THE ESTIMATION OF COTTON COSTS IN THE SOUTHEAST*

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The Agriculture Act of 1964 provided for the development of a special cotton research program designed to produce information which could be used to reduce the cost of producing upland cotton in the United States. Authorization of $10 million annually for the special program provided for the extensive collection of data and for an annual report to congressional committees by the Secretary of Agriculture on the progress of the program. Field surveys have been conducted for the 1964, 1965, 1966 and 1969 crop years on about 5,000 cotton farms across all production regions in the United States.

By presenting regional and national aggregates of input costs per pound, the Economic Research Service (ERS) has provided a focus for research designed to increase cotton production efficiency [8]. The published reports summarize the data in terms of total and direct costs per pound of lint, acreage harvested and yields per harvested acre. Distributions of the percent of cotton which is produced below specified cost per pound levels are given by regions with little discussion of the implications.

It is our contention in this paper that the data used without great care may produce misinformation. First, the purposes originally specified for the data are reviewed briefly. Next, alternative methods of using the data are reviewed. The paper closes with recommendations concerning the use of the data in other regions and for other years.

OBJECTIVES AND MEANS

Cost reduction was specified as the major objective of the cotton cost surveys [8]. The logic must have been that cross-sectional data on costs would be sufficient for the specification of the geographic or input dimensions of resource misallocation. Alternatively, it may have been hypothesized that information about means and distributions would in, and of itself, cause firm managers to reorganize their operations in such a way that costs would be reduced. Information is a special kind of resource and its acquisition and use is of concern to extension workers and other adult educators. Nevertheless it seems likely that the primary purpose behind the collection of the cotton cost data was to permit the specification of cost and production functions useful in identifying resource allocation problems.

Data needed to estimate mean costs for three sizes of farms in each of 18 areas would be of little use if they gave no hint of the structure of costs as a function of size or of optimal resource mix for individual farms. In our earlier work [6] we used the data to estimate returns to size and to estimate production elasticities. While our work departs from the calculation of means which appears in the preliminary analysis [8], it fits within the structure and purpose of cost of production analysis. This earlier work directed our attention to two major problems that we wish to discuss: (1) the erratic effects of weather and pests on costs and profits, and (2) systematic errors in reporting fixed factors such as land and human resources.

ERRATIC EFFECTS IN COST ANALYSIS

We think it is reasonable to compute some measures of cost and to relate them to volume as occurred in early data summaries and our own study,

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*North Carolina Agr. Exp. Sta. Journal Series Paper No. 3680. The authors wish to thank our colleagues at NCSU and an anonymous *Journal* reviewer for their suggestions.

but the variables must be carefully chosen. Initial regression of costs on acres and yields involved the use of realized variables: cost per pound *harvested*, yield on *harvested* land, and acreage *harvested*. Annual data necessarily include disturbances from weather and pest sources that move any given firm away from expected relationships. With good weather, costs would increase proportionately less than realized yield, while with bad weather costs would decrease proportionately less than realized yield. Thus, the use of realized yield as an independent variable could bias the estimated relationship between costs and yield. Similar problems exist for planted and harvested acreage. The average abandonment of cotton has been about 5 percent in the Southeast, but 20-40 percent has not been uncommon in some states in recent years [6]. A superior way to proceed would be to use expected yields and acreage as independent variables. Projected yield, defined in the price support program, and planted acreage probably closely approximate expected values.

Three average total cost formulations are compared in Table 1. All regressions are linear in the logarithms, and regression coefficient standard errors are given in parentheses. Equation 1 was the original formulation with total cost per pound of lint regressed on yield per harvested acre and acres harvested. Equation 2 was an attempt to correct for deviations of yield in 1966 from the yield history by including the ratio of actual to projected yield. The final specification, which we believe to be the most satisfactory, utilizes projected yield and acreage planted as measures of expected yield and acreage, respectively. As anticipated, the expectations model explains more of the interfarm cost variability. Growers appear to be allocating expenditures based on projected yield and planted acreage rather than actual yield and harvested acreage.

Table 1 RELATIONSHIP BETWEEN TOTAL COST PER POUND OF COTTON AND SIZE FACTORS, ESTIMATED IN LOGARITHMS FOR SOUTHEASTERN COTTON FARMS, 1966[a]

	Variables[b]						
Equation number	Constant	X_1	X_2	X_3	X_4	X_5	R^2
1	1.606	-.745 (.025)	-.099 (.010)				.71
2	1.578	-.727 (.030)	-0.087 (.010)	-.021* (.021)			.71
3	2.067				-.950 (.020)	-.044 (.010)	.83

[a]Survey data from 507 cotton farms in the Southern Piedmont, Eastern and Southern Coastal Plains defined in the basic survey [8].

[b]Y = total cost per pound of cotton produced per farm, X_1 = yield per acre harvested, X_2 = acres harvested, X_3 = yield harvested acre/projected yield, X_4 = projected yield, and X_5= acres planted.

*Not significant at .01 level.

Figure 1 shows the economies of size curve from equations two and three for given levels of the other variables. As expected, the average cost per pound of lint falls as farm size increases. Notice, however, that most of the cost reduction due to size is obtained when a farm is producing approximately forty acres of cotton. As might be expected, costs fall much faster with expansion of harvested acreage than with planted acreage. Unfortunately, the magnitude of revenue that was generated on the abandoned acres from other crops is not known.

SYSTEMATIC ERRORS IN CROSS–SECTIONAL COST ANALYSIS

At least one other factor keeps variation in average total costs from being explained: derivation of the land cost. Cash rents where they were paid and

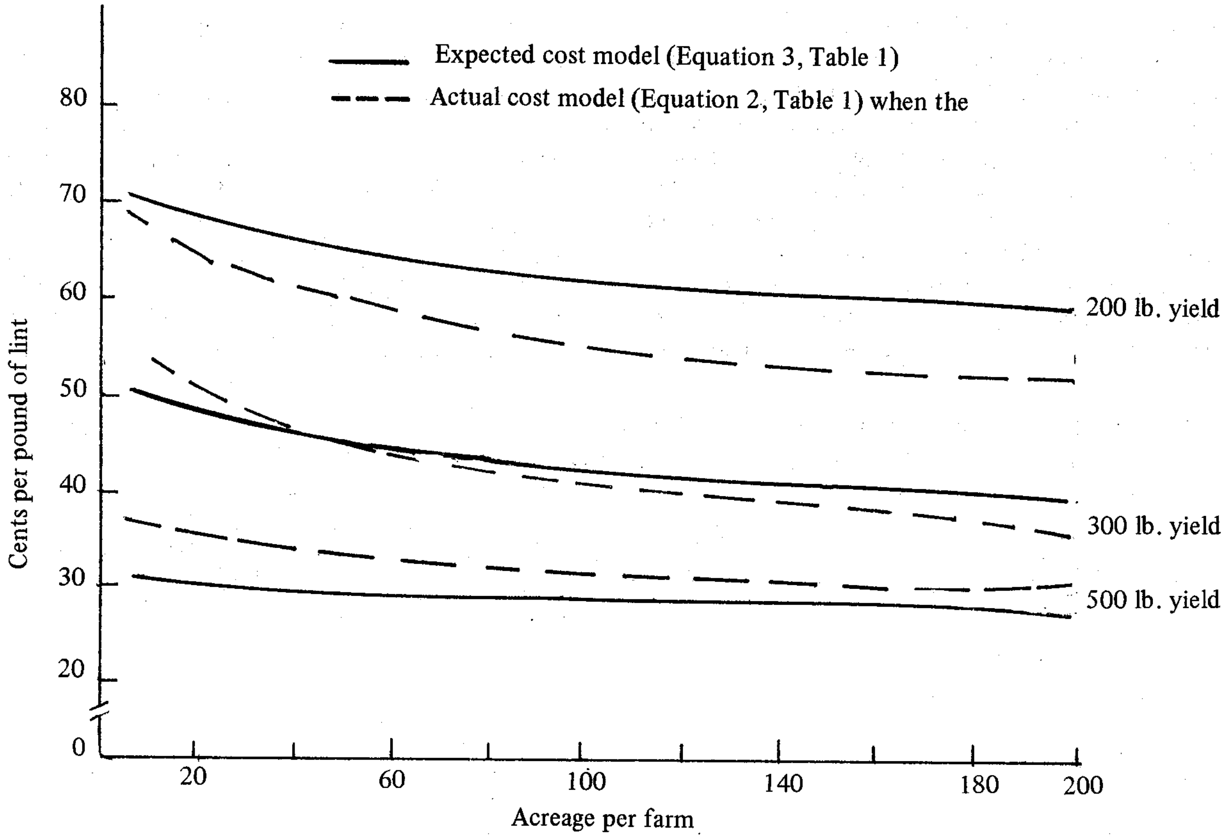

Figure 1. AVERAGE TOTAL COST OF PRODUCING COTTON FOR ALL FARMS AS RELATED TO ACREAGE AND YEILDS OF LINT, SOUTHEAST, 1966

land values times a 4 percent interest rate were used by ERS to derive a land charge for each farm [8]. The ratio of cotton land to total land varied from farm to farm. Land used for cotton is probably above average in productivity. Thus, a random element is introduced if any noncotton land affected the imputed cost of cotton land. Second, the relationship between value and rental return to cotton allotment has been shown to be equal to a ratio of 4 to 5, rather than the ratio of 25 inferred from the 4 percent land charge [2, 7].The result is random variation in reported costs between cotton produced on owned and rented land.

The costing of input flows from fixed assets is apt to introduce systematic errors which will trouble the analysis of costs because of some subtleties of both land and human capital markets. We take the position for both assets that costing procedures tend to overstate the cost of capital inputs of below-average productivity and understate those of above-average productivity.

The cost of non-hired labor in the ERS reports was measured at the "prevailing wage rate in the area" [8]. To assume that management labor is of equal quality across farms ignores the possibility of adjusting opportunity costs for levels of human capital. Table 2 shows characteristics of cotton farms and operators in the Southeast from the 1964 Census of Agriculture. Each of the three variables–percent of operators over 55, percent of operators with less than eight years of education, and percent of operators nonwhite–is closely correlated with smaller farms. Assuming that on the average higher levels of human capital are associated with higher levels of education, being under 55, and white, biased estimates of direct costs are introduced by charging the same rate for all levels of supervisory and family labor [9]. Since the economic classes of the census correspond closely to firm size, labor costs are biased upward for small and downward on large sized cotton enterprises. This helps account for the extremely low (0.6) estimate of the marginal value of labor on small farms in the earlier study [6].

Similarly, the survey measurement of land cost probably tends to undervalue good land and overvalue poor land. Several studies have shown that direct estimates of land values by operators will be biased toward the mean land price [4]. A test of this hypothesis applied to cotton land will help in any corrections for bias in the relationship between land quality and total cost of production.

We have experimented with alternative ways to organize the data so that we could examine the question of production adjustment. We reasoned that production decisions could be more adequately analyzed from an enterprise point of view rather than from data on costs and returns per pound of product. This approach led to the inclusion of diversion costs and returns in the analysis and to the discovery that data on insurance indemnities had inadvertently not been collected in the survey. While probably not important in the aggregate, omission of insurance indemnities which amounted to 7 cents per pound of lint on acreage indemnified affected the dispersion of net enterprise returns [6]. Median diversion payments per pound of harvested lint were 6.7 cents in 1966. The effect of accounting for diversion payments on the break-even point in terms of direct costs for 1966 output in the area is clear: only 10.4 percent of total production was below break-even on the net enterprise basis compared with 21.8 percent on the per-pound accounting of earlier reports [6].

Table 2. CHARACTERISTICS OF COTTON FARMS AND OPERATORS IN THE SOUTHEAST, 1964[a]

Item	Economic class I	II	III	IV	V	VI
	Percent					
Education of operators						
8 years or less	17.7	31.1	46.6	64.1	72.1	82.1
12 years or more	57.7	39.7	23.9	14.9	10.3	6.1
Operators 55 years of age and over	23.2	26.1	29.5	32.9	37.8	44.8
Nonwhite operators	2.4	5.4	20.8	42.1	56.4	73.3
Cotton harvested, per farm[b]						
5-14 acres	-	-	-	3.2	38.3	89.9
15-49 acres	-	1.8	35.8	89.0	61.3	10.1
50 acres and over	100.0	98.2	64.2	7.8	.4	-

[a]Source: U. S. Census of Agriculture, 1964, aggregation of data from North Carolina, South Carolina, Georgia and Alabama.

[b]On farms with 5 or more acres of cotton harvested.

As a preliminary attempt to combine the expected cost formulation and the net enterprise returns formulation, the following cotton enterprise profit model was estimated:

$$\pi_i = b_o + b_1 X_{1i} + B_2 X_{2i} + b_3 X_{3i} + b_4 X_{4i} ;$$

where

π = returns less total or direct costs of cotton enterprise,

X_1 = (yield per harvested acre - projected yield) x acres harvested,

X_2 = (acres planted - acres harvested),

X_3 = (projected yield - regional average yield) x acres planted,

X_4 = Total crop sales per farm (including cotton), and

i = farm observations.

Variable X_1 represents gains or losses in profit from annual deviations in historical total production per farm. Its coefficient is expected to be positive since costs are hypothesized to rise less than yield with good weather. X_2 captures the influence of the cross-farm differences in acres abandoned on profits. X_3 and X_4 are intended to represent the effects of the mismeasurement of the opportunity costs of land and human capital on survey-generated estimates of profits. Deviations from regional projected yield levels (X_3) constitute the only estimate of land productivity differentials available to us. The use of total crop sales (X_4) as a proxy for management or human capital follows the work of Massell [5] and our earlier paper [6]. Admittedly, this is a rough measure of human capital flows, but no farm operator characteristics were collected in the cotton survey. State aggregates of operator characteristics from the census do not reflect interfirm differences. We expect the coefficients of X_3 and X_4 to be positive since the opportunity costs of higher levels of land productivity and management are hypothesized to have been understated.

Table 3 summarizes the cotton enterprise profit functions which we have estimated. The dependent variable for the first two equations is gross receipts from cotton plus diversion payments less total costs. In equations three and four diversion payments and costs have been deleted from the dependent term. Equations five and six have as a dependent variable total revenue minus total direct costs and diversion payments. In equations two and four, actual production less expected production (X_5) replaces X_1 and X_2, the two dimensions of the annual deviations in production conditions: realized yield and abandonment.

Table 3. COTTON ENTERPRISE PROFIT REGRESSIONS[a]

Equation number	Variables[b]						
	Constant	X_1	X_2	X_3	X_4	X_5	R^2
1	929.01	.1218 (.0076)	-62.287 (13.244)	.3080 (.0167)	.0431 (.0032)	– –	.814
2	914.59	– –	– –	.3170 (.0147)	.0430 (.0032)	.1188 (.0065)	.816
3	72.99	.1641 (.0060)	-78.845 (10.450)	.2106 (.0132)	.0187 (.0025)	– –	.839
4	52.56	– –	– –	.2254 (.0116)	.0186 (.0025)	.1584 (.0051)	.840
5	464.79	.2793 (.0084)	-130.590 (14.540)	.3330 (.0180)	.0443 (.0035)	– –	.890
6	429.41	– –	– –	.3606 (.0162)	.0441 (.0035)	.2685 (.0072)	.891

[a]All variables are significant at the .01 level. The dependent variable includes diversion payments in equation 1 and 2, but not in 3 and 4. There were 507 observations.

[b]All variables as described in the text; X_5 is a combination of X_1 and X_2; X_5 = yield per harvested acre x acres harvested less projected yield x acres planted.

The profit analysis indicates that erratic factors such as abandonment (X_2) and yield deviation on harvested acres (X_1) are closely connected with cotton enterprise profits. Human capital as measured by the crop sales proxy (X_4) is highly significant in explaining profits. Land productivity exhibits the positive association with profits confirming the tendency for biased measurement of land prices in the cotton survey. As expected, the omission of fixed costs in equations five and six (Table 3) allows a more complete explanation of profit variability. However, the above results do not define an industry supply curve. Nor do they bring us much closer to answering the question of how the characteristics of resource ownership should be used in determining public policies on price support levels, allotment exchange limits, level of public cost reduction research, or restrictions on cotton pesticides.

FUTURE WORK

The survey data for the 1969 crop year which are now available will provide a more current data base for analysis. We suggest that the next analysis should follow the lines of thought which we have developed here. First, analysis of costs should be made on direct costs rather than total costs. The problem of systematic errors in land charges can be avoided by this procedure. Systematic errors in labor costs can probably be substantially reduced if labor charges for only unskilled tasks are included. In addition, the simultaneous effect of cotton program payments on both costs and returns can be avoided. The flow of residual profits to the limited resource–allotment in this case–is a widely recognized phenomenon. With allotment values determined by cotton prices rather than determining them in a cost of production sense, the usual costs-returns relationships do not prevail. With returns less than "costs"–including returns to allotment–allotment values could fall, but production would continue. With asset values and imputed costs affected by returns, there is a circularity in the analysis that can be avoided by going to the analysis of direct costs.

Second, moving to enterprise returns and away from returns per pound is a step toward data which are more relevant to entrepreneurs. Our next step probably will follow the line of Lau and Yotopoulos [3]. That is, a profit analysis in terms of relative prices of the variable factors and quantities of fixed factors. This approach allows the analysis of price as well as technical efficiency [1] when farm-level factor prices are known. It is developed from a specified direct cost structure and permits examination of factor demand and cotton supply relationships.

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