AN ECONOMETRIC MODEL OF COTTON AND TEXTILE DEMAND

Carlos A. Valderrama
Economist
International Cotton Advisory Committee
Washington, DC

Introduction

A review of economic literature on consumer demand during the last 40 years shows a wide variety of methodologies developed on the subject. Perhaps because the basic problem, limitation of data, has persisted, new methodologies concentrated largely on special cases of traditional consumer theory. Nonetheless, important work has been done in regard to the determination of the structure of and changes in markets for specific goods, which has led to a more detailed classification of markets.

Faced with these set of circumstances, econometric work directed at modeling and predicting demand for consumer goods took the path of partial and static analysis in an effort to construct simplified versions of the models offered by traditional theory. As a result, during the 1950's and 1960's a good number of studies established ranges for income and price elasticities that, with few exceptions, were found to conform with the underlying theory. These studies were based on the Engel curve formulation derived from family budgets.

Within this context, how an individual consumer chooses to spend a given monetary income subject to a determined set of prices became the crucial question in consumer demand research. In terms of prediction of market demand, a combination of cross section and time series models is frequently used to determine income elasticities, which are then combined with expected income and population projections. It was determined that given the size of residual trends in almost every model of this type, consumer demand was associated with unspecified factors such as changes in tastes and habits of consumers, which theory assumed to be very stable over time.

More recently, since the 1970's, research has been done to incorporate these factors into regression analysis, but the results have not been encouraging due principally to measurement difficulties. Promising research efforts are those on demand creation and transformational growth. These theories attempt to explain the part of consumer demand not directly related to income and prices in terms of demand management by producers. Accordingly, as producers spend on advertising and invest in capturing the imagination of consumers through fashion design and the entertainment industry, they are able to shape the direction of demand by supplying specific information to consumers about products on the market.

Furthermore, the dynamic interaction of a wide array of economic phenomena have strengthened the elemental notion that consumer demand is determined in a simultaneous macroeconomic environment rather than in a static and virtually insular microeconomic one.

Current econometric research on the textile market is mainly inspired by the work on elasticities developed during the late 1950's and early 1960's.

In a 1972 study that attempted to establish income elasticities of demand for agricultural products, FAO used logarithmic and semilogarithmic forms to estimate expenditure elasticities for clothing in several countries. The study found that the general trend was to spend higher percentages of income on clothing as income rises. Although no attempt was made to estimate income elasticities of textiles consumed measured in quantity terms, rather than monetary expenditures, the study enumerated several of the problems encountered and their effects in making projections. Perhaps the most relevant problem is that "since the data do not arise from planned experiments but from the natural workings of economic processes, the amount of information they contain on the individual influence on demand of individual causal factors, such as income, may be small because of the close correlation between the individual factors themselves. The number of factors that can be isolated is therefore strictly limited."

In recognition of the limitations of microeconomics-based models for prediction of demand, the Secretariat's work does not concentrate on the elaboration of income and price elasticities. Less attention is given to the role of elasticities in a partial equilibrium environment. Instead, it is argued that elasticities should be seen as changing over time. Moreover, it is assumed that in a macroeconomic setting, the income/consumption relationship measures not only the choices of an average consumer given income and prices, but the overall impact of economic conditions upon demand for textiles. The main concern is to devise a model to predict textile demand that captures the crucial relationships and is flexible enough to accommodate to economic events that affect aggregate demand and demand for textiles. Specifically, an alternative is offered to determine world demand for textiles under recession conditions.

Textile Consumption

The textile industry can be divided into three main sectors: fiber production, textile mill production and end-use textile production. Consequently, consumption of fibers has different stages. A first stage is the consumption of raw fiber by mills; a second stage is the consumption of semiprocessed fiber in the form of yarns and fabrics by textile manufacturers; a finished end-use product is then consumed in a third stage by the final consumer. Consumption in the first two stages is ultimately dependent upon consumption of end-use products, which is the subject of this study.

Measuring consumption at the end use level has some unavoidable difficulties. An attempt to measure final consumption directly is virtually impossible, as it would require very expensive logistics to cover a sizeable and representative portion of a population and very complex and time-consuming statistical processes not easily affordable by many countries. Indirect measuring techniques have been developed that account for fiber available for consumption, that is, actual consumption plus inventories.

Although somewhat imprecise, this way of measuring textile consumption is cost-effective and thought to be a good approximation. Availability for consumption in a country, sometimes also called apparent consumption, is the result of adding consumption at the mill point to the overall textile trade balance. While domestic mill consumption accounts for trade of raw fibers, the textile trade balance comprises imports and exports of yarns, fabrics, clothing and other textile manufactures.

The textile industry uses a wide variety of fibers, usually classified as natural fibers (including cotton, wool, silk, flax, ramie, and other less known fibers) and chemical fibers (including synthetic fibers, such as polyester and nylon, and cellulosic fibers such as rayon). For the purpose of this study the universe of textile fibers is composed of cotton and wool as natural fibers and cellulosic and synthetics as chemical fibers.

Determinants of Textile Demand

Consumption of textile fibers is principally influenced by income, population, price of textiles, consumer tastes and propensity to spend.

Population

In 1960, world textile fiber consumption was about 15 million tons, or 5 kilograms per capita. It is estimated that in 1989, textile fiber consumption reached 38 million tons, a 160 percent increase in 30 years. During the same period of time, world population increased from 3 billion to 5.2 billion, a 70 percent increase. If per capita consumption had been held at the 1960 level, world textile fiber consumption would have reached only 26 millon tons in 1989. According to these calculations, 40 percent of absolute textile consumption growth between 1960 and 1989 was determined by population growth.

While population size and growth are important elements determining the impact of population upon textile consumption, the structure of the population plays an important role. Changes in the age distribution alter consumption of textiles. It is well known that children consume more textiles per capita as they outgrow and wear out clothing items.

According to United Nations statistics, changes in the age distribution of the world population, between 1960 and 1990 have resulted in an increase in the median age, a measure that divides the population into two equal parts. Although the median age decreased between 1960 and 1970, it increased during the last 20 years. As a result, since 1970 the world has experienced an aging of the population. While the 0 to 14 age group decreased as a percent of the total, from 37.5 to 32.4 percent between 1970 and 1990, age groups 15 to 64 and 65 and over increased from 57 to 61.6 and 5.5 to 6.0 percent respectively.

The changing age distribution of the world population must have had an impact on the faster growth of textile consumption during the 1960's compared to the 1970's and 1980's.

Table 6
STRUCTURE OF THE WORLD POPULATION AND MEDIAN AGE

	Age Groups			
	0 - 14	15 - 64	65 +	Median Age
1960	37.2	57.4	5.4	22.5
1970	37.5	57.0	5.5	21.6
1980	35.0	59.1	5.9	22.6
1990	32.4	61.6	6.0	24.3

Income

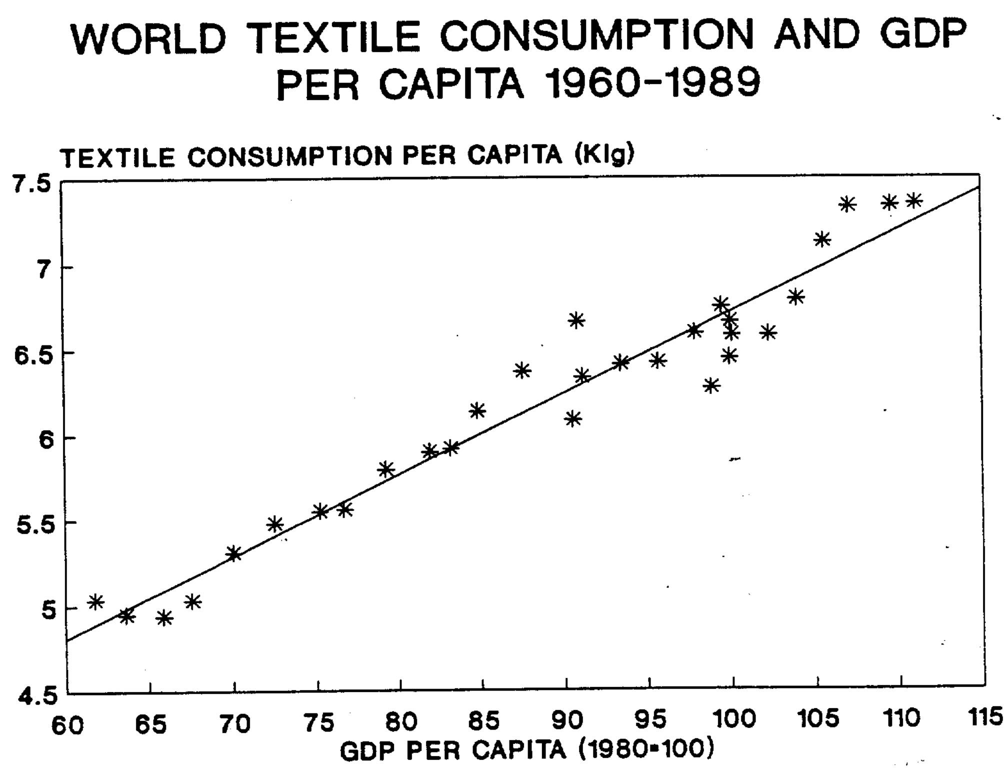
The different treatment of the income variable in explaining a consumption function by macroeconomic and microeconomic theory illustrates different conceptual elements about the dynamics of consumption. Whereas in microeconomic theory income is a given datum, in macroeconomic theory there is an interrelationship between income and consumption.

It is from the macroeconomic point of view that the most important knowledge about the relationship between consumption and income has been developed. The conceptual background of consumption theory in a macroeconomic setting was pioneered by Keynes in 1936 and his work has been further developed by several more recent theories of consumption, among which are Modigliani's life cycle theory, Friedman's permanent income theory and Duesenberry's relative income theory.

An interesting aspect of macroeconomic consumption theories is the attention given to the various elements by which the income/consumption relationship may change in the short and long run periods. Most of these elements have as common ground the expectations of consumers about the future, that is, about economic conditions.

Evidence shows that under normal conditions, income is positively related to consumption. Graph 3 shows that textile consumption does not excape this economic corollary.

Graph 3



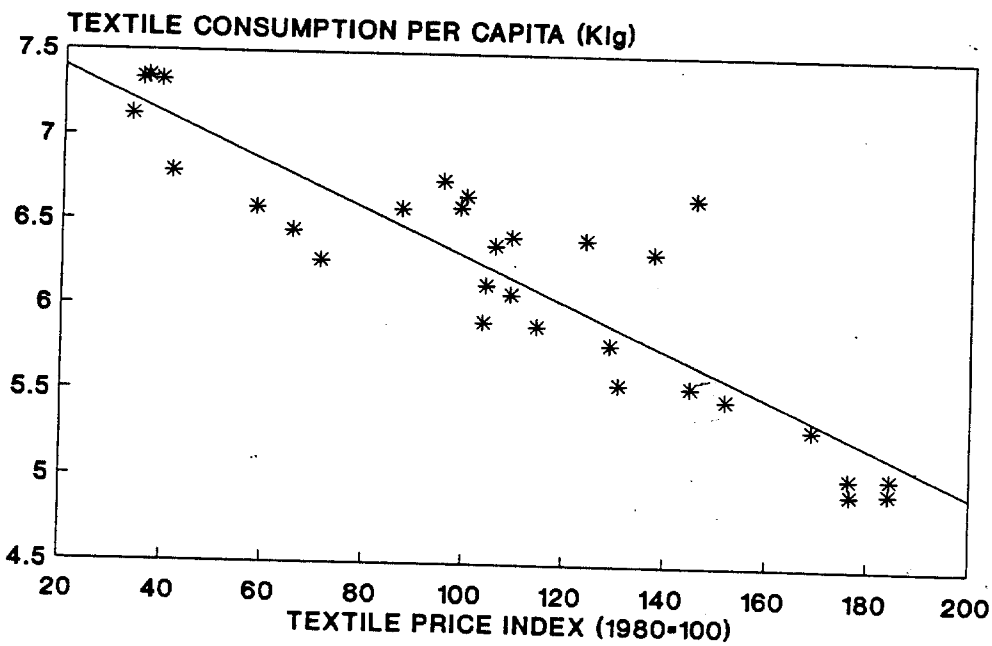
As suggested above, increases in income per capita and variables other than population numbers account for 60 percent of the increase in world textile fiber consumption between 1960 and 1989. But income in a macroeconomic equillibrium equals production. Therefore, the impact upon textile consumption is the result of a whole set of economic conditions and not only a simple given income as described in microeconomic theory. In light of this fact, it seems reasonable to include GDP per capita as a measure of overall economic conditions.

Prices

Choosing a price variable that is representative of the textile market at the end-use level presents several difficulties, particularly in a world basis. Price indexes at the end-use level are only calculated in a few countries.

Graph 4

WORLD TEXTILE CONSUMPTION PER CAPITA
AND TEXTILE PRICE INDEX 1960-1989 *



Price index with one year lag.

The end-use-level price paid by consumers can be broken down into several cost items, representing production costs in the different stages of production. These costs vary according to price conditions of the input markets and levels of profitability of the textile industry in each stage of production. By making use of a relaxed version of the mark-up theory of prices, according to which a producer chooses the price of a produced good by marking up by a percent the cost of the inputs, it is possible to trace back to fiber prices an important part of price movements at the end-use level.

It should be pointed out that a fiber price measure would be acceptable, if it constitutes a good proxy of the movement of prices at the end-use level, regardless of the percentage that fiber costs represent in the final product.

In order to investigate how good a proxy fiber prices would be, a textile fiber price index for the United States was constructed. The index is composed of the price of middling cotton, wool, rayon, and polyester prices in the United States weighted by the share of each fiber in US consumption of textiles each year expressed in US cents per kilogram and deflated by the US consumer price index.

The US apparel price index from the US Department of Commerce was regressed against the US textile fiber price index with data from 1972 through 1989. The results of this exercise, shown in table 7 suggest a good degree of correlation between the two indexes. With a coefficient of .98 between the two price indexes, the regression equation run in logarithmic form explains 60 percent of the changes in the apparel price index.

Table 7
U.S. APPAREL PRICE INDEX AGAINST U.S. TEXTILE FIBER PRICE INDEX
REGRESSION RESULTS

Independent variable		Coefficient	T statistic
Textile Fiber Price Index		.98	4.6
Constant		.02	
R2= 0.60	n=17	DW=1.80	

In light of these results, it seems that a textile fiber price index, although imcomplete as it is, serves as a good proxy to account for price movements at the end-use level.

Accordingly, a world textile fiber price index can be constructed using suitable world market price measures and deflating by a world consumer price index.

Other Variables

Another important variable that plays a role in determining the demand for textile goods is consumer tastes. Traditional microeconomic theory maintains that tastes cause only marginal changes in total consumption and, therefore, can be considered as given. As suggested above, recent research relates changes in tastes with demand management by producers. Along these lines, a study by V. Aggarwal associates the decline of cotton's market share to the implementation of long term agreements (LTA) in the early 1960's in industrial countries, which forced textile importers to advertise chemical fibers not restricted by the agreements. Similarly, with the implementation of the multifiber arrangements (MFA) in the early 1970's, which covered both cotton and chemical fibers, chemical fibers started losing ground and cotton has since regained market share.

In a world basis, it is virtually impossible to find a variable that would account for this kind of event even if assumptions are made such that tastes are explained by advertising expenditures of the textile industry. Such an impact will remain unexplained or be partially picked up by other included variables in any model.

Finally, the propensity to spend affects textile consumption through the income coefficient and is part of the overall economic conditions accounted for in a model by a GDP per capita variable.

Textile Consumption Model

A functional form of textile demand can be expressed as follows.

(1) TC = f(Pop, GDP, P)

where:

TC = Textile consumption at the end-use level

Pop = Population

GDP = Gross Domestic Product, and

P = Textile fiber price index

This function expressed in linear logarithmic form and per capita terms can be regressed using ordinary least squares.

(2) $\text{Log}(TC_t/Pop_t) = c + b_1 * \log(GDP_t/Pop_t) + b_2 * \log(P_{t-1})$

The results are those of an econometric reduced form and do not depict directly demand for textiles. The equation accounts for the reaction of textile consumption to economic phenomena represented by the independent variables. Regression results for the world are shown in table 8.

Table 8
WORLD TEXTILE FIBER CONSUMPTION REGRESSION RESULTS FROM MODEL 1

Independent variable		Coefficient	T statistic
GDP per capita		.473	3.300
Fiber price index[-1]		-.060	1.870
Constant		-.015	.190
Autocorrelation		.582	3.030
R2= 0.958	n=26	DW=1.51	
Without a constant			
GDP per capita		.470	33.630
Fiber price index[-1]		-.060	4.270
Autocorrelation		.583	3.820
R2= 0.9317	n=26	DW=1.26	

Cotton Consumption Equation

Cotton consumption being part of overall textile fiber consumption is explained by the same set of variables as textile fiber consumption. Therefore, an equation similar to equation (2) can be used to estimate cotton consumption.

(3) $$Log(CC_t/Pop_t) = c + b_3*log(GDP_t/Pop_t) + b_4*Log(CP_{t-1}/NCTPI_{t-1})$$

Where:

CC = Cotton consumption at the end-use level

Pop = Population

GDP = Gross Domestic Product

CP = Cotlook A Index, and

NCTPI= Non cotton textile fiber price index

However, since cotton competes with other fibers in the same market, the price variable should reflect the relationship between cotton and non-cotton prices rather than that of textiles and other goods competing for a fixed amount of income. Therefore, the price variable included should be the ratio of cotton prices to a non-cotton textile fiber price constructed in the same fashion as the textile fiber price index with the exclusion of cotton.

In order to adjust the cotton equation results to the results of textile fiber consumption equation, it is necessary to use a non-cotton textile equation as well, using GDP per capita and the inverse price ratio used for cotton consumption. The results of this exercise are shown in table 9.

Graph 5

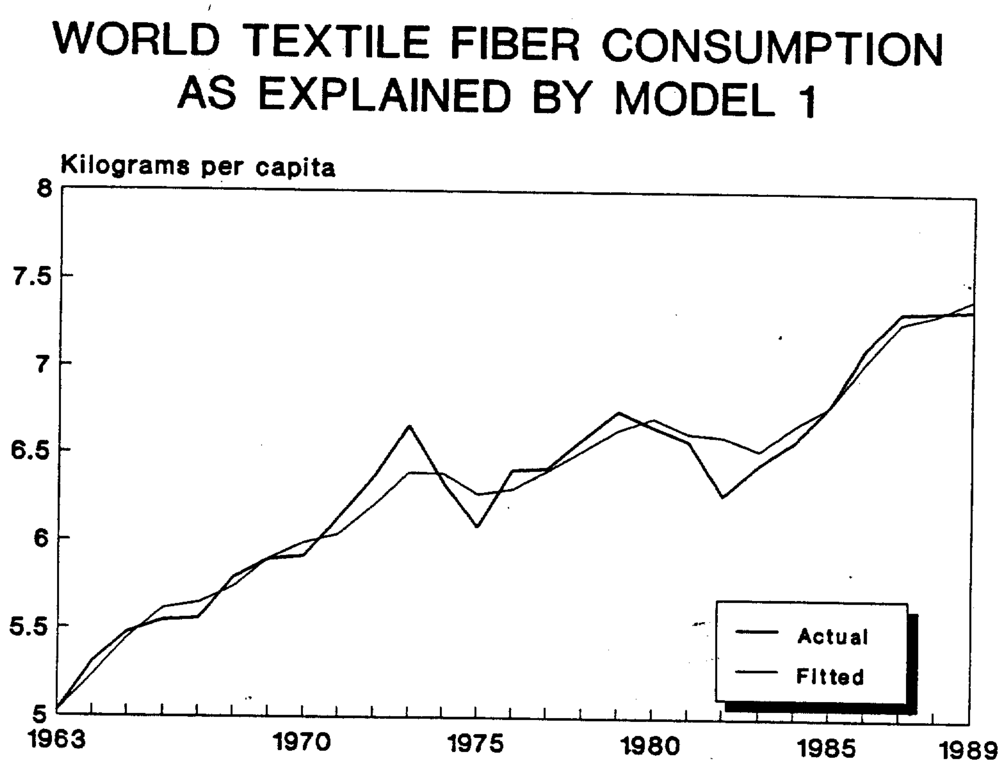


Table 9
WORLD COTTON AND NON-COTTON CONSUMPTION PER CAPITA
RESULTS OF LOGARITHMIC REGRESSIONS*

Country Group / Period	Constant	GDP Per Capita	Price of Cotton/Other Textile Fibers Price Index(t-1)	Autocor-relation	R2	Durbin Watson Statistic
Cotton						
World 1975-1989	-4.638 (2.890)	1.256 (3.643)	-.067 (1.870)	.609 (4.447)	.90	1.30
Noncotton						
World 1975-1989	-3.356 (3.090)	1.069 (3.600)	-.071 1/ (1.970)		.80	1.62

* The dependent variable is end-use cotton consumption per capita for cotton and end-use noncotton textile consumption per capita. Both equations were regressed in logarithmic form. The numbers in parentheses are t-statistics. t-1 indicates a time lag of one year.
1/ The price variable is the relative price of noncotton textiles.

Demand For Textiles Revisited

A graphic inspection of the performance of the textile model in table 8 as shown in graphic 5, illustrates the response of the model to low income growth during the 1974/75 and 1981/82 recession periods. In 1974 although the model forecast level is better than in the previous three years, it fails to predict the direction of change. In 1975 it predicts the direction, but textile consumption is over estimated. The model performs somewhat better in the 1981/82 period. It predicts very well for 1981, but in 1982, although the direction is correct, the model fails to forecast the actual deeper decline. In 1983, the model seems to be still reacting to the trend of the last two years and fails to predict the direction of change. As in 1974, the forecast turns out to be very close to the actual level. With the exception of the 1971/73 period, the model seems to adapt easily to an increasing trend, but has difficulties whenever the trend suddenly changes.

Since the historical behavior of textile consumption fits with fairly good accuracy a linear model with respect to income, the model follows a trend mainly through the relative importance it gives to the past, which in the model equation is the autocorrelation term. The autocorrelation term can also be seen as an adjustment parameter such as the ones used in partial adjustment models. However, in this case the adjustment of both prices and income is the same one. It is necessary to create an adjustment structure in the model that represents with some degree of accuracy income changes so that the model is able to predict sudden changes in economic conditions.

Shortrun/Longrun Elasticities of Textile Demand

Economic theory suggests that short run changes cover a relative brief period of time and appear in a frequent cyclical pattern. Short run changes, however, may act to cause permanent changes in the structure of the market. In contrast, long run changes are thought to occur more gradually compared to short run changes and a cyclical pattern, if it exists, is difficult to describe. Not only in the market for textiles but in any sphere of economic development, both short and long run changes are known to be interrelated. There are, however, limitations in capturing the nature and particular attributes that differentiate short from long run periods.

One of the most restrictive assumptions in trying to represent in a model the evolution of economic events is to assume precisely a time span to differentiate short from long run periods. This assumption is further restricted by the time frame in which available statistics are presented. Textile consumption, income and demographic data series for most countries are only available on an annual basis.

The market for textile fibers is an integral part of the world economy. Textiles interact in various degrees with the rest of the economy in every country, from industrial and home uses to clothing. This interaction in a wide variety of markets changes constantly, due to economic, demographic, and technological factors that affect overall demand for textiles in short and longrun periods. Although there seems to be agreement with respect to the different impact of those variables in different time frames (vis-a-vis, short and long run), it is virtually impossible to have direct statistical data that accounts for these differences. Therefore, available data contain both short and long run changes.

An indicator of the relationship between short and long run impacts can be developed with the help of a partial adjustment process that estimates an adjustment parameter between short and long run elasticities in an econometric model. This method can be easily adapted to textile demand.

The method postulates that in a constant elasticity model of the form

(4) $$Y_t = C + AX_t$$

the linear double logarithmic form with a Koyck transformation

(5) $$Y_t = c + bY_{t-1} + aX_t$$

presents coefficient b as an estimate of an adjustment parameter where the estimated long run elasticity **a'** is a function of coefficient a, the short run elasticity, and the adjustment parameter.

(6) $$\mathbf{a}' = a/(1-b)$$

Lets consider the specific case of textile consumption as described by model 1 on table 8, which makes textile consumption per capita a function of income per capita and prices.

In a given time, a change in prices, say a substantial price rise, may cause consumers to restrict their acquisition of new textiles and perhaps expand the lifetime of their existing stock. As acquisition of additional textiles becomes necessary, a decision should be made whether to acquire the same amount and quality of textiles previously planned by allocating more of the budget to textile consumption or by acquiring lower quality textiles in order to preserve the existing budget.

Table 10
PARTIAL ADJUSTMENT MODEL COMPARED TO TEXTILE MODEL 1
RESULTS OF LOGARITHMIC REGRESSIONS

Period	Constant	GDP Per Capita	Textile Price Index(t-1)	Textile Consumption Per C.(t-1)	R2	Durbin Watson Statistic
Income Partial Adjustment Equation						
1963-1989	-.579	.370		.411	.93	1.27
	(1.950)	(2.790)		(2.270)		
Price Partial Adjustment Equation						
1963-1989	.884		-.058	.668	.94	1.61
	(4.460)		(3.795)	(8.812)		
Model 1						
1963-1989	-.015	.473	-.0601	.582*	.96	1.51
	(.190)	(3.300)	(1.870)	(3.030)		

	Partial Adjustment Equations			Model 1
	Short Run Elasticity	Long Run Elasticity	Adjustment Parameter	Constant Elasticity
INCOME	.370	.628	.411	.473
PRICE	-.058	-.173	.668	-.060

The dependent variable is world textile fiber consumption per capita.
* Autocorrelation term.

Similarly, a reduction of income may cause consumers to restrict their acquisition of new textiles, while new sources of income are determined or consumption patterns change to new income levels.

Demographic changes may also cause some sort of partial adjustment to consumption patterns. Geographical mobility creates new markets or expands existing ones. However, a period of time will pass while suppliers respond to such changes and desired consumption rates are achieved. Therefore, it is reasonable to say that the current consumption rate is a combination of current and previously desired consumption rates.

Table 10, presents the results of a partial adjustment exercise compared to model 1. The adjustment parameter for income elasticity is about half of that for price elasticity. As a result, the difference between short run and long run elasticities differs markedly in the case of prices. The adjustment parameters suggest that textile per capita consumption reacts more slowly to changes in income than to changes in prices.

In year 1, 66 percent of the total desired price adjustment takes place, while only 41 percent of the desired income adjustment takes place. These, however, are partial adjustments. Individual adjustment parameters in an equation that combines prices and income cannot be found. This is the case of model 1. Nonetheless, when the constant elasticities from that model are compared to the partial adjustment elasticities, it is clear that the income elasticity of the model is half way between the short and the long run elasticities of the partial adjustment equation. In contrast, the price elasticity of the model is very close to the short run elasticity. Therefore, because of the different adjustment structure of textile consumption to changes in income and prices, the resulting elasticities of the model represent different time frames. This characteristic shows that textile consumption behaves just like aggregate consumption, reacting more rapidly to prices than income.

Structural Change of Demand

The partial adjustment analysis suggests that the inability of model 1 to adapt efficiently to years of low income growth is an indication of a sudden change in the income/consumption relationship. It is reasonable to expect that if a way can be found to weight the recession years, it would be possible to use such an alternative model to predict textile demand under different economic scenarios. Additionally, it is also expected that any alternative model would have to be in conformance with the basic properties described in the partial adjustment analysis.

Basically, if a change in the income/consumption relationship is recognized, there is no reason to believe that there is no change in the price/consumption relationship. In fact, a whole set of alternative equations is available due to the fact that changes in the coefficients of a model represents structural change.

Two variables can in fact be developed which are able to control any sudden change in the income and price relationships during the years when textile fiber consumption per capita has declined. The new variables can be constructed by multiplying the logarithms of GDP per capita and the textile fiber price index, by a dummy variable that becomes operative during textile recession years. The new single equation model is:

$$(7)\quad Log(TC_t/Pop_t) = c + b_5*log(GDP_t/Pop_t) + b_6*log(P_{t-1}) + \\ + b_7*log(GDP_t/Pop_t)*D_t + b_8*log(P_{t-1})*D_t$$

Where:

$$D_t = \begin{cases} 1 & \text{for } TC_t/Pop_t < TC_{t-1}/Pop_{t-1} \\ 0 & \text{Otherwise} \end{cases}$$

and other variables are as described in equation (1).

The statistical results of the model with structural change variables are satisfactory. Table 11 shows basic statistics of the regression. In addition, the structural model captures the elements described by the previous partial adjustment analysis. Finally a graphic inspection of the performance of the model in graph 6, shows a highly improved explanatory power of the model when sudden change of economic conditions, as transmitted by the price and income variables, affect textile fiber consumption.

Graph 6

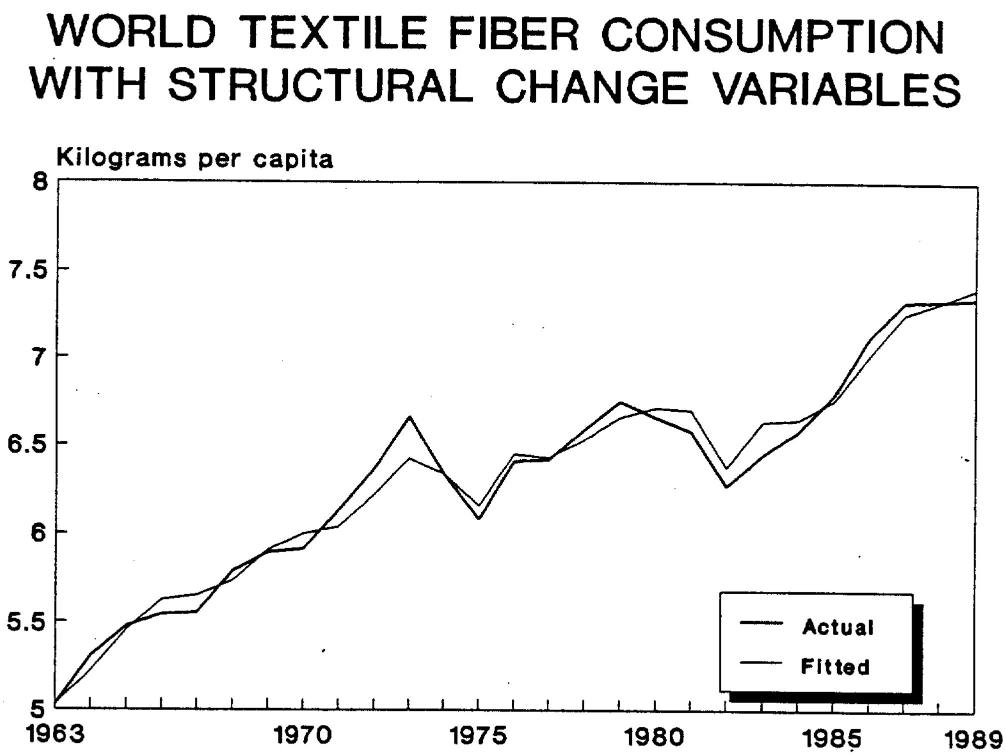


Table 11
TEXTILE FIBER CONSUMPTION PER CAPITA
RESULTS OF LOGARITHMIC REGRESSIONS*

Country Group / Period	Constant	GDP Per Capita	Textile Price Index(t-1)	Structural Income Weight	Structural Price Weight	Autocor-relation	R2	Durbin Watson Statistic
World 1963-1989	-5.354 (2.520)	.464 (30.630)	-.053 (3.400)	-.985 (2.490)	.181 (2.300)	.681 (2.520)	.97	1.09
Eastern Europe & USSR 1963-1987	2.440 (4.750)	.117 (1.720)	-.091 (1.630)	-.003 (1.180)		.500 (3.290)	.87	1.67
Industrial Countries 1963-1987		.681 (37.700)	-.042 (2.720)	-.130 (3.270)	.110 (3.040)		.93	1.09
Developing Countries 1963-1987	-2.520 (7.340)	.845 (12.590)	-.022 (2.220)	-.008 (2.750)			.97	1.44
Developing:								
Africa 1963-1986	-2.330 (2.420)	.577 (2.770)	-.100 (5.460)	-.010 (3.340)		.400 (2.050)	.84	1.87
Asia 1963-1986	-2.310 (2.130)	.840 (5.820)	-.090 (.910)			.520 (2.560)	.94	1.88
Europe 1963-1986	.424 (1.437)	.592 (4.581)	-.307 (4.966)				.56	1.81
Middle East 1963-1986		.573 (9.790)	-.107 (2.230)	-.010 (2.100)		.790 (6.170)	.92	1.55
Latin America & Caribbean 1963-1986		.383 (27.830)	-.018 (1.810)	-.008 (2.370)		.660 (4.100)	.88	1.77

* The dependent variable is textile fiber consumption per capita for each country group. All equations were regressed in logarithmic form. The numbers in parentheses are t-statistics. t-1 indicates a time lag of one year. The autocorrelation coeficient is an estimation defined by a Cochran-Orcutt process. The textile price index is the relative textile fiber price index for the appropiate region, except in industrial countries, Africa and the Middle East, where due to multicollinearity, an absolute textile price index was used. Income and Price weight variables are the GDP per capita and fiber price index multiplied by a dummy variable that distinguishes between years of normal consumption growth and years where per capita consumption declined.

REFERENCES

Aggarwal V., Liberal Protectionism: The International Politics of Organized Textile Trade, University of California Press, 1985.

Ando A. and Modigliani F., The Life Cycle Hypothesis of Saving: Aggregate Implications and Tests, American Economic Review, March 1963.

Branson W., Macroeconomic Theory and Policy, Harper and Row, 1979.

Duesenberry J., Income, Saving and the Theory of Consumer Behavior, Harvard University Press, 1949.

Eatwell J., Theories of Value, Output and Employment, in Eatwell J. and Milgate M., Keynes Economics and the Theory of Value and Distribution, Oxford University Press, 1983.

FAO, Income Elasticities of Demand for Agricultural Products, 1972.

Friedman M., A Theory of the Consumption Function, Princeton University Press, 1957.

Garegnany P., A reply to J. Robinson, in Eatwell J. and Milgate M., Keynes Economics and the Theory of Value and Distribution, Oxford University Press, 1983.

Johnston J., Econometric Methods, McGraw-Hill, 1984.

Kennedy P., A Guide to Econometrics, The MIT Press, 1987.

MIT, The U.S. Textile Industry: Challenges and Opportunities, in The Working Papers of the MIT Commission on Industrial Productivity, The MIT Press, 1989.

Nell E., Prosperity and Public Spending: Transformational Growth and the Role of the Government, Unwin Hyman Ltd., 1988.

UN, World Population Trends and Policies: Monitoring Report, Vol. 1, 1981.

Wallis K., Introductory Econometrics, Gray-Mills Publishing Ltd., 1979.

COTTON:
Review of the World Situation

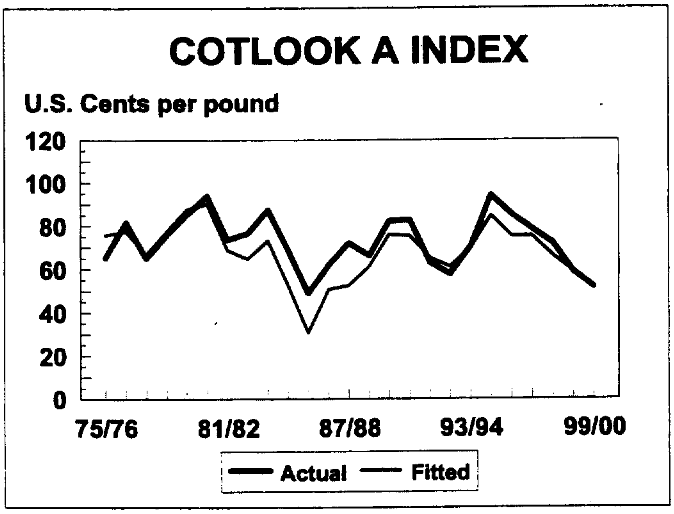
International
Cotton
Advisory
Committee

Volume 53–Number 6
July-August 2000

A REVISION OF THE ICAC PRICE MODEL

By Carlos Valderrama, ICAC

The ICAC Price Model has served siince 1988 as a tool to understand the relationship between prices and market conditions and develop projections of the likely movement of international cotton prices, as refelcted by the Cotlook A Index. The model was initially devised as a simple inverted supply-demand model widely used in economics to explain changes in agricultural prices. Along these lines, the changes in the Cotlook A Index are explained by changes in market fundamentals,as represented by the stocks-to-use ratio outside China (Mainland) and net trade of China (Mainland) with the rest of the world. In 1993, the model was extended to include new market conditions that altered the price formation mechanism in the early 1990s after the break-up of the USRR. With the newly created cotton producing replublics in Central Asia, the bathering of cotton ex-



ported from that region became important in international trade and had an influence on prices. As barter arrangements virtually disappeared in the late 1990s and new shocks exogenous to the cotton market —such as the financial crisis in Asia— influenced international cotton prices, the model, as designed in 1993, became less powerful in explaining the evolution of cotton prices. A newly designed version of the ICAC price model includes the initial approach to market fundamentals and uses Ordinary Least Squares with data in differences to calculate the parameters used in price projections. Ongoing research is attempting to simplify the variables accounting for market expectations and exogenous events. Experimenting with new approaches to price projection techniques is continuing.

Previous Versions of the ICAC Price Model

The initial ICAC model assumed a market equilibrium where the variation in stocks equals consumption minus production as follows:

1) **Δstocks/consumption = 1 – production/consumption**

2) **price = f (stocks/consumption)**

Equation 1) shows that the fundamental relationship between supply and demand in a market can be represented by a stocks-to-use ratio and equation 2) shows the inverted functional form of a typical supply and demand system.

In a world market differentiated between China (Mainland) and the rest of the world, equation 1) for the rest of the world becomes,

3) $\Delta stocks_{RW}/consumption_{RW} =$

$$1 - (production_{RW} + (M_{RW} - X_{RW}))/consumption_{RW}$$

where, RW is the world-less-China-(Mainland), M_{RW} is imports of RW from China (Mainland), and X_{RW} is exports of RW to China (Mainland).

Since in a world with two trading partners,

$$(M_{RW} - X_{RW}) = X_{Ch} - M_{Ch} = \text{net trade by China Mainland}$$

then, equation 3) can be expressed as

4) $(\Delta stocks_{RW} - \text{net trade by China Mainland})/consumption_{RW}$

$$= 1 - production_{RW}/consumption_{RW}$$

The ratio expressed on the left side of equation 4) measures the supply and demand situation in the world-less-China (Mainland) region.

In addition, the ratio

5) **net trade by China/consumption$_{RW}$**

measures China's impact on the market of the rest of the world.

Using equations 2), 4) and 5), the initial ICAC model can be expressed as:

6) **price = f (X1,X2)**

where,

X1: net exports by China-(Mainland) as a share of world-less-China-(Mainland) consumption, and

X2: world-less-China (Mainland) ending stocks less net exports by China (Mainland) as a share of world-less-China-(Mainland) consumption.

The events that led to declines in cotton prices beyond the levels supported by supply and demand conditions during the early 1990s were related to uncertainty related mainly to barter arrangements in international trade conducted by cotton producing countries in Central Asia. Along these lines, an improved price model was specified as follows:

7) $price_t = f(X1_t, X2_t, \text{expectations factor}_t)$

8) $\text{expectations factor}_t = NovFeb_{(t-1)} + NovFeb_{(t-2)} + Balance_{(-1)} + Barter_t$

where, NovFeb is the logarithm of the absolute difference between the November and February quotations of the NYBOT December futures contract; Balance is a variable that measures the difference between world production and consumption; and Barter is the percentage of barter trade between the former USSR and the rest of the world in relation to total former USSR exports (a detailed description of the two versions of the ICAC Price Model appeared in *Cotton: Review of the World Situation*, Vol 6, No. 6, July-August 1993).

The ICAC Price Model Revisited

Barter trade played an important role in the determination of prices and price expectations in the international cotton market during the 1990s. However, barter arrangements declined at the end of the decade and have been virtually nonexistent since 1998. Whereas, barter accounted for less than 10% of all exports by Central Asian countries to non-former-Soviet destinations during the 1970s and 1980s, the break-up of the USSR resulted in an increase of barter to 49% of exports in 1990/91 and 57% in 1993/94. However, barter as a percent of exports

REVISED ICAC MODEL REGRESSION RESULTS

Variable	Coefficient	t-Statistic
C	-0.8473	-0.9087
X1	-3.6579	-7.6433
X2	-1.3538	-6.4648
AR(1)	-0.5289	-2.6533
R-squared	0.7868	N = 24
D-W	1.6675	

declined to 45% in 1994/95 and 10% in 1997/98. By 1998/99, barter arrangements from Central Asian countries were negligible. It is evident that the expectations factor of the ICAC Price Model, which performed well between 1993 and 1997, has had little bearing on the price formation mechanism for the cotton market since 1997/98.

The first idea that comes to mind is to simply remove the expectations factor included in 1993, bringing back to life the initial model as expressed in equation 6). Nonetheless, the events that took place during the 1990s make it difficult for the initial model to perform as it did between 1988 and 1992. In fact, the initial model with data between 1975 and 1998 explains 63% of cotton price variations during the period as opposed to 82% with data only through 1990.

Although the model still explains a good portion of price variation, its power of prediction is greatly diminished. One possible solution is to attempt to arrange the data fed to the model in such a way that it becomes stationary. Non-stationary data is a problem common to most time-series used in econometric analysis and is usually bypassed by operating the model in differences (Peter Kennedy, *A Guide to Econometrics*, MIT Press, 1985, p. 205). The operation of the ICAC Price Model as explained by equation 6) in differences, in fact, improves the explanatory power to 79%. However, the standard error of regression is 7 cents, two cents more than the standard error in the initial model for the period 1975-1990.

This new version in differences, with data through 1998/99, is able to project the season average Cotlook A Index for 1999/00 within two cents of the actual average. In addition, restricting the data sample to 1996/97 and 1997/98, the model projects season averages for the following years within 5 cents of actual values. The relationship between market fundamentals and prices suggests that a 42,000-ton decline in net trade by China (Mainland) with the rest of the world (exports–imports) results in a one-cent increase in the season average Cotlook A Index, and that an increase of one percentage point in the supply-to-use ratio of the rest of the world translates into a one-cent decline in average prices.

Research in Progress

Recognizing that despite its good properties the new model still has a relatively high standard error of regression, the Secretariat continues to assess potential improvements.

The inclusion of an expectations factor into the ICAC Price Model in 1993 accounted for the overall uncertainty in the market about future prices and, although not the only factor, barter played an important role in the formation of expectations during the 1990s. As expected, a reassessment of expectations as they appear in equation 8) demonstrated that the variable NovFeb (without lags) improved the explanatory power of the model in differences. The other two variables, barter and balance, were not statistically significant.

9) $\mathbf{price_t = f(X1_t, X2_t, expectations\ factor_t)}$

and, $\mathbf{expectations\ factor_t = NovFeb}$

The model shown in equation 9) explains 83% of the variation in prices, and with data between 1975/76 and 1998/99, the model is able to account for the full decline in cotton prices in 1999/00. The standard error of regression is lowered to 6 cents. Furthermore, the relationship between market fundamentals and prices remains virtually unchanged. A 47,000-ton decline in net trade by China (Mainland) with the rest of the world (exports–imports) results in a one-cent increase in the season average Cotlook A Index. Similarly, an increase of one percentage point in the supply-to-use ratio of the rest of the world translates into a one-cent decline in the season average Cotlook A Index. Finally, a five-cent increase in the November quotation of the NYBOT December contract with respect to the February quotation, translates into a one-cent increase in the season average Cotlook A Index. Nonetheless, when the data sample is restricted to 1996/97, average prices are predicted ten cents higher than actual prices for 1998/99 and 7 cents higher for 1999/00.

On an experimental basis the Secretariat is also researching an alternative model based on the assumption that international prices depend on prices in domestic markets. Along these lines, as domestic prices in turn depend on local supply and demand conditions, international prices can be a function of supply-to-use ratios in key markets. A functional form of this type of model has good econometric results only if a deflator to the Cotlook A Index is used. The technique, therefore, makes cotton price projections highly dependent on price projections of other commodities. The Secretariat is currently studying ways to overcome this limitation (a detailed description appears in http://www.icac.org/icac/cottoninfo/speeches/speeches.html).