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Analyses of Factors That Affect Mill Consumption of Cotton in the United States

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Research discussed in this article represents one phase of a comprehensive project designed to study the demand for the principal textile fibers in this country—cotton, wool, and synthetic fibers. Results from the larger study are to be reported in a technical bulletin which will include a more detailed version of this paper, possibly slightly revised if warranted by research still in progress. From the standpoint of quantities consumed, cotton is by far the most important fiber of the group. Annual variations in total fiber consumption—including flax and silk—have conformed rather closely to those for cotton, despite the steady advance in use of synthetics. Determination of factors primarily responsible for variations in cotton consumption and their relative significance is a noteworthy step toward understanding fluctuations in the use of all fibers in the aggregate.[1]

CONSUMPTION OF COTTON in the United States far exceeds that of all other textile fibers taken together. In 1952, for example, 28 pounds of cotton per capita were consumed compared with a total of approximately 12 pounds of wool, synthetic fibers, flax, and silk. The relative advantage of cotton was even greater in earlier years. Figure 1 shows the varying trends in consumption of the principal textile fibers in this country.

An analysis of factors that affect domestic mill consumption of cotton—henceforth designated Analysis I—was published in the April 1952 issue of this journal.[2] As a consequence of research since 1952 and some additional data, the demand equation for cotton in the domestic market has been modified and extended. The modification involves substitution of (1) deflated personal disposable income and the year-to-year change in such income for the index of industrial production, and (2) consumption of all synthetic fibers for that of rayon and acetate alone. The extension consists of the incorporation of data that measure the degree of imbalance existing at any given time at the mill level between the supply of, and the level of demand for, cotton broad woven goods. Because of its novelty, special attention is given to the nature and use of this new measure. The revised analysis is a distinct improvement over Analysis I.

In considering these changes and their significance, this paper uses the following procedure.

[1] Research on which the report is based was made under authority of the Agricultural Marketing Act of 1946 (RMA, Title II). The authors are indebted to the American Cotton Manufacturers Institute, Inc. for basic data relating to stocks and unfilled orders of cotton cloth, especially to Claudius T. Murchison and William T. Shymanski.

[2] LOWENSTEIN, FRANK. FACTORS AFFECTING THE DOMESTIC MILL CONSUMPTION OF COTTON. Agricultural Economics Research 4: 44–51. April 1952.

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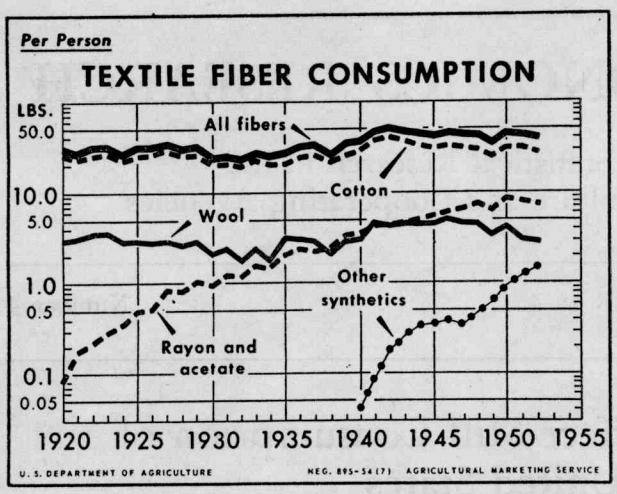

FIGURE 1.—The vertical scale of this figure is logarithmic, thus enabling comparison of percentage changes over time. Cotton is far in front of other fibers but has steadily lost ground during the last 3 decades. In 1952 cotton consumption per capita represented 69 percent of total fiber consumption—including flax and silk—compared with 88 percent in 1920, 85 percent in 1930, and 81 percent in 1940.

First, a brief recapitulation of statistical aspects of Analysis I is given as background material. Second, the modifications of Analysis I and the results therefrom are discussed under Analysis II. The measure of imbalance in the mill supply-demand relation for cotton broad woven goods is then considered and results from its use are given as Analysis III. Because of a lack of data for the imbalance measure, Analysis III covers fewer years than Analysis II. For comparison, Analysis IV was run for the same years as Analysis III and with the same variables as Analysis II. The principal statistical coefficients obtained from each of the four analyses are shown in table 1.

Analysis I—Industrial Production

Analysis I is based on the years 1921–40 and 1947–50 and uses the following variables:

X_1=mill consumption of cotton per capita

X_2=Federal Reserve Board index of industrial production (1935–39=100), on a per capita basis

X_3=rayon consumption per capita

X_4=average annual price of Middling, 7/8-inch cotton at the 10 spot markets deflated by the Bureau of Labor Statistics index of wholesale prices (1926=100).

A lead of 6 months was used for X_4 on the assumption that the quantity of cotton consumed by mills was influenced more by the purchase price of cotton than by the concurrent market price. X_4 th[illegible] comprises data for years beginning in Ju[illegible], whereas X_1, X_2, and X_3 are based on calendar years. As the relation between these variables is believed to be proportional rather than linear, the analysis was run with the variables expressed in logarithms.

Table 1 shows the principal statistical results obtained from Analysis I. The three independent variables explained 79 percent of the variation in mill consumption of cotton per capita.

The equation expressing the relation between the variables follows:

$$\text{Log } X_1 = 6.94 + 0.84 \log X_2 - 0.12 \log X_3 - 0.30 \log X_4$$

As the analysis was run in logarithms, the net regression coefficients show the approximate percentage change in the per capita consumption of cotton for a 1-percent change in each of the independent variables with the other independent variables held constant.

Analysis II—Substitution of Income and Consumption of All Synthetic Fibers

Analysis II differs from Analysis I in two respects: (1) Personal disposable income and t[illegible] change in disposable income from the previous year, both adjusted for price changes, are used in place of the index of industrial production to measure changes in general demand conditions that affect cotton consumption. (2) Consumption of all synthetic fibers—rayon, acetate, nylon, orlon, and others—instead of consumption of rayon and acetate alone is used to represent the effect of substitute fibers.

In demand analyses, personal disposable income is commonly used as the demand shifter for consumer goods. The index of industrial production is frequently employed when the commodity considered is essentially an industrial raw material.[3] Cotton cannot be said to satisfy either criterion exclusively. The largest outlets for cotton are in items directly associated with consumer demand and easily identifiable as cotton products. In peacetime years since 1939, 60 percent or more of the cotton that was traced to various end uses

[3] FOOTE, RICHARD J., and FOX, KARL A. ANALYTICAL TOOLS FOR MEASURING DEMAND. U. S. Dept. Agr. Handbook No. 64. January 1954. Page 9.

TABLE 1.—*Principal statistical coefficients from 4 analyses of factors that affect mill consumption of cotton, United States* [1]

Correlation coefficient	Analysis							
	I		II		III		IV	
	Value	Standard error	Value	Standard error	Value	Standard error	Value	Standard error
Multiple determination, R^2	0. 79		0. 75		0. 95		0. 84	
Standard error of estimate	. 03		. 03		. 02		. 03	
Highest order:								
Partial regression:								
b_2	. 84	0. 13	. 89	0. 16	. 92	0. 13	1. 05	0. 23
b_3	−. 12	. 03	. 82	. 22	. 93	. 16	1. 15	. 27
b_4	−. 30	. 09	−. 09	. 03	−. 09	. 03	[2] −. 12	. 04
b_5			−. 24	. 08	−. 23	. 06	[2] −. 27	. 10
b_6					−. 08	. 02		
Partial determination: [3]								
r^2_2	. 69		. 61		. 81		. 64	
r^2_3	. 46		. 41		. 75		. 60	
r^2_4	. 34		. 37		. 54		[2] . 38	
r^2_5			. 32		. 60		[2] . 37	
r^2_6					. 71			

[1] These values relate to the regression equations when all variables, except X_6, are expressed in logarithms. See pp. 102, 105, and 110 for variables in these analyses.

[2] This coefficient differs significantly from zero at the 5-percent probability level but not at the 1-percent level.

[3] Square of the partial correlation coefficient.

was used in items of apparel and in household products (table 2). The other main use of cotton is for industrial purposes. However, the use of cotton for industrial purposes has been declining both relatively and absolutely in recent years.

Industrial products that use cotton include such items as bags, shoes, tire cord, automobile upholstery, insulation, cordage and twine, and tarpaulins. Chains of technical coefficients connect the demand for the raw cotton in these uses with

TABLE 2.—*Cotton: Quantities consumed by category of use, 1939–53*

Year	Quantity [1]				Percentage distribution		
	Apparel	Household	Industrial	Total	Apparel	Household	Industrial
	1,000 bales	*1,000 bales*	*1,000 bales*	*1,000 bales*	*Percent*	*Percent*	*Percent*
1939	2, 276	1, 638	2, 440	6, 354	36	26	38
1940	2, 143	1, 827	2, 639	6, 609	32	28	40
1941	2, 526	1, 958	3, 361	7, 845	32	25	43
1942	2, 346	1, 748	3, 173	7, 267	32	24	44
1943	2, 807	1, 575	3, 347	7, 729	36	21	43
1944	2, 630	1, 401	3, 167	7, 198	37	19	44
1945	2, 430	1, 317	3, 036	6, 783	36	19	45
1946	2, 414	1, 748	3, 051	7, 213	34	24	42
1947	2, 740	2, 288	2, 935	7, 963	34	29	37
1948	2, 741	2, 255	2, 739	7, 735	36	29	35
1949	2, 749	2, 116	2, 446	7, 311	38	29	33
1950	3, 122	2, 655	2, 687	8, 464	37	31	32
1951	3, 008	2, 600	2, 611	8, 219	36	32	32
1952	3, 220	2, 650	2, 190	8, 060	40	33	27
1953 [2]	3, 387	2, 734	1, 938	8, 059	42	34	24

[1] These estimates do not account fully for the total consumption of cotton as reported by the Bureau of the Census. Generally less than 30 percent of the reported total was not covered, part of which presumably was exported as finished or semifinished products.

[2] Preliminary.

National Cotton Council of America.

demand for finished products. Some finished products that use "industrial cotton"—automobiles, shoes, and luggage for instance—are basically consumer goods,[4] demand for which would be affected by changes in consumer income. On the other hand, demand for industrial products such as insulation, machinery belts, and industrial thread is related only remotely to demand by ultimate consumers for the products manufactured.

In Analysis I the index of industrial production soloed, so to speak, as the indicator of consumer and industrial demand for cotton. Major movements in industrial production are closely similar to those in consumer income. This would imply that, even if consumer income is the proper representative of consumer demand for cotton, the high correlation between it and industrial production would tend to minimize any error resulting from use of industrial production for this purpose.

Because of the declining importance of industrial uses and the increasing importance of apparel and household uses, it would be particularly desirable to use demand shifters that relate directly to each segment of demand for cotton. As total industrial production and consumer income are highly intercorrelated, it was not possible to use both of them as independent variables in a regression analysis. It was hypothesized that the components of the index of industrial production that represent the important industrial consumers of cotton, such as nondurable goods, might be closely related to cotton consumption and still not be too highly intercorrelated with consumer income.

The index of industrial production was broken into some of its components parts. These components were then correlated with cotton consumption per capita. But the evidence failed to fit the hypothesis. Segments of industrial production that apparently were most highly correlated with cotton consumption were iron and steel and minerals production.[5]

There is no logical causal relationship between either of these industries and cotton consumption. Neither industry makes products that contain cotton to an important extent. But iron and steel and minerals apparently do react to changes in general business conditions much as the cotton textile industry does. This being true, a better analysis of causal factors affecting consumption of cotton would be obtained by using the general factor as a demand shifter and eliminating the intervening industries. Based on the foregoing, the index of industrial production is not so well suited as consumer income for the role of a primary demand shifter.

Apparently both current and last year's income are significant in this respect. In Analysis II, X_2 denoted deflated disposable income per capita. This variable measures the influence on cotton consumption of the level of income in the current year. Consumer demand for cotton products is affected also by the direction of the change in income from the year earlier. As most cotton products are semidurable, consumers within certain limits can "live off" inventories and can postpone purchases or defer replacement of some items when income is declining. Similarly, they may replace worn or out-of-style items sooner and "stock up" on others when income rises.[6] In Analysis II change in income is denoted at X_3.

An indication of the importance of the effect of change in income on cotton consumption can be obtained by recourse to Analysis II. With the other factors in the analysis held constant at their average level for 1948–52, cotton consumption would have been 28.8 pounds per person if current real income at its 1948–52 average level of $1,269 per person were unchanged from the year earlier; 31.4 pounds per person if the $1,269 per capita reflected a 10-percent rise in real income from the preceding year; and 26.6 pounds if the year's real income of $1,269 per person were 10 percent under that of the preceding year.

[4] The National Cotton Council of America, in connection with its estimates of the quantity of cotton consumed by end use (table 2), stated: ". . . Articles whose cotton content is quite secondary to some other material—the leather in shoes for example—are classified as 'industrial.' In keeping with general practices, the term 'industrial' has been employed to cover all uses other than 'apparel' and 'household.' " NATIONAL COTTON COUNCIL OF AMERICA, COTTON COUNTS ITS CUSTOMERS, revised 1952 and preliminary 1953. Memphis, Tenn. June 1954. Page 4.

[5] Results of these analyses and additional analyses now in progress will be discussed in the forthcoming technical bulletin.

[6] For a discussion of income and changes in income as they affect demand for durable consumer goods, see ATKINSON, L. JAY. THE DEMAND FOR CONSUMERS' DURABLE GOODS. U. S. Dept. Commerce Survey of Current Business. Vol. 30, No. 6. June 1950.

X_4 in Analysis II represents the per capita consumption of all synthetic fibers, whereas in Analysis I the per capita consumption of rayon and acetate alone was used. Use of the newer synthetics as a group—nylon, orlon, dacron, and others—has been increasing at a rate similar to that for rayon in its formative years (fig. 1). The sharp growth trend in consumption has been the primary factor in demand for the newer synthetic (noncellulosic) fibers in the postwar years as it was for rayon in the interwar years. Until the end of the 1930's the growth factor tended to mask the effect of market forces, such as income, on rayon consumption. As a percentage of total synthetic fiber consumption, consumption of rayon has steadily declined, dropping to about 80 percent in 1953 from 95 percent in 1947. The newer synthetics are taking markets away from rayon and, perhaps to a small extent, from cotton. In many types of tires, for example, rayon tire cord, having almost completely replaced cotton, is now being succeeded by nylon tire cord.[7] Although use of the newer synthetics still is relatively small, comprising less than 5 percent of total fiber consumption in 1953, the likelihood of their continued rapid growth and imposition on the markets for other fibers warrants their inclusion in the analysis at this time.

To review, the variables used in Analysis II are as follows:

X_1=mill consumption of cotton per capita [8]
X_2=deflated disposable income per capita
X_3=change from the preceding year in deflated disposable income per capita
X_4=synthetic fiber consumption per capita
X_5=deflated average annual price of Middling, 7/8-inch cotton at the 10 spot markets, year beginning the preceding July.

Analysis II was based on data converted to logarithms for the years 1920–40 and 1947–52. Series used in Analysis II are given in table 3. Results are shown in table 1.

[7] Data from the Bureau of the Census indicate that more nylon tire cord and tire cord fabrics are now being produced than such cord and fabrics (excluding chafer fabrics) made from cotton.

[8] This variable differs slightly from that used in Analysis I in that it incorporates recent revisions made in the population and cotton consumption series.

The four factors explained 75 percent of the fluctuations in mill consumption of cotton. On the average, a 1-percent change in personal real dis-

TABLE 3.—*Analysis II: Factors that affect mill consumption of cotton, United States, 1920–52*

Year	Per capita			Deflated price per pound of cotton, year beginning preceding July [4]
	Mill consumption of cotton [1]	Disposable income, deflated [2]	Consumption of synthetic fibers [3]	
	Pounds	*Dollars*	*Pounds*	*Cents*
1920	26. 14	748	0. 08	24. 75
1921	23. 62	651	. 18	15. 32
1922	26. 09	740	. 22	18. 31
1923	27. 51	829	. 29	25. 24
1924	22. 79	817	. 36	30. 44
1925	26. 17	829	. 50	24. 52
1926	27. 00	843	. 51	19. 75
1927	29. 74	849	. 83	14. 90
1928	26. 08	872	. 82	20. 18
1929	27. 74	911	1. 08	19. 67
1930	20. 97	826	. 95	17. 61
1931	21. 10	771	1. 26	12. 53
1932	19. 46	647	1. 23	9. 02
1933	23. 96	642	1. 71	10. 70
1934	20. 76	705	1. 54	[5] 19. 86
1935	21. 36	765	2. 01	[5] 21. 01
1936	26. 74	858	2. 48	[5] 16. 84
1937	27. 92	886	2. 33	15. 11
1938	22. 18	824	2. 50	10. 84
1939	27. 34	891	3. 46	11. 20
1940	29. 55	943	3. 63	12. 57
1941	38. 37	1, 081	4. 46	12. 82
1942	41. 21	1, 225	4. 72	18. 67
1943	38. 03	1, 292	5. 01	18. 85
1944	34. 14	1, 392	5. 37	18. 87
1945	31. 85	1, 385	5. 79	19. 57
1946	33. 54	1, 329	6. 50	21. 78
1947	31. 93	1, 215	7. 10	23. 83
1948	30. 02	1, 232	8. 22	21. 07
1949	25. 37	1, 216	7. 17	19. 02
1950	30. 45	1, 302	9. 70	[6] 19. 72
1951	30. 99	1, 295	9. 46	23. 89
1952	28. 16	1, 300	9. 25	22. 11

[1] Mill consumption expressed as pounds of lint cotton, divided by the population of continental United States on July 1, including Armed Forces overseas, Bureau of the Census, adjusted for underenumeration of all age groups.

[2] Disposable personal income, estimated by the Agricultural Marketing Service for 1920–28 and by the Department of Commerce since 1929, divided by the population as described in footnote 1, and deflated by Bureau of Labor Statistics consumers' price index (1947–49=100).

[3] United States producers' domestic shipments and imports for consumption of rayon and acetate since 1920 plus nylon, orlon, glass fiber, etc., since 1940, *Textile Organon*, publication of the Textile Economics Bureau, Incorporated, divided by the population as described in footnote 1.

[4] Average price of cotton, American Middling, 7/8-inch at 10 spot markets, Agricultural Marketing Service, deflated by Bureau of Labor Statistics wholesale price index (1926=100).

[5] For the period August 1933 to December 1935 a processing tax of 4 cents a pound gross weight is added to the cotton price.

[6] Eleven-month average.

posable income was associated with a change of 0.9 percent in consumption of cotton in the same direction. Similarly, if the other factors remain unchanged, a 1-percent change in the ratio of the current to the preceding year's deflated personal disposable income was associated with a change of 0.8 percent in the same direction. These income relationships indicate that current income has about twice as much effect on cotton consumption as does last year's income.[9]

The other independent variables had a significant but smaller effect. On the average, a 1-percent change in consumption of synthetic fibers was associated with a change in cotton consumption in the opposite direction of 0.1 percent and a 1-percent change in the price of cotton was associated with an opposite change in consumption of 0.2 percent. The regression equation for Analysis II was as follows:

$$\text{Log } X_1 = -0.90 + 0.89 \log X_2 + 0.82 \log X_3 - 0.09 \log X_4 - 0.24 \log X_5$$

Comparison of the results from Analysis II with those from Analysis I reveals only minor differences in the value of the coefficients (table 1). On logical grounds, Analysis II is preferred.

Analysis III—Stocks, Unfilled Orders, and Cotton Consumption

In the formulations of the demand equations for cotton discussed heretofore, a relatively large proportion of the variation in consumption was left unexplained—25 percent in the case of Analysis II. Some part of the unexplained variation probably reflects the degree to which consumer income is deficient in representing the level of mill demand for cotton. Sources of demand for cotton textiles not explicitly taken into account in Analysis II include industrial, foreign, military or defense, and inventory demand. Industrial demand, as indicated, has trended downward in recent years. For the most part it is satisfactorily represented, though indirectly, by consumer income.

Neither foreign nor military or defense demand for cotton products was apparently large enough in most years to warrant inclusion in the analysis. Reliable published data on quantity of cotton annually consumed in the United States for military or defense purposes are not at present available. Although military purchases of cotton items in connection with wars and defense emergencies undoubtedly have a notable effect on mill consumption of cotton,[10] in most peacetime years before World War II this source of demand was probably stable and of minor significance. Hence, failure to account for military demand in an analysis covering essentially a peacetime period before World War II would not be likely to affect seriously the results obtained. It may have had more importance since 1945; it is hoped that data on military demand for the postwar years can eventually be obtained.

Export demand for manufactured textiles also appears to be relatively stable. Except for the immediate post-World War II period when shortages of productive factors abroad kept foreign demand for United States cotton products unusually high, exports of cotton goods, in terms of equivalent pounds of raw cotton, seldom exceeded 8 percent of domestic mill consumption of cotton during 1920–52. An analysis differing only in the use of per capita mill consumption of cotton adjusted for the raw cotton equivalent of cotton manufactures in foreign trade as the dependent variable, gave results similar but slightly inferior to those obtained from Analysis II.

Inventory demand is another matter. In any given period mill consumption of cotton may be out of balance with consumer purchases of cotton products because of changes in inventories at various levels of fabrication and distribution. For example, when inventories of cotton products are being built up at any level of marketing, the increments represent an increase in demand for cotton fabrics, and hence for cotton, over and above current consumption.

Of importance among factors that affect inventories are changes in sales or expectations thereof. Merchants may try to keep inventories in a fixed—

[9] Using the relevant part of the demand equation, this may be demonstrated by simple algebraic manipulation as follows:

$\text{Log } X_{1t} = 0.89 \log X_{2t} + 0.82 \log X_{3t}$.

But $\log X_{3t} = \log X_{2t} - \log X_{2t-1}$

so $\log X_{1t} = 0.89 \log X_{2t} + 0.82 (\log X_{2t} - \log X_{2t-1})$

$= 1.71 \log X_{2t} - 0.82 \log X_{2t-1}$.

[10] The relatively large difference between actual and "calculated" consumption of cotton in 1951 (fig. 3) is probably due in part to the increase in the military demand for cotton products arising out of hostilities in Korea.

or relatively fixed—ratio to their rate of sales. If consumer purchases of cotton goods decline, merchants would try, other factors being the same, to adjust inventories to a level commensurate with the changed conditions of demand. Current demand would be satisfied temporarily from stocks of goods produced in the past. Orders for cotton products thus would tend to decline by an amount greater than that of the decrease in retail sales. As the decline in demand spreads to preceding stages of distribution and manufacture, it would grow in intensity to the extent that inventories on these levels also are reduced proportionately. Ultimately, the magnified reduction in consumer demand is reflected back to the mill level.[11] A result of the adjustments in inventories along the line is a rate of cotton consumption less than that indicated by the decrease in consumer demand. Although inventory changes may bear some relationship to changes in consumer income, the latter measure could not be expected to account fully for the effect of the former on mill consumption of cotton.

Other factors that affect demand for goods for inventory, given the marketing and technological structure of the industry, include fears of shortages, expectations concerning price changes, and other facets of the economic outlook. Prices themselves are not immune to inventory changes. For example, the decision to acquire additional stocks, perhaps in line with a rise in consumer purchases, would add to the upward pressure on prices for textiles. The price rise, in turn, induces, for speculative and precautionary reasons, further increases in stocks and an inventory-price-inflation spiral may develop. Thus actions taken with respect to stocks may affect and be affected by prices.

In addition to changes in inventory, the size of the total inventory in the cotton textile system is to be noted. Obviously, the larger this inventory, the deeper will be the effect of, and the longer the adjustment to, a decline in consumer demand. Conversely, if demand were to increase suddenly and sharply, with inventories overly low, an industry-wide speculative movement could be generated because of the prevailing tight supply condition.[12] Stocks of cotton goods thus affect demand schedules for cloth and hence mill demand for cotton.

A change in demand for cotton goods is translated at the mill level into a change in volume of new business both for immediate and future delivery. The reaction of output to a change in demand, however, is usually not instantaneous. It takes time for production to adjust to a new level of sales. Influential among reasons for the relatively slow response of production are the momentum of the manufacturing process, uncertainty concerning the lasting nature of the change, the time it takes to obtain additional materials or to cancel orders, and cost and time considerations relating to removing shifts and shutting down looms or to adding shifts and starting up idle equipment. Initially, mill stocks of cotton textiles[13] would tend to bear the brunt of a change in demand, probably varying inversely to it. Theoretically, adjustment in output, when it comes, would account for the involuntary change in stocks plus any tendency for mill inventories of textiles to be brought into line with the new level of demand. Hence cotton consumption would be expected to reflect both the lag in response of output to a change in demand and the resulting adjustment in level of stocks.

Adjustment in production is often carried too far; that is, output is found to be forthcoming at a rate too high or too low when compared with the level of demand. Hence it may more than compensate for the earlier change in stocks. If output were maintained at a level above that of demand, textile stocks would tend to accumulate. But if output were cut back and maintained below the level of demand, stocks would tend to decline. If, concurrently, demand were to shift in the opposite direction the imbalance could be magnified. Ultimately production would have to be adjusted and, if carried too far again, could affect

[11] The tendency for moderate variations in consumer demand to be converted into more drastic changes in demand for the various goods in process is known in economic theory as the acceleration principle. See HABERLER, GOTTFRIED. PROSPERITY AND DEPRESSION. League of Nations, Geneva. 1941.

[12] See DAVIS, HIRAM S. INVENTORY TRENDS IN TEXTILE PRODUCTION AND DISTRIBUTION. The Textile Foundation. Washington. 1941.

[13] The term "cotton textiles" as used here refers to semifinished items produced at the mill, including primarily cotton fabrics, knit goods, and sales yarn.

stocks similarly but in an opposite direction.[14]

Prices of cotton textiles, actual or expected, have been omitted from the preceding discussion but actually they are interwoven into the dynamics of the industry. The apparent tendency of price to respond almost immediately to changes in the demand for cotton textiles is *prima facie* evidence of the lagged output response. If the change in demand is sudden, following a period of stock accumulation or liquidation, the effect on prices can be extreme until the necessary adjustment is made in stocks and output. If the change in price initiates a further change in inventory demand and possibly a price-inventory spiral up the line, the shift in demand would be greater and the supply adjustment required by the industry magnified. When prices are thought to be fully discounted and production curtailment is proceeding apace, the desire to cover forward at low prices or the incentive to acquire stocks in anticipation of higher prices may initiate a buying wave. At this point risks connected with stock acquirement may be low compared with those associated with the continued deferment of needs. The low textile prices also may lead to an increase in retail sales with all its back ramifications on the demand for textiles. On the other side, expectations of lower prices may cause a general falling off in demand.

Largely as a consequence of these varied forces and their interrelationships, mill product stocks tend to change in a cyclical fashion, frequently being out of line with demand. The tendency for output to be kept at relatively high levels in the short run despite unfavorable economic conditions apparently is characteristic of the cotton textile industry.[15] Clearly the tendency on the part of the industry not to respond readily or properly to changes in demand can affect the timing and extent of mill consumption of cotton considerably and, if possible, should be accounted for in the mathematical formulation of mill demand for cotton.

Recently the American Cotton Manufacturers Institute, Inc.—henceforth designated as the Institute—made available to the United States Department of Agriculture for research purposes data on production, stocks, and unfilled orders of cotton broad woven goods in physical units at the mill level. The data are given in terms of yards of cotton cloth in a time series beginning with January 1928 and continuing by months to the present, with the exception of the period January to July 1933, when no information was collected. Stock and unfilled orders data represent the mills' position as of the end of a reporting period, generally at or near the end of a calendar month. Data on production cover the intervening period; hence they coincide approximately with a calendar month. Similar data for 1926 and 1927 were obtained from reports of the Association of Cotton Textile Merchants of New York—henceforth designated as the Association.[16]

Because mills participate in the Institute's statistical program on a voluntary basis, the percentage of the industry covered by the reports tends to vary. Apparently the sample is much more comprehensive now than when collection of these data was first begun in 1926.[17] Data before October 1927 at least are known not to be comparable with later figures. As of June 1953 the sample comprised a wide range of fabrics and, according to the Institute, it represented about 7[illegible] percent of the cotton broad woven goods industry.[18]

Census reports for 1947 indicate that about 75 percent of yarn spun from cotton was woven into cloth, 9 percent was used by the knit-goods industry, 9 percent was used in tire cords, and the rest was used in making threads, twine, cordage, carpets, and other goods. Thus, the Institute data could be considered currently to represent roughly

[14] The apparent tendency in the industry for buying movements to come in irregular and concentrated spurts also may be partly responsible for the sharp variations in mill stocks of cotton textiles, by causing sudden and severe shifts in demand.

[15] See TREANOR, GLEN R., and MAGNUSSON, OLGA L. THE COTTON TEXTILE INDUSTRY. U. S. Bureau of Internal Revenue. December 1948. Page 16.

[16] To the authors' knowledge, data obtained from the Institute for the period beginning August 1933 as described are not available to the general public. Data for August 1927 to December 1932 are published in the BAE report, WAUGH, FREDERICK V., FARRINGTON, CARL C., and COOPER, MAURICE R. RECENT DEVELOPMENTS IN THE DOMESTIC COTTON TEXTILE INDUSTRY. U. S. Bur. Agr. Econ. September 1933. Table 8.

[17] For a brief history of the early collection of these data, see The Association of Cotton Textile Merchants of New York. 25 YEARS. 1944. Pages 21–22.

[18] Comparison of the Institute series on production of cotton broad woven goods with that reported quarterly by the Bureau of the Census shows that the Institute's data comprised from 49 to 70 percent of the Census series from first quarter 1943 to first quarter 1953, with an average of about 63 percent.

50 percent of the total cotton textile industry. Because of the varying degree of industry representation, and hence the lack of strict comparability over time, it was found advisable to use the data in a ratio form to adjust roughly for changes in the reporting sample.

The ratio of mill stocks of cotton cloth to unfilled orders was computed as of the end of each month for the full period covered by the data. The average end-of-month ratios for 1926–32 and 1934–52 are shown in figure 2. The ratio reflects the degree of imbalance between stocks, output, and demand at the mill level. When the ratio is relatively high, unless an increase in demand is forthcoming, a downward adjustment in output to reduce stocks is indicated. Conversely, a relatively low ratio suggests the likelihood of a higher output rate in the near future. The ratio indicates also the cyclical character of changes in inventories of mill products.

Obviously some inventory is necessary if a business is to function properly and efficiently. The amount of inventory not considered excessive may vary directly with the volume of business, so that a relatively constant ratio between the two is sought. Whether mill stocks of cotton cloth are too high or too low at a given time probably depends more on the amount of business expected in the near future—reasonably approximated by the level of unfilled orders—than on past volume.

Some "normal" ratio of stocks to unfilled orders thus may be postulated about which the actual ratio would fluctuate and toward which it would tend. Departure from normal—indicative of imbalance in the industry—would be expected to lead to changes in mill consumption of cotton. For want of information, it was decided to use the average of the ratios as normal.

The average level of the ratios shifted from almost one in the prewar period 1926–40 to slightly more than one-third in the postwar period 1947–52 (fig. 2). The shift appears to be a structural one and hence more or less permanent. To account for it in measuring the degree of imbalance, both prewar and postwar average ratios were used and deviations from these normals were computed. Although the normal ratios used are still open to debate and are not to be regarded as fixed, they are apparently the best estimates possible under the circumstances.

The residuals from Analysis II in logarithms

FIGURE 2.

were found to be fairly closely correlated with actual deviations from normal of the stock-unfilled order ratio for cotton cloth. The best result—a coefficient of correlation of −0.85—was obtained when the new variable led the residuals series by 5 months. This lead is consistent with the 3 to 6 months' lead that would have been expected from *a priori* considerations.[19]

To throw more light on the importance of the effect of imbalance in mill inventories of cotton cloth on mill consumption of cotton, the deviations of the stock-unfilled order ratio from normal were added as a fifth independent variable in Analysis III. As the new variable is believed to affect mill consumption of cotton in an additive fashion, actual deviations from normal were used. The other variables are the same as in Analysis II and they were kept in logarithms when the analysis was run. Analysis III is based on 1927–32, 1935–40, and 1948–52, the only full years for which data on stocks and unfilled orders are available when a lead of 5 months is employed. The results of Analysis III, as shown in table 1, are surprisingly good, considering that, because of fewer observations and an additional variable, there are 9 less degrees of freedom than for Analysis II. All of the coefficients are statistically significant.

[19] The coefficient of correlation obtained using a 5-month lead was only slightly higher than those obtained using a lead of 3, 4, or 6 months. In actuality there may be greater flexibility toward the expansion of output than toward curtailment but, even if the data permitted this to be taken into account, it is not likely results would be significantly improved from a statistical standpoint.

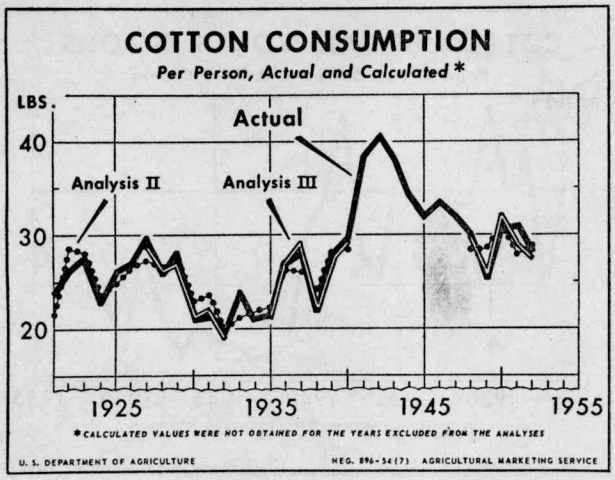

FIGURE 3.

The five factors—real disposable income, the change in this income, consumption of synthetic fibers, deflated purchase price of cotton, and actual deviations from normal of the stock-unfilled order ratio for cotton cloth at the mill—explained 95 percent of the variation in mill consumption of cotton per capita. On the average, an actual deviation of 0.1 points from normal in the stock-unfilled order ratio was associated with a change in cotton consumption of 0.08 percent in the opposite direction. The other regression coefficients, within sampling limits, are nearly the same as those obtained from Analysis II. Changes in actual deviations from normal of the stock-unfilled order ratio, on the average, account for a larger percentage of the variation in mill consumption of cotton than does the price of cotton or the consumption of synthetic fibers, after allowing for the effects of the other independent variables. Changes in disposable personal income and changes in the ratio of the current to the preceding year's income, in that order, are still more important in this respect. (See the coefficients of partial determination shown in table 1.) The regression equation for Analysis III was as follows:

$$\text{Log } X_1 = -1.00 + 0.92 \log X_2 + 0.93 \log X_3 - 0.09 \log X_4 - 0.23 \log X_5 - 0.08 X_6$$

Figure 3 shows the values for cotton consumption calculated from this regression equation for 1927–32, 1935–40, and 1948–52. The closer fit obtained with this formulation of the demand equation for cotton is immediately evident. Inventory imbalance at the mill level apparently accounted in large part for the sharp decline in mill consumption of cotton per capita in 1938 and 1949. The frequent disparities between output and sales, as reflected in recurrent accumulations of stocks of cotton cloth at the mill, evidently have a highly significant effect on mill consumption of cotton. Inclusion of this factor, rough as it is, in the formulation of the demand equation for cotton increases considerably its validity and predictability.[20]

Analysis IV—Same Period as Analysis III, Same Variables as Analysis II

To permit a direct comparison of the analyses run with and without the measure of imbalance in mill inventories, Analysis IV was run for the same years as Analysis III but in the same form and with the same variables as Analysis II. Results from Analysis IV are given in table 1. The regression equation was as follows:

$$\text{Log } X_1 = -1.34 + 1.05 \log X_2 + 1.15 \log X_3 - 0.12 \log X_4 - 0.27 \log X_5$$

By adding X_6 (actual deviations of the stock-unfilled order ratio for cloth from normal), the multiple coefficient of determination was raised from 0.84 to 0.95. Also, there was improvement in the partial correlation coefficients, and a substantial reduction in the standard error of estimate. The regression coefficients from Analysis IV, though uniformly higher, do not differ significantly in a statistical sense from those for Analysis III.

[20] One note of caution must be given. Application of the single-equation least-squares approach to this problem necessarily assumes that the independent variables used are "predetermined." This means that each of these variables is determined by forces in operation before the current time period, by factors outside the structure in question, or by both. As consumer income cannot be said to be significantly affected by changes in mill consumption of cotton and as synthetic consumption is based primarily on a trend factor, these variables may be deemed predetermined. In the case of the price of cotton and of the inventory imbalance measure, a lead of less than 1 year was used. As annual data were used, these variables may be only partly predetermined with respect to the given demand structure. If this is true, the regression coefficients given in the text may be biased. Two alternatives are possible. One is to run the analysis using semi-annual data and the other is to set up and solve a system of simultaneous equations. Work along both lines is in progress.