Economic Evaluation of Commodity Promotion Programs in the Current Legal and Political Environment

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Edited by:
Jennifer L. Ferrero
Cynda Clary

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Economic Evaluation of the Cotton Checkoff Program

Oral Capps, Jr.
David A. Bessler
George C. Davis
John P. Nichols

Introduction

The 1996 Federal Agricultural Improvement and Reform (FAIR) Act calls for independent evaluations of grower-funded checkoff programs. The following report, in keeping with this mandated action, evaluates the checkoff program for cotton.

The legislative intent of the Cotton Research and Promotion Act of 1966 (PL89-502), and later of the Cotton Research and Promotion Amendments Act of 1990, was to authorize and enable the establishment of an orderly procedure for the development of an effective, continuous, and coordinated program of research and promotion. The design of both Acts was to strengthen the competitive position of cotton *vis-à-vis* primarily manmade fibers and to expand domestic and foreign markets for uses of U.S. cotton.

The Cotton Research and Promotion Amendments Act of 1990 enacted by Congress under Subtitle G of Title XIX of the Food, Agriculture, Conservation and Trade Act of 1990, contains two provisions that authorized changes in the funding procedures, thereby distinguishing the Act of 1990 from the Act of 1966: (1) all cotton marketed in the United States, whether from domestic or foreign production, was to share in the cost of the research and promotion program; and (2) the right of cotton producers to demand a refund of assessments was terminated. The Amendments Act of 1990 was approved by producers and importers voting in a referendum held July 17-26, 1991.

Financing of the checkoff program occurs through one dollar per bale assessments plus a fractional percentage of value (specifically, 5/10 of 1 percent), collected by first handlers on domestically-produced cotton, imported cotton, and the cotton content of imported products. The Cotton Board receives all assessments and contracts, with a producer-controlled organization to carry out the research and promotion activities authorized by the legislative acts. Initially, the producer-controlled organization was the Cotton Producer Institute, but beginning in 1970, Cotton, Inc. ((CI) headquartered in New York), was charged with the task of carrying out research and promotion activities under contract with the Cotton Board. From 1986 to 1991, the magnitude of funding under the assessment was on the order of $18.5 million to $28.5 million in nominal terms. This funding remained after up to 35 percent of the assessment had been refunded. From 1992 to 1996, the magnitude of funding from the assessment rose upwards of $43 to $60 million in nominal terms. The difference in magnitude of the assessments for the period 1986 to 1991 versus the period 1992 to 1996 was due to the changes in the checkoff program, described previously.

Roughly 66 percent of the assessment is used for promotion activities and 20 percent is directed to textile research activities. The remainder is spent on agricultural research activities and administration activities. Under the current program, the share of assessments is 75 percent for domestic producers and 25 percent for importers, on average. Promotion activities include television advertising campaigns, seasonal promotions, and special public relations programs. Textile research activities include technical processing and production support to mills as well as product development and textile development.

Objectives

The purpose of this study is to conduct a retrospective analysis to determine the results achieved through investment of the contributors to the research and promotion programs. Specifically, we attempt to provide answers to the following two general questions: (1) what are the effects of the research and promotion activities on the domestic consumption of cotton; and (2) what is the rate of return associated with the program? Put another way, do the program benefits outweigh the program costs, and if so, by how much? In this analysis, we define domestic consumption as the sum of mill consumption of cotton plus net imports of raw fiber-equivalent cotton textile products (yarn, thread, and fabric; apparel; and home furnishings). Data were not available to measure demand by final consumers, so we measure domestic demand as the sum of mill use plus net imports. The principal data sources for our analysis were: (1) *Cotton and Wool Situation and Outlook*; (2) *Survey of Current Business*; and (3) *Monthly Labor Review.*

Historical Perspective on U.S. Fiber Consumption from 1986-1995

In this section we present a historical perspective of the cotton industry over the period 1986 to 1995. Attention is centered on this period for several reasons. First, our empirical analysis rests on the use of monthly data to provide a sufficiently large sample size to carry out statistical analyses; while data on most variables indigenous to the analysis were available on a monthly basis prior to 1986, monthly data pertaining to promotion and research expenditures, key variables in this study, were available only from 1986 on. Second, there was a dramatic shift in agricultural policy with the introduction of the marketing loan provisions of the 1985 Food Security Act. This act was geared to provide greater market orientation and more international competition than in the past. The legislation intended to change the domestic price support from a rigid loan rate to a formula-based competitive adjusted world price (Stults, Glade, Sanford, and Meyer). Prior to the 1985 Food Security Act, the loan rate had set the *de facto* price floor for the U.S. market, which was substantially higher than world market price. This marketing loan program was implemented in August 1986. With a focus on the period 1986 to 1995, we subsequently eliminate concerns about structural shifts in agricultural policy. Thus, this ten year interval constitutes a relatively homogeneous period for empirical analysis in terms of the absence of salient structural shifts.

As exhibited in Table 1, total domestic consumption, defined as U.S. mill consumption plus net imports, saw a dramatic increase from nearly 5,000 million pounds in 1986 to roughly 8,000 million pounds in 1995. On a per capita basis, domestic consumption rose from 20 to 30 pounds over the 1986 to 1995 period; mill consumption rose from 13.5 to 20 pounds per capita, and net imports rose from 6.8 to 10.3 pounds per capita. Counting both mill use and net imports, the share of total fiber consumption for cotton went from 31 percent in 1986 to roughly 39 percent in 1995.

Table 1. U.S. Fiber Consumption: Total and Per Capita by Type of Fiber

Year and Fiber	U.S. Mill Use	Percent of Fibers	Textile Trade[a] Exports	Total Trade[a] Imports
COTTON	(million pounds)	(percent)	(million pounds)	
1986	3254.6	26.6	274.8	1910.5
1987	3753.2	29.0	298.0	2335.7
1988	3482.3	27.1	325.3	2118.8
1989	4046.0	30.2	467.2	2304.8
1990	4115.3	31.0	624.8	2370.2
1991	4347.5	32.0	669.4	2556.6
1992	4761.6	32.5	793.7	3145.7
1993	4937.7	32.3	915.5	3523.8
1994	5230.6	32.5	1069.0	3737.6
1995[c]	2750.9	33.3	658.9	1998.0
WOOL				
1986	136.7	1.1	16.0	275.6
1987	142.8	1.1	23.5	276.1
1988	144.2	1.0	30.7	248.7
1989	134.7	1.0	66.3	222.3
1990	132.7	1.0	59.6	205.8
1991	151.5	1.1	63.3	210.9
1992	150.8	1.0	72.2	237.4
1993	156.8	1.0	77.6	260.5
1994	153.3	0.9	91.6	309.6
1995[c]	80.0	1.0	53.3	146.0
MANMADE FIBERS				
1986	8852.0	72.3	519.3	1703.0
1987	9047.9	69.7	591.9	1805.4
1988	9217.3	71.6	681.6	1758.9
1989	9217.6	68.0	1060.5	1715.7
1990	9047.0	67.3	1339.3	1750.4
1991	9092.2	66.3	1400.1	1769.0
1992	9730.9	66.0	1418.8	2126.5
1993	10160.6	66.1	1388.1	2221.2
1994	10732.3	66.1	1448.1	2530.0
1995[c]	5371.9	65.0	753.7	1279.4

[a] Raw fiber--equivalent of imports and exports of textile products (yarn, thread, fabric, apparel, and house furnishings).

Table 1 (Continued).

		Per Capita		
Total Domestic[b] Consumption	Percent of Fibers	Mill Use	Net Imports	Domestic Consumption
(million pounds)	(percent)	(pounds)		
4890.3	31.0	13.5	6.8	20.3
5790.9	33.7	15.4	8.5	23.9
5275.8	32.0	14.2	7.3	21.5
5883.6	34.7	16.3	7.5	23.8
5860.7	35.4	16.3	7.2	23.5
6234.7	37.3	17.2	7.4	24.6
7113.4	38.1	18.6	9.2	27.8
7546.0	38.5	19.1	10.2	29.3
7899.2	38.0	20.1	10.3	30.4
4090.0	38.8	--	--	--
396.3	2.5	0.6	1.0	1.6
395.4	2.3	0.6	1.0	1.6
350.7	2.1	0.5	0.9	1.4
290.7	1.7	0.5	0.7	1.2
278.9	1.7	0.5	0.6	1.1
299.1	1.8	0.6	0.6	1.2
316.0	1.7	0.6	0.6	1.2
339.7	1.7	0.6	0.6	1.2
371.3	1.8	0.6	0.8	1.4
172.7	1.6	--	--	--
9835.7	62.4	35.8	4.9	40.7
10261.4	59.7	37.1	5.0	42.1
10285.2	62.1	37.4	4.4	41.8
9872.8	58.7	37.3	2.6	39.9
9458.1	57.9	36.2	1.6	37.8
9461.1	56.8	36.0	1.5	37.5
10438.6	56.3	38.1	2.8	40.9
10993.7	56.1	39.4	3.2	42.6
11814.2	56.6	41.2	4.1	45.3
5897.6	55.9	--	--	--

[b] U.S. Mill Consumption plus net textile products trade balance.
[c] Data for the first six months.

On a per capita basis, total domestic consumption for manmade fibers ranged from 37.5 to 45.3 pounds; mill consumption ranged from 35.8 to 41.2 pounds per capita, and net imports ranged from 1.5 to 5.0 pounds per capita. Counting mill use and net imports, the share of fiber consumption for manmade products fell from 62 to 56 percent over the 1986 to 1995 period. The market share for wool over this period fell from 2.5 to 1.6 percent. To sum up, in terms of market share, the 1986 to 1995 period was favorable to cotton but not for manmade fibers or wool.

Historical Perspective on Cotton Incorporated Budget Allocations from 1986 to 1995

Without adjustments for inflation, the CI budget to cover promotion, textile research, agricultural research, and administrative activities grew from $18.5 million in 1986 to about $60 million in 1996. There are pronounced seasonal patterns in promotion and research due primarily to the timing of the disbursements made by Cotton, Incorporated. Therefore, it was necessary to remove this seasonal pattern to give a more clear picture of the trend in promotion and textile research expenditures. The seasonal indices for promotion and textile research expenditures are available from the authors upon request. Expenditures made in December exceed those made in any other month; expenditures made in January are the lowest relative to any other month. Finally, to complete the adjustment process for promotion and research expenditures, the effects of inflation are accounted for.

Simply put, for the purpose of this analysis, we consider real (removal of inflation), seasonally-adjusted promotion and research expenditures. In terms of 1982-84 dollars, the average promotion expenditure per month over the period January 1986 to July 1995 was $1,690,600, and the average textile research expenditure per month was $539,490. Just as with the case of the nominal figures, real, seasonally-adjusted promotion expenditures are roughly three times real, seasonally-adjusted research expenditures.

Historical Perspective on Fiber Prices from 1986 to 1995

In a nutshell, we wish to identify and assess factors which affect the domestic consumption of cotton (mill use plus net imports) over the period 1986 to 1995 on a per capita basis. Besides promotion and textile research efforts, there are other potentially important determinants of domestic cotton consumption. In this section, we concentrate on raw fiber equivalent prices, notably cotton prices, Strict Low Middling (SLM) 1 1/16" at Group B mill points, net weight; rayon prices, 1.5 and 3.0 denier, regular staple at f.o.b. producing plants; and polyester prices, 1.5 denier, staple at f.o.b. producing plants. Rayon represents the class of cellulosic manmade fibers (rayon and acetate), while polyester represents the class of noncellulosic manmade fibers (polyester; acrylic, polypropylene; and nylon). From the earlier section on historical perspective on U.S. fiber consumption, manmade fibers are cotton's principal competitors. In this section, we also address world fiber prices via a discussion of the A index, and we also address subsidies to augment cotton price at the mill level, namely user certificates.

Mill prices of cotton products and competing textiles are commonly measured in cents per pound. Although consumption of all fibers is measured in pounds, a pound of cotton does not equal the same amount of textiles as a pound of other fibers, such as cellulosic or noncellulosic manmade fibers. In 1963, the U.S. Department of Agriculture developed a method for adjusting the pounds of fiber used in manufacturing textiles so that the quantity of cotton needed to provide the same quantity of textiles could be estimated (Donald, Lowenstein, and Simon). This adjustment of fiber consumption is known as "cotton equivalent" pounds, representing the quantity of cotton that would be needed to replace a pound of other fibers as raw material for textile productions. USDA publishes estimates of domestic fiber consumption in cotton equivalent pounds. Actual prices are converted to raw fiber equivalent prices as follows: cotton, divided by 0.90, and rayon and polyester, divided by 0.96.

Nominally, raw fiber equivalent prices of cotton at the mill level have ranged from a low of 39 cents per pound in August 1986 to 131 cents per pound in June 1995. A subsidy, which came into effect in August 1991, may be given to mills in the form of user certificates. Available on a weekly basis, this subsidy is based on a comparison of the Northern European (Liverpool) current price (NE) to the five-day average of the lowest U.S. current quote (USNE). The user certificate value (CV) is calculated as follows: CV = (USNE - NE) - 1.25. Certificate value is in terms of cents per pound. If CV<0, then the certificate value is 0. Also, the subsidy occurs as long as the adjusted world price (AWP) is less than 130 percent of the loan rate for cotton. So for a subsidy to occur, certificate value must not only be positive, but the AWP must also be less than 130 percent of the loan rate. The weekly values of the user certificates from 8/29/91 to 7/27/95 ranged from 0 to 5.28 cents per pound. These weekly values were then averaged to obtain a monthly user certificate value. The resulting monthly values ranged from 0 to 4.818 cents per pound. This monthly value in turn is subtracted from the nominal mill price of cotton to obtain the "effective mill price" of cotton. Finally, this effective mill price is adjusted for inflation.

Nominal raw fiber equivalent prices of rayon and polyester ranged from 78 to 130 cents per pound and from 65 to 96 cents per pound, respectively. There is less volatility in the mill prices of the manmade fibers *vis-à-vis* the mill price of cotton.

Given that our definition of consumption includes net imports of raw cotton equivalent products, it is necessary to consider world prices of cotton. We can use either adjusted world price (AWP) or the A index as measures of world prices. The A index and the AWP move together quite closely, although the A index is always higher than the AWP. Over the period 1986 to 1995, on average, the A index exceeded the AWP by 15 cents per pound. Generally then, on average, the AWP was equal to A index minus 15 cents per pound. Given this relationship between the A index and the AWP, without loss of generality, we use the A index in our analysis. The nominal A index ranged from 37 to 114 cents per pound over the period 1986 to 1995.

Historical Perspective on Other Potential Determinants of Domestic Consumption of Cotton from 1986 to 1995

Besides promotion and research expenditures and fiber prices, there are other potential determinants of domestic consumption of cotton: U.S. and rest-of-world ending stocks of cotton; U.S. population; the U.S. rate of inflation; U.S. and rest-of-world income; and prices of inputs used in the production of textiles at the mill level.

Over the period 1986 to 1995, U.S. ending stocks of cotton varied from 1.7 to 9.6 million 480-pound bales; world ending stocks ranged from 22.75 to 51.65 million 480-pound bales; and rest-of-world ending stocks 20.50 to 42.52 million 480-pound bales. Unequivocally, fluctuations were evident in U.S., world, and rest-of-world ending stocks during this time interval.

U.S. population grew from 239 million to almost 263 million over the time period, a growth rate of roughly 1 percent per year. We measure the U.S. rate of inflation via the growth in the consumer price index. Over the 1986 to 1995 period, the U.S. inflation rate was about 3.5 percent per year. The growth in the price index for apparel and upkeep was on the order of 2.8 percent per year over the same time frame.

U.S. per capita income in nominal dollars rose almost monotonically from $12,200 to $20,000 over the 1986 to 1995 period. In real terms, 1982-84 dollars, U.S. per capita income grew from $11,140 to $13,140 a growth rate of 1.7 percent per annum. We use the index of world gross domestic product (GDP) to monitor world income. Over the 1986 to 1995 period, world GDP grew at the rate of 2.4 percent per annum.

Materials, energy, and labor are inputs in production of textiles at the mill level. The price of materials and energy are indices, 1982-84 = 100. Wages are expressed in terms of dollars per hour. Nominal wages ranged from $9.00/hour to $11.00/hour. In real terms, wages varied from $7.50/hour to $8.30/hour in 1982-84 dollars.

Approach

We plan to provide a quantitative assessment of the effectiveness of the Cotton Research and Promotion Program over the period 1986 to 1995. When historical data are available, we are able to employ empirical approaches of evaluation. Our empirical approaches rest on the development and use of econometric models and time-series models. Using these models, we will be able to quantify the relationships between promotion and research, and the domestic consumption for cotton. The structural/econometric model approach emphasizes the theoretical description of behavioral relations that imposes identifying restrictions on model specification. The time-series approach focuses on reduced-form estimation with few parameter restrictions and does not attempt structural interpretation of data. This two-track approach is especially innovative in terms of project design. Results based on the same data set yet generated from two distinctly different modeling procedures serves as a check on robustness.

Because the Cotton Research and Promotion Program has several dimensions, it is necessary to analyze them as separate components. To account for carryover effects, indigenous to any evaluation of the promotion and research program, we rely on the use of a polynomial inverse lag (PIL) procedure in the econometric/structural model (Mitchell and Speaker). The attractive features of the PIL include: (1) a flexible representation of the lag structure allowing both humped and monotonically declining lag weight distributions; (2) a parsimonious representation of the lag structure; (3) no requirement of a fixed lag length; and (4) no imposition of endpoint restrictions. The estimation of the PIL involves a search for the polynomial degree using a series of nested OLS regressions. Based on Monte Carlo work, the PIL outperforms other popular distributed lag models (e.g., the Almon lag). To complement the structural/econometric approach, we use a time-series model to assess the direction of causality and timing of response between domestic consumption, cotton price, and promotion and research expenditures. The focus of the time-series approach is the dynamic or lagged response nature of such relationships.

This section provides the theoretical basis for the empirical analyses. We first discuss how to ascertain the effects of the program on domestic consumption of cotton. Subsequently, we discuss how to discern the rate of return for the checkoff program.

Development of Structural/Econometric Model

There are two fundamental aspects of the structural approach to analyzing the effect of promotion and research on the cotton market. First, in the structural approach it is recognized that there are several interrelated markets existing between the consumers of cotton products and the producers of cotton. Second, it is assumed that each of these markets can be represented by supply and demand schedules, and where supply and demand intersect there exists an equilibrium price and quantity. The structural approach captures the effects of promotion and research by incorporating them into the appropriate supply and demand schedules, and using market equilibrium conditions to model the effect of promotion and research on the price and quantity of cotton sold.

Partial Reduced-form--Domestic Consumption

Cotton promotion is directed at the retail level of the market chain. Research is directed at the textile level of the market. Thus, promotion does not directly enter the demand equation for cotton at the mill level, while research does. In order to get promotion into the demand equation for cotton, a market linkage model must used. The framework for these linkages is well-established and is found in Pigott, Pigott, and Wright; Wohlgenant (1993); and Wohlgenant and Clary, among others. We make the assumption of perfect competition in this analysis.

The Retail Market consists of the apparel market, the home furnishings market and others (see *The U.S. Cotton Content of Textiles and Apparel Imports-Implications for Expanding Markets,* prepared for the Cotton Board by ERS). The Textile Market consists of textile producers and consumers within the United States. This market represents the major demand for cotton in the United States. The general theoretical model is as follows:

Retail Market

(1) $D_r = D_r(p_r, a_1, Y_r)$ Retail Demand

(2) $S_r = S_r(p_r, p_t, W_r)$ Retail Supply

(3) $D_r = S_r$ Equilibrium

Textile Market

(4) $D_t = D_t(p_r, p_t, W_r)$ Total Derived Demand for Textile Output

(5) $S_t = S_t(p_t, p_c^d, p_c^f, a_2, W_t)$ Supply of Textiles

(6) $D_t = St$ Equilibrium

Derived Demand for Cotton from Textiles Industry

(7) $D_c = D_c(p_c^d, p_c^f, p_t, W_t)$

where p_r is the price in the retail market, a_1 are promotion expenditures; Y_r is a vector of demand shifters in the retail market (e.g., income, population); W_r is a vector of supply shifters for the retail market (e.g., wage rates, energy price, other materials); p_t is the price of textiles; p_c^d is the domestic price of cotton at the mill level; p_c^f is the foreign price of imported cotton fiber; a_2 are research expenditures; and W_t is a vector of supply shifters for the textile industry (e.g., price of rayon, price of polyester).

Placing the advertising variables and other retail demand determinants in equation (7) can be justified as follows. Using equation (3), the partial reduced-form price equation for the retail markets is:

(8) $p_r = p_r(p_t, a_1, a_2, Y_r, W_r)$

and similarly for the textile market:

(9) $p_t = p_t(p_r, p_c^d, p_c^f, W_r, W_t)$.

Solving (8) and (9) for the partial reduced-form of p_t yields:

(10) $p_t = p_t(p_c^d, p_c^f, a_1, a_2, Y_r, W_r, W_t)$.

Finally, substituting (10) into (7) yields the partial reduced-form demand equation for cotton,

(11) $D_c = D_c(p_c^d, p_c^f, a_1, a_2, Y_r, W_r, W_t)$.

Net Imports of Cotton Fiber

The underlying assumption in the above model is that U.S. and foreign cotton fiber are differentiated products in the full Chamberlain sense. Thus, the export and import demand equations can be defined quite generally following a similar logic to above as:

(12) $X = X(p_c^d, p_c^f, Y_x)$ Export demand for U.S. cotton fiber

(13) $M = M(p_c^d, p_c^f, a_1, a_2, Y_m)$ Import demand for cotton fiber

where Y_x is a vector of export demand shifters and Y_m is a vector of import demand shifters.

Total Cotton Fiber Demand

The total cotton fiber demand is then:

(14) $$Q = D_c(p_c^d, p_c^f, a_1, a_2, Y_r, W_r, W_t) + M(p_c^d, p_c^f, a_1, a_2, Y_m) - X(p_c^d, p_c^f, Y_x)$$
$$Q = Q(p_c^d, p_c^f, a_1, a_2, Y_r, Y_m, Y_x, W_r, W_t).$$

While equation (14) may appear conceptually simple, it is extremely complex and empirically intractable. The theoretical dimensions of the vectors Y_m, Y_x, W_t, and W_r are prohibitive to empirical analysis, and so the first step prior to any estimation is to try to identify a subset of the possible variables in (14) that are likely to explain most of the variation in total cotton fiber consumption.

The vector Y_r denotes shifters in the demand for domestic retail products and is represented by real per capita income in the United States (y_{us}). The vector Y_m denotes shifters in the import demand equation, and these are represented by real per capita income (y_{us}) and U.S. beginning stocks of cotton (s_{us}). The vector Y_x denotes shifters in the export demand equation for U.S. cotton fiber, and these are represented by a rest-of-world income measure (y_{rw}) and rest-of-world beginning stocks of cotton (s_{rw}). The vectors W_t and W_r represent supply shifters in the retail and textile markets (given the high level of aggregation), wages (p_l), energy cost (p_e), and materials (p_m) represent supply shifters in both of these industries. In addition to these inputs at the textile mill level, the price of substitute fibers is also potentially important, and these are represented by the price of rayon (p_r) and the price of polyester (p_p).

Thus, a theoretically consistent and empirically tractable partial reduced-form equation for aggregate domestic cotton fiber demand is as follows:

(15) $Q = Q(p_c^d, p_c^f, p_r, p_p, p_l, p_e, p_m, a_1, a_2, y_{us}, y_{rw}, s_{us}, s_{rw})$.

Total Cotton Fiber Supply

The supply of cotton fiber corresponding to equation (15) would be the supply made available to the U.S. textile mills and the net import supply of cotton fiber on a monthly basis. At the mill and exporter/importer level, the monthly supply equation is dictated by stock behavior. Thus, a general stock determination equation is of the form (see Labys, Chapters 4, 5, and 6):

(16) $S = S(Q, p_c^d | \Omega)$

where Ω may represent the information set available in stock release decisions. Stock equations are usually specified to depend on expectations of future demand and hence, future prices. However, whether the expectations assumption is naive, adaptive, or rational, the empirical model can easily turn out to be observationally equivalent in all cases. Empirically implementing the expectations models usually involves assuming that the data generation process for the variables to be forecast is some type of ARIMA process that is assumed to be known to the agents but not to the analyst. Thus, expectation variables are replaced with some function of lagged variables, and (16) becomes a function of any contemporaneous and lagged variables deemed to be in the information set (Pesaran). There are many alternative formulations for the stock equations. However, the key point here is that in a monthly model for total cotton fiber demand, the monthly supply is determined by the release of stocks being held. We do not need to estimate directly the stock release equation.

Based on market clearing conditions, with appropriate substitution and algebraic manipulation, solving for p_c^d yields a partial reduced-form expression:

(17) $p_c^d = p(p_c^f, p_r, p_p, p_l, p_e, p_m, a_1, a_2, y_{us}, y_{rw}, s_{us}, s_{rw} | \Omega)$.

Now because the information set Ω can potentially include any information relevant to the stock release decision, it may contain lagged values of all variables, including p_c^d. In this context a transfer function can be considered a reduced-form price equation. The two equations to empirically implement and estimate in our analysis are equations (15) and (17).

Empirical Results of the Econometric Model

To empirically implement equations (15) and (17) requires making two assumptions prior to any estimation. First, a functional form must be selected. Second, variables must be chosen to represent the theoretical variables. Once these choices are made, we can proceed to the estimation.

Functional Form

There are three criteria that we require of the estimating functional form: (1) linearity in parameters; (2) imposition of the restriction of diminishing marginal returns to promotion and research; and (3) that parameter estimates are elasticities. The first and third criteria allow for ease of comparison with prior research in the demand for cotton fiber. The second is a theoretical restriction. Given these criteria, the functional form that may come to mind is the double log specification, where all variables are expressed in natural log form. However, keeping the ultimate goal in mind of doing the counter factual analysis of price and quantity changes with and without promotion and research, we want a functional form that will allow for ease of removal of the promotion and research activities. That is, we want a functional form that will make it very easy to set the values of promotion and research to zero in the evaluation. A log transformation does not allow this action because the log of zero is not defined. To avoid this problem yet retain the diminishing marginal return relationship, we use a square root transformation on promotion and research, and a log transformation on all other variables.

Specification and Estimation

The general specification is given as follows:

(18) $$DCPC_t = \alpha_0 + \sum_{i=1}^{11} \alpha_i m_{it} + \beta W_t + \delta I_t + \gamma D_t + \eta A_t + \epsilon_t$$

where the variables will be defined as follows:

m_{it} = monthly dummy variables for seasonality, reference month, December; M_{it} equals 1 if month is I, 0 otherwise; I=1, ..., 11.

W_t = a vector of input prices defined to be W_t = ($REFFPCOT_t$, $RPRAY_t$, $RPPOLY_t$, $RWNDG_t$, $RPENRG_t$, $RPMAT_t$)′

I_t = a vector of international variables defined to be I_t = ($RAINDEX_t$, $WGDPI_t$, $ROWSTK_{t-1}$)′

D_t = a vector of domestic variables defined to be D_t = ($RPCINC_t$, $USSTK_{t-1}$)′

A_t = a vector of the promotion and research expenditures defined to be A_t = ($RPROMOS_t$, $RRESCHS_t$)′

ϵ_t = the error term

t = the observation.

The measurement variables in the vectors are:

$DCPC_t$ = log of U.S. per capita mill consumption of cotton plus raw fiber equivalent (rfe) of net imports

$REFFPCOT_t$ = log of rfe price of cotton at U.S. mills adjusted for user certificate values deflated by CPI (1982-84=100)

$RPRAY_t$ = log of rfe price of rayon deflated by CPI (1982-84=100)

$RPPOLY_t$ = log of rfe price of polyester deflated by CPI (1982-84=100)

$RWNDG_t$ = log of nondurable goods wage rate deflated by CPI (1982-84=100)

$RPENRG_t$ = log of nondurable goods energy price index (1982-84=100) deflated by CPI (1982-84=100)

$RPMAT_t$ = log of nondurable goods materials price index (1982-84=100) deflated by CPI (1982-84=100)

$RAINDEX_t$ = log of A index of world cotton prices deflated by CPI (1982-84=100)

$WGDPI_t$	=	log of index of GDP of OECD countries
$ROWSTK_t$	=	log of rest-of-world beginning cotton stocks
$RPCINC_t$	=	log of U.S. per capita income deflated by CPI (1982-84=100)
$USSTK_t$	=	log of U.S. beginning cotton stocks
$RPROMOS_t$	=	square root of seasonally-adjusted total expenditures on promotion deflated by CPI (1982-84=100)
$RRESCHS_t$	=	square root of seasonally-adjusted total expenditures on research deflated by CPI (1982-84=100)

Procedures for Empirical Specification Search

While economic theory is invaluable for suggesting the appropriate set of regressors in a regression, it fails to provide any guidance in three important areas. The first two have already been discussed -- functional form and observable variables to use for the unobservable theoretical variables. The third area that theory provides no real guidance for is in the area of dynamics, the search for acceptable lag structures on variables. This search is accomplished in our study through the use of the Akaike Information Criteria (AIC). Also, previous work in the demand for cotton is used to help form priors on the length and type of lags to be used and on parameter magnitudes, where possible.

The U.S. textile industry is characterized by lags between orders and deliveries. As explained by Stennis, Pinar, and Allen, forward ordering is prevalent in this industry. Often, distributors and retailers contract for cotton fiber 12 months or more prior to delivery. These dynamics are taken into account by allowing for lagged fiber prices in the empirical specifications. Forward contracting is an important part of the cotton and textile industry so the price observed today influences consumption in the future. Thus, the textile manufacturer, for example, is making future decisions based on today's prices. Because this decision-making process involves the optimal choice of all inputs simultaneously, then prices of other inputs would be expected to have the same lag length as the price of cotton. Using the AIC, the optimal lag length was 13 months. This value is very much in line with the value found and used by Wohlgenant (1986) and Shui, Beghin, and Wohlgenant, who considered a lag length of 12 months.

To determine the appropriate lag length on promotion and research, we chose to use the polynomial inverse lag (PIL) formulation of Mitchell and Speaker. The PIL does not require specifying the lag length, is conceptually an infinite lag, and, based on Monte Carlo work, outperforms several other popular distributed lag models (e.g., the Almon or polynomial distributed lag). A PIL is defined as follows:

$$(19) \qquad Z_{jt} = \sum_{i=0}^{t-1} \frac{X_{t-i}}{(i+1)^j} \qquad j = 2, \ldots\ldots, n,$$

with weights:

$$(20) \qquad W_i = \sum_{j=2}^{n} \frac{\theta_j}{(i+1)^j} \qquad I = 0, \ldots, \infty.$$

In our analysis, X_t represents either the promotion expenditure or research expenditure, and θ_j the parameter vector associated with jth order polynomial, j=2, ..., n.

The polynomial inverse lag has a flexible shape, allowing both humped and monotonically declining lag weight distributions. The lag is similar in spirit to the Almon lag, but it is an infinite lag and thus does not require specification of a fixed lag length. The estimation involves a search for the polynomial degree using a series of nested OLS regressions. The best combination in terms of the composite criteria of the AIC and signs and significance of the parameters was a second order PIL on both promotion and research, with a lag on promotion beginning at eight and the lag on research beginning at nine.

We ran several diagnostics on our final model specification. The Reset test is a test for omitted variables bias, and we failed to reject the null hypothesis of no specification bias. We did not find significant first and second-order serial correlation, but we did find significant higher order serial correlation based on Box-Pierce or Ljung-Box Q-statistics. The residuals were run through an ARIMA identification process by looking at the autocorrelation and partial autocorrelation plots. Because of the uncertainty regarding the structure of the serial correlation process, we used the Newey-West estimator to correct the variance-covariance matrix of the parameter vector; consequently all t-statistics are based on that estimator.

Finally, to address the question of pretest bias, given the model selection path was rather involved, we used a bootstrap procedure involving 1000 replications of the model. The results are very similar to those of the OLS model, indicating that the OLS parameters are reasonable from a statistical point of view.

The empirical results from the econometric/structural model for domestic per capita consumption of cotton are exhibited in Table 2. The results rest on the use of the Newey-West procedure to deal with serial correlation. It was necessary to implement a fourth-order autocorrelation correction to alleviate this problem. The Newey-West estimator of serial correlation parallels the White estimator for heteroskedasticity. Given the similarity of the results from the Newey-West procedure and from the bootstrapping procedure, we discuss the former's results. The level of significance chosen for this analysis is 0.10. Our results show no evidence of specification bias or structural change; consequently our results suggest that the specification captures the essential dynamics present in the data.

Seasonality, unequivocally, is a key determinant of cotton consumption. Cotton consumption is higher in all months relative to the base or reference month, December. For example, consumption is highest in January, June, August and October; relative to December, cotton consumption in these months is higher by 20 to 25 percent. In the other months, consumption is higher by 7 to 18 percent relative to December.

The own-price elasticity at the mill level is estimated to be -.1655, statistically different from zero. Previous studies have estimated the price elasticity of demand for cotton between -0.1 and -0.3 (Donald, Lowenstein, and Simon; Waugh; Meyer). Holding all other factors constant, a 10 percent change in mill price leads to a 1.6 percent change in domestic consumption per capita in the opposite direction. The lag of 13 months is consistent with previous studies (Shui, Beghin, and Wohlgenant).

Both rayon and polyester prices exert a statistically significant influence on cotton consumption. The cross-price elasticity of cotton with respect to rayon is .2600, indicating that rayon is a substitute for cotton. On the other hand, the cross-price elasticity of cotton with respect to polyester is -.5479, indicating that polyester and cotton are complements. This situation perhaps reflects the blending of cotton and polyester in textiles.

Wages, after a lag of 13 months, are also a significant factor of the domestic consumption of cotton. A 1 percent change in real wages leads to a 3.25 percent change in cotton consumption in the opposite direction. Neither the price of energy nor the price of materials has a statistically discernible effect on cotton consumption.

Both U.S. and rest-of-world beginning stocks of cotton are determinants of U.S. mill consumption and net imports of cotton. A 10 percent change in U.S. beginning stocks leads to a 0.70 percent change in domestic cotton consumption; whereas a 10 percent change in rest-of-world beginning stocks after a lag of two months, gives rise to a 2.1 percent change in domestic cotton consumption.

The A index, with a lag of two months, is also a determinant of domestic cotton consumption. A 10 percent change in this world price measure leads to a 4.0 percent change in U.S. per capita cotton consumption, holding all other factors constant. This result presumably is attributable to the substitutability of U.S. cotton with foreign cotton. Neither U.S. income nor rest-of-world income is a statistically important factor in domestic cotton consumption.

The estimated coefficients of the promotion and research variables, ZP2 and ZR2 in Table 2, represent the short run or current effects after initial delays. The long run effects are given by the sum of all current and subsequent effects which turns out to be the product of the respective coefficients of ZP2 and ZR2 times the infinite series:

$$\left[1 + \frac{1}{2^2} + \frac{1}{3^2} + \ldots + \frac{1}{k^2} + \ldots\right] = \sum_{k=0}^{\infty} \frac{1}{k^2}.$$

It can easily be shown that this series converges to a finite limit, say L. Given that there is no closed form expression for L, we approximate this sum using the first 100 terms. L then is given by 1.63517. Thus, the long run effect is approximately 1.635 times the short run effect.

From Table 2, the coefficients for ZP2 and ZR2 are .000068353 and .00024975, respectively. From the previous discussion, these coefficients are the short run impacts of promotion and research. This makes the long run impacts .000109766 and .000396089, respectively.

After an eight month delay, promotion programs significantly affect cotton consumption, *ceteris paribus*. The short run elasticity due to promotion efforts, at the sample mean, is 0.0367. That is, a 10 percent change in promotion expenditures, after a delay of eight months, gives rise to a 0.36 percent change in domestic per capita cotton consumption. To put this result in perspective, a 10 percent change in promotion expenditures translates to a 2 million pound change in cotton consumption in the short run. The long run elasticity due to promotion efforts is 0.0600.

After a nine month delay, research programs significantly influence cotton consumption, holding all other factors invariant. The short run elasticity due to research efforts, at the sample mean, is 0.0771. So a 10 percent change in research expenditures after a delay of nine months, leads to a 0.77 percent change in domestic per capita cotton consumption. This 10 percent change in research expenditures translates to a 4 million pound change in cotton consumption in the short run. The long run elasticity due to research efforts is 0.1261.

Both research and promotion, after accounting for other factors, significantly and positively impact cotton consumption. There is a delay of eight to nine months. The elasticities, calculated at the sample means, are consistent with those from similar studies in the extant literature. The impact of research efforts is twice that of promotion efforts. The respective patterns of promotion and research effects resemble a geometric lag process, where mean lag (the average amount of time necessary to effect changes in cotton consumption), due to promotion and research efforts is about two months after the initial eight to nine month delay.

Table 2. Empirical Results From the Econometric/Structural Model for Domestic Per Capita Consumption of Cotton

Variable	Coefficient	T-Statistic
M1	.2131 (.2137)[a]	5.51 (6.90)[a]
M2	.1193 (.1202)	4.93 (4.08)
M3	.1678 (.1675)	6.57 (5.64)
M4	.0685 (.0692)	2.05 (2.22)
M5	.1544 (.1542)	4.64 (5.09)
M6	.1830 (.1834)	5.61 (5.79)
M7	.1419 (.1425)	3.82 (4.27)
M8	.2240 (.2245)	4.69 (6.56)
M9	.1171 (.1175)	3.37 (3.11)
M10	.1926 (.1923)	5.38 (6.61)
M11	.0941 (.0950)	3.52 (2.89)
REFFPCOT13	-.1655 (-.1644)	-3.53 (-3.69)
RPRAY13	.2660 (.2567)	1.82 (1.49)
RPPOLY13	-.5479 (-.5581)	-2.61 (-2.93)
RWNDG13	-3.2769 (-3.2560)	-1.77 (-1.77)
PENRG13	.0673 (.0705)	0.74 (0.58)
PMAT13	.2733 (.2864)	1.04 (1.09)
RAINDEX2	.4043 (.4010)	4.03 (4.22)
USTK	.0708 (.0691)	1.72 (1.66)
RSTK2	.2077 (.2047)	2.82 (2.80)
RUSY	-.8022 (-.7908)	-1.39 (-1.05)
RWY2	-.2762 (-.2888)	-0.31 (-0.31)
ZP2	.6835E-04 (.6858E-04)	1.95 (2.09)
ZR2	.2497E-03 (.2534E-03)	2.52 (1.71)
INTERCEPT	13.765 (13.677)	1.68 (1.44)
R^2	.8678	
$\bar{R}^2$	.8266	
DW	2.07	

[a] Bootstrapping procedure.

Development of Time-series Model (Vector Autoregression)

In this section we consider the time-series properties of the data theory suggested as relevant for the study of the response of mill price and consumption to promotion and research expenditures. Augmented Dickey-Fuller and Durbin Watson tests are used to examine unit roots at zero frequency. These tests suggest that the data are stationary with one regular difference. In addition, we consider the possibility of seasonal nonstationarity and use the monthly version of the HEGY (Hylleberg, Engle, Granger, and Yoo) test as developed by Beaulieu and Miron to throw light on the seasonality question. While no evidence of unit roots at seasonal frequencies was found, seasonal patterns in the data were evident. These seasonal patterns were removed using a set of monthly dummy variables on the first differences of each variable. Given stationary deseasonalized data, we use the Schwarz loss metric and the search procedure suggested by Hsiao (1979) to help us in identifying the dynamic relationship among each of the 14 variables under study. As this criterion has been shown to not overfit (select too many lags in time-series regression), it is useful in assigning zero coefficients to lags in dynamic models; however, its properties in sorting out influences of groups of weakly significant individual effects but having strongly significant group effects, are less well-studied and established. Accordingly, we make a couple of adjustments to the Schwarz-selected lagged relationships.

The representation of the 14 equation vector autoregression is exhibited in Table 3. The numbers in parentheses are standard errors of the estimated coefficients. R^2 is the coefficient of determination. DW is the Durbin Watson statistic associated with first-order autocorrelation in the residuals. While not strictly interpretable as a test for first-order autocorrelation in equations including lagged dependent variables, the DW does offer heuristic help in flagging problems with first-order autocorrelation and possible problems with spurious regression (Granger and Newbold). No particular problems are noted in the estimated equations (DW less than R^2 is a particularly ominous indicator of spurious regression (Granger and Newbold)).

Interpretation of the relationships among variables in multiple time-series is difficult from the autoregressive representation (Sims). The problem of following a variable's influence through time and across equations, accounting for possible feedback effects from previously affected variables is analogous to sorting out the proverbial "can of worms." However, one can interpret such dynamic interactions through the algebraically equivalent moving average representation.

That is to say, one can take the autoregressive model given in Table 3 and derive its moving average representation. This representation gives the dynamic response of each series to historical shocks in every other variable (including itself).

The moving average representation can be illustrated by starting from a vector autoregression, such as:

$$(21) \qquad x_t = \sum_{k=1}^{K} \alpha(k)x_{t-k} + \delta_t$$

Here $\alpha(k)$ is an autoregressive matrix of dimension (14x14) at lag k which connects x_t and x_{t-k}. δ_t is a vector residual term of dimension (14x1). In terms of the equations in Table 3, many (actually most), of the autoregressive parameters $\alpha(k)$ are equal to zero; K is the maximum lag, found through the Hsiao procedure. Moving all terms involving x_t and x_{t-k} to the left-hand side of equation (21) and writing lags in terms of the lag operator, we get the autoregressive representation as:

$$(22) \qquad (1 - \alpha(B))x_t = \delta_t$$

Merely inverting equation (22) gives us the standard moving average representation:

$$(23) \qquad x_t = (1 - \alpha(B))^{-1}\delta_t.$$

Written in more discernable terms as an infinite sum:

$$(24) \qquad x_t = \delta_t + \pi(1)\delta_{t-1} + \pi(2)\delta_{t-2} + \pi(3)\delta_{t-3} + \pi(4)\delta_{t-4} + \ldots$$

Here $\pi(i)$ are moving average parameter matrices of dimension (14x14) derived from equation (23) and δ_{t-i} are vectors of historical shocks of dimension (14x1). The structure of equation (24) allows us to decompose the x vector at t into its historical components. For any particular element of x_t, say element i, we can write it as:

$$(25) \qquad x_{it} = \delta_{it} + \sum_{j=1}^{14} \pi_{ij}(1)\delta_{jt-1} + \sum_{j=1}^{14} \pi_{ij}(k)(2)\delta_{jt-2} + \ldots$$

Table 3. **Representations of the 14-Equation Vector Autoregression**

Model	R^2	DW
$\Delta lnCP_t^* = .51\ \Delta lnAI_{t-1}^* + .07\ \Delta lnMP_{t-4}^*$ (.11) (.03)	.25	2.13
$\Delta lnRP_t^* = .25\ \Delta lnRP_{t-4}^* + .11\ \Delta lnCP_{t-1}^* + .03\ \Delta lnPP_{t-3}^* - .27\ \Delta lnCQ_t^*$ (.09) (.06) (.01) (.09) $.20\ \Delta lnAI_{t-5}^* - .27\ \Delta lnAI_{t-6}^* + .06\ \Delta lnMP_{t-5}^*$ (.08) (.08) (.02)	.38	2.11
$\Delta lnPP_t^* = 1.0\ \Delta lnUS_{t-10}^* + .52\ \Delta lnMP_{t-1}^*$ (.18) (.13)	.35	2.20
$\Delta lnCQ_t^* = -.84\ \Delta lnCQ_{t-1}^* - .51\ \Delta lnCQ_{t-2}^* + .02\ \Delta lnPP_{t-4}^* + .02\ \Delta lnWS_{t-6}^*$ (.09) (.09) (.01) (.01) $-.04\ \Delta lnMP_{t-2}^* + .02\ \Delta lnRE_{t-6}^* + .03\ \Delta lnRE_{t-7}^* + .05\ \Delta lnRE_{t-8}^*$ (.02) (.01) (.02) (.02) $+.06\ \Delta lnRE_{t-9}^* + .03\ \Delta lnRE_{t-10}^* + .02\ \Delta lnRE_{t-11}^*$ (.02) (.02) (.01)	.60	1.94
$\Delta lnPE_t^* = -.68\ \Delta lnPE_{t-1}^* - .58\ \Delta lnPE_{t-2}^* + .15\ \Delta lnWS_{t-1}$ (.08) (.08) (.04)	.51	2.20
$\Delta lnRE_t^* = -.89\ \Delta lnRE_{t-1}^* - .85\ \Delta lnRE_{t-2}^* - .74\ \Delta lnRE_{t-3}^* - .37\ \Delta lnRE_{t-4}^*$ (.09) (.12) (.13) (.12) $-.24\ \Delta lnRE_{t-5}^* + 2.02\ \Delta lnCQ_{t-5}^* + 2.11\ \Delta lnCQ_{t-6}^* + .36\ \Delta lnPE_{t-3}^*$ (.10) (.66) (.64) (.14) $-1.96\ \Delta lnPI_{t-5}^*$ (.89)	.67	2.06
$\Delta lnUS_t^* = -.69\ \Delta lnCP_{t-1}^* - .85\ \Delta lnRP_{t-4}^* - .21\ \Delta lnPP_{t-2}^* + .15\ \Delta lnPP_{t-3}^*$ (.20) (.31) (.04) (.04)	.38	1.71
$\Delta lnWS_t^* = .23\ \Delta lnRE_{t-1}^* - 1.0\ \Delta lnAI_t^*$ (.09) (.49)	.10	1.92
$\Delta lnAI_t^* = .24\ \Delta lnAI_{t-1}^* - .20\ \Delta lnCP_{t-5}^* - .04\ \Delta lnPP_{t-4}^* + .05\ \Delta lnRE_{t-2}^*$ (.08) (.07) (.02) (.02)	.42	1.77
$\Delta lnPI_t^* = -.32\ \Delta lnPI_{t-1}^*$ (.10)	.10	2.04
$\Delta lnWI_t^* = .82\ \Delta lnWI_t^*$ (.06)	.70	1.83
$\Delta lnMP_t^* = .74\ \Delta lnMP_{t-1}^*$ (.07)	.54	2.09
$\Delta lnEP_t^* = .34\ \Delta lnEP_{t-1}^*$ (.10)	.10	1.93
$\Delta lnWP_t^* = -.24\ \Delta lnWP_{t-1}^*$ (.11)	.04	1.99

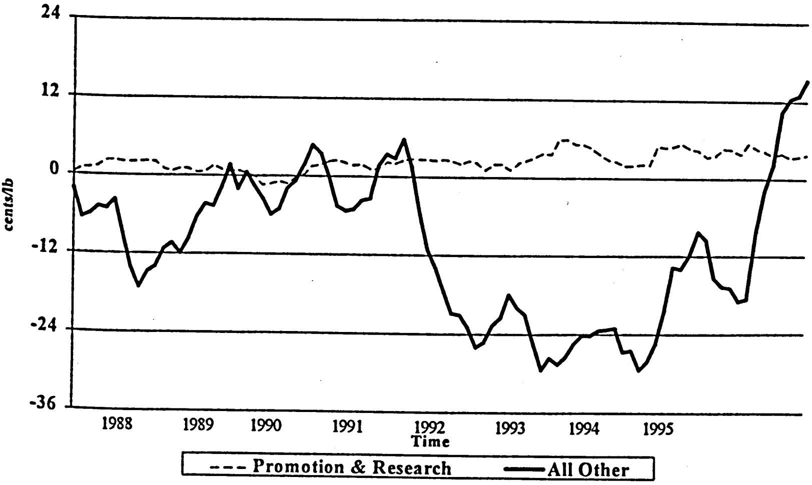
The asterisk (*) indicates the series have been deseasonalized and Δln is the first difference operator. The numbers in parentheses are standard errors of the estimated coefficients. R^2 is the coefficient of determination and DW is the Durbin-Watson statistic.

Here δ_{jt-k} is the shock in series j in period t-k and $\pi_{ij}(k)$ is the i,j element of the π matrix of equation (24), which gives the response of series i to the shock in period t-k in series x_j. At any time t, we can accumulate that portion of the series which is "due to" past shocks in any of the particular series (j) of the vector time-series.

Historical decompositions of time-series models are not independent of the ordering of contemporaneous correlation. To deal with this situation, we used the Bernanke ordering as described in Doan. Cotton price in contemporaneous time is allowed to be caused by movements in polyester price, research expenditures, and world stocks; rayon price in contemporaneous time is allowed to be caused by research expenditures and world income; mill consumption in contemporaneous time is allowed to be affected by research expenditures; promotion expenditures in contemporaneous time are caused by wages; and research expenditures in contemporaneous time are caused by personal income. These relationships were examined using the likelihood ratio test as described in Doan and were rejected at a significance level of .17. Alternative orderings were investigated and were either rejected at much lower levels of significance (.05 or lower) or resulted in similar decompositions.

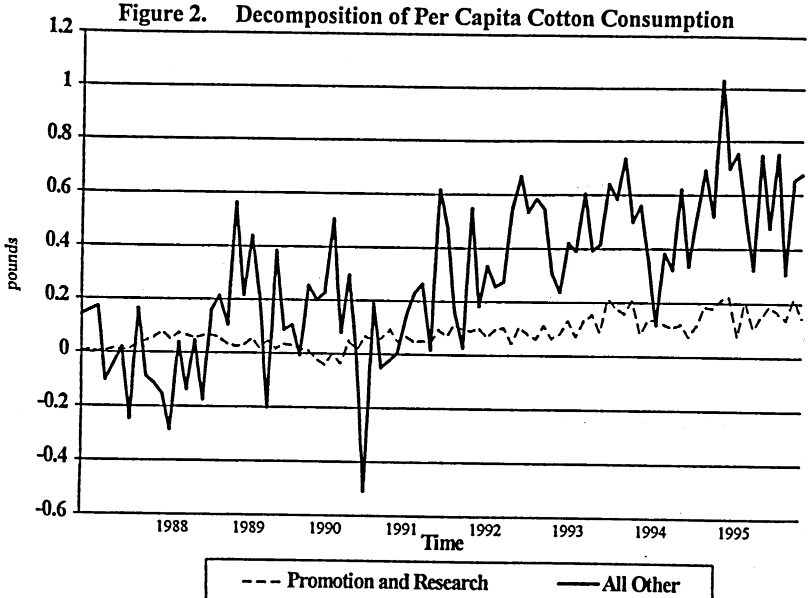
Historical decompositions for cotton price and for domestic consumption are available from the authors upon request. We began the decomposition in January 1988 and ran it out through July 1995. Plots of these decompositions are exhibited in Figures 1 and 2. For both cotton price and domestic consumption, promotion and research expenditures have a positive influence almost everywhere. Their influence on cotton price is, on average, 2.3 cents per pound over the sample period. Promotion and research expenditures result in about a .08 pound per capita per month increase in consumption. The percentage change in domestic consumption due to a 1 percent change in promotion/research expenditures is roughly .0410 from the time-series analysis. If we weight the respective promotion and research elasticities from the econometric model by their budget allocation, the aggregate elasticity measure is .0459. Thus, in aggregate, the time-series and econometric models yield essentially identical results in terms of impacts of promotion and research on domestic consumption.

Figure 1. Decomposition of Cotton Price



Measured relative to price in December 1987

Figure 2. Decomposition of Per Capita Cotton Consumption



Measured relative to per capita consumption in December 1987

Rate of Return Calculations

While our analysis shows a statistically significant response of cotton consumption and price to promotion and research expenditures, the major issue is the level of returns. We calculate the return to the cotton checkoff program through the ratio of cumulative net returns to cumulative assessments. We also present separate calculations using the structural/econometric modeling approach and the time-series modeling approach.

Once an econometric model or a time-series model is developed, simulations are often used to derive conclusions about rates of return and alternative allocation policies. Using historical data, one can simulate demand assuming no checkoff expenditures. These predicted gains provide a base for judging the returns from all advertising, marketing, and research expenditures. Taking this difference gives the estimated total effect and provides the numbers for calculating a rate of return. In fact, this procedure was used by Ward, and Ward and Lambert in calculating a rate of return for the checkoff program in the beef industry. The use of the econometric approach and the use of the time-series approach in the computation of rates of return to checkoff programs is unique. The use of the two approaches provides a check on the robustness of the results.

The conceptual apparatus for calculating net returns is the change in "producer" surplus due to promotion and research within a supply and demand diagram. Let (P_{0t}, Y_{0t}) correspond to the equilibrium price and quantity for domestic cotton fiber when there are no promotion or research expenditures in time period *t*. Alternatively, let (P_{1t}, Y_{1t}) correspond to the equilibrium price and quantity for domestic cotton fiber when there are promotion and research expenditures in time period *t*. Now because of the assessment, the price that the producer receives as a result of promotion and research expenditures is $P_{1t} - \tau$, where τ is the amount of the assessment. The calculation of τ, (the assessment paid by domestic producers and importers), on a per pound basis by month over the time period January 1986 to July 1995 is available from the authors. On a real raw fiber equivalent basis, this assessment varies from .3529 to .5287 cents per pound.

Approximating the market with linear supply and demand curves, it is easy to show that the formula for the change in producer surplus ΔPS_t, or net returns, is:

$$(26) \quad \Delta PS_t = (P_{1t} - \tau - P_{0t})\, Y_{0t} + \tfrac{1}{2}(P_{1t} - \tau - P_{0t})(Y_{1t} - Y_{0t})$$
$$= (P_{1t} - P_{0t})\, Y_{0t} + \tfrac{1}{2}(P_{1t} - P_{0t})(Y_{1t} - Y_{0t}) - \tau Y_{0t} - \tfrac{1}{2}\tau (Y_{1t} - Y_{0t})$$

The rate of return for any given time period is the ratio of ΔPS_t to the change in expenditures on promotion and research. In this hypothetical experiment, the change in research and promotion expenditures represents the difference between the actual level of expenditures and no expenditures, so the change in expenditures equals the actual level of promotion and research expenditures in time t, denoted by E_t. The rate of return in period t is then obtained for both the structural model and time-series model by simulating the estimated price and quantity equations with and without promotion and research, substituting into (26) appropriately, and then dividing by E_t. The average rate of return is then calculated as:

$$\frac{\sum_{t=1}^{T} \left(\frac{\Delta PS_t}{E_t} \right)}{T}$$

Because of the use of lagged variables in both modeling approaches, it is only possible to calculate rates of return from January 1988 to July 1995. The checkoff program over the period January 1988 to July 1995 yielded a rate of return between 5.38 (from the time-series model) and 5.95 (from the structural/econometric model). For each \$1 of assessments, a net return of between \$5.38 and \$5.95 was evident. The fact that the two alternative methods yielded very similar results increases our confidence in the accuracy of these results.

As exhibited in Table 4, our rates of return for the checkoff program are in the interval established by studies done for other commodities. From that standpoint, our estimates of rates of return are not unreasonable. Importantly, our estimates are robust in the sense that the differences between the structural/

econometric model and the time-series model are negligible. Importantly, the estimated rates of return are upper-bounds due to the fact that they are based on short-run (monthly) responses to promotion and research.

Table 4. Returns to Generic Commodity Promotion in the United States

Commodity/Study	Revenue per $ Invested
Milk --Fluid Only	
Liu, et al.	7.04
Ward and McDonald	1.85
Milk--Fluid and Manufactured	
Liu, et al.	4.77
Kaiser, et al.	2.04
Milk and Cheese	
Kinnucan and Forker	11.29
Meat--Beef (U.S.)	
Ward	5.74
Catfish	
Kinnucan and Venkateswarn	0.57-1.30 (short run) 0.17-0.57 (long run)
Soybeans and Products (export)	
Williams	14.00
Orange Juice	
Lee and Fairchild	2.28
Grapefruit Juice	
Lee	10.44
Apples	
Ward and Forker	6.74
Australian Wool	
Dewbre, et al.	1.94

CI conducted a rate of return analysis of the checkoff program over the time period 1975 to 1992. Similar to our work, cotton consumption was defined as the sum of mill consumption plus net imports of yarns, fabrics, and finished goods. No formal econometric or time-series models were used. CI simply calculated the cumulative difference between the actual level of consumption for cotton and a hypothetical level; this hypothetical level was arrived at under the assumption that the market share for cotton would have continued to decline until 1985, and thereafter it would have stabilized at a 25 percent share after 1985. Under this scenario, the rate of return calculated by CI was estimated to be 3 to 1. The key assumptions in the analysis conducted by CI were: (1) that the market share for cotton would have continued to decline after 1975 if research and promotion activities had not been initiated; and (2) that the efforts of CI were totally responsible for affecting cotton's market share of total fiber consumption. Our analysis does not hinge on these assumptions.

Limitations and Suggestions for Further Research

While our analysis provides useful information about the cotton checkoff program, there are limitations; consequently, suggestions are made for further research. Up to this point, neither the structural/econometric model nor the time-series model provided sufficient detail to investigate the distribution of the benefits of the checkoff program. By definition, domestic consumption of cotton lumps net imports with mill use. Although we show that there exists a positive link between promotion/research and consumption, at present it is not possible to say whether the increase in consumption comes in the form of increases in net imports (imports and exports), mill use, or both. Without this information, it is impossible to say whether domestic producers or importers benefit from promotion/research efforts. To this end, it is worthwhile to investigate the impacts of promotion/research expenditures on domestic producers and importers.

Another suggestion for further research is to incorporate branded advertising into the structural/econometric and time-series models. One may rely on the use of Leading National Advertisers (LNA) data in this regard (Green, Carman, McManus; Brester and Schroeder). The LNA data constitutes a summary of advertising expenditures in the following media: (1) consumer magazines; (2) Sunday magazines; (3) newspapers; (4) network, spot, syndication, and cable television; (5) billboards; and (6) network and spot radio. Thus, these data are a great source for identifying media occurrences. However, the LNA information is not without its drawbacks. First, spot TV monitoring is limited to 80 percent of the population; newspapers and magazines are measured from a limited list; trade publications are not measured; all rate card prices are provided by media sellers so expenditures are often inflated; all TV rates are based on monthly averages instead of specific telecasts; magazine expenditures are based on one-time open rates and do not take into account frequency or negotiation discounts; and there is no independent check on the accuracy of the information.

Importantly, the design of branded advertising campaigns is to increase market share for the particular manufacturer. The goal of generically-oriented campaigns, such as the CI program, is to increase consumption and market share. Generic programs call attention to the product, placing emphasis on its attributes. Branded advertising is more focused on attributes and images that can be associated with a specific brand within the commodity group. Often, branded advertising programs follow generic programs. The branded programs then seek to capture market share via product differentiation. One may argue that because our analysis excludes branded advertising, our estimates of rates of return are overstated. However, without a generic promotion/research effort, there may be no foundation on which to build a branded advertising campaign.

Similarly, one may argue that our rates of return may be overstated due to the omission of cross-professional research effects. Lee, Brown, and Fairchild concluded that failure to incorporate the impact of advertising on closely related goods can lead to biased estimates of advertising effects. Also, to take into account cross-promotional/research effects, one may need to employ a demand systems approach in lieu of single-equation models (Brester and Schroeder; Green, Carman, and McManus). Kinnucan contends that benefit-cost analyses (rate of return calculations) based on single-equation models may overstate returns to generic advertising. To test this hypothesis in future research efforts, one needs to obtain the relevant data for cross-promotion. Often, these data are not available, as was the case in our study.

Third, given the different impacts of promotion and research on cotton demand, it may be worthwhile to investigate the optimal way to allocate expenditures of the checkoff program. That is, one can address the following: is the current allocation of promotion and research expenditures optimal in the sense of maximizing returns? In examining the distribution of gains from promotion and research for the U.S. beef and pork industries, Wohlgenant (1993) argued that producers should prefer a research-induced decrease in production costs to an equivalent promotion-induced increase in retail price for maximizing net returns.

Finally, generic promotion seems to work best in industries where supply is controlled. The literature reveals that the more responsive supply is to rising prices, the more likely that the potential returns from generic promotion is at least partially, if not totally, eroded from increases in supply. Kinnucan determined that supply response completely eliminated returns to advertising of catfish over time. Carman and Green found that while avocado producers benefited from generic advertising during the initial years of the program, supply expansion eventually led to negative returns to producers from continued advertising. The problem of advertising response in an industry without supply controls was first discussed by Nerlove and Waugh in 1961. Given that relatively few studies of the effects of advertising have considered the possibility of a supply response, future research efforts in this regard are likely to pay dividends.

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