# THE EFFECT OF PLANTING FLEXIBILITY ON COTTON INDUSTRY INFRASTRUCTURE IN MISSISSIPPI

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## Abstract

The paper studies the implications of reduced cotton acreage on the cost structure of cotton gins in the Mid-South. A volume/cost elasticity for cotton gins is presented which predicts the percent increase in ginning costs required to off-set a one percent decline in annual volume.

## Introduction

Cotton production in Mississippi has been fairly stable in modern times. Excluding 1983 (the PIK program), Mississippi growers produced an average of 1.65 million bales on 1.23 million harvested acres between 1970 and 1995 (Robinson and Martin, 1996). The standard deviations over this same period are 308,527 bales and 186,389 acres. In the aggregate, therefore, the State has not seen widespread variation in cotton acreage and production. The relative stability of Mississippi's cotton industry has allowed the development of a considerable infrastructure of gins, input supply businesses, and labor oriented towards producing and harvesting cotton. In the grower's short-run viewpoint, this infrastructure represents a set of fixed resources, some of which (e.g., grower co-ops) are jointly used and resemble congestible public goods or club goods.

Recent events has dramatically increased the potential variability of cotton production in Mississippi. The planting flexibility provisions of the Federal Agricultural Improvement and Reform (FAIR) Act of 1996 removed the historical program impetus for planting cotton. Mississippi growers are now free to consider a wide variety of planting options in response to potential market profitability or risk (Robinson, 1996).

Cotton Industry Destabilization. Several factors have combined with the new planting flexibility provisions to increase instability in Mississippi cotton acreage. First, average cotton production costs have increased, largely due to higher insect control costs (Scott, Cooke and Freeland, 1996). The boll weevil-eradicated states like Georgia have predictably gained a comparative advantage over Mississippi of about nine cents per pound in insect control cost (Mississippi Cooperative Extension Service, 1996). Increased costs have thus hurt cotton's position from the standpoint of relative profitability and riskiness. This situation has been exacerbated by relatively good prices for substitute crops like corn and soybeans. All of these factors contributed to a decline in cotton of 300,000 acres (i.e., 1.5 standard deviations) and into corn or soybeans during the 1996 growing season. Grower planting intentions for 1997 are unclear, but there are some expectations for additional shifts out of cotton acreage into grains.

The destabilization or loss of cotton acreage has serious implications for regional cotton infrastructure in Mississippi. The distribution of Mississippi cotton gins and cotton acreage is concentrated in the Delta region with the remainder of gins and acreage spread thinly across the central and northeastern regions. Of particular concern is the sustainability of gins in the non-Delta areas where distances between available gins are greater. Obviously, declines in local cotton acreage and production reduce the volume of bales, which affects fixed costs and/or net revenues for the area gins. The issue is highlighted by the map of gins that have closed within the last ten years. Some of these closings affect the potential feasibility (or at least the cost) of ginning in some central and northeast areas.

Producer Theory. The sustainability of cotton gins has both short-run and long-run dimensions. Short-run decisions involve the optimal level of output, i.e., is there sufficient total revenue from continued ginning to cover total variable expenses? If so, then the firm should continue to operate in the short run, even if the net effect is a loss (Ferguson, 1969). In the long-run, such firms must either adjust plant size or go out of business. The long-run planning horizon allows for adjustment of output and plant size, as well as whether to remain in the current industry. In this paper, we only consider the short-run implications.

The purpose of this paper is to examine the impact of potential declines in cotton acreage on the sustainability of cotton gin operations. In addition, we attempt to estimate the impact on cotton growers of higher ginning costs due to reduced volume. A volume/cost elasticity for cotton gins is estimated which describes how declines in volume affect the costs of the average gin in Mississippi.

## Data Development

Ginning Costs. Mayfield, Willcutt and Childers (1996) recently estimated the cost structure of various sized gins in the Mid-South and Southeast. We applied their total average cost data (i.e., total cost per bale) for small ($0.5 million investment), medium ($2 million investment) and large ($5 million investment) gins to calculate total and marginal costs, by ginning volume. Total cost and average total cost, by ginning volume, are presented in the first three columns of Tables 1-6. Each table represents the cost structure of a specified gin size and useful life.

Marginal and Total Revenue. Gins collect revenue through a variety of methods including cottonseed receipts, per-bale

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assessments, and various other charges. Because of the variety of revenue collection methods, a standardized approach was used involving the long-run average value of cottonseed. Average revenue per bale from cottonseed receipts was calculated using Mississippi cotton production and price data (Robinson and Martin, 1996) for the period 1970 - 1995. This data series excluded 1983 as an outlier because of the PIK program. The marginal revenue for the average gin was thus estimated at $33 per bale. Total revenue for each of the three gins sizes, by ginning volume, was figured by multiplying the volume of bales by the per bale marginal revenue of $33 per bale (Tables 1-6, Column 5).

Cost/Volume Elasticity. In order to measure the direct impact on gins (and the subsequent indirect impact on cotton producers) of reduced gin volume, a volume/cost elasticity was formulated as the percent change in ATC, average total ginning costs (Tables 1-6, Column 2), divided by the percent change in V, ginning volume (Tables 1-6, Column 1): $[(ATC_1\text{-}ATC_0)\ /ATC_1]/[(V_1\text{-}V_0)/V_1]$. This elasticity allows decisionmakers to determine the percent change in ginning costs given an one percent change in ginning volume. Thus cotton growers can determine the impact of their collective planting decisions on their subsequent production costs (i.e., ginning).

## Analysis and Discussion

Gin Sustainability. Total cost and revenue curves are plotted for each gin size for gins with 10-year life (Figures 1-3) and 20-year remaining life (Figures 4-6). An unusual feature is that the total cost (TC) line for all of the gins appears linear. This stems from the variable costs presented by Mayfield, Willcutt and Childers (1996) who noted that ginning variable cost is more influenced by management and gin design than by capacity. In essence, average variable costs/bale are constant over the range of gin volume considered by Mayfield et al. It can still be envisioned, however, that total variable costs (and thus total costs) would eventually curve upward at extremely high capacities due to increasing labor or repair costs.

It can be noted that all of the representative firms examined in this paper (or by Mayfield et al., for that matter) are operating at sub-optimal levels (Tables 1-6). To achieve profit maximization, these gins would need to increase ginning volume such that the slope of the total cost curve increased and equaled the slope of the total revenue curve. As mentioned above, we assume that total costs would eventually curve upward, but this does not occur within the range of ginning considered by Mayfield, Willcutt and Childers (1996).

However, all of the firms examined in this paper should continue to operate in the short-run. This is clear because total revenue at all ginning volumes (Column 5, Tables 1-6) exceeds total variable cost (Column 6, Tables 1-6). There is a point depicted in the cost structure for each gin where total cost and total revenue intersect (Figures 1-6). Ginning volumes below this point reflect a short-run loss which would not be sustainable in the long run. Gins operating below this point would eventually shut down after depreciating out it's equipment. This appears to be the situation for the $0.5 million gin with 10-year life (Figure 1) for which total cost (TC) exceeds total revenue (TR) over the entire ginning range.

As noted by Mayfield, Willcutt and Childers (1996), the cost structure of gins varies by gin life span. Gins with a twenty-year life were more efficient than similar sized gins with a ten-year life. This is evidenced by lower total cost lines and total cost/total revenue intersections closer to the origin for the twenty year gins (Figures 4-6) as compared to the respective ten-year gin of the same size (Figures 1-3). This implies that the newer gins obviously have more ability to adjust to annual declines in ginning volume than do older, higher cost gins.

Ginning Costs. The second major issue addressed in this paper is the effect of planting decisions on cotton production costs. Consider a gin with cost structure in Table 2 if a gin is currently operating at an annual volume of 32,000 bales. Suppose that local cotton acreage is expected to decline such that expected ginning volume drops to 30,000 bales. The data in Table 2 show that the 2000 bale drop in volume is associated with an increase in average total costs from $34/bale to $35/bale. This cost increase is due to the fixed cost component. In percentage terms, the cost/volume elasticity at this point indicates that a 1% decrease in volume below 32,000 bales results in an increase in average total costs per bale of about 0.4%. An easier rule of thumb would be that a 5% drop in gin volume would raise average total costs per bale by 2%. The decrease in ATC becomes smaller at higher annual volumes (Mayfield, Willcutt and Childers, 1996), therefore, the cost/volume elasticity is smaller at higher volumes.

The relationship between specific declines in expected volume and increases in expected ginning costs is useful for both ginners and growers. Gin managers could use this type of information for budgeting purposes, i.e., to see how much additional cost will need to be covered. Growers can likewise use this information to calculate their while-farm costs more accurately. Specifically, if a grower was contemplating a reduction in cotton acres in lieu of some other crop, the subsequent increase in ginning costs on his remaining cotton should be incorporated into the break-even decision. This assumes the grower knows how much his cotton acreage reduction will affect the overall gin volume. It even raises a potential public goods problem: the individual planting decisions of growers affect the subsequent ginning costs (or ginning availability) of all remaining cotton growers around a given gin. Such a situation could be modeled in a proper game theoretic framework to predict the effect on gins whose patrons are non-cooperative agents.

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TABLE 1. COST STRUCTURE FOR $0.5M GIN WITH 10-YR LIFE

| Bales | ATC* | Elasticity | TC | TR | TVC |
|---|---|---|---|---|---|
| 3,000 | $63 | -- | $188,610 | $99,660 | $68,850 |
| 4,000 | $53 | -0.75% | $211,560 | $132,880 | $91,800 |
| 5,000 | $47 | -0.64% | $234,500 | $166,100 | $114,750 |
| 6,000 | $43 | -0.56% | $257,460 | $199,320 | $137,700 |
| 7,000 | $40 | -0.50% | $280,420 | $232,540 | $160,650 |
| 8,000 | $38 | -0.45% | $303,360 | $265,760 | $183,600 |
| 9,000 | $36 | -0.41% | $326,340 | $298,980 | $206,550 |
| 10,000 | $35 | -0.38% | $349,300 | $332,200 | $229,500 |

*ATC is average total cost in $/bale. Elasticity is (% change in AVC)/(% change in bales). TC is total cost, TR is total revenue, and TVC is total variable cost, all for a given gin volume.

Position Statement. Unpublished document.

TABLE 2. COST STRUCTURE FOR $2 M GIN WITH 10-YR LIFE

| Bales | ATC* | Elasticity | TC | TR | TVC |
|---|---|---|---|---|---|
| 10,000 | $62 | -- | $623,700 | $332,200 | $214,700 |
| 12,000 | $56 | -0.74% | $666,600 | $398,640 | $257,640 |
| 14,000 | $51 | -0.67% | $709,520 | $465,080 | $300,580 |
| 16,000 | $47 | -0.62% | $752,480 | $531,520 | $343,520 |
| 18,000 | $44 | -0.58% | $795,420 | $597,960 | $386,460 |
| 20,000 | $42 | -0.54% | $838,400 | $664,400 | $429,400 |
| 22,000 | $40 | -0.51% | $881,320 | $730,840 | $472,340 |
| 24,000 | $39 | -0.48% | $924,240 | $797,280 | $515,280 |
| 26,000 | $37 | -0.46% | $967,200 | $863,720 | $558,220 |
| 28,000 | $36 | -0.43% | $1,010,240 | $930,160 | $601,160 |
| 30,000 | $35 | -0.42% | $1,053,000 | $996,600 | $644,100 |
| 32,000 | $34 | -0.40% | $1,096,000 | $1,063,040 | $687,040 |
| 34,000 | $34 | -0.38% | $1,139,000 | $1,129,480 | $729,980 |
| 36,000 | $33 | -0.37% | $1,181,880 | $1,195,920 | $772,920 |

*ATC is average total cost in $/bale. Elasticity is (% change in AVC)/(% change in bales). TC is total cost, TR is total revenue, and TVC is total variable cost, all for a given gin volume.

TABLE 3. COST STRUCTURE FOR $5M GIN WITH 10-YR LIFE

| Bales | ATC* | Elasticity | TC | TR | TVC |
|---|---|---|---|---|---|
| 20,000 | $66 | -- | $1,322,400 | $664,400 | $354,800 |
| 25,000 | $56 | -0.86% | $1,411,000 | $830,500 | $443,500 |
| 30,000 | $50 | -0.77% | $1,499,700 | $996,600 | $532,200 |
| 35,000 | $45 | -0.71% | $1,588,300 | $1,162,700 | $620,900 |
| 40,000 | $42 | -0.66% | $1,677,200 | $1,328,800 | $709,600 |
| 45,000 | $39 | -0.62% | $1,765,800 | $1,494,900 | $798,300 |
| 50,000 | $37 | -0.58% | $1,854,500 | $1,661,000 | $887,000 |
| 55,000 | $35 | -0.55% | $1,943,150 | $1,827,100 | $975,700 |
| 60,000 | $34 | -0.52% | $2,032,200 | $1,993,200 | $1,064,400 |
| 65,000 | $33 | -0.50% | $2,120,300 | $2,159,300 | $1,153,100 |
| 70,000 | $32 | -0.47% | $2,209,200 | $2,325,400 | $1,241,800 |
| 80,000 | $30 | -0.46% | $2,386,400 | $2,657,600 | $1,419,200 |
| 90,000 | $28 | -0.42% | $2,564,100 | $2,989,800 | $1,596,600 |

*ATC is average total cost in $/bale. Elasticity is (% change in AVC)/(% change in bales). TC is total cost, TR is total revenue, and TVC is total variable cost, all for a given gin volume.

TABLE 4. COST STRUCTURE FOR $0.5M GIN WITH 20-YR LIFE

| Bales | ATC* | Elasticity | TC | TR | TVC |
|---|---|---|---|---|---|
| 3,000 | $55 | -- | $166,110 | $99,660 | $68,850 |
| 4,000 | $47 | -0.69% | $189,040 | $132,880 | $91,800 |
| 5,000 | $42 | -0.57% | $212,000 | $166,100 | $114,750 |
| 6,000 | $39 | -0.50% | $234,960 | $199,320 | $137,700 |
| 7,000 | $37 | -0.44% | $257,880 | $232,540 | $160,650 |
| 8,000 | $35 | -0.39% | $280,880 | $265,760 | $183,600 |
| 9,000 | $34 | -0.36% | $303,840 | $298,980 | $206,550 |
| 10,000 | $33 | -0.33% | $326,800 | $332,200 | $229,500 |

*ATC is average total cost in $/bale. Elasticity is (% change in AVC)/(% change in bales). TC is total cost, TR is total revenue, and TVC is total variable cost, all for a given gin volume.

TABLE 5. COST STRUCTURE FOR $2M GIN WITH 20-YR LIFE

| Bales | ATC* | Elasticity | TC | TR | TVC |
|---|---|---|---|---|---|
| 10,000 | $53 | -- | $533,700 | $332,200 | $214,700 |
| 12,000 | $48 | -0.66% | $576,600 | $398,640 | $257,640 |
| 14,000 | $44 | -0.60% | $619,640 | $465,080 | $300,580 |
| 16,000 | $41 | -0.55% | $662,560 | $531,520 | $343,520 |
| 18,000 | $39 | -0.51% | $705,420 | $597,960 | $386,460 |
| 20,000 | $37 | -0.47% | $748,400 | $664,400 | $429,400 |
| 22,000 | $36 | -0.44% | $791,340 | $730,840 | $472,340 |
| 24,000 | $35 | -0.42% | $834,240 | $797,280 | $515,280 |
| 26,000 | $34 | -0.39% | $877,240 | $863,720 | $558,220 |
| 28,000 | $33 | -0.37% | $920,080 | $930,160 | $601,160 |
| 30,000 | $32 | -0.36% | $963,000 | $996,600 | $644,100 |
| 32,000 | $31 | -0.34% | $1,006,080 | $1,063,040 | $687,040 |
| 34,000 | $31 | -0.33% | $1,048,900 | $1,129,480 | $729,980 |
| 36,000 | $30 | -0.31% | $1,091,880 | $1,195,920 | $772,920 |

*ATC is average total cost in $/bale. Elasticity is (% change in AVC)/(% change in bales). TC is total cost, TR is total revenue, and TVC is total variable cost, all for a given gin volume.

TABLE 6. COST STRUCTURE FOR $5M GIN WITH 20-YR LIFE

| Bales | ATC* | Elasticity | TC | TR | TVC |
|---|---|---|---|---|---|
| 20,000 | $55 | -- | $1,097,400 | $664,400 | $354,800 |
| 25,000 | $47 | -0.78% | $1,186,000 | $830,500 | $443,500 |
| 30,000 | $42 | -0.71% | $1,272,900 | $996,600 | $532,200 |
| 35,000 | $39 | -0.63% | $1,363,250 | $1,162,700 | $620,900 |
| 40,000 | $36 | -0.58% | $1,452,000 | $1,328,800 | $709,600 |
| 45,000 | $34 | -0.54% | $1,540,800 | $1,494,900 | $798,300 |
| 50,000 | $33 | -0.51% | $1,629,500 | $1,661,000 | $887,000 |
| 55,000 | $31 | -0.48% | $1,718,200 | $1,827,100 | $975,700 |
| 60,000 | $30 | -0.45% | $1,807,200 | $1,993,200 | $1,064,400 |
| 65,000 | $29 | -0.43% | $1,895,400 | $2,159,300 | $1,153,100 |
| 70,000 | $28 | -0.40% | $1,984,500 | $2,325,400 | $1,241,800 |
| 80,000 | $27 | -0.39% | $2,161,600 | $2,657,600 | $1,419,200 |
| 90,000 | $26 | -0.36% | $2,339,100 | $2,989,800 | $1,596,600 |

*ATC is average total cost in $/bale. Elasticity is (% change in AVC)/(% change in bales). TC is total cost, TR is total revenue, and TVC is total variable cost, all for a given gin volume.

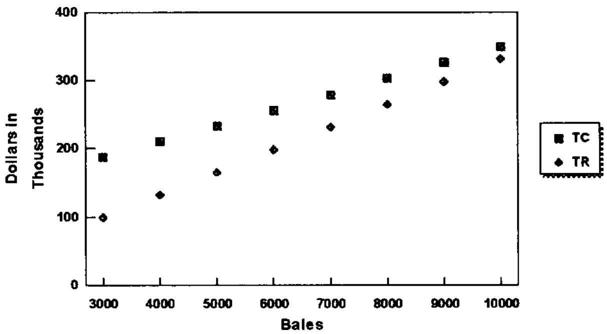


Figure 1. Total Cost and Total Revenue for Representative $0.5 Million Gin with 10-Year Life.

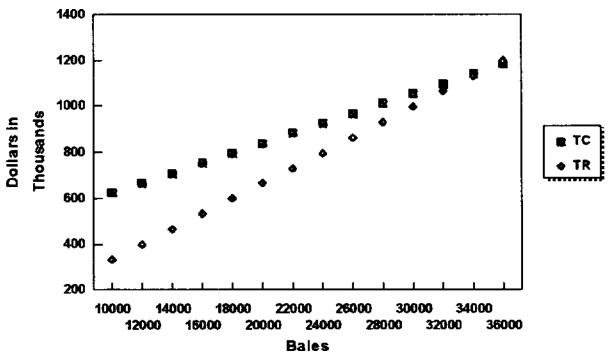


Figure 2. Total Cost and Total Revenue for Representative $2 Million Gin with 10-Year Life.

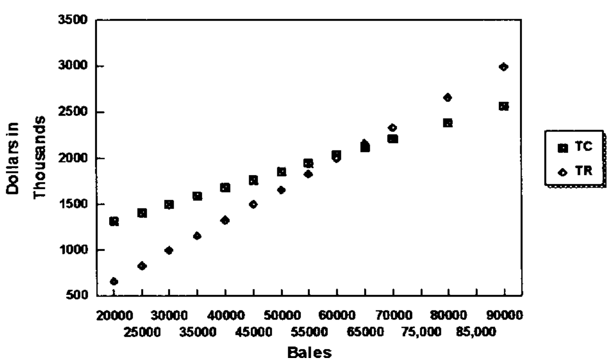


Figure 3. Total Cost and Total Revenue for Representative $5 Million Gin with 10-Year Life.

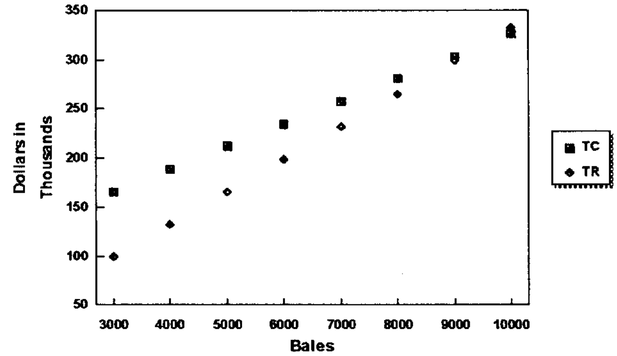


Figure 4. Total Cost and Total Revenue for Representative $0.5 Million Gin with 20-Year Life.

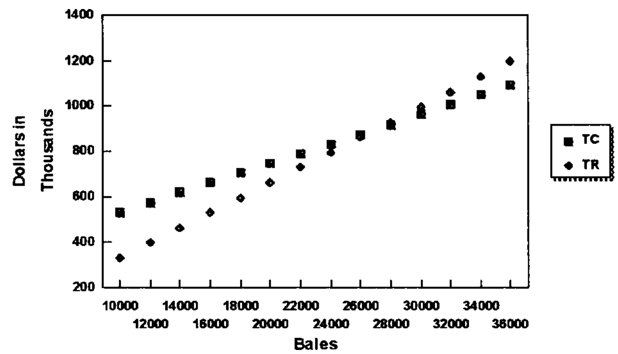


Figure 5. Total Cost and Total Revenue for Representative $2 Million Gin with 20-Year Life.

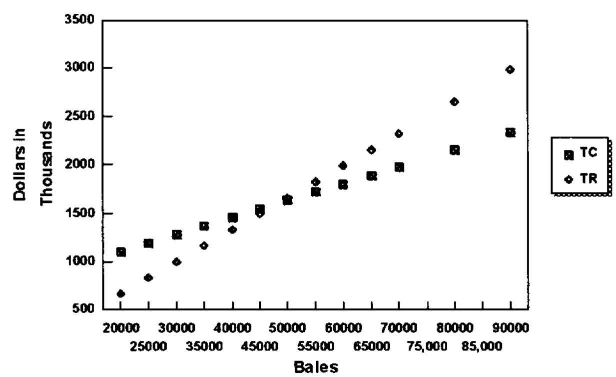


Figure 6. Total Cost and Total Revenue for Representative $5 Million Gin with 20-Year Life.