929 emphasized the stabilization of domestic prices at fairly high levels by buying and storing excess supply during surplus years and releasing it in years of low production and supply. This act also established loan operations for a number of crops, with the initial loan rate for cotton set at 16 cents per pound in October 1929 (Cable, 1957, p. 5). Cotton prices rose immediately to the loan rate level, but declined after only a few months due to the beginning of the Great Depression. The effect of declining demand on prices was aggravated by a bumper crop of 17 million bales in 1931 (Hakim, 1972, p. 10).

The failure to stabilize farm prices led to additional legislation aimed at direct production controls. The Agricultural Adjustment Act of 1933 (Committee on Agriculture, 1966, pp. 39-40) attempted to raise the price of cotton towards the parity price of 1909-1914 through voluntary reduction of cotton area, use of direct compensation for participation in acreage control programs, regulation of marketing through voluntary agreements with processors and associations of producers, and licensing of marketing groups to avoid unfair practices. The act also provided for non-recourse loans of ten cents a pound. This legislation caused a reduction of 1933 acreage to about 29.4 million acres. Due to high yields, however, output approximated that of 1932. The market control provisions of the act were strengthened with the Bankhead Cotton Control Act of April 1934 (Hakim, 1972,

p. 14), limiting production of cotton to 10 million bales. As a result, the 1934 acreage dropped to about 26.9 million acres, farmers' incomes increased to 989 million dollars in 1935-1936 and government stocks declined from 6.7 million bales to about 3.9 million bales in 1936. However, this act was invalidated by the decision of the Supreme Court as being unconstitutional (Hakim, 1972, p. 15).

The Soil Conservation and Domestic Allotment Act of 1936 was the replacement for the former act, and emphasized payments to farmers for voluntary shifting of acreage from soil-depleting crops to soil-conserving crops such as legumes and grasses. Producers of cotton received five cents a pound in 1936 for diverted acreage. The act was ineffective, as acreage reached 29.8 million acres and prices of middling 7/8 inch dropped from 12.8 cents per pound in 1936 to 8.8 cents per pound in 1937.

The Agricultural Adjustment Act of 1939 represented a shift to price support legislation as a means to maintain farm income. Emphasis was also shifted from marketing quotas to direct acreage controls. The effect of the latter policy on acreage was negated as yields per acre increased. The emphasis on price policy was maintained in the Agricultural Acts of 1948, 1949 and 1952. These acts aimed at price parity for growers who approved marketing quotas (Hakim, 1972, p. 27) and provided flexible price supports. The marketing quotas and price support policies were invalidated during 1951 and 1952 in order to secure sufficient fiber during the Korean War, and extended again in 1952 to cover both 1953 and 1954 cotton crops. Production increased substantially, and Commodity Credit Corporation stocks reached 8.2 million bales in 1954, compared to 2.5 million bales during the 1950-1953 period.

The Agricultural Act of August 1954 provided for price supports ranging from 82.5 percent to 90 percent of parity for the 1955 crop and from 75 to 90 percent of parity thereafter (Hakim, 1972, p. 30). These parity levels did not discourage production, and carryover reached 11.1 and 14.5 million bales for 1955 and 1956, respectively.

The Agricultural Act of 1956 attempted to reduce stocks of cotton with acreage reserve and conservation programs. The maximum acreage that could be placed under acreage reserve was not to exceed half the allotment or ten acres, whichever was larger, and the minimum acreage to qualify the farmer for payment was not to be less than ten percent of the allotment or two acres, whichever was larger, with payments of 15 cents a pound on the average output of the acreage reserve (Cable, 1957, p. 34).

To further reduce excess supplies, the Commodity Credit Corporation was authorized to sell at world prices. The difference between domestic and world prices was met by an export subsidy, a policy which remained in effect during the 1955-65 period. While export sales reduced publicly-held levels of stocks, the effect was only temporary. Increases in acreage allotments during the early 1960's caused increases in stocks. By 1966, government stocks reached 14.3 million bales (USDA, Statistics on Cotton and Related Data, 1960-1978, pp. 1 and 36).

Opposition to the Agricultural Act of 1956 increased in the 1960's, since export subsidies reduced production costs in foreign mills and thereby weakened the competitive position of United States' textile manufacturers (Hakim, 1972, p. 37). The Cotton-Wheat Act of 1964 authorized the Secretary of Agriculture to make subsidy payments to textile mills, but the high cost of the program resulted in elimination of both the export and textile mills subsidies via the Agricultural Act of 1965. The act also provided diversion payments for acreage diverted out of cotton production into conservation uses. The program was effective in controlling production, but prices still declined as shown in Table 5. The 1978 and 1980 Agricultural Acts aimed at the policy of supporting cotton prices in the farm level.

Thus, for much of the post-war period, policies caused domestic prices to exceed world prices. In addition, U.S. price policies during the 1950's and 60's dictated world market prices, due to the substantial stock levels of the Commodity Credit Corporation. The costs of these policies gradually led the government to reduce the loan rate, resulting in a pricing system dominated by free market forces after 1972. The patterns of production and prices became dominated by the world market.

The hedonic analysis will be used to test the effect of government set prices for grades and staple lengths on market integration. Government policy determined market prices before 1973, but not in the post-1973 period. Given that pre-1973 government prices are equal to market prices, a comparison will be made between the premia and discount structure for grades and staple lengths for that period, and

TABLE 5. U.S. Cotton: Acreage Harvested, Production, Stocks and Prices, 1964-1978

Year	Acreage Harvested (1,000 acres)	Production (1,000 bales)	Stocks (1,000 bales)	Price (cents/pound)
1964	14,057	15,145	12,378	31.07
1965	13,615	14,938	14,291	29.35
1966	9,552	9,557	16,862	21.75
1967	7,997	7,443	12,533	26.70
1968	10,160	10,926	6,448	23.11
1969	11,055	9,990	6,521	22.00
1970	11,155	10,192	5,760	22.93
1971	11,471	10,477	4,252	28.23
1972	12,984	13,704	3,234	23.30
1973	11,970	12,974	3,939	44.60
1974	12,547	11,540	3,743	42.90
1975	8,796	8,302	5,481	51.30
1976	10,914	10,581	3,594	64.10
1977	13,275	14,389	2,920	52.30
1978	12,367	10,841	5,326	60.50

Source: USDA, Statistics on Cotton and Related Data, 1960-1978.

the structure of market prices in the post-1973 period. Also, the hedonic analysis will be used to test how U.S. government policy distorted relative market prices.

CHAPTER FOUR

METHODOLOGY, DATA, RESULTS AND INTERPRETATIONS

The technique used for the hedonic analysis of Sudanese and United States' cotton prices is to combine all cross-section and time-series data and perform ordinary least square (OLS) regression on the entire data set. To show the number of observations and degrees of freedom in such a pooling process, consider the following two-variable model:

$$Y_{it} = \alpha + \beta x_{it} + e_{it}$$

where,

$i = 1,2,\ldots\ldots, N$, cross-section observations

$t = 1,2,\ldots\ldots, T$, time periods

If all the classical assumptions about the error term hold (no correlation with x, the expected value of the error term is zero, its variance does not vary with time, its value is independent of the value of any other term, and they are normally distributed), then separate cross-section regressions could be estimated, each involving N observations. For time period T=1, the cross section regression would be:

$$Y_{i1} = \alpha + \beta_{i1} + e_{i1}$$

where,

$i = 1,2,\ldots\ldots, N$

There would be a total of T such equations. Similarly, N time-series regressions could be estimated with T observations in each. However, if both α and β are constant over time and across cross-section units, more efficient parameter estimates can be obtained if all the data are combined, so that one large pooled regression is run with TN observations. In this pooling technique, there will be NT-2 degrees of freedom (since estimation of the two parameters uses up 2 degrees of freedom).

Data for cotton prices include prices for staple length and grade. For the hedonic analysis, independent variables form a set of (0,1) -valued dummy variables appropriate to each observed price. The estimated equation is of the form:

$$\ln P = \alpha + \beta_1 S_1 + \beta_2 S_2 + \ldots\ldots\ldots$$

where,

$\ln P$ = natural logarithm of average price

$S_1, S_2 \ldots$ = different quality characteristics

A time dummy variable is included, both as an independent variable and as a multiplicative factor in the analysis, to test for significant shifts in the values of the coefficients between two periods. The coefficient of the time dummy variable thus represents the shift in the average value of the base staple length. The coefficients on the interaction terms indicate how the discounts and premia associated with these quality differences change between the two periods. When the time dummy and the interaction terms are included, the estimated equation becomes:

$$\ln P = \alpha_0 + \Sigma_i \alpha S_i \quad \alpha_{n+1} D + \sum_{j+n+z}^{Zn+1} \alpha_j (DS_i)$$

where,

S_1 = dummy variable for quality differences

D = time dummy

(DS_i) = interaction terms

Sudanese Data, Results and Interpretations

The Sudan supplies for export a spectrum of different qualities and staple lengths, ranging from short staple to extra-long staple. The extra-long and long staples are grown in the Gezira Scheme, the White Nile Schemes and the ex-private estates, all of which are located in the alluvial plain confined between the White Nile and Blue Nile. The Acala 4-42 variety, a medium staple upland variety, is grown commercially in Khasin El Gibra Scheme, Suki, Tokar Delta, the Gezira Scheme, and the newly erected Rahad Scheme. The Rahad and Suki Schemes are located in the central region of the country. The El Girba and Tokar Schemes are located in the eastern part of Sudan. The different varieties of Sudanese cotton for the period 1963-1980 are presented in Table 6. The main source of Sudanese data is the Sudan Cotton Bulletin, the annual publication of the Cotton Public Corporation. FOB price data are reported on an annual basis and are distinguished by staple length and grade.

Definitions for grades of cotton vary from country to country. Lower quality grades are characterized by higher processing costs or lower quality end products. In Sudan, the grade is determined by cotton color, waste content of ginned cotton, and preparation. The

TABLE 6. Sudanese Cotton Varieties

Season	Extra-Long and Long Staple	Medium and Short Staple
1963/64	BAR XL1, Domain Sakel, BAR 14/25 Albar, and G.A. 34	Acala 4-42, BAR Hope II, BAR 7/8-1 and BAR11/7
1964/65	BAR XL1, BAR 14/25 Pima, LM 17, LM 26 and BAR A(57) 12	Acala 4/42, BAR 11/7 and BAR 7/8-1
1965/66	BAR XL1, BA I 14/25 Pima, LM 26, LM 63, and V.S.1	Acala 4/42 BAR A(57) 12, BAR 11/7 and BAR 7/8-1
1966/67	BAR XL1, BAR 14/25 Pima 178, LM 17, LM 26 LM 63, and V.S.1	Acala 4/42, BAR 11/7, BAR 7/8-1, and BAR A(57) 12
1967/68	Sakel, LM 17, LM 26 LM 63, and V.S.	Acala 4/42 and American type
1968/69	Sakel, LM 17, LM 26, LM 63, and V.S.	Acala 4-42 and Tayiba, BAR A(57) 12, BAR 11/8
1969/70	LM 17, LM 26, LM 63, V.S., and Barakat	Acala 4-42 and American type
1970/71	V.S., Barakat, and Tayiba	Acala and American type
1971/72	V.S. and Barakat	Acala and American type
1972/73	V.S. and Barakat	Acala and American type
1973/74	V.S. and Barakat	Acala and American type
1974/75	V.S. and Barakat	Acala and American type
1975/76	V.S. and Barakat	Acala and American type
1976/77	V.S. and Barakat	Acala and American type
1977/78	V.S. and Barakat	Acala and American type
1978/79	V.S. and Barakat	Acala and American type
1979/80	V.S. and Barakat	Acala and American type
1980/81	V.S. and Barakat	Acala and American type

different grades for the Sudanese cottons are shown in Table 7. To maximize uniformity within the bales and lots, cotton is ginned according to area and pick number. The cotton is usually baled at the gin and pressed into export bales with a density of 35 pounds per cubic foot. At the gin, bales are assembled in lots of 300 bales, each weighing 420 pounds, and sent to Port Sudan. There each lot is again sampled by lint classifiers and the grade mark finished.

The hedonic analysis for Sudanese cotton uses F.O.B. prices as dependent variables, and the staple lengths and the grades as independent variables. This study is restricted to the period 1969-1980 due to lack of earlier data. Another reason for this choice of period is that varieties of the four different staple lengths were not widely grown prior to 1969.

The analysis is based on five cross-section time-series pooling equations. First, extra-long staple (V.S.) and long staple (Barakat) cottons are pooled in one equation. Six grades are included for each of the two staple lengths. The six grades of V.S. are G2V.S., XG3V.S., G3V.S., XG4V.S., G4V.S., and XG5V.S. The six grades of Barakat are 2B, X3B, 3B, X4B, 5B and X5B. The two top grades and the lower four grades from each staple length are excluded because data are not available for most of the years. The period of study is 1969-1980. Second, extra-long staple and medium staple (Acala 4-42 RG) cotton prices are pooled. Prices of three grades from each staple length are selected—G2V.S., XG3V.S. and G3V.S. from V.S., and RG1, RG2 and RG3 from Acala. The period of study is 1972-1980. The third equation pools the extra-long staple and the medium staple (Acala 4-42 SG)

TABLE 7. Sudanese Cotton Grades

V.S.	Barakat	Acala RG	Acala SG	Nuba
G.V.S.	1B	RG_1	SG_1	1A
XG2V.S.	X2B	RG_2	SG_2	2B
G2V.S.	2B	RG_3	SG_3	3C
XG3V.S.	X3B	RG_4	SG_4	4D
G3V.S.	3B			
XG4V.S.	X4B			
G4V.S.	4B			
XG5V.S.	X5B			
G5V.S.	5B			
XG6V.S.	X6B			
G6V.S.	6B			
CG6V.S.	C6B			
DG6V.S.	D6B			

Source: Sudan Cotton Review, 1967.

cotton prices. As in the second equation, prices of three grades from each variety are selected, and the study period is 1972-1980. Fourth, extra-long staple and the short staple (Nuba) cotton prices are pooled. Three grades from each variety are utilized for the period 1972-1980. Finally, extra-long staple, long staple, medium staple (Acala RG) and short staple cotton prices are pooled in one equation. F.O.B. prices for three grades of each staple length were selected. The grades are not included as independent variables in this equation in order to show the effect of only staple lengths on prices. The effect of left-out variables on regression results is captured by the error term and will result in lower t-statistics. The period of study is 1972-1980.

In each of these equations, the independent variables are the grades, the staple length, time dummy, and the interaction terms between the time dummy and each of the grades and staple length. Since the grades and staple lengths are qualitative, they are entered as dummies taking one or zero values.

A single general equation can be shown for the first four equations. For a simple case, suppose we have three grades:

$$LnP = \alpha_0 + \alpha_1 + \alpha_2 + \alpha_2 G_3 + \alpha_3 SL + \alpha_4 TD + \alpha_5 X_1 + \alpha_6 X_2 + \alpha_7 X_3$$

where,

LnP = natural logarithm of Sudan cotton prices

G_2 = dummy variable for grade 2 taking the value of 1 if grade 2 and the value of 0 is otherwise

G_3 = dummy variable for grade 3, taking the value of 1 if grade 3 and the value of 0 if otherwise

SL = dummy variable for staple length, taking the value of 0 if extra-long staple and 0 if otherwise

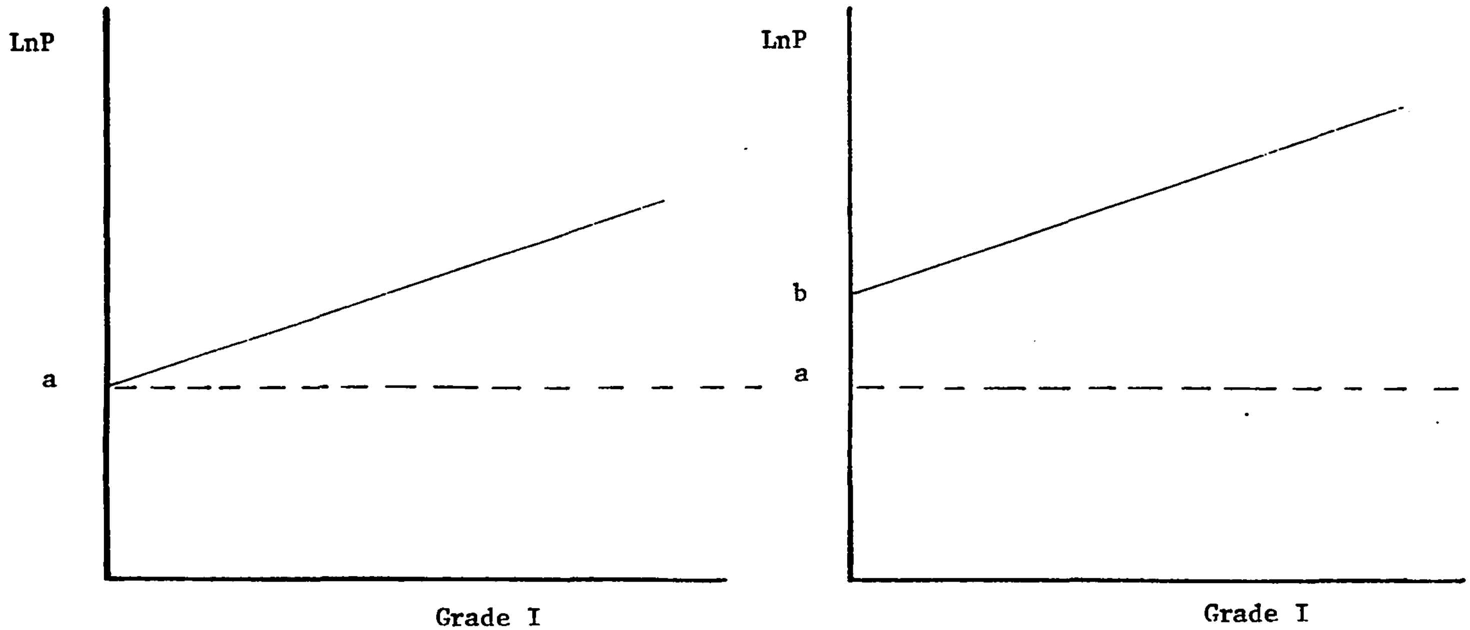
TD = time dummy, i.e., 0 before 1973 and 1 after that

X_1 = interaction term between grade 2 and time dummy

X_2 = interaction term between grade 3 and time dummy

X_3 = interaction term between staple length and time dummy

The base value is grade 1 of the relevant staple length, so grade 1 need not be included as an independent variable. A time dummy is included to examine the consistency in the price effect of the quality characteristics over time. World cotton prices increased substantially after 1973. The coefficient of the time dummy, α_4, represents the shift in the average value of the grades and staple length. A diagram illustrates the effect of this shift. Figure (1.a) shows that the intercept, α_0, is the average price of cotton having grade 1 prior to 1973. In the diagram, α_0 is represented by a. Diagram (1b) shows the situation after 1973, when the average price of grade 1 increased sharply. In that diagram, the distance ab is equal to the slope dummy which is α_4, and $\alpha_0 + \alpha_4$ is the base period value after 1973. The values of α_5 to α_7 show how the discounts and premia associated with the grades and staple length change between the two periods. The values of α_1, α_2, and α_3 give the value of discounts and premia from the base for grades 2, 3 and staple length, respectively. If the values of α_5 to α_7 are zero, then the percentage differences in price across grades and staple lengths are completely stable between the two periods, and the slopes of the two lines will be identical. The same argument holds for the single equation of pooled staple lengths.



(1.a) Before 1973

(1.b) After 1973

FIGURE 1. The Effect of Time Dummy on Prices.

Tables 8-12 show the results of hedonic analysis for these five equations. The coefficients of G_2-G_6 in Table 8 are as expected, indicating progressively larger discounts relative to grade 1. The discounts are not significant, however. The insignificance is attributed to the fact that the difference between grades does not have the same effect on extra-long staple prices as it does on long staple prices. The long staple cotton (Barakat) trades at a discount to the extra-long staple and its coefficient is statistically significant. The dummy value for the post-1973 period is quite significant, indicating the large differences that occurred in cotton prices between the two periods. The coefficients of the interaction terms are both small and insignificant with respect to grades, which suggests a stability of percentage differences in prices across grades throughout the two periods. The slope dummy for the staple length is significant, however, indicating that long staple cotton prices have appreciated relative to extra-long staple cotton prices since 1973. That is, the long staple cotton prices have appreciated by about 11 percent over the extra-long cotton prices between the two periods.

The hedonic analyses for the Sudanese ELS cotton pooled with the medium and short staple cottons, presented in Tables 9-11, show that grades 2 and 3 trade at a discount to grade 1, although it is not statistically significant. The coefficients of the staple lengths are again significant. The coefficients of the time dummies are large and quite significant, indicating the large differences in cotton prices between the two periods. The coefficients of the interaction terms, being small and insignificant, indicate a stability of the

TABLE 8. Hedonic Analysis of Sudanese Extra-Long and Long Staple Cotton Prices, Period 1969-1980 (Dependent Variable, Natural Logarithm of Price)

Variable	Coefficients	T-Statistics
Constant	3.801	88.99
G_2	- 0.025	- 0.31
G_3	- 0.053	- 0.66
G_4	- 0.077	- 0.97
G_5	- 0.108	- 1.35
G_6	- 0.127	- 1.60
SL	- 0.257	- 5.42
TD	0.729	13.93
X_2	0.021	0.22
X_3	0.022	0.22
X_4	- 0.004	- 0.04
X_5	0.009	0.09
X_6	- 0.023	- 0.23
X_{10}	0.109	1.87
R^2	0.784	
F(13,202)	61.017	

G_2-G_6 = dummy variables for grades 2 to 6

SL = dummy variable for the staple length; taking the value of 0 if it is extra-long staple (ELS) and 1 if it is long staple

TD = time dummy variable; taking the value of 0 before 1973 and the value of 1 after that

X_2-X_6 = interaction terms between time dummy and each one of the 6 grades

X_{10} = interaction term between time dummy and the staple length

TABLE 9. Hedonic Analysis of Sudanese Extra-Long and Medium Staple (Acala, RG) Cotton Prices, Period 1972-1980 (Dependent Variable, Natural Logarithm of Price)

Variables	Coefficients	T-Statistics
Constant	4.030	23.68
G_2	- 0.008	- 0.04
G_3	- 0.059	- 0.28
SL	- 0.489	- 2.87
TD	0.638	3.53
X_1	- 0.037	- 0.17
X_2	- 0.138	- 0.63
X_3	- 0.107	- 0.59
R^2		
F(7,46)	20.161	

G_2-G_3 = dummy variables for grade 2 and 3, respectively

SL = dummy variable for the staple length; taking the value of 0 if it is ELS and 1 if it is medium (RG)

TD = time dummy variable; taking the value of 0 before 1973 and the value of 1 after that

X_1-X_3 = interaction terms between time dummy and the two grades and the staple length, respectively

TABLE 10. Hedonic Analysis of Sudanese Extra-Long and Medium Staple (Acala, SG) Cotton Prices, Period 1972-1980 (Dependent Variable, Natural Logarithm of Price)

Variables	Coefficients	T-Statistics
Constant	4.030	23.42
G_2	- 0.007	- 0.04
G_3	- 0.028	- 0.29
SL	- 0.422	- 2.61
TD	0.618	3.59
X_1	- 0.021	- 0.09
X_2	- 0.124	- 0.58
X_3	- 0.084	- 0.48
R^2	0.734	
F(7,46)	20.050	

G_2-G_3 = dummy variables for grade 2 and 3, respectively

SL = dummy variable for the staple length; taking the value of 0 if it is ELS and 1 if it is medium (SG)

TD = time dummy variable; taking the value of 0 before 1973 and 1 after that

X_1-X_3 = interaction terms between time dummy and the two grades and the staple length, respectively

TABLE 11. Hedonic Analysis of Sudanese Extra-Long and Short Staple Cotton Prices, Period 1972-1980 (Dependent Variable, Natural Logarithm of Price)

Variables	Coefficients	T-Statistics
Constant	3.820	24.31
G_2	- 0.021	- 0.13
G_3	- 0.352	- 0.32
SL	- 0.331	- 2.12
TD	0.527	3.47
X_1	- 0.086	- 0.10
X_2	- 0.235	- 0.71
X_3	- 0.626	- 0.46
R^2	0.731	
F(7,46)	19.815	

G_2-G_3 = dummy variables for grades 2 and 3, respectively

SL = dummy variable for the staple length; taking the value of 0 if it is ELS and 1 if it is short staple

TD = time dummy variable; taking the value of 0 before 1973 and 1 after that

X_1-X_3 = interaction terms between time dummy and the two grades and the staple lengths, respectively

TABLE 12. Hedonic Analysis of Sudanese Cotton Prices, Period 1972-1980 (Dependent Variable, Natural Logarithm of Price)

Variables	Coefficients	T-Statistics
Constant	3.968	27.05
LS	- 0.315	- 1.55
MS	- 0.407	- 1.97
SS	- 0.622	- 2.99
TD	0.68122	4.38
X_1	0.141	0.64
X_2	- 0.215	- 0.97
X_3	- 0.087	- 0.40
R^2	0.653	
F(7,100)	29.799	

LS = dummy variable for long staple; taking the value of 1 if it is long staple and 0 otherwise

MS = dummy variable for medium staple; taking the value of 1 if it is medium staple and 0 otherwise

SS = dummy variable for short staple; taking the value of 1 if it is short staple and 0 otherwise

TD = time dummy variable; taking the value of 0 before 1973 and 1 after that

X_1-X_3 = interaction terms between time dummy and each one of the three staple lengths, respectively percentage differences in prices between the two periods. The independence of cotton markets across grades may be attributed to inconsistencies in the pricing system with respect to the different grades. That is, the extra cost of lower grades may not be equal for all staple lengths.

The results of the hedonic analysis for staple lengths are presented in Table 12. The base value is the extra-long staple variety. The shorter staple lengths sell at a discount to the ELS. The coefficient of long staple cotton is insignificant, whereas that of medium and short staple cottons are statistically significant. The long staple coefficient is insignificant because long staple cotton has appreciated relative to ELS cotton prices, as indicated in Table 8. The omission of independent variables from the price equation is another reason. The coefficient for the time dummy is large and statistically significant. The coefficient of the interaction term for the time dummy and the long staple dummy suggests an increase of 14 percent in the price of long staple after 1973--similar to the earlier results. The interaction terms for the medium and short staples are small and statistically insignificant.

The insignificance of the long staple cotton coefficients suggests that the long staple cotton market may be independent of the other cotton markets. This result contradicts the results presented in Table 8. This could be explained by two factors. First, the number of observations in the fifth equation is fewer compared to the others. Second, the fifth equation lacks independent variables for grades, thus leading to left-out variable problems and increased In summary, the cotton market appears integrated.

Integration of the cotton market across staple length is caused by a number of factors, such as advances in spinning technology and the emergence of synthetic fibers. Spinning machinery has the capability to substitute across staple lengths in the production of specific threads and yarns. A recent study by Rogers (1978) of U.S. Spinning Mills, for example, revealed that both the grade and staple length of cotton were in excess of the minimum qualities needed by the textile industry. Less than 11 percent of the cotton used by mills required a staple length above 34. Actual production of 34 staple cottons accounted for nearly one-half of total production. In terms of grade, less than one percent of the cotton required a grade of middling, while in actual production middling grades accounted for nearly 20 percent of the total.

Sewing threads require long staple lengths for strength and fineness properties. Recent spinning technology has produced substitutes that offset that restriction. The fiber fineness problem, for example, could be solved by direct substitution for ELS cottons by long staples. If this direct substitution is not plausible, then mixing of the longer staple cottons with the shorter staple varieties could solve the problem. Also, the shorter staple varieties could be further improved in stages before spinning. For example, in the stage of lint preparation, more cleaning and combing would remove more shorter staple fibers and improve the parallel run of fibers.

Substitution across different staple lengths is simpler for the production of yarn than for sewing threads. Micronaire readings and fiber strength are not as crucial requirements for yarns as for sewing threads. As in the manufacture of threads, mixing of shorter staple lengths with longer staple lengths, and cleaning and combing of shorter staple lengths in the pre-spinning stages could be applied to the yarn spinning industry. Other techniques, such as slower spinning speeds, are also used to compensate for shorter staple lengths in the manufacture of yarns.

Man-made fibers are a second factor which causes the markets for different staple lengths of cotton to be integrated. Competition between synthetic fibers and cotton was not so intense when synthetics were first produced in the period immediately after World War II. Synthetic fibers had not yet been well developed, prices were high and the demand for all types of fibers was strong as the result of the Korean War. However, the emergence of polyester fibers during the late fifties intensified competition. Falling costs of production led to decreases in the prices of synthetic fibers, and further technical advances in fiber quality and fineness allowed for expanded end uses. By the early 1970's, synthetic fibers assumed a dominant role in the fiber market. In 1950, synthetic fibers accounted for only three out of 18 billion pounds of total world fiber consumption, but by 1980 synthetic fibers represented 33 of 52 billion pounds of total world fiber consumption (Hicks, 1967). Thus, improvements in the production of synthetic fibers have forced all staple lengths to respond to the price of synthetic fibers. This situation helped result in an integrated market for cotton.

This result means that the demand for Sudanese ELS cotton in the world market is infinitely elastic and Sudan cannot control the price. The implication of this situation for Sudanese cotton policy is that Sudan may find it profitable to reallocate cotton production patterns. The premia earned by the different staple lengths (Table 13) are significant and consistent across equations, with the exception of long staple. These estimates suggest that the ELS cotton acreage should be reduced. There is a 30 percent price difference between extra-long and medium staple cottons for the period 1972-1980 (Table 4). On the other hand, the yield premium for medium staple cotton is almost double that of ELS cotton. Thus, the higher yields of shorter staple lengths offset their price discounts compared to ELS varieties, and growing shorter staple cotton would result in more farm income and foreign exchange earnings.

Estimation of Cost of Quality Deterioration

Higher qualities of cotton receive higher prices than lower qualities because spinning cost increases as quality declines. Thus, the deterioration of quality represents foregone income to lint cotton exporters. Table 14 presents the percentage share of different cotton grades in total production for some of the main schemes during 1963-1980. Unfortunately, the data available for long and extra-long staples are limited. Grades are categorized in four groups. For medium and short staples, all four grades are used in the estimation. Figures 2-5 represent the trends of quality deterioration for the four types of Sudanese cotton.

Grade I of ELS cotton contributed nearly 45 percent of production in 1963, declined slightly in the 1964-68 period, and recovered again in 1969. After 1970, the distribution of grades has shown

TABLE 13. Production of Sudanese Cotton in the Main Scheme According to Grades for the Period 1969-1980 (Bales (lb. 480/Bales)

Years	Extra-Long Staple				Long Staple				Medium Staple				Short Staple			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
1969	8396	10391	13479	19353	18209	42420	44714	57769	113103	32174	6276	1200	15004	14018	8596	388
1970	7588	19692	17121	18312	14055	52228	52228	55002	115921	43145	2116	1628	12223	19394	12127	3898
1971	6567	22576	19429	20523	10471	54273	51831	57938	114718	58836	5482	3654	7562	18299	3601	3274
1972	7438	13415	20854	27804	13190	33943	58390	70349	92634	73039	5522	6948	13666	14859	4736	2892
1973	5094	7250	22925	30044	8536	39264	51384	71528	79178	87742	6118	1748	5960	8502	5677	7824
1974	4628	5261	19656	28291	2953	23467	63719	65273	30982	101869	21250	8111	5122	6930	6848	8492
1975	2439	11361	17236	24385	975	11702	70047	79798	15674	123180	24363	7156	2110	3781	5293	7984
1976	796	2330	25180	28534	3542	10793	76391	77909	12273	136042	20916	3630	1610	3907	8650	9230
1977	395	7466	17611	18445	5296	5452	70099	74928	12189	104823	29253	16252	1444	5654	7340	9235
1978	80	5299	16415	18129	3108	2826	65842	69515	20103	115091	9821	8440	916	3405	7029	8563
1979	712	3813	17223	20156	2663	1065	61379	68036	4398	74460	42462	30330	906	2684	7127	8834
1980	307	3104	15366	19543	816	680	60891	73532	4743	59353	43401	36216	634	1822	7035	8097

For extra-long staple cotton (V.S.)

I - includes G2V.S. and XG3V.S.
II - XG4V.S. and G4V.S.
III - G5V.S. and XG6V.S.
IV - CG6V.S. and DG6V.S.

For long staple cotton (Barakat)

I - includes 2B and X3B
II - X4B and 4B
III - 5B and X6B
IV - C6B and D6B

For medium staple cotton (Acala 4-42 RG)

I - RG1
II - RG2
III - RG3
IV - RG 4

For short staple cotton (Nuba)

I - 1A
II - 2B
III - 3C
IV - 4D

TABLE 14. Percentage Share of Sudanese Cotton Grades, Period 1963-1980.

Years	Extra-Long Staple				Long Staple				Medium Staple				Short Staple			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
1963	44.9	29.4	19.6	6.1	58.9	26.1	14.0	1.0	19.6	41.4	30.5	8.5	34.1	36.3	27.1	2.5
1964	31.1	26.5	27.0	15.4	38.6	23.6	19.6	18.2	32.9	59.4	7.3	0.4	29.5	55.0	14.9	0.6
1965	28.5	28.5	5.6	27.4	40.5	20.3	19.5	19.7	42.5	38.9	13.5	5.1	18.8	75.2	5.2	0.8
1966	40.5	30.2	16.4	12.1	45.6	19.2	15.4	19.8	45.6	36.8	12.6	5.0	20.1	71.0	4.7	4.2
1967	38.8	30.2	16.6	14.4	36.6	31.9	21.2	10.3	56.0	23.1	16.9	4.0	49.3	32.7	17.9	0.1
1968	41.1	45.3	7.2	6.4	31.8	28.4	29.9	9.9	80.8	16.7	1.7	0.8	44.0	34.7	18.3	3.9
1969	45.6	35.4	12.5	6.5	40.1	35.5	18.0	6.4	74.0	21.1	4.1	0.8	39.5	36.9	22.6	1.9
1970	27.5	31.5	27.4	14.1	8.1	30.1	30.1	31.7	71.2	26.5	1.3	1.0	25.4	40.3	25.2	8.1
1971	9.6	33.0	28.4	30.0	6.0	31.1	29.7	33.2	62.8	32.2	3.0	2.0	23.1	55.9	11.0	10.0
1972	10.7	19.3	30.0	40.0	7.5	19.3	33.2	40.0	52.0	41.0	3.1	3.9	27.8	41.1	13.1	8.0
1973	7.8	11.1	35.1	46.0	5.0	23.0	30.1	41.8	45.3	50.2	3.5	1.0	21.1	30.1	20.1	27.7
1974	8.0	9.1	34.0	48.9	1.8	15.1	41.0	42.0	19.1	62.8	13.1	5.0	18.7	25.3	25.0	31.0
1975	4.4	20.5	31.1	44.0	0.6	7.2	43.1	49.1	9.2	72.3	14.3	4.2	12.0	21.5	30.1	45.4
1976	1.4	4.1	44.3	50.2	2.1	6.4	45.3	46.2	7.1	78.7	12.1	2.1	7.5	18.2	40.3	43.0
1977	0.8	17.0	40.1	42.0	3.4	3.5	45.0	48.1	7.5	64.5	18.0	10.0	6.1	23.9	31.9	39.0
1978	0.2	13.3	41.2	45.5	2.2	2.0	46.6	49.2	13.1	75.0	6.4	5.5	4.6	17.1	35.3	43.0
1979	1.7	9.1	41.1	48.1	2.0	0.8	46.1	51.1	2.9	49.1	28.0	20.0	5.1	15.1	40.1	49.7
1980	0.8	8.1	40.1	51.0	0.6	0.5	44.8	54.1	3.3	41.3	30.2	25.2	1.0	4.5	44.4	51.1

Source: Computed from Table 6.

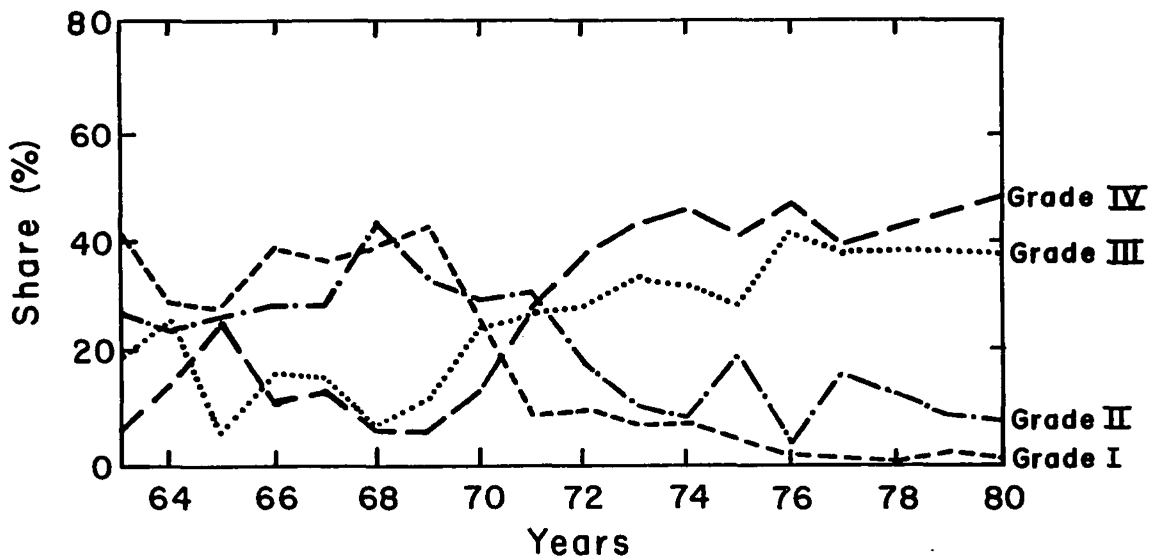


FIGURE 2. Deterioration of Sudanese Extra-long Staple Cotton Quality According to Grades.

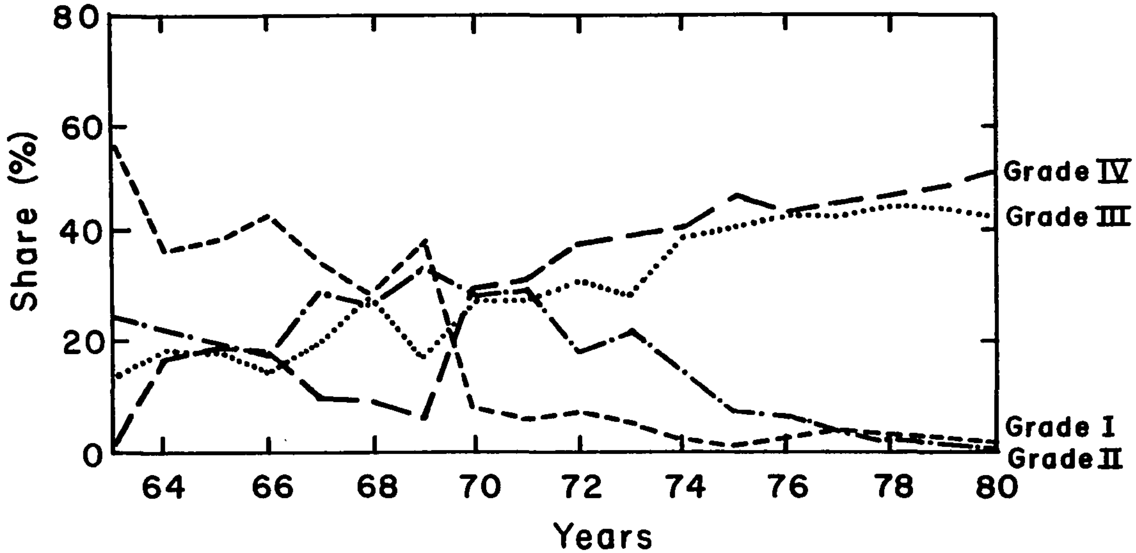


FIGURE 3. Deterioration of Sudanese Long Staple Cotton Quality According to Grades.

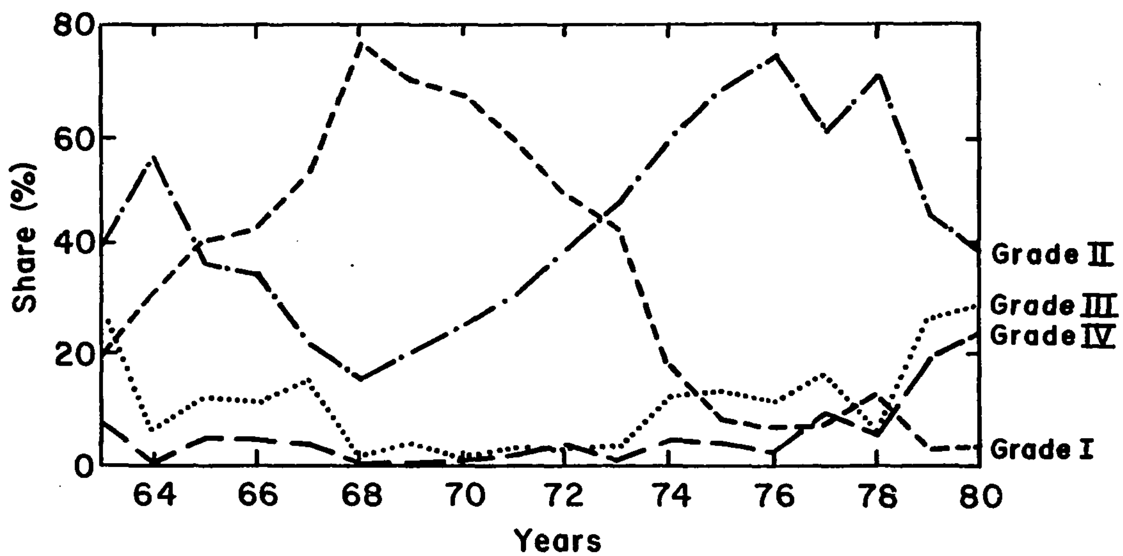


FIGURE 4. Deterioration of Sudanese Medium Staple Cotton Quality According to Grades.

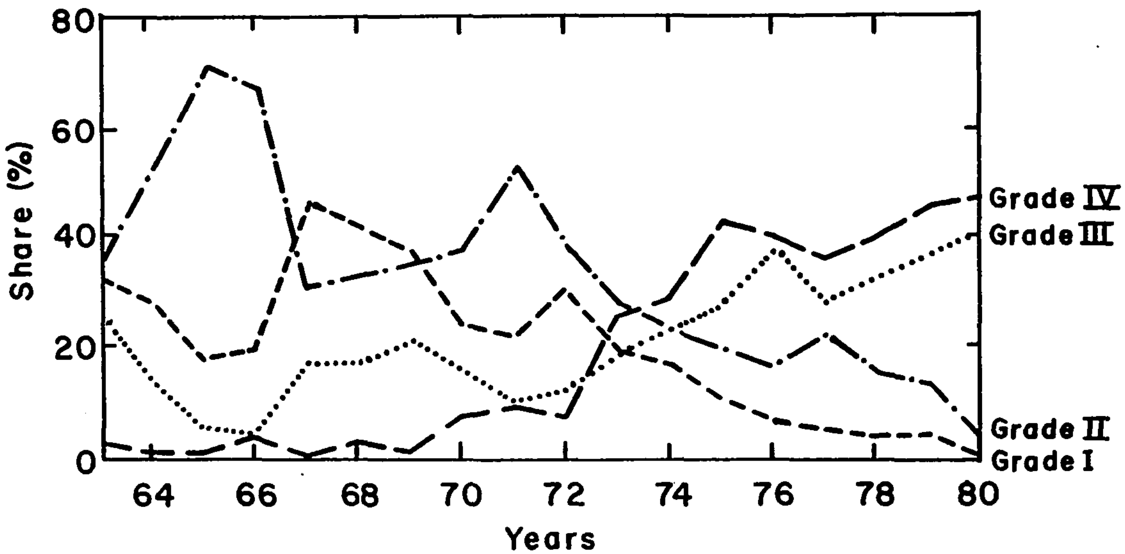


FIGURE 5. Deterioration of Sudanese Short Staple Cotton Quality According to Grades.

continuous deterioration, with Grade I accounting for only 0.2 percent and 0.8 percent of production in 1978 and 1980, respectively. Grade II of ELS cotton has shown the same phenomenon. In the 1963-1971 period, its share in production ranged from 45.3 percent in 1968 to 26.3 percent in 1964. When Grade I and Grade II decrease, the other two grades, III and IV, automatically increase, indicating quality deterioration. The two top grades of the other staple lengths deteriorated in a similar manner but with some exceptions. For example, the shares of Grade I of the medium staple cotton ranged above 19 percent for a long period of time, from 1963 to 1974. Also, the percentage shares of Grade II of the same staple length were above one-third during most of the study period. This could be explained by the fact that in the 60's and 70's three main schemes were established especially for the production of medium staple cottons. These are El Girba, Suki and Rahad. These schemes, being newly established on fertile lands without pests and disease problems, gave higher quality of cotton in the early years. The higher cotton quality could also be attributed to the fact that domestic price incentives were better for medium staple production than for ELS and long staple production.

The cost of quality deterioration in the 1969-1980 period can be estimated with the following equation:

$$C = (X_1)(Q)(P_1) + (X_2)(Q)(P_2) + (X_3)(Q)(P_3) + (X_4)(Q)(P_4) -$$
$$(Z_1)(Q)(P_1) + (Z_2)(Q)(P_2) + (Z_3)(Q)(P_3) + (Z_4)(Q)(P_4)$$

where,

C = current cost of quality deterioration

X_1-X_4 = 1969 and 1972 percentage share of ELS and long staple and medium and short staple cotton Grades I-IV, respectively

P_1-P_4 = nominal average prices of Grades I-IV, respectively, for the period 1973-1980

Q = quantity of cotton produced in 1980

Z_1-Z_4 = 1980 percentage share of Grades I-IV, respectively

The nominal prices ($/bale) of each grade were estimated using the following regression equation:

$$\ln P = \alpha_0 + \alpha_1 G_2 + \alpha_2 G_3 + \alpha_3 G_4 + \alpha_4 TD$$

where,

α_0 = constant term

lnP = natural logarithm of prices in U.S. dollars

G_2-G_4 = dummy variables for Grades II-IV, respectively

TD = time dummy (0 from 1969-1972; 1 for 1973-1980)

The base value is Grade I and its coefficient is the constant α_0. The nominal prices generated by the regression are presented in Table 15 and represent the average prices of the 1973-1980 period. Data of Tables 6, 7 and 8 are used to estimate the cost of Sudanese cotton quality deterioration. The cost of deterioration is estimated for each staple length separately.

a. ELS cotton

$$C = [(0.456)(38420)(391.13) + (0.354)(38420)(375.86) + (0.125)(38420)(366.87) + (0.065)(38420)(328.72)] - [(0.008)(38420)(391.13) + (0.081)(38420)(375.86) + (0.41)(38420)(366.87) + (0.51)(38420)(328.72)]$$

$$= \$937.250$$

TABLE 15. The Nominal Prices of the Four Grades ($/Bale)

Grade	ELS		Long Staple		Medium Staple		Short Staple	
	Coefficient	Nominal Price	Coefficient	Nominal Price	Coefficient	Nominal Price	Coefficient	Nominal Price
I	3.9606 (73.265)	391.13	3.6613 (45.863)	282.03	3.5549 (84.586)	222.94	3.4891 (71.268)	197.71
II	-0.0500 (-0.0078)	375.86	-0.0340 (-0.3689)	272.60	-0.0671 (-1.2250)	208.47	-0.0023 (-0.0374)	197.26
III	-0.0742 (-1.1892)	366.87	-0.0668 (-0.7246)	263.81	-0.1100 (-2.0063)	199.72	-0.0057 (-0.0938)	196.59
IV	-0.1840 (-2.948)	328.72	-0.1135 (-1.2308)	251.77	-0.1568 (-2.8605)	190.59	-0.0507 (-0.8362)	187.94

t-statistics are in parentheses.

b. Long Staple Cotton:

$$C = [(0.401)(135919)(282.03) + (0.355)(135919)(272.6) + (0.18)(135919)(263.81) + (0.064)(135919)(251.77)] - [(0.006)(135919)(282.03) + (0.005)(135919)(272.6) + (0.448)(135919)(263.81) + (0.541)(135919)(251.77)]$$

$$= \$2,176,942$$

c. Medium Staple Cotton

$$C = [(0.52)(143325)(222.94) + (0.41)(143325)(208.47) + (0.031)(143325)(199.72) + (0.039)(143325)(190.59)] - [(0.033)(143325)(222.94) + (0.413)(143325)(208.47) + (0.302)(143325)(199.72) + (0.252)(143325)(190.59)]$$

$$= \$1,895,700$$

d. Short Staple Cotton

$$C = [(0.378)(17588)(197.71) + (0.411)(17588)(197.26) + (0.131)(17588)(196.59) + (0.08)(17588)(187.94)] - [(0.01)(17588)(197.71) + (0.045)(17588)(197.26) + (0.44)(17588)(196.59) + (0.511)(17588)(187.94)]$$

$$= \$56,387$$

The total loss is estimated at \$5,066,279. Losses are larger than this estimation total, since the estimation considers only 335,252 bales of a total export of 900,000 bales, 37 percent. Extrapolation suggests a total loss of \$13,600,668, or 12.5 percent of 1980 export values. This result implies that Sudanese cotton policy should consider the loss accruing to the foreign exchange earnings and try to improve cotton quality.

United States Data, Results and Interpretations

The analysis of U.S. cotton prices is based on two data samples. The first includes government support prices issued by the Commodity Credit Corporation. Premia and discounts for grades and staple lengths of strict low middling upland cotton are selected for the period 1962-1981. The grades selected for the study are spotted, tinged, and gray and staple lengths are 30, 30, 34 and 36 thirty seconds of an inch. The analysis considers the whole period as a single sample and the two periods 1962-1971 and 1971-1981. This is for comparison of these samples with each other and with the sample of free market prices that prevailed after 1973. The base value is white (grade 41) of staple length 34.

The second sample includes market price data for the period 1973-1981. The sample data is based on monthly average premia and discounts per pound for specified qualities of strict low middling upland cotton. The base value is white (grade 41) of staple length 34 in El Paso, Texas. Three months in each year are selected. The qualities are grades 43 (spotted), 44 (tinged) and 47 (gray) and staple lengths 34, 36, 28, 40 thirty seconds of an inch.

The data for the free market pricing system are based on medium (34) staple length and the long (36, 38 and 40) staple lengths, and does not include the short staples of 30 and 32. Therefore, the comparison between the two government programs and the free market prices with respect to staple lengths will be based on the 34 and 36 staples only. The dependent variable for both of the two programs is the natural logarithm of premia and discounts.

A single general equation for the two samples takes the form:

$$LnP = \beta_0 + \beta_1 L_1 + \beta_2 L_2 + \beta_3 L_3 + \beta_4 S + \beta_5 T + \beta_6 G + \beta_7 D + \beta_8 T_1 + \beta_9 T_2 + \beta_{10} T_3 + \beta_{11} T_4 + \beta_{12} T_5 + \beta_{13} T_6$$

where,

LnP = natural logarithm of premia and discounts

L_1-L_3 = dummy variables for the three staple lengths, taking the value of 1 if it is the specific staple length and 0 if otherwise

S, T and G = dummy variables for the three grades taking the value of 1 if it is the specific grade and 0 if otherwise

D = time dummy (see below for choice of years)

T_1-T_6 = interaction terms between each one of the staple lengths and grades and the time dummy

The results of the hedonic analysis for the 1962-1981 period are presented in Table 16. The coefficients of the three staple lengths are as expected. The short staples, 30 and 32, sell at a discount to the medium staple, whereas the long staple (36) trades at a premium. Only staple lengths 30 and 36 are significant, suggesting little difference between the 32 and 34 classification. The percentage differences between the nominal prices predicted by this equation are only 8.7%, 2.6% and 4.5% for the staple lengths 30, 32 and 36, respectively. The time dummy coefficient is small and strongly significant. Compared to the free market prices, the time dummy coefficient on loan prices did not increase quite as much. The change in the loan prices was 8.2 percent and that of free market price was 9.3 percent (Table 17). This difference probably occurs because the time dummy has a value of zero for the loan prices before 1973 and a value of zero for the free market price before 1974. The coefficients of

TABLE 16. Hedonic Analysis of the United States Strict Low Middling Upland Cotton Premia and Discounts (1962-1981): Government Loan Prices (Dependent Variable, Natural Logarithm of Premiums and Discounts)

Variables	Coefficients	T-Statistics
Constant	7.437	303.44
L_1	-0.087	- 3.01
L_2	-0.026	- 0.91
L_3	0.045	1.85
D	0.082	2.37
S	-0.111	- 3.97
T	-0.271	- 9.70
G	-0.221	- 7.91
T_1	-0.083	- 1.81
T_2	-0.040	- 0.88
T_3	0.024	0.53
T_4	0.076	1.71
T_5	0.157	3.55
T_6	0.220	4.98
R^2	0.722	
F(13,216)	46.766	

L_1-L_3 = dummy variables for staple lengths 30, 32 and 36, respectively

D = time dummy variable; taking the value of 0 before 1973 and 1 after that

S, T and G = dummy variables for the grades spotted, tinged and gray

T_1-T_6 = interaction terms between time dummy and each one of the staple lengths and grades, respectively

TABLE 17. Hedonic Analysis of the United States Strict Low Middling Upland Cotton Premia and Discounts (1973-1981); Free Market Prices (Dependent Variable, Natural Logarithm of Premiums and Discounts)

Variables	Coefficients	T-Statistics
Constant	7.199	131.73
L_1	0.256	1.79
L_2	0.270	2.01
L_3	0.292	1.91
D	0.093	2.66
S	-0.914	- 11.80
T	-1.059	- 13.66
G	-1.088	- 14.04
T_1	0.099	0.47
T_2	0.113	0.53
T_3	0.091	0.43
T_4	0.080	0.97
T_5	0.175	1.11
T_6	0.073	0.88
R^2	0.859	
F(13,352)	313.017	

L_1-L_3 = dummy variables for the staple lengths 36, 38 and 40, respectively

D = time dummy variable; taking the value of 0 before 1974 and 1 after that

S, T and G = dummy variables for the grades spotted, tinged and gray

T_1-T_6 = interaction terms between time dummy and each one of the staple lengths and grades, respectively

of the grades (S, T and G) are strongly significant and consistent. The slope dummies for the staple lengths tell that the change in the premia are small and insignificant after 1973, whereas those of grades show large and significant changes. These results indicate that the market for different staple lengths and grades are integrated. The only exception is the market for staple length 32.

The hedonic analysis for the 1962-1972 period (Table 18) confirmed the above results. The market for the staple length 32 is again independent of the markets for other staple lengths. The percentage difference in prices between the two periods is small and significant as shown from the coefficient of the time dummy, indicating about 6.9 percent decrease in prices after 1967. Compared to that of the free market prices, the effect of the price support program indicated little change occurred between the two periods.

The analysis for the period 1972-1981 (Table 19) shows markedly different results. The coefficients for all staple lengths are small and insignificant. The coefficients of 43 (spotted) is statistically insignificant, whereas those of 44 (tinged) and 47 (gray) are strongly significant. The coefficient on the slope dummies for the staple lengths are small and insignificant and those for the grades are large and significant. Since the 1972-1981 prices are not market prices, they show nothing about market integration.

The hedonic results for the free market period show coefficients for the staple lengths that are consistent and significant. also, the coefficients of the grades are large, consistent and strongly significant. The coefficient of the time dummy is small but significant.

TABLE 18. Hedonic Analysis of the United States Strict Low Middling Upland Cotton Premia and Discounts (1962-1971); Government Loan Prices (Dependent Variable, Natural Logarithm of Premiums and Discounts)

Variables	Coefficients	T-Statistics
Constant	7.467	448.31
L_1	- 0.062	- 3.15
L_2	- 0.012	- 0.59
L_3	0.042	2.13
D	- 0.069	- 2.92
S	- 0.109	- 5.76
T	- 0.271	- 14.28
G	- 0.204	- 10.72
T_1	- 0.070	- 2.51
T_2	- 0.031	- 1.11
T_3	0.011	0.39
T_4	- 0.008	- 0.29
T_5	- 0.021	- 0.78
T_6	- 0.037	- 1.38
R^2	0.778	
F(13,216)	62.886	

L_1-L_3 = dummy variables for staple lengths 30, 32 and 36, respectively

D = time dummy variable; taking the value of 0 before 1967 and 1 after that

S, T and G = dummy variables for the grades spotted, tinged and gray, respectively

T_1-T_6 = interaction terms between time dummy and each one of the staple lengths and the grades, respectively

TABLE 19. Hedonic Analysis of the United States Strict Low Middling Upland Cotton Premia and Discounts (1972-1981); Government Loan Prices (Dependent Variable, Natural Logarithm of Premiums and Discounts)

Variables	Coefficients	T-Statistics
Constant	7.486	82.45
L_1	- 0.094	- 0.88
L_2	- 0.040	- 0.37
L_3	0.041	0.39
D	0.080	0.75
S	- 0.103	- 1.50
T	- 0.257	- 2.51
G	- 0.233	- 2.28
T_1	- 0.195	- 1.54
T_2	- 0.066	- 0.52
T_3	0.051	0.39
T_4	0.224	1.61
T_5	0.252	2.06
T_6	0.399	2.25
R^2	0.480	
F(13,216)	15.332	

L_1-L_3 = dummy variables for staple lengths for 30, 32 and 36, respectively

D = time dummy variable; taking the value of 0 before 1973 and 1 after that

S, T and G = dummy variable for the grades spotted, tinged and gray

T_1-T_6 = interaction terms between time dummy and each one of the staple lengths and grades, respectively

These results support the hypothesis of market integration. The premia and discounts associated with the staple lengths for the free market period (1973-1981) compared to that of the government loan program in the 1962-1971 period show that the percentage price differences for the price of staple length 36 is 29.2 percent in the free market program, whereas it is only 4.2 percent for the same staple length in the government loan program for the 1962-1971 period. Both samples show consistent and signficant coefficients for the different grades.

The coefficients of time dummies in both programs are small but significant, suggesting small differences that occurred in prices after 1974 in the case of the free market program and after 1967 for the government loan program. All these results suggest that the pricing policy under the government loan program has added distortions and does not reflect the true market incentives for the different staple lengths and grades, especially after the 1973 period.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

The extent of market integration for the different qualities of cotton and the effect of the pricing policies of the United States and Sudan on the world market for cotton were tested by the use of hedonic analysis of cotton prices. Another focal point was to estimate the cost of quality deterioration of Sudanese cotton.

The statistical technique used for the hedonic analysis was to combine all cross-section and time-series data and to perform ordinary least square (OLS) regression on the entire data set. The dependent variables were the natural logarithm of price, premia and discounts. The independent variables (staple lengths and grades) were entered as a set of (0,1) minus valued dummy variables. For Sudan the analysis was based on five pooled cross-section, time-series equations. In each of the first four equations, one of the long, medium (two varieties) and short staple variety prices were pooled with extra-long staple cotton prices. In the fifth equation, grades were excluded as independent variables.

The hedonic analysis of the first four equations for Sudan showed that the cotton market for different staple lengths is integrated. This is not true across the grades. The independence of cotton markets across grades was attributed to inconsistencies in the pricing system with respect to different grades. In the fifth equation, the market for long staple cotton was independent. This was attributed as an error that resulted from few numbers of observations and the omitted variables in the fifth equation. The cost of quality deterioration was estimated at about 12.5 percent of the total cotton export values.

The United States' hedonic analysis involved three equations for the government loan program and one equation for the free market program. Under the government loan program the three equations included the 1962-1981, 1962-1971 and 1972-1981 periods, whereas that of the free market was for 1973-1981. The reason for this division was to compare the results that prevail before and after the emergence of the free market orientation. The hedonic analysis for the United States showed that the government price support program added distortions to prices.

The emergence of synthetic fibers and advances in spinning technology have made the superiority characteristics of extra-long staple cotton over the shorter staple cotton of decreasing importance. The result has been a decline in the premium of ELS cotton relative to long staple. The price gap between the ELS cotton and the shorter staple cottons is constant and reflects elastic demand for ELS cotton in the world market.

In view of these results, it is very important for the Sudan to revise its cotton production policy, which currently favors ELS cotton over the shorter staple cotton. A reallocation of the cotton varieties and other agricultural resources is needed. The Sudan also should try to improve its cotton quality.

Grade classification of the Sudanese cotton currently provides no useful information to the importers, as indicated by the inconsistencies in the percentage difference of prices across grades from year to year. The estimated premia of the Sudanese cotton grades indicate that there is no standard grading system and each year the importers will require samples in order to evaluate grades. In contrast, the U.S. cotton grades show consistent premia, especially under the free market program. The coefficients of the grades 43 (spotted), 44 (tinged) and 47 (gray) are -0.914, -1.059 and -1.088, respectively, and they are statistically significant. In view of that, it is recommended for Sudan to revise the cotton grading system by using a standard classification for provision of consistent premia across grades. This policy should allow grades to provide better information to importers and should reduce the discounts paid for Sudanese varieties relative to the prices for similar staple lengths from other countries.

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